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December 7, 2011

Ms. Alanna Gillis
Acting Commission Secretary
British Columbia Utilities Commission
Sixth Floor – 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Ms. Gillis:

**RE: British Columbia Utilities Commission (BCUC)
British Columbia Hydro and Power Authority (BC Hydro)
F2006/F2006 Revenue Requirements Application
BCUC Decision: Order No. G-96-04 October 29, 2004, Directive 66 (page 197)**

BC Hydro is writing to submit its F2011 Demand Side Management Milestone Evaluation Summary Report (**the Report**), dated December 2011 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 F2011 for the following:

1. Low Income Program - Energy Savings Kits F2009 and F2010;
2. Residential Behaviour Program F2010;
3. Refrigerator Buy Back Program F2010
4. Residential Lighting Program F2010;
5. Product Incentive Program F2010;
6. Power Smart Partners – Transmission Program F2008 and F2009;
7. Transmission Service Rate F2010;
8. Residential Inclining Block Rate F2010; and
9. Residential Energy Code F2009 and F2010.

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 e-mail at bchydroregulatorygroup@bchydro.com.

Yours sincerely,

Janet Fraser
Chief Regulatory Officer

gh/ma

Enclosure (1)

BC hydro
powersmart

F2011 Demand Side Management Milestone Evaluation Summary Report

December 2011

ABSTRACT

This report provides a summary of Milestone Demand Side Management (**DSM**) Impact Evaluations completed by Power Smart Evaluation and Research during F2011.

ACKNOWLEDGEMENTS

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

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Glossary

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.

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

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.

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.

Pledge – Households that have joined Team Power Smart, but that have not added an account online – either because they have not yet done so (yet), or they are not a BC Hydro customer, for example when their utility bill is included in their rent.

Price Elasticity of Demand - The price elasticity of demand measures the responsiveness of demand to a change in price and it is defined as the percentage change in quantity divided by the percentage change in price.

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.

Spill-over - Spill-over occurs when individuals are influenced 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

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

CDD – Cooling Degree Day. A measurement designed to reflect the demand for energy needed to cool a home or business. For each day, every degree of mean temperature above 18 degrees Celsius is considered to be a “cooling degree-day”, with monthly cooling degree-days the sum of the daily cooling degree-days.

DI – Direct Install Program

ESK – Energy Savings Kits.

HDD – Heating Degree Day. A measurement designed to reflect the demand for energy needed to heat a home or business. For each day, every degree of mean temperature below 18 degrees Celsius is considered to be a “heating degree-day”, with monthly heating degree-days the sum of the daily heating degree-days.

KAM – Key Account Manager

PIP – Product Incentive Program

PSP – Power Smart Partners

RBB – Refrigerator Buy-Back Program

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 resumed demand-side management activity in 2002 and, since the resumption of DSM, undertaking evaluations of DSM initiatives has been a core activity. Program evaluation activities center on three main categories, which are described below: process evaluations, market evaluations and impact evaluations. The basic objectives of program evaluations are to document program activities, assess program impacts and identify opportunities for program improvement.

The BCUC Resource Planning Guidelines note that: "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 program 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 Oversight Committee (**EOC**), chaired by a manager from outside the Power Smart department. The EOC membership also has two external senior advisors who 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 Evaluation Oversight Committee, which represents key stakeholders.

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[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.

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 stakeholders?
- What the gross impacts of the initiative on energy and peak?
- What are the net impacts of the initiative on energy and peak?

1.3 Evaluation Studies

Evaluations summarized in this report include the following:

1. Low Income Program - Energy Savings Kits F2009 and F2010
2. Residential Behaviour Program F2010
3. Refrigerator Buy Back Program F2010
4. Residential Lighting Program F2010
5. Product Incentive Program F2010
6. Power Smart Partners – Transmission Program F2008 and F2009
7. Transmission Service Rate F2010
8. Residential Inclining Block Rate F2010
9. Residential Energy Code F2009 and F2010

2 Residential Inclining Block Rate F2009

2.1 Low Income Program – Energy Savings Kits F2009 and F2010

2.1.1 Introduction

In 2007, the B.C. Provincial Government set out a plan to meet 50 per cent of future resource needs through energy conservation by 2020. In partial support of this initiative, BC Hydro designed an energy acquisition program for low-income residential customers in line with these long-range goals. Similar programs are widely available in many jurisdictions in North America.

Reaching low-income customers is important because of:

(a) ***The number of households.*** Between 15 and 20 per cent of BC Hydro residential customers are designated low-income. This translates to a population of approximately 260,000 low-income households depending on prevailing socio-economic conditions.

(b) ***Special marketing considerations.*** 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 marginalisation).

The Low Income Program includes Energy Saving Kits, Basic Retrofits and Advanced Retrofits with varying eligibility requirements for each of the three program components.[2] This evaluation focuses on the Energy Saving Kit (**ESK**) component, which is a package of basic, low-cost energy savings measures believed to be easily installed by any homeowner or tenant. The kit includes Compact Florescent Lights (**CFL**), faucet aerators, low-flow shower heads, pipe wrap, caulking and draft proofing materials, outlet gaskets, window film and a number of smaller products and information on how to save energy in the home.

Program goals include:

- Generating electricity savings by replacing inefficient with efficient technologies;
- Increasing energy efficiency awareness by actively communicating with customers;
- Informing customers of the general benefits of energy efficient products;
- Helping transform the market for specific technologies;
- Better meeting the needs of chronically underserved low-income customers and
- Increasing customer satisfaction.

2.1.2 Approach

The evaluation issues examined in this study were determined by consulting internal BC Hydro stakeholders. The five main evaluation issues are:

2 The Energy Conservation Assistance Program (**ECAP**) provides free Basic and Advanced retrofits to customers with high electricity consumption. Services are provided through BC Hydro program contractors.

- **Program Review.** Describe the program component and provide an analysis of program logic.
- **Consumption Change.** Characterize consumption change by item provided in the Energy Saving Kit.
- **Customer Survey.** Assess customer participation and satisfaction with the program; tabulate the number of products installed and calculate free-ridership and spill-over rates.
- **Energy and Peak Savings.** Evaluate energy and peak savings attributed to the program in Fiscal Years 2009 and 2010.
- **Cost Effectiveness.** Estimate the cost of conserved energy for some of the main products provided through the Energy Saving Kit.

The evaluation issues, data sources and methods used in the study to examine the evaluation issues are listed in Table 2.1.1.

Table 2.1.1 Low Income Program Evaluation Issues, Data Sources and Methods

Issues	Main data sources	Method
Program review	Discussions with Program Managers and Administrators	Logic Model
End use consumption by kit component	Initial Technical Analysis by Item; Billing data	Engineering algorithms informed and affirmed by billing analysis
Participation, satisfaction, product installation, free-riders, participant spill-over	Customer survey (n = 400)	Cross tabulations
Energy and Peak savings	Bi-monthly Billings, Low Income Household Applications and REUS 2008	Pre and Post Test (double-differenced), group means t-test

Information on all program applicants receiving Energy Saving Kits during fiscal years 2009 and 2010 was obtained in April 2010. In addition to application dates, information was available on program application status, fuel type, household income, location and demographic detail – all of which help to provide an in-depth profile of program activity.

Customer awareness, satisfaction, program experience, respondent free-rider and participant spill-over questions were addressed in a telephone survey of 400-program participants conducted during January of 2010. Respondents were recruited from a list of program applications for the relevant fiscal year.

Gross and net energy savings were estimated for program activity completed during fiscal years 2009 and 2010. Since gross savings do not account for factors external to the program that might affect savings calculations, net savings were calculated to adjust initial savings estimates for the influence of non-program related factors. These include the effects of free-ridership, participant spill-over (naturally occurring conservation is already accounted for in the gross savings calculations). Initial (gross) savings estimates for ESK are calculated using a Pre and Post experimental design which uses a program group and a comparison group – each with pre-program and post-program measurements. The assumption is that, if the program and comparison groups are sufficiently comparable any difference in outcome between the two groups may be plausibly attributed to the program. The program and comparison groups were analysed across various indicators such as geographic location, dwelling type and primary heating fuel.

Equation (1) shows how average gross energy savings are estimated. The average savings per participant were measured as the difference between average participant and non-participant changes in energy consumption for the sample. Both *acquired* and *run-rate* savings are calculated. In the special case of acquired savings, Δ kWh is adjusted for the date each participating customer acquired the kit[3]. Some adjustment was also made to account for known differences in annual savings rates between those participants installing the kits themselves and those receiving assistance from vendors[4]. Equation (2) shows how total gross savings are estimated while Equation (3) shows how the total gross savings were adjusted to calculate total net savings using an attribution rate.

(1) Δ kWh = $(\text{BasekWh}-\text{PostkWh})_{\text{participants}} - (\text{BasekWh}-\text{PostkWh})_{\text{non-participants}}$

(2) Δ GWh (Gross) = N_{PP}[5] $* \Delta \text{ kWh} / 1{,}000{,}000$

(3) Δ GWh (Net) = $N_{PP} * \Delta \text{ kWh} * \text{Attribution} / 1{,}000{,}000$

Attribution is calculated using *free-rider* and participant *spill-over* rates. As these rates are proportions, the attribution rate is calculated by subtracting the free-rider rate from one and adding the spill-over rate[6]. The free-rider rate is added to account for customers who would have purchased the new technology on their own while the participant spill-over rate is included to account for additional energy efficient purchases collateral to (but influenced by) the program.

Peak savings were estimated by applying load factors based on hourly consumption data to Equation (2). Net peak demand is estimated by applying the same attribution rate in Equation (3) to gross peak demand.

2.1.3 Results

Program Rationale

As of March 31, 2010, the Low Income Program has provided approximately 21,000 low-income residential customers with ESK's, resulting in greater awareness of inexpensive high-efficiency products and improving their access to information on how to save energy in their homes. The program rationale was examined using a program logic model, examining the linkages among inputs, outputs, purpose and goal for each activity. The logic model is consistent and reflects a strong program rationale.

Customer Satisfaction

A detailed survey was conducted with 400-program participants covering a wide range of program attributes. When customers were asked how they became aware of the ESK offering the most important sources of customer awareness were BC Hydro billing statements (44 per cent), friends and relatives (14 per cent), magazines and newspapers (12 per cent) and the BC Hydro website (8 per cent). Satisfaction level was assessed using the response to the question, "On a scale of 1 to 5 with 1 being very dissatisfied and 5 being very satisfied, how

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3 For example, if a customer acquired her kit 6 months into the fiscal year, acquired savings would be reduced by approximately half; run-rate savings calculations require no such adjustment.

4 This step ensures that the total number of kit recipients is correct and represents the actual break-out of participants into either (a) those who self-install or (b) those who receive assistance from vendors.

5 **N_{PP}** is the total number of official program participants in a given fiscal year.

6 Therefore, the equation is: **Attribution = 1 – Free Rider Rate + Spill-over Rate**.

satisfied were you overall with the Energy Savings Kit?". Overall, the combined top box score[7] was 89 per cent satisfaction.

Energy and Peak Impacts

Gross and net energy savings were based on program activity in two fiscal years – one for the period April 1, 2008 through March 31, 2009 (F2009) and another for the period April 1, 2009 through March 31, 2010 (F2010). The evaluation estimated program impact in the following stages:

(a) ***Gross savings.*** A pre and post experimental design with participant and non-participant groups (N = 507) was used to compare pre-program and post-program measurements. Calculation of gross savings is then based on consumption comparisons between the participant and non-participant groups.

(b) ***Net savings (annual run-rate).*** Net (evaluated) savings were estimated by modifying gross savings with free-rider and participant spill-over rates, calculated from survey response data. For F2009, evaluated energy savings are 2.3 GWh/year compared to gross savings of 3.1 GWh/year; evaluated peak savings are 0.9 MW compared to gross peak savings of 1.3 MW. For F2010, evaluated energy savings from new applicants are 2.6 GWh/year compared to gross savings of 3.6 GWh/year; evaluated peak savings were 1.1 MW compared to gross peak savings of 1.5 MW.

2.1.4 Conclusions and Recommendations

The LIHP (**ESK**) is meeting its stated objective of increasing the penetration of simple, easy-to-install energy-efficient behaviours and technologies into the low-income residential market. Most low-income households appear to have more difficulty implementing simple energy efficiency behaviours than those in the general population. Social marginalization due to literacy issues, a disproportionate number of elderly customers and access to information are major barriers to program participation[8]. As a result, low-income households are somewhat underserved by regular Power Smart programs for residential customers. This supports the overall program rationale of providing special, low-cost assistance to low-income residential customers.

While the ESK is well-received and perceived as useful in assisting customers to reduce energy consumption, it is recommended that items recognized as useful in lowering household consumption yet difficult to install or use be considered for vendor assisted installation. Some kit items which customers do not appear to use (such as water measuring bags) might be excluded from the kits altogether.

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7 Top box scores include categories 4 and 5.

8 The *2009 CFL Impact Evaluation* (Min Yu, BC Hydro Power Smart: 2009) showed a positive relationship between income and the number of CFL bulbs purchased per household. This is further evidence that low-income customers require a different and more aggressive form of program intervention.

2.2 Residential Behaviour Program F2010

2.2.1 Introduction

BC Hydro launched Team Power Smart in 2007 as an umbrella advertising campaign for Power Smart; it changed into a loyalty program when the Residential Behaviour Program was integrated in October 2008.

The Behaviour Program is modeled after the key findings from a BC Hydro pilot project and other programs both from within the utility industry as well as outside the utility industry, and it is based on the key elements of the social marketing construct. Residents of British Columbia can join Team Power Smart online or at Outreach events throughout the province and commit to use 10 per cent less electricity. Every Team Power Smart member gets access to their online Members' Tool Box at bchydro.com, including special offers and members-only contests. They also receive a monthly eNewsletter. However, if a Team Power Smart member adds their account online to their membership, they enjoy additional members benefits, including exclusive use of online tools such as Compare Your Home and Analyze Your Home and complimentary magazines. In addition, those Team Power Smart members who commit to participate in a 12-month challenge to reduce their electricity consumption by 10 per cent or more, receive challenge correspondence and can become eligible for a $75 reward if they finish their challenge successfully.

The objectives of the Residential Behaviour Program are to:

- Capture cost-effective behavioural savings;
- Entrench new behaviours to form habits by constantly engaging customers;
- Provide a specific opportunity for customers to reduce their bill;
- Identify opportunities for cross-promotion to other residential programs;
- Identify advocacy opportunities;
- Identify opportunities to make the connection between behaviour at home and at work; and
- Prevent behaviour and savings 'slide-back'.

The objective of this study is to conduct a process and impact evaluation of the Residential Behaviour Program for F2010.

2.2.2 Approach

The areas of interest relating to this evaluation are as follows.

- **Population of Interest and Profiling:** Define Pro-Participants as the population of interest and profile their housing and demographic composition.
- **Process Evaluation:** Conduct a review of the program concept using an appropriate social marketing framework.
- **Impact Analysis - Pre-Program Matching:** Match program participants with non-participants based on pre-program consumption.

- **Impact Analysis - Program Impacts:** Estimate net energy and peak savings for the 12 month period F2010 due to the Behaviour Program.

- **Participant and Program Diagnostics:** Measure participant behaviours, attitudes and experience as related to program achievement.

Evaluation issues, data sources and methods for this study are summarized in Table 2.2.1.

Table 2.2.1 Residential Behaviour Program Evaluation Issues, Data Sources and Methods

Issues	Main Data Sources	Method
Population of Interest and Profiling	Program documentation, survey samples	Program review, inferential statistics
Process Evaluation	Documents review, literature review and interviews	Social marketing program planning framework
Impact Analysis – Pre-Program Matching	Billing data file	Matching estimator
Impact Analysis – Program Impacts	Billing data file	Estimate energy and peak savings: Double deflation method using a matching estimator
Participant and Program Diagnostics	Pro-Participant/Non-participant surveys, 2008 Residential End-Use Survey	Inferential statistics and z-test for difference of sample proportions

Population of Interest and Profiling

The population of interest are Behaviour Program participants, defined as those who have joined Team Power Smart and added their account on-line such that their energy reduction efforts can be officially tracked and logged. Profiling has been facilitated by a survey sample of 3,657 Pro-Participants collected in May 2010, a survey sample of 2,422 Non-Participants also collected in May 2010, as well as findings from the 2008 Residential End-Use Survey.

Process Evaluation

The process evaluation was conducted by an external contractor, AED. The AED team examined program documentation and reports, conducted one-on-one in person interviews with BC Hydro staff, reviewed other utility and non-utility companies exhibiting social marketing best practices, and conducted telephone interviews with staff from eight programs.

Impact Analysis – Pre-Program Matching

The objective of the impact evaluation is to estimate the causal energy saving effect of the Residential Behaviour Program. A quasi-experimental design was selected to estimate the difference in the change in energy consumption between Behaviour Program participants and a comparison group before and after the program was launched.

The period of October 2006 to September 2007, which was a year prior to the launch of Team Power Smart, is defined as the pre-program period. The 12-month period from April 2009 to March 2010 is defined as the post-program period for the impact evaluation. The matching process and statistical analysis are conducted among two separate sub-sets of Behaviour program Pro-Participants that were derived in order to facilitate the program evaluation: 1) Challenge households and 2) Non-Challenge households.[9]

To select a comparison group that matches as closely as possible the characteristics of program participants, all BC Hydro's residential customers who have not participated in the program are considered as a pool of potential comparable homes. For each Challenge and Non-Challenge participant that meets the eligibility criteria for matching, a pair-wise matched non-participant (Comparison household) is selected to minimize the difference of annual consumption between the two homes during the pre-program year.

To address observable factors, including region, dwelling type and primary space heating fuel, which might drive the energy consumption of individual residential customers, these factors are incorporated into the matching process. In other words, the comparison group is matched on a case by case basis by consumption prior to the program across four regions (Lower Mainland, Vancouver Island, South Interior and Northern Region), five dwelling types (single family dwelling/duplex, row/town house, apartment/condominium, mobile home and other), and two primary space heating fuels (electric versus non-electric space heating).

Impact Analysis – Program Impacts

For the program impacts, energy savings are given by the following algorithm, sometimes referred to as the double deflation method, where the subscripts refer to the pre-experiment value of the treatment group, the post-experiment value of the treatment group, the pre-experiment value of the control group and the post-experiment value of the control group, respectively. Matching estimators are used separately for the Pro-Participant Challenge and Non-Challenge groups. The matching methodology strengthens the internal validity of quasi-experiment because individual treated and comparison samples are paired based on critical characteristics.

$$\text{Average savings} = (\text{Avg. } kWh_{pre\_challenge} - \text{Avg. } kWh_{post\_challenge}) - (\text{Avg. } kWh_{pre\_comparison} - \text{Avg. } kWh_{post\_comparison})$$

Average or per capita savings for each of the Challenge and Non-Challenge pools of households in the matching analysis are then boosted-up or extrapolated to the entire population of Challenge households and Non-Challenge households.

Participant and Program Diagnostics

Participant and program diagnostics are facilitated by the survey samples as mentioned above in Population of Interest and Profiling. Among other areas of interest, this section of the report uncovers the reasons households joined the Behaviour Program (Team Power Smart "Pro") and their experience with it, and details their self-reported in-home conservation behaviours in contrast to those of Non-Participants.

2.2.3 Results

Population of Interest and Profiling.

As of March 31, 2010, the population of interest for the Residential Behaviour Program was exclusively comprised of approximately 45,000 Pro-Participants – defined as households which

[9] Alternate approaches to calculating per capita and run rate savings were explored such as disaggregating by space heating fuel type within Challenge and Non-Challenge groups. However, none proved to be any more robust than the current approach.

have a) joined Team Power Smart and b) added their BC Hydro account online, thus passing one of several eligibility criteria should they wish to participate in an energy reduction challenge. This figure does not include additional members of the household, which are captured during the enrolment process, and Pledge households and which bring the total number of individuals to over 250,000.

Generally speaking, the regional distribution and housing profile of Pro-Participants follows that of all residential customers in BC Hydro's service territory. However, their homes are somewhat more likely than all others to be electrically space heated.

The impact analysis in this report disaggregates Pro-Participants into two categories to facilitate the evaluation: Challenge households and Non-Challenge households. Challenge households are Pro-Participants which have started and/or completed one or more energy reduction challenges by March 31, 2010. Non-Challenge households are those which have not yet embarked on a challenge, including those which cannot yet do so because of insufficient pre-program consumption.

Process Evaluation.

To support the program review, AED conducted an evaluation of the concepts for the Power Smart Residential Behaviour Program. AED used Kotler and Lee's Social Marketing Program Planning Framework for the analysis and reviewed relevant program manuals and reports, conducted one-on-one interviews with BC Hydro staff, reviewed other social marketing programs and conducted telephone interviews with staff of eight other programs.

The Kotler and Lee framework has ten main components: (1) program background, purpose, and focus; (2) situational analysis; (3) target market profile; (4) marketing objectives and goals; (5) target market barriers, benefits and competition; (6) positioning statement; (7) marketing mix strategies; (8) evaluation plan; (9) budget; (10) implementation plan. For each of these ten components, the Behaviour Program's approach was reviewed in the context of social marketing best practices.

Overall, AED found that the Behaviour Program reflects a solid social marketing concept with exceptional expertise, resources, brand equity and market access.

Impact Analysis – Pre-Program Matching.

Some 15,688 Challenge households were matched to a comparison group using the nearest neighbour matching approach. The matching also controlled for the key covariates of region, dwelling type and space heating fuel. The match was accurate to less than one-tenth of a kWh across the entire pool of Challenge households. In the same way, some 545 Non-Challenge households were matched to a separate comparison group using the nearest neighbour matching approach.

Impact Analysis – Program Impacts.

The main purpose of the energy and demand analysis is to estimate the average energy and demand savings per household for the Challenge and the Non-Challenge group.

Net change in consumption for each Challenge and Non-Challenge account and each of their respective paired Comparison account is defined as their pre-program consumption less their post-program consumption.

Total savings for the Challenge group is estimated to be 5.15 GWh over the 12-month period in F2010. This is calculated by the total number of eligible accounts (24,774) multiplied by the average savings per account (207.7 kWh) as measured among the sub-set included in the matched analysis. The evaluated peak savings are 1.02 MW based on a coincidence peak factor of 0.199. There are no savings for the Non-Challenge group.

Table 2.2.2 Residential Behaviour Program Energy and Peak Savings

	Reported energy savings (GWh per year)	Evaluated energy savings (GWh per year)	Reported peak savings (MW)	Evaluated peak savings (MW)
Total F2010	6.2	5.15	-	1.02

Participant and Program Diagnostics.

Potential bill savings emerge well ahead of all other reasons – including the preservation of the environment – as the main reason why Pro-Participant households were first motivated to join the Behaviour Program. This finding is no different than findings uncovered from many other studies in regards to residential program positioning and messaging.

A total of 85 per cent of Pro-Participants report that they are currently making at least a fair amount of effort to conserve electricity in their homes. To compare, this top-two box proportion measures 7 points lower at 78 per cent among Non-Participants.

The gap between the two groups doubles in size to 16 points in regards to their conservation momentum. A total of 72 per cent of Pro-Participants, but only 56 per cent of Non-Participants, report that their household was making at least a little more of an effort to conserve electricity in their home compared to one year ago.

In terms of their in-home behaviours, findings suggest Pro-Participants likely incurred savings due to enhanced efforts on a number of different fronts – such as space heating, laundry and dishwasher appliances. In fact, the overwhelming majority of behaviours explored do measure more favourably among Pro-Participants than among Non-Participants.

Lastly, two in three Pro-Participants reflect upon their experience to date with the Behaviour Program favourably – 11 per cent rating it as having been ‘excellent’ and 55 per cent rating it as having been ‘good’. The overwhelming majority of all others rate their experience as ‘fair’ rather than ‘poor’ or ‘very poor’.

2.2.4 Conclusions and Recommendations

The Power Smart Residential Behaviour Program has been successful in building a reasonable level of participation among its target market. The program has achieved favourable customer experience levels, and it is meeting its goal of reducing barriers to behavioural change among residential customers. It is recommended that program management review the recommendations from the process evaluation with a view to increasing program participation and impact.

2.3 Residential Lighting Program F2010

2.3.1 Introduction

BC Hydro's Residential Lighting program is a multi-year energy acquisition and market transformation initiative that encourages its customers to use energy-efficient lighting, with a focus on compact fluorescent lamps (**CFLs**) and ENERGY STAR fixtures. The objectives of the program include: (1) transform the market for lighting fixtures; (2) reduce energy consumption; and (3) reduce peak consumption. The purpose of this study is to conduct a process, impact and market evaluation of BC Hydro's Residential Lighting Program in F2010.

2.3.2 Approach

The basic evaluation methodology is a post-only, quasi-experimental design, using a treatment group and a comparison group. The treatment group is 604 randomly selected residential customers in BC Hydro's service territory, and the comparison group is 601 randomly selected residential customers in North and South Dakota. North and South Dakota are chosen as the comparison group because they are demographically similar to British Columbia, but they have had no substantive residential lighting programming. Table 2.3.1 summarizes the evaluation issues, data sources and methods for this study.

Table 2.3.1 Residential Lighting Program Evaluation Issues, Data Sources and Methods

Issues	Main data sources	Method
Program review	Program files Program interviews	File review
Supply side assessment	Retail shelf space study Literature review	Cross tabulations
Demand side assessment	BCH survey (n = 604) Dakotas survey (n = 601)	Descriptive statistics
Peak demand for lighting	In home metering (n = 77)	Load shape analysis
Fixture prices	Retail shelf space study	Cross tabulations
Energy and peak savings	BCH survey (n = 604) Dakotas survey (n = 601)	Engineering algorithms

2.3.3 Results

Program Review.

BC Hydro has employed a phased strategy to transform the residential lamp and lighting fixtures market and acquire energy and peak savings. At the time of program launch in 2001, there was low awareness of CFLs and ENERGY STAR fixtures among consumers and retailers, there was limited availability of the energy efficient product on store shelves, and prices for CFLs ENERGY STAR qualifying products were higher than for conventional lighting fixtures. The program has successfully addressed these barriers. The program rationale has been examined using a program logic model, which was developed from interviews with staff, a documents review and a literature review. This review and analysis confirms that the basic program 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.

Supply Side Assessment.

The supply side assessment is based primarily on the F2010 shelf stock study, which included visits to some 40 establishments. Product information was collected for eight main types of CFLs. The following CFL trends are worth noting: first, the average CFL share of light bulb shelf space has increased from 14 per cent in 2006 to 23 per cent in F2010, second, the increase in CFL share has been particularly pronounced among the retail/pharmacy store type, but it has been substantial for all surveyed store types. Product information was also collected for eight main types of ENERGY STAR fixtures. The following ENERGY STAR fixture trends should be noted, first, the overall share of shelf space occupied by ENERGY STAR fixtures has remained fairly constant at about 5 per cent, so there is considerable room for market development, second, the early program emphasis given to ENERGY STAR torchieres has resulted in a high sustained market share, with the low share for the 2007 survey apparently due to the fact that high sales levels had stripped the shelves of product.

Demand Side Assessment.

The demand side assessment is based primarily on the F2010 customer surveys, which were conducted in November 2009 and included 604 treatment group customers and 601 comparison group customers. Awareness of CFLs, recall of any CFL advertising and purchase of CFLs are all statistically significantly higher for the BC treatment group than the Dakotas comparison group. Awareness of ENERGY STAR fixtures, recall of any ENERGY STAR fixture advertising and purchase of ENERGY STAR fixtures are all higher for the BC treatment group than the Dakotas comparison group.

Product Prices.

Reductions in prices for energy efficient products are a key objective of market transformation programs, and the successive shelf stock studies have collected detailed information on the prices of CFLs, incandescent lamps, and ENERGY STAR fixtures. Price information was collected for eight main types of CFLs. Among the more popular shapes, the average price of five types (spiral, globe, A-shape, bullet and circular) fell an average of 11 per cent between 2006 and 2009. The average price on the other three types rose, most notably, the average price for tubes more than doubled in the same time period. Price information was also collected for eight main types of ENERGY STAR fixtures. The prices of five types (flush mounted ceiling lamps, suspended ceiling lights, floor lamps, table lamps and wall fixtures) have fallen an average of 55 per cent, with suspended ceiling lights the most dramatic drop at 88 per cent.

Energy and Peak Savings.

Treatment and comparison group surveys were used to estimate a discrete choice model which was then used to estimate the incremental number of CFLs installed in BC due to the program. This procedure eliminates the need to estimate market effects such as free-riders. Program data was combined with survey data to estimate the incremental number of ENERGY STAR fixtures installed due to the program. Shelf stock study data was used to estimate the net demand savings for each class of CFLs and ENERGY STAR fixtures, and the shelf stock study was also used to generate weights which were used to estimate average demand savings for CFLs and ENERGY STAR fixtures. On-site logging of lamps was used to estimate hours of use and peak coincidence factors. Finally, all of this information was combined in engineering algorithms to estimate total energy and peak coincident demand impacts. The energy and peak impacts for F2007 were estimated at 43.3 GWh and 13.4 MW respectively.

Table 2.3.2 Residential Lighting Program Energy Savings and Peak Savings

	Period	Energy savings (GWh)		Peak savings (MW)	
		Reported	Evaluated	Planned	Evaluated
Residential Lighting	F2010	19.2	43.3	-	13.4

2.3.4 Conclusions

The Residential Lighting program has achieved considerable success in building product awareness, purchase intent and purchase behaviour for CFLs and more limited but still significant success in building product awareness, purchase intent and purchase behaviour for ENERGY STAR fixtures in British Columbia. The program has facilitated planned changes to minimum energy performance standards at the provincial and the federal level which are expected to substantially eliminate inefficient residential screw-base lamps.

2.4 Refrigerator Buy-Back Program F2010

2.4.1 Introduction

The Refrigerator Buy-Back (**RBB**) Program, initiated by BC Hydro as a component of the residential demand side management (**DSM**) portfolio, aims at promoting energy conservation and improving end-use efficiency in BC Hydro's residential market. The program was one of BC Hydro's first residential DSM initiatives in the early 1990s. Supported by financial incentives and a free refrigerator pick-up service, the program encourages, facilitates and accelerates the recycling of old and energy inefficient refrigerators. Qualifying refrigerators must be between 10 and 24 cubic feet and be operational at the time of pick up. The re-launch of the RBB Program in 2002 is a direct response to BC Hydro's long-term conservation strategy to slow the growth of the secondary refrigerator ownership and upgrade households to more energy efficient refrigerators. The program has been a contributing factor in maintaining British Columbia's low secondary refrigerator saturation rate compared to the national average.

This program evaluation covers process evaluation (including a review of the program logic model, customer response and satisfaction), market analysis, and an impact evaluation for F2010.

2.4.2 Approach

The methodology employed for evaluating the RBB program included program logic model development, engineering calculations of energy savings based on the metering study results, program data, and customer surveys for estimating the ratio of the recycled units with replacement to the recycled units without replacement. Finally, net savings were estimated by adjusting the initial gross savings estimates by the expected influences of free-ridership and spill-over, based on customer surveys.

The methodology for calculating energy and peak demand impacts was based on the per unit energy savings of recycled refrigerators, the free-rider and spill-over rate, cross-effects, and coincidence load factor during the winter peak demand time.

The calculations of per unit energy savings were based on the following factors:

1. Whether a refrigerator was replaced after being recycled;

2. Whether the recycled refrigerator would have stayed in the market and consumed electricity if the RBB program were not in place; and

3. Whether the program participants were influenced by the RBB program in the decision to remove the refrigerator.

The following table summarizes the major evaluation issues, methodology and data resources employed in this report.

Table 2.4.1 Refrigerator Buy-back Program Evaluation Issues, Data Sources and Methods

Issues	Main data sources	Method
Program review	Program files review, Program staff interviews, Literature review	Logic model
Customer survey	Participant surveys (n = 500, conducted in Feb 2010), Non-participant surveys (n = 402, conducted in Feb 2010)	Cross tabulations
Program participation and awareness,free-ridership, spill-over rate	Same as above	Same as above
Customer satisfaction	Same as above	Same as above
Cross effects	Engineering data	Engineering simulation, data analysis
Market analysis	Program data base, program participants and non-participants survey, Natural Resources Canada statistics, Previous evaluations	Cross tabulations, secondary research
Energy and peak savings	Refrigerator metering (n = 298), Program data base, 2010 Retail Space Study of Appliances	Engineering algorithms, Cross tabulations

2.4.3 Results

Program Review.

By providing a free refrigerator pick-up and recycling service and a $30 incentive, the RBB program encourages BC Hydro's residential customers to recycle their old and energy inefficient refrigerator. The program is promoted through a combination of radio and newspaper advertising, outreach activities and awareness campaigns as well as being supplemented by bill inserts.

The review of the program logic model indicates that the program rationale is valid, credible and acheivable.

Customer Survey.

The results of the surveys with 500 program participants and 402 non-participants in 2010 were generally in line with the 2008 survey. Based on the survey results, it was determined that the operation of the RBB program was consistent and customers collectively expressed a need for the program.

Key findings from the participant survey included:

- About one third of recycled refrigerators were more than 15 years old and two out of five were less than 10 years old. The significance of this distribution was that in general, refrigerators under 15 years old - those manufactured after 1995 - were more energy efficient than those older than 15 years due to technology improvements. The age distribution also supported the laboratory metering study results, which indicated that the average consumption rate was lower than two years ago. With about two thirds of recycled units being less than 15 years old, the vintage of recycled refrigerators had a significant impact on the average energy savings achieved from each recycled unit.

- About four out of five (78 per cent) respondents indicated that the total number of refrigerators they had at home remained the same compared to a year ago, while one fifth said that they had one or two refrigerators less.

- Almost all the respondents (99 per cent) indicated that their refrigerators were plugged in all year long before they were recycled.

Key findings from the non-participant survey included the following:

- About nine out of ten non-participants reported that they did not recycle their refrigerators over the past 12 months—mainly for the reason that their refrigerators were still being used.

- Most of the non-participants (78 per cent) had a secondary refrigerator less than 15 years old. Only about a quarter reported that their secondary refrigerators were more than 15 years old.

- About one third of the non-participants reported that they bought another refrigerator in the past 12 months. Among them, three quarters reported that the refrigerator they bought was new. About three quarters of the non-participants did not intend to purchase another large home appliance in the next 12 months.

- Knowing the true costs of refrigerator disposal, but not knowing about the RBB Program, an increasing number of non-participants indicated that they definitely/probably would not dispose of their refrigerators (44 per cent in 2007, 53 per cent in 2008 and 62 per cent in 2010). This may be due to the need for those refrigerators that were relatively new.

Customer Satisfaction.

The RBB program achieved high levels of customer satisfaction. Based on the participant survey, almost all program participants had a “very satisfied” or “somewhat satisfied” rating for the program. Table 2.4.2 compares the survey results of F2010 with the previous two surveys, which indicate a consistently high level of satisfaction in many aspects of the program operation.

Table 2.4.2 RBB Key Customer Satisfaction Indicators

Participants Survey	2007 (%)	2008 (%)	2010 (%)
Time Convenience (very convenient or convenient)	97	97	93
Crew Courtesy (excellent or good)	92	95	94
Crew Punctuality (excellent or good)	88	93	92
Ease of Scheduling (very easy or moderately easy)	93	96	95
Timeliness of Refund (timely)	90	90	95
Overall Satisfaction (very satisfied or somewhat satisfied)	99	99	99

Source: RBB Participant Survey in 2007, 2008 and 2010.

Market Analysis.

To understand the market impacts of the RBB program, the evaluation examined trends in the saturation rate of second refrigerators in B.C. and in Canada, as shown in Table 2.4.3. Based on Natural Resources Canada's 2007 Survey of Household Energy Use, the average saturation rate of two or more refrigerators across Canada was about 30 per cent. The 2008 BC Hydro Residential End Use Survey indicated that the saturation rate of two or more refrigerators per household in B.C. was about 24 per cent[10].

Table 2.4.3 Household Penetration of Secondary Refrigerator, B.C. versus Canada

	1997 (%)	2003 (%)	2005 (%)	2006 (%)	2007 (%)
Canada (percentage of households)	33	36	30	33	30
B.C. (percentage of households)	30	29	21	24	24

Source: *Surveys of Household Energy Use conducted by Natural Resources Canada and BC Hydro Residential End-Use Survey (2008).*

Energy and Peak Impacts.

The net energy and demand savings attributable to the RBB program are presented in Table 2.4.4. Results from the previous two years are shown for comparison.

Table 2.4.4 RBB Program Impact—Net Energy Savings and Peak Demand Savings

	F2008	F2009	F2010
Number of Refrigerators Collected through the RBB Program	33,159	37,846	**37,521**
Gross Energy Savings Run Rate (GWh/year)	34.0	36.5	**30.0**
Net Energy Savings Run Rate(GWh/year)	26.5	28.3	**22.6**
Net to Gross Ratio (%)	78	78	**76**
Reported Savings (GWh/year)	27.8	19.2	**21.2**
Demand Savings (MW)	3.6	4.1	**2.8**
Coincidence Peak Demand Savings less Cross–Effects (MW)	3.0	3.4	**2.5**
Annual Net Energy Savings per Unit (kWh/year)	798	747	**604**
Persistence (years)	7	7	**7**

2.4.4 Conclusions

The RBB program has performed consistently to educate and motivate customers to participate in the RBB program, which results in the elimination of secondary refrigerators or the replacement of less efficient primary refrigerators..

The RBB program was a key contributing factor to maintain a low secondary refrigerator saturation rate in B.C. compared to the Canadian national average. Meanwhile, the age of recycled refrigerators became younger, which had a significant impact on per unit energy savings.

10 The survey methodology and definition of secondary refrigerator between Natural Resources Canada's survey and BC Hydro's may differ in early years' survey as the Canada average exhibited a wide fluctuation.

3 Commercial Programs

3.1 Product Incentive Program F2010

3.1.1 Introduction

The Product Incentive Program (**PIP**) started in November 2003 to encourage business and institutional customers to make simple, energy-saving retrofit installations. Although a wide variety of products are eligible through the program, most energy savings to date come from energy-efficient lighting products. The program is administered through an online application site, which simplifies application and lowers administrative cost. Projects are periodically audited with site meters to validate retrofit savings estimates and hours of use while random on-site visits are employed to verify the installation of the rebated equipment.

Key program goals include:

- Generating electricity savings by replacing inefficient with efficient technologies.
- Increasing energy efficiency awareness by actively communicating with customers.
- Informing customers of the general benefits of energy-efficient products.
- Helping transform the market for specific technologies.
- Increasing customer satisfaction.

In 2009, a Direct Install (**DI**) component was added to the program to help hard-to-reach, small to medium sized commercial customers reduce energy consumption by adopting energy efficient lighting technologies. The primary objectives of the DI component are to:

(a) Make energy efficiency lighting more accessible to smaller commercial customers;

(b) Provide energy savings for BC Hydro;

(c) Provide smaller, hard-to-reach commercial customers with opportunities to reduce their electricity bills;

(d) Increase knowledge and awareness of energy efficiency among smaller commercial customers not adequately served by existing programs; and

(e) Utilise and leverage the expertise and product delivery capabilities of Power Smart Alliance members.

The target market of DI consists of approximately 62,000 hard-to-reach small and medium[11] commercial, governmental and institutional customers will annual electricity bills below $20,000.

The DI component is delivered through Power Smart Alliance (**PSA**) members[12] who already have expertise in efficiency technology and can act as effective sales and project implementers with back-up support provided by Power Smart business phone line support staff.

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11 Most commercial customers exceed the $20,000 revenue threshold.

This purpose of this report is to provide a process, market and impact evaluation of the PIP (Regular) and DI component in F2010.

3.1.2 Approach

Evaluation issues examined in this study were made in conjunction with internal BC Hydro stakeholders. The 5 main evaluation issues are:

- **Program Review.** Describe the program and provide an analysis of program logic.
- **End Use Consumption.** Characterize end use consumption by principal end use and building segment.
- **Customer Survey.** Assess customer participation and satisfaction with the program; tabulate the number of products installed and calculate free-ridership and spill-over rates.
- **Market Analysis.** Examine program sales by product group and space type.
- **Energy and Peak Savings.** Evaluate energy and peak savings attributed to the program in Fiscal Year 2010.

The evaluation issues, data sources and methods used in the study are summarized in Table 3.1.1. The main evaluation method is based on engineering algorithms.

Table 3.1.1 PIP Evaluation Issues, Data Sources and Methods

Issues	Main data sources	Method
Program review	Program files Program interviews	File review
End use consumption by segment	Site visits (n = 124) Billing data Weather data	Building energy simulation models
Participation, satisfaction, product installation, free-riders, spill-over	Customer surveys (PIP n = 150, DI n = 150) Program interviews	Cross tabulations and algorithms.
Market analysis	Program data base Previous evaluations	Cross tabulations
Energy and peak savings	On-site metering Program data base	Engineering algorithms

Customer awareness, satisfaction, program experience, respondent free-rider and spill-over questions are addressed in a telephone survey of 150-program participants for PIP, and 150-program participants for DI, conducted during May 2010. Respondents were recruited from a list of program applications for the relevant fiscal year.

[12] These are suppliers of high efficiency technology who work in close cooperation with Power Smart and BC Hydro.

Gross and net energy savings were estimated for program activity completed by vendors between April 1, 2009 and March 31, 2010. Since gross savings do not account for factors external to the program that might affect savings calculations, net savings adjust initial savings estimates for the influence of non-program related factors. This includes the effects of free-ridership and spill-over. Initial (gross) savings estimates for PIP and DI are calculated automatically from online project information provided by the installer and derives from deemed[13] savings algorithms by technology type.

Gross savings were estimated using the following algorithm, where W_{pre} and W_{post} are the wattages of the original and replacement products, hours refers to hour of use for the relevant space type, area refers to the area of the relevant space type and the summation is over areas:

(1) $$Gross\ kWh_{savings} = \sum (W_{pre} - W_{post}) * hours\ of\ use_{area} / 1000.$$

Since the program applications provided these calculations with assumed hours of use, the principal task for the evaluation was to correct the assumed hours of use using space-weighted actual hours of use from metering data.

Gross peak demand is then estimated by using the ratio of average kWh to peak kWh from the fiscal year 2009 evaluation report.

Net savings apply a modified form of the algorithm shown in Equation (1) in which W_{pre} and W_{post} are wattages of original and replacement products, hours of use pertain to space type and area refers to space type. A *free-rider rate* is added to account for customers who would have purchased the new technology without incentives; a *spill-over rate* is included to account for additional energy efficient purchases collateral to (but influenced by) the program. Results are then summed over space areas as indicated in Equation (2) below:

(2) $$Net\ kWh_{savings} = \sum (W_{pre} - W_{post}) * hours\ of\ use_{area} / 1000 * (1 - free\text{-}rider\ rate + spill\text{-}over\ rate).$$

Net peak demand is estimated by using the ratio of average kWh to peak kWh from the fiscal year 2009 evaluation report.

3.1.3 Results

End Use Consumption.

Building energy simulation models based on detailed site audits were used to examine end use consumption by building type. The updated[14] analysis found that total consumption per square foot varies substantially across building segments – from 6.4 kWh per square foot per annum for secondary schools to 58.3 kWh per square foot per year for large grocery stores and restaurants. Interior lighting is the most important end use across all sampled building segments followed by refrigeration and HVAC (air conditioning). Savings opportunities with these end uses continue to be the most promising.

13 *Deemed* refers to savings based on estimated hours of use and energy efficiency assumptions of program management.

14 26 additional buildings were added to the 98 included in the preliminary findings for fiscal year 2009.

Table 3.1.2 End-use Electricity Consumption (kWh/ft^2/year)

Facility Type	Heating	Cooling	Interior light	Equipment	HVAC aux	Refrigeration	Exterior light	Elevators	Hot Water	Cooking	Total
Elementary school	0.8	0.1	4.5	1.4	0.9	2.2	0.0	0.0	0.1	0.0	10.0
Secondary school	0.0	0.2	2.7	0.3	0.9	2.1	0.0	0.1	0.0	0.1	6.4
Extended care	0.0	0.5	4.7	0.4	1.5	4.1	0.8	0.4	0.0	0.1	12.7
Hospital	0.0	0.3	7.0	0.7	3.1	4.5	0.6	0.7	0.0	0.0	16.8
Grocery/Restaurant	0.0	1.4	22.3	3.1	3.0	6.3	17.2	0.2	0.1	4.7	58.3
Stand-alone retail	0.0	0.5	12.2	1.2	1.7	3.7	0.0	0.4	0.0	0.0	19.9
Large mall	0.9	1.8	8.6	0.4	0.7	2.1	0.1	0.0	0.1	0.1	14.8
Low-rise Office	4.4	2.1	5.6	1.3	3.9	3.0	0.0	0.4	0.4	0.1	21.2
High-rise Office	1.3	1.6	6.9	1.6	4.3	4.6	0.0	0.4	0.1	0.0	20.7
Motel/Hotel	7.5	0.8	5.0	1.1	1.1	4.4	0.5	0.4	0.0	0.0	20.8
High-rise Residential	2.5	0.0	2.2	1.9	1.4	0.4	0.0	0.2	0.2	0.1	8.8

Customer Surveys

A detailed survey was conducted with 150 PIP program participants, covering a range of program aspects. When customers were asked how they became aware of PIP, the most important sources of customer awareness were electrical distributors or contractors (53 per cent), BC Hydro bill inserts or other promotional literature (10 per cent), BC Hydro Account Manager or Customer Care Representative (9 per cent), and colleagues (7 per cent). When asked about the importance of various factors in their decision to participate, customers reported the most important factors as (1) reducing energy use to save money (top box score of 4 or 5 is 93 per cent) and (2) expected incentive from the program (top box score of 4 or 5 is 83 per cent).

A detailed survey was also conducted with 150 DI component participants. When asked about the importance of various factors in their decision to participate, DI customers reported the most important factors as (1) reducing energy use to save money (top box score of 4 or 5 out of 90 per cent) and (2) reducing energy use to save the environment (top box score of 4 or 5 of 86 per cent). Customer satisfaction was particularly high with respect to the the service provided by contractors, distributors and BC Hydro personnel. Customer satisfaction was slightly lower with respect to the variety of products offered as well as the level of incentive provided.

Market Analysis

To understand market impacts, the evaluation examined the distribution of applications by product type and by facility type. Total product installations under PIP for F2010 were 694,781 and the top product shares were: Energy Saving T8 (61 per cent); CFL (11 per cent); and Standard T8 (7 per cent). Most program activity occurred in office spaces with 50 per cent of the overall applications, and 7 per cent each from government buildings and hotel/motel/strata.

For DI installations, the product shares were dominated by energy savings T8 (51 per cent); standard T8 lighting (27 per cent); CFL (10 per cent); and halogen infrared (8 per cent). During F2010, 119,822 product installations were recorded. Program activity was quite concentrated, with office and retail space accounting for over 54 per cent of applications; and restaurants at 8 per cent.

Energy and Peak Impacts

Gross and net energy savings were estimated for program activity in the period April 1, 2009 through March 31, 2010, as shown in Table 3.1.3. This evaluation addressed gross program savings as follows: (1) the gross savings algorithms and parameter assumptions used in the calculation of program deemed savings were reviewed and modified using BC Hydro lighting logger data and reference data used by other similar utility incentive programs; (2) net savings were based on gross savings modified by survey based free-rider and spill-over rates.
Table 3.1.4 summarizes evaluated energy savings and peak savings for F2010. Evaluated net energy savings for PIP's regular component are 85.4 GWh/year compared to program reported net energy savings of 81.0 GWh/year. Evaluated peak savings are 11.6 MW compared to peak savings based on the program reported energy savings of 11.0 MW, using the energy-peak relationship from the F2009 PIP evaluation. Evaluated energy savings for the DI component are 10.7 GWh/year compared to program reported energy savings of 11.5 GWh/year. Evaluated peak savings are 1.5 MW, again applying the energy-peak relationship from the F2009 PIP evaluation.

Gross savings are different than program-reported values as a result of adjustments to retrofit technology hours of use. These adjustments are largely based on a sample of metered energy use conducted by the BC Hydro[15].

Table 3.1.3 F2010 Estimated Energy Impacts

Component	Fiscal Year	Gross savings (GWh/year)	1 – FR + SO	Net savings (GWh/year)
PIP Regular	F2010	78.3	1.09	85.4
Direct Install Component	F2010	10.3	1.04	10.7
Total		**88.6**		**96.1**

[15] *Deemed* (assumed) hours of use for retrofit lighting for the Direct Install program come from PIP and these values are used to compute Reported Savings. A sample of annualised hours taken in 2010 by BC Hydro suggested lower usage – between 80 and 90 per cent of deemed hours for PIP. This information is behind the adjustment to gross savings.

Table 3.1.4 F2010 Program Energy Net Savings and Peak Savings

Component	Energy (GWh/year)		Peak (MW)	
	Reported[16]	Evaluated	Reported	Evaluated
PIP Regular	81.0	85.4	-	11.6
Direct Install Component	11.5	10.7	-	1.5
Total	**92.5**	**96.1**	**-**	**13.1**

3.1.4 Conclusions

PIP has already built a high level of product awareness and increased consumption of energy efficient lighting products in the commercial and institutional sectors. Building on the momentum of PIP and focussing more on the assumed needs of an underserved commercial customer market, the DI component facilitated relatively simple lighting retrofits by contracting professionals to directly install incented products at customer sites.

16 Note that reported results include an adjustment of about 109 per cent. This is the attribution rate from the F2009 program evaluation.

4 Industrial Programs

4.1 Power Smart Partners – Transmission Program F2008 and F2009

4.1.1 Introduction

The Power Smart Partner (**PSP**) Industrial Program was launched in April 2002 and focused on providing services and funding to help BC Hydro's industrial customers identify and implement demand-side management (**DSM**) measures. With the introduction of the industrial Stepped Rate in April 2006 (also referred to as the Transmission Service Rate, or simply "TSR") the program changed substantially, and for the large industrial customers served at transmission voltage levels, became known as the Power Smart Partner Transmission Program or PSP-T. The most significant change was the elimination of financial incentives that had been available to that point to help customers fund the implementation of DSM projects. The revised program focused on providing educational and project support services to enable and facilitate customers' implementation of energy efficiency measures under the new rate structure.

The PSP-T Program is built on the following five foundation components which are structured to assemble a comprehensive and integrated approach to energy management:

1. **Energy Managers:** BC Hydro co-funds energy managers with industry specific skills, knowledge, and expertise to identify and plan energy efficiency improvements at customer facilities. The energy manager can be a customer's employee or a 3rd party consultant working for an individual customer or for a small consortium of similar companies.

2. **Energy Studies and Audits:** BC Hydro provides co-funding and technical support services for audits and studies to identify and prioritize energy efficiency opportunities. Co-funding up to 100 per cent is offered if the identified efficiency measures are installed and their performance is verified and documented.

3. **Monitoring, Targeting, and Reporting (MT&R):** MT&R helps customers understand the key drivers of their energy consumption, enhances the value of their energy reporting, improves the ability of operators to track and manage energy consumption, and encourages a consistent culture of energy improvement activities.

4. **Motor Management Planning:** BC Hydro provides an opportunity assessment for the adoption of a motor management plan. Customers complete a Motor Practices survey and develop a list of motors. An electric motors expert conducts an on-site audit and identifies potential energy savings and trains employees who deal with the motors. The program identifies end-use system opportunities, simplifies repair and replacement procedures, and contributes to improvements in plant reliability through the maintenance plan.

5. **Education, Training and Awareness:** This component is designed to help customers engage and educate their employees about energy efficiency through understanding the importance of energy efficiency; building a sense of ownership for the energy management plan; identifying key energy efficiency issues, and demonstrating how employees can help achieve the energy efficiency goals. BC Hydro provides a variety of workshop and promotional services and materials to initiate and build behavioural and cultural changes within the organization.

In April 2008, financial incentives to co-fund customer DSM projects were re-introduced to help customers to implement DSM measures in response to the TSR, particularly those customers that had reduced much of their Tier 2 consumption and therefore had less incentive for more DSM measures (due to the much lower price of Tier 1 energy).

Process and impact evaluations of the PSP-T program were completed in Fall 2009 and Spring 2010, respectively. These evaluations, summarized in this report, examined the impacts of the program for F2008 and F2009.

4.1.2 Approach

The **process evaluation** was based primarily on two series of customer interviews, which examined the TSR, the PSP-T Program and the interaction between the two. To prepare for these customer interviews, preparatory discussions and interviews were completed with BC Hydro staff in August 2008. The customer interviews were completed in two series in October 2008 and March 2009, each with about 20 industrial customer executives. The combination of customers selected for these interviews resulted in a sample considered reasonably representative of the overall population of BC Hydro's industrial transmission-voltage customers. Customers were interviewed from companies in pulp & paper, forest products, chemicals, refineries, mining, shipping terminals and other sectors.

At the time these interviews were conducted, the dramatic world-wide economic downturn due to the financial crisis was taking hold, the seriousness of which became evident approximately at the time of the October 2008 interviews. By the second round of interviews in March 2009, most firms had or were in the process of making serious adjustments to their business plans, such as reducing production and reducing or deferring expenditures and facility investments, including DSM measures.

The sampling plan for the **impact evaluation** was based on BC Hydro data, which provided the expected energy savings and related documentation for industrial facilities participating in the PSP-T program. Project energy savings showed a high degree of variability across the population, with a relatively small number of large projects accounting for a high percentage of the estimated savings. The sample design used to select sites for detailed documentation reviews and on-site evaluation took account of this distribution by weighting the sample toward those with greater savings. This approach ensures that the sample will have appropriate weightings with some units of high savings, some of moderate savings, and some of relatively low savings. The final sample selection was adjusted slightly to take into account practical constraints or limitations that simply prevented physical on-site reviews, such as the economic closure of some industrial facilities.

In F2008, a total of 24 industrial customer sites participated in the PSP-T program resulting in expected gross energy savings of about 228 GWh/year. From this population, 12 sites (7 sites with large savings and 5 with lower savings) were selected for detailed evaluation and site reviews. For F2009, the total population of participants consisted of 12 sites producing expected gross energy savings of about 138 GWh/year, of which 7 sites (4 sites with larger savings and 3 with lower savings) were selected for detailed evaluation and site review.

Procedure to Verify Gross Energy Savings

The determination of evaluated gross energy savings is based primarily on documentation reviews of energy savings for each sample site, and on-site verification of the installation and operation of the energy efficiency measure(s) at those sample sites.

The review of energy savings calculations focused on the most important factors that determine energy use, such as operating hours and usage patterns. Metered data was used to verify operating conditions, where appropriate and available. For some equipment, data on hours of use was available through BC Hydro data while for other sample sites, additional on-site monitoring was conducted.

On-site inspections were completed to verify the installation and to gather information about the actual operating parameters of equipment and the facility. Information was gathered from several sources during the on-site review, including discussions with site staff, review of site documents or records, and visual inspections of control settings, operating levels and other relevant parameters. Monitoring of specific end-uses was conducted at some sites where it was useful and feasible to do so.

These procedures were used to calculate the gross realization rates for the sample groups. Gross savings for the program for each fiscal year were then calculated by applying the realization rates from the sample groups to the full program participant population.

4.1.3 Results

Process Evaluation

In the process evaluation, a primary topic explored was the interaction between the TSR and the PSP-T program. Therefore, key questions were explored around the effectiveness of the rate to motivate customer funded DSM projects, versus the need for the PSP-T program – both in terms of financial support for DSM projects, and the program enabling support activities.[17]

With the introduction of the TSR in April 2006, the PSP-T Program changed considerably to support the Stepped Rate and to be more adaptable and comprehensive for a given customer's situation. Essentially all of the direct financial incentives intended to motivate customer DSM came in the form of rate savings at the higher priced Tier 2 level. Until April 2008, the program was primarily designed to enable customers to take advantage of the TSR by assisting customers with DSM investment decision-making and allowing customers greater latitude in documentation requirements associated with their participation. In April 2008, capital incentives to co-fund customer DSM projects were reintroduced, in part because some customers had reduced their Tier 2 energy consumption to the point that they were near the Tier 1 threshold and in need of further incentives to continue further conservation efforts. Although a few customers were considering the new capital incentives at the time of this evaluation, none had made use of the updated capital incentive program. Several customers commented that the incentives offered were not of a sufficient level to impact their decision making in favour of further energy efficiency measures.

PSP-T Program support for TSR: Several customers commented directly on the importance of the PSP program as a complement to the TSR, and the fact that they now find the PSP program to be less frustrating to participate in. While the focus and function of PSP changed dramatically with the introduction of the TSR, customers recognize the need for and value of PSP to support the energy efficiency projects motivated by the rate. More detailed observations about the various components of the program are provided below.

Program Satisfaction: As part of the impact evaluation, customers were also asked a number of process review questions including their overall perceptions of the PSP-T Program. Overall, respondents rated the Power Smart program positively, with 87 per cent stating that they would "Very Likely" or "Somewhat Likely" recommend the program to colleagues in their industry. About 93 per cent of respondents indicated they would be "Somewhat Likely" or "Very Likely" to implement another project under Power Smart.

[17] This section provides the key insights on the PSP-T program. Section 5.2 provides the key insights on the TSR.

Customers were asked to rate the components of the PSP-T program. About 87 per cent of respondents rated project support and information services from BC Hydro as good or excellent. Compared to past evaluations, customers now view participation in the PSP program as generally more satisfying; but unfavourable comments remain on the perceived length of time to get things done in the program. However, 73 per cent of all respondents rated the length of time to receive savings approval as poor or fair.

Performance Risk of Efficiency Projects: Some customers view the performance risk of efficiency projects as a barrier to their implementation. The concept is that if the customer is putting up funding to implement an efficiency project that is consistent with the specifications and estimates of an energy study completed by a consultant approved by BC Hydro, then the estimated energy savings ought to be accepted as estimated, without subsequent adjustments for actual project performance. Other customers considered the magnitude of financial incentives to be too small to influence their business plans in favour of efficiency projects. (At the time of this evaluation, the financial incentive rate was set at a maximum of $20/MWh.) Other customers had difficulty meeting some of the qualification criteria to take advantage of the offer. Given the diversity of industrial customers, combined with the range of business performance in the current economic environment, it is unlikely that a financial incentive rate and incentive structure could be found to satisfy all parties, including prudence requirements with other BC Hydro customer rate classes.

Energy Managers: The energy manager offer was viewed to be an important component of PSP services. All the customers participating in the program interviewed were very positive about it, even when it became evident that customer funding constraints in some cases limited the rate at which efficiency measures could be implemented, and results were often realized more slowly.

Energy audits: The objective of energy audits is to identify and evaluate potential efficiency projects at customer sites. The ultimate success of these studies is realized when efficiency projects are successfully implemented. Anecdotal evidence suggests the percentage of audits that ultimately results in implemented projects (40 per cent) appears to be comparable to other regions in North America.

Measurement & verification for impact studies: In general, customers understand the need for measurement and verification of the performance results of efficiency projects. However, there are significantly divergent views on the responsibility for and the level of detail and accuracy required for these studies.

Employee Awareness: Not surprisingly, employees at customer facilities know their production processes well and are an important ally and resource to help achieve multiple efficiency objectives both for the customer and BC Hydro. The rapid success of employee efficiency awareness initiatives at some sites has taken customer managers by surprise. However, it is typically difficult to trace energy savings to employee behaviours.

Although the range of services offered in support of employee efficiency awareness seems to be well received, the applicability of those services to the full range of industries and customers is uncertain. For example representatives from other industries observed that initial efforts seemed to be heavily focused on the pulp & paper industry.

MT&R (monitoring, targeting & reporting): Although the uptake of MT&R has been slow, customers generally recognize the value of conducting MT&R. Many customers see MT&R in the context of their existing business management practices.

Impact Evaluation Summary for F2008

Energy savings were evaluated for the sample of 12 sites from F2008. The evaluated gross energy savings estimates were determined by completing site-by-site analyses, reviewing available project documentation and collecting on-site data. Table 4.1.1 summarizes the evaluation results:

Table 4.1.1 PSP-T Evaluated Savings and Realization Rates for Sample Sites for F2008

Stratum	Sector/Site	Expected Gross Savings (kWh/year)	Evaluated Gross Savings (kWh/year)	Realization Rates (%)
Higher Savings	Mining	38,454,000	29,006,000	75.4
Higher Savings	Mining	27,078,000	26,470,000	97.8
Higher Savings	Pulp & Paper	25,000,000	23,819,106	95.3
Higher Savings	Oil & Gas	20,100,000	17,384,000	86.5
Higher Savings	Pulp & Paper	19,000,000	19,033,209	100.2
Higher Savings	Pulp & Paper	7,039,100	6,790,038	96.5
Higher Savings	Pulp & Paper	5,330,789	4,321,809	81.1
Aggregate		142,001,889	126,824,162	89
Lower Savings	Manufacturing	2,998,000	1,499,000	50.0
Lower Savings	Wood Products	1,803,662	1,803,662	100.0
Lower Savings	Manufacturing	893,021	1,077,086	120.6
Lower Savings	Manufacturing	885,000	1,117,319	126.3
Lower Savings	Wood Products	229,000	236,520	103.3
Aggregate		6,808,683	5,733,587	84

Some of the highlights of the resulting changes in the estimated savings are as follows:

- The greatest magnitude of reduction in savings is attributable to a mine and an oil & gas facility, due to computational corrections and on-site measurements.
- Similar reviews at other sites (particularly at two manufacturing facilities) resulted in significant increases in evaluated savings, primarily due to on-site findings being more favourable than had been included in file estimates.

While the above table provides summary results, it is worth noting that the detailed site reviews at each location included examination of several projects, in many cases involving several different industrial technologies.

Table 4.1.2 applies the aggregate stratum-level realization rates above to the overall F2008 program-level expected gross energy savings, resulting in an estimate of evaluated gross savings for the program of about 198 GWh/year.

That total includes an additional adjustment for one site where project documentation was weak and site information could not support the full estimate of savings. In this circumstance two extreme positions could be taken: the estimated savings could be accepted as is or discounted to zero. BC Hydro decided to discount the estimated savings by 50 per cent. The end result is that for overall performance of the PSP-T program, a realization rate of 87 per cent was estimated for F2008.

Table 4.1.2 Evaluated Savings for F2008

Stratum	Expected Gross Savings (kWh/year)	Realization Rates (%)	Evaluated Gross Savings (kWh/year)
Higher Savings	203,111,889	89	180,769,581
Higher Savings, Adjusted	9,437,000	50	4,718,500
Lower Savings	15,336,805	84	12,882,916
Total Program	227,885,694	87	198,370,997

Impact Evaluation Summary for F2009

Savings were evaluated for a sample of 7 sites from F2009, as described in section 4.2.2. As with the F2008 analysis, evaluated gross energy savings estimates were determined by completing site-by-site analyses, reviewing available project documentation and collecting on-site data. Table 4.1.3 summarizes the evaluation results:

Table 4.1.3 Evaluated Savings and Realization Rates for Sample Sites for F2009

Stratum	Sector/Site	Expected Gross Savings (kWh/year)	Evaluated Gross Savings (kWh/year)	Realization Rates (%)
Higher Savings	Mining	34,012,000	34,012,000	100.0
Higher Savings	Pulp & Paper	17,252,490	17,252,490	100.0
Higher Savings	Oil & Gas	13,293,600	13,293,600	100.0
Higher Savings	Mining	10,844,000	10,844,00	100.0
Aggregate		75,402,090	75,402,090	100.0
Lower Savings	Pulp & Paper	4,183,000	4,130,800	98.8
Lower Savings	Pulp & Paper	2,355,000	2,560,690	108.7
Lower Savings	Pulp & Paper	1,731,000	1,204,800	69.6
Aggregate		8,269,000	7,896,290	95.5

These energy savings adjustments may appear rather inconsequential. However, it is worth emphasizing the amount of field review work that was done to confirm these results. For example, at a pulp & paper facility the field review examined 11 different energy efficiency measures that had been implemented in 2009 to achieve the expected gross savings. The review confirmed the estimated savings for all 11 measures at that facility. In contrast, in the case of another pulp & paper facility, site information and measurements indicated a revision to the baseline computations with a resulting significant reduction in evaluated savings.

Table 4.1.4 below applies the aggregate stratum-level realization rates above to the F2009 program-level expected gross energy savings, resulting in an estimate of evaluated gross savings for the program of about 140 GWh/year. This represents an overall program-level realization rate of 95.4 per cent for the F2009 PSP-T program.

Table 4.1.4 PSP-T Program Level Aggregate Evaluated Savings for F2009

Stratum	Expected Gross Savings (kWh/year)	Realization Rates (%)	Evaluated Gross Savings (kWh/year)
Higher Savings	116,202,090	100	116,202,090
Lower Savings	22,127,736	95.5	21,130,369
Sites shut down	8,144,000	29.7	2,418,273
Total Program	**146,473,826**	**95.4**	**139,750,732**

The above final expected gross and evaluated gross results include adjustments in savings for facilities that were shut down in 2009 (a wood products facility and pulp & paper facility). Annual savings for efficiency measures at these two sites were prorated for the portion of the year that the sites were in operation. This adjustment was not counted against the realization rate for all the other facilities that were in operation for the full year.

4.1.4 Conclusions and Recommendations

Process Evaluation

Following are the key conclusions and recommendations from this process evaluation:

1. **PSP-T Program support for TSR.** Customers value the educational and technical services offered under the PSP program as a means to help them respond to the TSR by reducing their energy consumption under the Tier 2 price. BC Hydro should maintain and, where possible, explore augmenting those aspects of the PSP-T program that are most effective to enable the energy savings motivated by the TSR.

2. **PSP process is better but timelines still too long.** At a minimum, BC Hydro needs to quantify the accuracy of these customer views and continually seek opportunities to streamline the PSP process. Since this is a persistent theme over the years, BC Hydro should explore this issue with customers (e.g., via focus groups). The following questions should be asked: What timelines would customers view as reasonable? What would it take for BC Hydro to achieve those timelines?

3. **Performance risk of efficiency projects.** BC Hydro should assess the feasibility of establishing a “Deemed Savings” measure database for DSM measures installed in the industrial sector, which would typically cover standardized types of DSM measures. For customers installing measures that are in the Deemed Savings database, BC Hydro could accept as given those savings from such measures, with minimal administrative checks. Measures not in the database, typically encompassing the larger savings projects that often include certain unique characteristics, would still need to be evaluated.

4. **Level of financial incentives.** Given that no customers took advantage of the financial incentives in the first year after they were re-introduced in April 2008, consideration should be given to raising the incentive level and examining the other qualification criteria of the offer. In further discussions with customers, BC Hydro should explore if there are any other aspects of the re-introduced financial incentive offer that are presenting a barrier to customer acceptance.

5. **Energy Manager Component.** Energy managers are an important bridge between industrial customers and BC Hydro’s long-term DSM objectives. Maintain and where possible, enhance the energy manager component as need/opportunity arise, as may be identified in discussions with customers or industry organizations

6. **Energy Audits.** As BC Hydro's co-funding of these studies is increased (to 75 per cent), it is important to ensure that studies are not done unnecessarily in cases where there is limited intent or capacity to implement the study recommendations. BC Hydro should monitor the success rate of energy audits and studies to ensure funds are well spent.

7. **Measurement & verification for impact studies.** As a general rule, the level of effort and precision for measurement and verification should be commensurate with the magnitude of the projected energy savings, with greater effort/precision reserved for certain projects (e.g., those with large savings, new technologies or greater uncertainties). In consideration of customer perspectives on this issue, BC Hydro could consider establishing different acceptable error bands depending on the magnitude of the estimated energy savings. However, it also needs to be noted that some DSM projects are by nature harder to estimate through engineering algorithms due to project complexities and possible synergies or interactions across components or systems, thereby requiring greater M&V effort.

8. **Employee Awareness.** To the extent possible, customers in all sectors should be encouraged to monitor and measure the effectiveness of employee initiatives, including the documentation of baseline behaviours before changes are introduced. In addition to seeking employee support for operations and maintenance issues it is also useful to explicitly seek their suggestions for capital investments that may lead to large resource efficiencies.

9. **MT&R (monitoring, targeting & reporting).** Consideration should be given to reviewing the initial messaging and approach to MT&R with explicit customer input, to examine if customers consider the approach compatible with their business practices and that the program can deliver tangible benefits in a reasonable time. BC Hydro should also develop case studies to highlight those customers that have successfully undertaken MT&R and then communicate these examples to other customers. Customers may also recognize the value of MT&R in benchmarking and goal setting for their facility in comparison to other facilities under their corporate umbrella or compared to other industry players in their business association(s).

Impact Evaluation

Following are the key conclusions and recommendations from the impact evaluation:

1. **Gross versus net savings:** Due to the circumstances of this evaluation and the characteristics of the participant population, all in the context of the TSR and the PSP-T program, this evaluation has concluded that adjustments for free-ridership and spill-over to the evaluated savings are not possible.

   Recommendation: These findings also suggest the need to consider what, if any, changes need to be made to the evaluation approach or methodologies to reflect the characteristics of this marketplace. For example, future evaluations should explicitly consider how suitable comparisons between program participants and non-participants could be defined and identified (e.g., selecting non-participants outside of BC Hydro's service territory).

2. **Dynamic versus Static Evaluation Framework:** To date this and past evaluations of the program have examined program effects within a static time "snap-shot". Given that BC Hydro has had efficiency programs for large industrial customers in effect for many years, it is plausible that customers and the overall industrial marketplace have progressively "learned" new behaviours and changed their decisions over the years with respect to energy efficiency. Therefore, an evaluation of PSP that is made from a static, "this-program-only, this-year-only" perspective, may not address adequately the extent of free-ridership, spill-over and the cumulative, dynamic effects of promoting energy efficiency in the marketplace over many years.

Recommendation: Consideration should be given to formulating a framework for a dynamic evaluation process that makes use of data from repeated cross sections of program impacts over time. A market evaluation should be conducted in addition to a program evaluation (since program evaluations provide useful information for program improvements). By using data from several program years as repeated cross sections in an analysis, “longitudinal” type (time based) effects, such as those associated with learning may be identified, as part of the market evaluation.

5 Conservation Rates

5.1 Residential Inclining Block Rate F2010

5.1.1 Introduction

Following an oral hearing, the BCUC provided its decision on the Residential Inclining Block (**RIB**) Rate Application on August 28, 2008. The BCUC determined that it was in the public interest for BC Hydro to implement an inclining block rate and ordered that a two-step structure incorporate the following design principles:

- For the period commencing April 1, 2009, establish the Step 2 rate at 8.27 = cents per kWh and cap it at that amount.
- For the period commencing October 1, 2008 through March 31, 2009, establish the Step 2 rate as the above rate less one-half of the difference between that rate and 6.15 cents per kWh.
- Establish the Step 2 threshold at 1,350 kWh per billing period (approximately 90 per cent of median bi-monthly consumption for BC Hydro residential customers).
- Calculate both Step 1 and basic charges to achieve revenue neutrality for the residential rate class.

BC Hydro subsequently filed a revised rate schedule which included: (1) a basic charge of 12.38 cents per day; (2) a Step 1 rate of 5.98 cents per kWh; and (3) a Step 2 rate of 7.21 cents per kWh, all effective October 1, 2008.

The purpose of this study is to provide a limited process[18] and full impact evaluation of the RIB rate for F2010.

5.1.2 Approach

This study addressed the following issues:

1. **Customer Awareness**. Using information collected through the Power Smart Quarterly Tracking Survey (n ≈ 600), questions focussing on behaviour and customer awareness of the rate structure and were compared between the September 2009 and March 2010 surveys to capture any potential change during the 2010 fiscal year. Differences in the two sample proportions were then compared using statistical tests for sample proportions.

2. **Energy and Peak Savings.** Statistical regression models were used to estimate energy and peak savings. Three separate approaches were used as multiple lines of evidence to check the consistency of preliminary results.

   The primary approach used an econometric model to estimate Step 1 and Step 2 elasticities and therefore, energy and peak savings. The model was based on aggregated consumption data by region, dwelling type, heating type, income, heating degree days and an interactive term. Approximately 100 bi-monthly observations were utilized (3800 observations in total).

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18 The process analysis is limited to an examination of customer awareness of the new rate structure and results pertain only to F2010.

This econometric model was the preferred approach as while it may not control for every extraneous (lurking) variable, the model was representative of the entire population of BC Hydro residential accounts.

A separate econometric model based on customer level billing data was conducted on 1,000 randomly selected customers to check the consistency of preliminary results. Equal samples were drawn from each of four service regions (Vancouver Island, Lower Mainland, North and Southern Interior) with the proviso that each customer be active as of March 31, 2010 and bi-monthly consumption readings restricted to April 1994 or later[19]. Fifty per cent of customers (the two middle quartiles) had between 25 and 75 bi-monthly readings. Similar to the primary approach econometric model this approach may not control for every extraneous variable, but the model was representative of the total population of BC Hydro residential accounts.

Finally, hourly data from a sample of customers in single family dwellings located in the Lower Mainland were used to compare average consumption of customers on a single step (flat) rate[20] to those on the residential inclining rate. The difference in mean consumption between each customer group was to be calculated and tested for statistical significance.

5.1.3 Results

1. **Rate Structure Review.** The rate structure was reviewed in conjunction with program staff to understand its key features and to build a program logic model. Review of the logic model indicates that the rate structure is appropriate for the following reasons: (1) rate structure linkages have face validity and are plausible; (2) assumptions are reasonable and likely to be met; (3) there are verifiable indicators tracking key program outcomes against objectives; and (4) the difference between objective and outcome is measurable.

2. **Customer Awareness.** To measure changes in residential customer awareness of the rate, the following question was asked: "In October 2008 BC Hydro implemented a two-step or two-tiered conservation rate structure for its residential customers. In any given billing period, households pay one rate in the first block of their electricity consumption, and a higher rate for any additional electricity consumption that occurs in the second block. Were you previously aware of this new type of rate?" On the basis of responses to this question, customer awareness of the Conservation Rate was 37 per cent in September 2009 and 37 per cent in March 2010.

3. **Energy and Peak Savings.** The aggregate econometric model was used to estimate the price elasticities used to calculate energy savings. Table 5.1.1 below provides the estimated run-rate energy savings due to the rate structure for F2010[21]. Step 1 customers increased their consumption by an estimated 2.2 GWh/year and Step 2 customers reduced their consumption by an estimated 231.9 GWh/year. The net effect is an estimated reduction in consumption of 229.7 GWh/year.

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19 Not all customers have records going back this far in the past; on average (depending on region) each customer had between six and 10 years of billing history. Note also that April 1, 1994 is the date that the single (flat) rate structure was introduced; prior to this time a declining block structure was in effect.

20 A sample of 124 customers in the Lower Mainland residing in single family (non-detached) dwellings remains on a single-step rate that would have been applied to all residential customers had not the inclining block structure been introduced. The two rates are designed to be revenue neutral.

21 Savings due to the rate structure consider the percentage change in stepped prices at the beginning of F2010 (April 1, 2009).

Table 5.1.1 F2010 Rate Structure Energy Savings.

Step	Price Elasticity by Step (δ)	Change in Rate (Δ)[22]	δ x Δ Rate	Number of Accounts	Mean kWh per Account	GWh/year Savings
1	-0.054	-0.0117	0.0006	851,768	4,572	**2.2**
2	-0.111	0.1470	-0.0169	768,089	17,909	**-231.9**
Both				1,619,857	10,896	**-229.7**

Price elasticity estimation is affected by Power Smart DSM programs, since savings reduce overall consumption in a given fiscal year. However, since price variables in these models are regressed on actual residential consumption the elasticity estimates only reflect customer response to price net of such programs. This ensures that no double counting of savings takes place. By contrast, reported savings numbers were based on forecasted consumption that required the additional accounting step of removing the estimated savings from other residential Power Smart programs.

Table 5.1.2 below summarizes the estimated energy and peak impacts of the rate structure for F2010 and compares evaluated energy savings with the reported estimate.

Table 5.1.2 F2010 Rate Structure Energy and Peak Savings.

Program	**Fiscal Year**	**Energy savings (GWh/year)**		**Peak savings (MW)**	
		Reported	**Evaluated**	**Reported**	**Evaluated**[23]
Residential Inclining Block (**RIB**) rate	2010	249.0	229.7	-	66.8

4. **Results from Additional Lines of Evidence.** Although customer level data allows the separate depiction and modeling of individual customer demand schedules, it can obfuscate other effects. Whereas the top-down (aggregated) model captures all demand and hence all customer behaviour contributing to that demand, some customers from the sampled data may lack of the minimum number of bi-monthly consumption readings required to evoke a price signal. The high level results support the stepped elasticity values estimated in the top-down (aggregate) model and produced statistically identical results.

   For the model using hourly data, a statistical analysis of customer characteristics indicated that customers on the inclining block rate and those assigned to the single step (flat rate) equivalent[24] were not comparable prior to the introduction of the inclining block rate. This meant that the assumptions required to conduct a valid difference of means test were not met.[25] As a result, these data could not be applied to generate any confirmatory evidence of conservation behaviour.

5.1.4 Recommendation

Given customer awareness of the rate was unchanged between September 2009 and March 2010 it is recommended that residential customer awareness of the new rate be investigated to

22 Values in the Change in Rate column refer to percentage changes in price per kWh at April 1, 2009 for each stepped rate.

23 This value is derived from a previously determined peak-to-energy ratio (2009). As it does not explicitly consider any shift of energy use from peak to off-peak hours it must be treated as a rough estimate only.

24 This rate is designed to be an equivalent of the 2-step inclining block rate to the extent that both are designed to generate the same revenue for the utility.

25 Even if it is assumed that the single-step sample is representative of the overall customer population of interest, the actual differences are not significant.

better understand the possible effects of such awareness on consumption and possibly assess differences in consumption due to differences in awareness levels. This should include a re-examination of the survey instrument used to assess awareness levels.

5.2 Transmission Service Rate F2010

5.2.1 Introduction

The purpose of this study is to provide an impact evaluation of the Transmission Service Rate (**TSR**) in F2010, which was the fourth year of operation of the rate. This study uses an econometric model 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/installed by the customer. 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. This study does not evaluate reported DSM, which are estimates of energy savings reported to BC Hydro as part of the annual CBL adjustment process. Reported DSM is typically claimed as Power Smart energy savings and evaluated through the PSP – Transmission program evaluation.

5.2.2 Approach

This study uses a multiple lines of evidence approach. Multiple lines of evidence are appropriate when no single methodology or line of evidence can provide information on all of the evaluation issues of interest. The main data sources or lines of evidence in this study include: program staff interviews, file and documents review, billing data, DSM impacts, industrial output, industrial employment, and pre- and post-implementation executive interviews.

A major source of information for this study was a set of detailed interviews with 25 BC Hydro staff and 40 executives from 34 of the largest transmission voltage customers. The interviews were based on a detailed discussion guide and were open-ended, so that customers were able to talk about the issues that were important to them.

The main purpose of the econometric analysis was to quantify the unreported impact of the TSR on purchased electricity consumption. The key point was to estimate the price elasticity of demand, which is defined as the percentage change in purchased electricity consumption divided by the percentage change in price. Because TSR customers are subjected to two prices – the Tier 1 price and the Tier 2 price – both prices need to be included in the model. Two indicators of economic activity, shipments of durable goods and industrial sector employment, were used. Finally, because purchased electricity consumption is affected by Power Smart program activity, adjusted purchased electricity consumption was defined as the sum of actual purchases plus reported DSM savings.

The model was estimated using seven years of monthly data. Actual consumption is the sum of monthly consumption aggregated across TSR customers. Reported DSM program savings are aggregated across TSR customers. Tier 1 price and Tier 2 price data are from BC Hydro data. Durable shipments and industrial employment data are from BC Statistics.

The basic method for the impact analysis uses time-series regression modeling in log linear form. Log linear models have the advantage of having coefficients that are interpretable as elasticities. In the fullest version of the model, it is assumed that the log of consumption is a linear function of a constant, the log of Tier 1 price, the log of Tier 2 price, the log of durables output, the log of industrial sector employment, and an error term as shown in Equation (1). The impact of the TSR, or estimated unreported DSM, is then given by the Tier 2 price elasticity γ

times the relative change in the Tier 2 price from the base year times Tier 2 consumption lagged one year as given by Equation (2). Note that the measured price change is from the base period rather than from the previous year, because changing industrial energy consumption in response to a price change is a lengthy process that is unlikely to be completed within the year immediately following the price change.

Table 5.2.1 summarizes the main data sources for this study.

Table 5.2.1 TSR Evaluation Issues, Data Sources and Methods

Data required	Data Source	Details
Program description, other utility rate programs	File and documents review, interviews	Review of program documents, BCUC filings, relevant official and program evaluation literature and interviews with program staff and consultants
Consumption by sector and end use	Conservation Potential Review	Consumption and demand for nine end uses by five sectors
Energy consumption by step	BC Hydro	Consumption by step by year
Rate awareness and knowledge	Executive interviews (n = 40)	Customer awareness of the rate and knowledge of the rate, in particular as it affects their business operations
Energy consumption drivers	B.C. Government data, consultant reports	Determinants or drivers of energy consumption and indicators for these determinants

5.2.3 Results

Program Rationale.

The program rationale for the TSR was examined using a program logic model, which was developed from interviews with staff and consultants, a documents review and a literature review covering selected rates for business customers among other utilities. This review and analysis confirms that the basic program 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. There are credible and strong links among inputs, outputs, purpose and goal statements and indicators are clear, well defined and measurable.

Awareness and Knowledge.

Customers were asked a series of open-ended questions to determine their awareness and knowledge of the TSR and to identify any issues pertaining to communications by BC Hydro. All customers had at least a general awareness of the rate.

Table 5.2.2 TSR Awareness and Knowledge

End use	General awareness of TSR (%)	Knowledge of TSR (% good or better)
October 2008 interviews (n = 23)	100	96
March 2009 interviews (n = 17)	100	71

Based on the interviews, a number of implications can be drawn with respect to awareness, knowledge and communications of TSR.

Communicating Rate Complexity.

The TSR is a relatively complex rate and information is often required at multiple levels with customers so that they can optimize the benefits of the rate for their operations. It is important that understanding of the rate is communicated to a variety of relevant managers and operational staff depending on the decision-making structure of the customer.

Role of the KAMs.

BC Hydro's Key Account Managers (**KAMs**) have played a significant role in communicating the nuances of TSR to their customers. This focussed support will continue to be essential as transmission voltage customers continue to optimize the value of the rate for their operations.

Ongoing Communications.

Changes in ownership and in leadership roles within the transmission voltage customer group will require ongoing communications efforts about the TSR. Periodic surveys to track the effectiveness of communications could be useful in identifying opportunities for additional communications efforts.

Energy Use.

Energy use and demand profiles were developed using information from the Conservation Potential Review. Energy and demand were examined for nine end uses (pumps, fans and blowers, compressors, materials handling, lighting, process equipment, building services, cooling and refrigeration and other) and for five sectors (metal mining, sawmilling, pulp and paper, basic chemicals and coal mining). Some areas for further energy conservation were identified.

Consumption and Peak Impacts.

An econometric model was used to estimate the unreported impact of the TSR on energy consumption. The model includes the price variables P1 and P2 as well as durable shipments and employment as drivers. The sign of the coefficients on the log of both the Tier 1 price and Tier 2 price are negative as expected and they are statistically significant, and the coefficients on the log of durable shipments and the log of employment are positive as expected and are statistically significant.

Table 5.2.3 provides the details of the impact analysis. As indicated above, the unreported impact of the TSR is given by the Tier 2 price elasticity γ times the relative change in the Tier 2 price from the base year times Tier 2 consumption lagged one year. The estimated run rate impact of TSR is a reduction in purchased electricity of 38.2 GWh/year for F2010 and a reduction in demand of 3.6 MW.

Table 5.2.3 TSR Impact Analysis

Fiscal Year	Tier 2 price ($/MWh)	Δ P2/P2	Tier 2 energy (GWh)	Elasticity	Δ GWh /year	ΔMW
F2010	7.36	1.6910	139	-0.1627	38.2	3.6

5.2.4 Conclusions and Recommendations

The study has several limitations. First, the industrial sector in British Columbia has been subjected to major external economic shocks. Although using sector gross domestic product (**GDP**) as a driver of the load to try to control for these shocks, this may be an imperfect control.

Second, it is premature to conclude that the observed load response is permanent rather than transitory. Third, the estimated quantitative impacts of the TSR are based on simple econometric models using sector level data, and it would be useful to repeat this study using site level information. However, at this time, comprehensive site level output information is not available. Fourth, since the whole population is in the treatment group, it is difficult to rule out the possibility that some of the estimated rate effects, in terms of reduction in load, may be due to factors outside of the rate. Fifth, it is possible that the methodology used does not capture all of the savings due to the rate. However, discussions with program management suggest that the size of additional savings is likely to be small.

6 Codes and Standards

6.1 Residential Energy Code F2009 and F2010

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 is to evaluate the impact of the B.C. Building Code on energy use in residential dwellings constructed in British Columbia for F2009 and F2010.

6.1.2 Approach

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 electricity and natural gas end-use consumption for the two benchmark years of 1995 and 2005 and to estimate energy and peak savings.

Table 6.1.1 Residential Energy Code Evaluation Issues, Data and Methodologies

Issue	Data	Method
1. Profile of new residential construction	Interviews Customer surveys	Survey analysis
2. Review building code	Official documents	Documents review
3. Estimate energy use	On-site visits	HOT-2000 models DOE 2.1 models
4. Estimate unit energy savings	On-site visits Developer survey Residential End Use Survey	HOT-2000 models
5. Estimate gross and net energy and peak savings	Consumption, GDP, electricity price, natural gas price and weather data	Econometric models

Profile of new residential construction. To develop a detailed profile of the new residential construction market in British Columbia, a baseline study of typical new residential construction is undertaken in the four regions of British Columbia. This baseline study used three main sources of information:

- Interviews with homebuilders, which covered number of dwellings, average dwelling size, space heating fuels, insulation, windows, and other construction features.
- Analysis of homes built since 2005 in British Columbia and which participated in the EnerGuide for Homes/EcoEnergy Program of the Government of Canada, which, covered basic dwelling characteristics, results of blower door tests on air changes per hour, and EnerGuide for Homes ratings.

- 2008 Residential End Use Survey, which collected detailed information on dwelling size, insulation levels, fenestration products, space heating, water heating, appliances and energy use behaviours.

Review building code.

To describe the energy use-related features of the building code, the code was reviewed and key features were extracted and evaluated. These included minimum insulation levels, installation of an air barrier, installation of a dedicated ventilation system, and the installation of, as a minimum, double glazed thermally broken windows.

Estimate energy use.

To understand trends in building construction prior to the introduction of the building code changes, estimates of energy use by building type and main space heating fuel from the results of modelling studies conducted in 1995 and 2005 were,used to construct a baseline, including detail for ten end-uses. For single family dwellings and duplexes, the end-use consumption estimates were based on HOT-2000 models. For multi-family dwellings, the results were based on DOE 2.1 models. The data used for the modelling comes from on-site audits in British Columbia sponsored by BC Hydro and by Natural Resources Canada. The 1995 modelling analysis was based on some 100 on-site audits while the 2005 modelling analysis was based on some 800 on-site audits. The on-site audits collected comprehensive information on building size and geometry, building envelope, heating, ventilation, air conditioning, domestic hot water, refrigeration, cooking, other appliances, and fuel types. This information was used to build a set of detailed input files, which were merged with weather files. A series of model runs was undertaken, until the models tracked actual consumption of electricity and natural gas appropriately.

Estimate unit energy savings.

To estimate unit energy savings for F2009 and F2010 by fuel (electricity in kWh and natural gas in GJ), sixteen prototype dwellings were built using HOT 2000. The 16 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). The archetypes were first modeled as representatives of typical new construction pre-code change. Then they were modeled to just meet the post-code change requirements. Unit savings were then defined as the difference between pre-code and post-code unit consumption. The prototype results were aggregated across regions using regional shares of completions.

Estimate gross and net energy and peak savings.

To estimate gross energy savings by segment, unit energy savings were multiplied by the number of completions for that segment. To estimate gross peak savings by segment, the peak to energy ratio obtained from previous work was applied. To estimate net energy savings by segment, gross energy savings were multiplied by the factor (one minus take back). To estimate net peak savings by segment, gross peak savings were multiplied by the factor (one minus take back). Take back or rebound effect, refers to the possibility that when the price of energy services falls, demand will increase, others things equal. Take back thus may reduce the potential impact of the installation of energy efficient technologies on energy consumption. The evaluation uses the price elasticity of demand as the measure of take back, which was estimated using standard econometric techniques. For calculations in this report, a take back rate of 11 per cent is applied.[26]

6.1.3 Results

New Residential Construction.

Based on data through the third quarter of 2009, completions were expected to be about one-half the 2009 level for 2010. Annual completions were relatively low at 13,500 in 2000 and 11,600 in 2001, but rose considerably to 18,200 in 2002 and have been over 20,000 for subsequent years until falling significantly in 2009 because of the recession. The composition of housing starts has changed considerably over time, with the shares of single family dwellings and duplexes falling and the shares of row houses and apartments rising.

Energy Features of the Building Code.

As of September 8, 2008, the B.C. Building Code requires an improvement in energy and water efficiency in B.C. and will apply to all new construction and renovation. The new requirements significantly increase minimal insulation levels in new residential construction.

End Use Consumption.

Whole building energy modelling was used to estimate end use consumption for electricity and for natural gas for the benchmark years of 1995 and 2005. Electricity consumption per square metre has been reasonably unchanged, but natural gas consumption per square metre has fallen significantly from 1995 to 2005.

Table 6.1.2 presents estimated unit electricity and natural savings for single family/duplex dwellings. Estimated unit program electricity savings were 1.58 GWh/year while estimated peak savings were 0.31 MW for F2009. A take back rate of 11 per cent is applied, so that estimated net program electricity savings were 1.41 GWh/year while estimated peak savings were 0.28 MW for F2009.

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[26] 11 per cent is a very conservative estimate of take back. Subsequent to this evaluation, further research and literature review suggested that a more appropriate take back rate for building code changes is 1%. This is primarily based on the assumption that for residential new construction, a new owner has little reference of what the energy costs would be for the same home not built in compliance with the code, thus is less likely to increase consumption based on lower energy costs.

Table 6.1.2 Single Family/Duplex

	Electric space heat: electric (kWh/year)	Gas space heat: electric (kWh/year)	Gas space heat: gas (GJ/year)
Lower Mainland			
Pre-code change	23,991	10,759	98.2
Post-code change	23,296	10,703	93.2
Change	695	56	5.0
Vancouver Island			
Pre-code change	23,241	11,009	90.2
Post-code change	22,518	10,981	87.6
Change	723	28	2.6
Southern Interior			
Pre-code change	27,466	10,981	112.0
Post-code change	26,382	10,925	107.8
Change	1,084	56	4.2
Northern Region			
Pre-code change	38,114	11,037	153.3
Post-code change	36,418	10,981	146.6
Change	1.696	56	6.8

Table 6.1.3 presents estimated unit electricity and natural gas savings for row houses and apartments. Estimated unit program electricity savings were 1.58 GWh/year while estimated peak savings were 0.31 MW for F2009. A take back rate of 11 per cent is applied, so that estimated net program electricity savings were 1.41 GWh/year while estimated peak savings were 0.28 MW for F2009.

Table 6.1.3 Row/Apartment

	Electric space heat: electric (kWh/year)	Gas space heat: electric (kWh/year)	Gas space heat: gas (GJ/year)
Lower Mainland			
Pre-code change	13,316	7,673	52.6
Post-code change	12,899	7,617	49.9
Change	417	56	2.6
Vancouver Island			
Pre-code change	12,899	7,562	51.6
Post-code change	12,705	7,506	49.9
Change	616	56	1.7
Southern Interior			
Pre-code change	15,207	7,284	60.3
Post-code change	14,539	7,284	57.6
Change	668	0	2.7
Northern Region			
Pre-code change	19,905	7,284	80.0
Post-code change	18,848	7,228	75.6
Change	1,057	56	4.4

Energy Savings.

Table 6.1.4 presents estimated electricity savings by dwelling type. Estimated gross program electricity savings were 1.58 GWh/year while estimated peak savings were 0.31 MW for F2009. A take back rate of 11 per cent is applied so net program electricity savings were 1.41 GWh/year and net peak savings were 0.28 MW for F2009.

Table 6.1.4 Electricity Savings F2009

	Single/duplex	Row/apartment	Total
Gross savings			
Electric heat			
Units	578	2,570	3,148
Savings per unit (kWh/year)	820	380	
Energy (GWh/year)	0.47	0.98	1.45
Peak (MW)	0.09	0.20	0.29
Natural gas heat			
Units	1,645	1,447	3,092
Savings per unit (kWh/year)	45	40	
Energy (GWh/year)	0.07	0.06	0.13
Peak (MW)	0.01	0.01	0.02
Electric and natural gas heat			
Energy (GWh/year)	0.54	1.04	1.58
Peak (MW)	0.10	0.21	0.31
Net Savings			
Energy (GWh/year)	0.48	0.93	1.41
Peak (MW)	0.09	0.19	0.28

Table 6.1.5 presents estimated gross natural gas savings by dwelling type for F2009. Estimated program natural gas savings were 11.02 TJ/year for F2009. A take back rate of 11 per cent is applied so that estimated net program natural gas savings were 9.81 TJ/year for F2009.

Table 6.1.5 Gross Natural Gas Savings F2009

	Single/duplex	Row/apartment	Total
Gross savings			
Units	1,645	1,447	3,092
Savings per unit (GJ/year)	4.5	2.5	-
Savings (TJ/year)	7.40	3.62	11.02
Net savings			
Savings (TJ/ar)	6.59	3.22	9.81

Table 6.1.6 presents estimated gross electricity savings by dwelling type. Estimated program electricity savings were 3.52 GWh/year while estimated peak savings were 0.70 MW for F2010. A take back rate of 11 per cent is applied, so that estimated net program electricity savings were 3.41 GWh/year while estimated peak savings were 0.68 MW for F2010.

Table 6.1.6 Gross Electricity Savings F2010

	Single/duplex	Row/apartment	Total
Gross savings			
Electric heat			
Units	1,405	6,245	7,650
Savings per unit (kWh/year)	820	380	
Energy (GWh/year)	1.15	2.37	3.52
Peak (MW)	0.23	0.47	0.70
Natural gas heat			
Units	3,997	3,516	7,513
Savings per unit (kWh/year)	45	40	
Energy (GWh/year)	0.18	0.14	0.32
Peak (MW)	0.03	0.03	0.06
Electric and natural gas heat			
Energy (GWh/year)	1.33	2.51	3.84
Peak (MW)	0.26	0.50	0.77
Net savings			
Energy (GWh/year)	1.18	2.23	3.41
Peak (MW)	0.23	0.45	0.68

Table 6.1.7 presents estimated gross natural gas savings by dwelling type for F2009. Estimated program natural gas savings were 26.78 TJ/year for F2009. A take back rate of 11 per cent is applied, so that estimated net program natural gas savings were 23.83 TJ/year for F2009.

Table 6.1.7 Gross Natural Gas Savings F2010

	Single/duplex	Row/apartment	Total
Gross savings			
Units	3,997	3,516	7,513
Savings per unit (GJ/year)	4.5	2.5	-
Energy (TJ/year)	17.99	8.79	26.78
Net savings			
Energy (TJ/year)	16.01	7.82	23.83

Table 6.1.8 shows the program reported and evaluated net energy and peak savings. Evaluated net incremental energy savings are 1.4 GWh/year in F2009 and 3.4 GWh/year in F2010. Evaluated net incremental peak savings are 0.3 MW in F2009 and 0.7 MW in F2010.

Table 6.1.8 Reported and Evaluated Net Energy Savings and Peak Savings

Program	Period	Energy Savings (GWh/year)		Peak Savings (MW)	
		Reported	Evaluated	Reported	Evaluated
Residential Energy Code	F2009	-	1.41	-	0.28
Residential Energy Code	F2010	4.40	3.41	-	0.68

6.1.4 Conclusions and Recommendations

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 residential housing market has been volatile in terms of starts and completions and shown significant evolution in construction practice. The recommendation is that BC Hydro continue to monitor the residential housing market to understand, in particular, new housing completions by region and housing type, size of floor area, ceiling insulation levels, wall insulation levels, window U-values, main and secondary space heating fuels used, water heating fuels used, furnace efficiency, central air conditioning installation and central air conditioning efficiency.