Fred James
Acting Chief Regulatory Officer
Phone: 604-623-4046
Fax: 604-623-4407
bchydroregulatorygroup@bchydro.com

January 13, 2017

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

Dear Ms. Ross:

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

BC Hydro writes to submit its Fiscal 2016 Demand-Side Management Milestone Evaluation Summary Report (the **Report**), dated December 2016 and full copies of final evaluation reports in compliance with Directive 66 (page 197) of the Commission 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 attached Report provides executive summaries of the milestone evaluation reports completed during Fiscal 2016, which were for the following programs:

1. New Home Program: F2008 – F2013;
2. New Plant Design Program: F2009 – F2014; and
3. Television Market: F2013 – F2014.

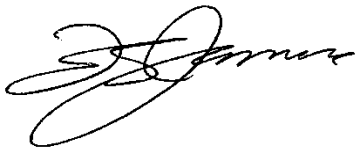
Also attached are full final evaluation reports for the following completed programs:

1. Refrigerator Buy-Back Program: Evaluation F2011 and F2012; and
2. New Home Program Evaluation: F2008-F2013.

During Fiscal 2016, BC Hydro completed two of its Demand-Side Management programs, the Refrigerator Buy-Back and the New Home programs. Both programs were evaluated in recent years and no further evaluations are planned. BC Hydro focuses its resources on the evaluation of ongoing programs, which can inform program cost effectiveness analysis, program management decisions and program electricity savings forecasts. Since no additional evaluations will be undertaken on the two completed programs, BC Hydro is filing the full reports of the last evaluations completed on these programs in compliance with Directive 66.

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

Yours sincerely,



Fred James
Acting Chief Regulatory Officer

st/ma

Enclosures (3)

BC Hydro
Power smart

Demand-Side Management Milestone Evaluation

Summary Report F2016

December 2016

Table of Contents

1.0 Introduction

This report summarizes the milestone evaluations of demand-side management (**DSM**) initiatives completed by BC Hydro in fiscal year 2016 (**F2016**). It is filed in compliance with Directive 66 of the British Columbia Utilities Commission (**BCUC**) decision on BC Hydro's F05/F06 Revenue Requirements Application (dated October 29, 2004), which "*directs BC Hydro to file the executive summaries of its milestone evaluation reports and full final evaluation reports of all its Power Smart programs*" (page 197).

BC Hydro evaluates its DSM initiatives to improve its estimates of realized DSM electricity savings and to improve their effectiveness and efficiency.

DSM evaluation activities are guided by the following six principles:

- Objectivity and Neutrality: Evaluations are to be objective and neutral.
- Professional Standards: Evaluation work is guided by industry standards and protocols.
- Qualified Practitioners: BC Hydro employs qualified staff and consultants to conduct evaluations.
- Appropriate Coverage: BC Hydro strives to achieve defined coverage levels for its evaluation of DSM initiatives.
- Business Integration: The evaluation function is integrated into BC Hydro's DSM business process of planning, implementation, reporting and evaluation.
- Coordination: BC Hydro evaluation work is coordinated with FortisBC and other DSM partners where feasible.

BC Hydro DSM evaluations are subject to an independent oversight process to ensure that they are neutral and unbiased, of sufficient quality for their intended purposes, and consistent with industry standards and protocols.

1.1 Completed Evaluations

Impact evaluations summarized in this report include the following:

- New Home Program: F2008-F2013;
- New Plant Design Program: F2009-F2014; and
- Television Market: F2013-F2014.

2.0 New Home Program: F2008-F2013

2.1 Introduction

The main purpose of the Power Smart New Home program evaluation was to determine the program's impact on energy savings in the new residential construction market. A secondary goal was to examine how the New Home program has influenced building practices to improve energy efficiency in British Columbia's residential construction market. The impact evaluation covers the six-year period from April 2007 through March 2013 (BC Hydro's fiscal years F2008 through F2013).

During the evaluation period, the New Home program provided financial incentives to residential home builders and developers for adopting higher energy efficiency standards in new construction and for installing more energy-efficient technologies and products. The program had two main offers, Home Performance and the Energy Star Package.[1] Builders could participate in either offer multiple times.

The Home Performance offer focused on encouraging the design and construction of energy-efficient homes, defined as single family detached dwellings and townhomes[2] achieving an EnerGuide rating of 80 (**EnerGuide 80**) or higher.[3] There were no criteria as to how an EnerGuide 80 rating could be achieved. Prior to F2013, a maximum incentive of $1,500 per unit was available to builders of single family detached homes rated as EnerGuide 80. This amount was increased to $2,000 per home in F2013.[4] Townhomes could receive a maximum incentive of $200 per unit throughout the evaluation period.

The Energy Star Package offer was available to builders of new single family detached homes, townhomes and multi-unit residential buildings. From 2006 to 2009, four Energy Star products were included in the package: refrigerator, dishwasher, bathroom fan, and six CFLs.[5] From 2009 to September 2013, front load clothes washers were added to the Energy Star products covered by the program. Applicants could install any combination of the five products, from a minimum of two to a maximum of five, to receive incentives of $50 (two products) to $200 (all five products).

---

1 Since 2012, FortisBC has been a partner in delivering the program offering rebates of up to $1,000 per unit for high-efficiency natural gas water heaters, fireplaces and/or boilers.

2 For this report, townhomes include semi-detached single family homes (e.g., duplexes) and row housing. For three of the evaluation years, multi-unit residential building units are also included in townhomes.

3 The EnerGuide Rating System is a national initiative delivered by Natural Resources Canada. An EnerGuide rating is a standard measure of a home's energy performance; how energy-efficient a home is. Program incentives were increased to help improve market penetration in the single family detached market and offset the incremental cost for builders aiming to achieve EG80 or higher. http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/5061#rating1.

4 Program incentives were increased to help improve market penetration in the single family detached market and offset the incremental cost for builders aiming to achieve EG80 or higher.

5 LEDs were introduced near the end of the evaluation period.

2.2 Approach

Six evaluation objectives were identified, each with specific researchable questions, as summarized in the following table:

Table 2.1 Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Market transformation	Was program participation in line with expected market coverage? To what extent has the New Home program addressed barriers faced by builders/developers to building more energy-efficient homes? To what extent has the program influenced home builder attitudes and practices in terms of building energy-efficient homes? Has there been a shift in demand from new homebuyers for more energy-efficient homes? Has the program created any spillover in the new construction market?
2. Non-energy benefits to builders/developers *	Are there non-energy benefits of program participation? If so, what are they and what kind of value is added?
3. Net electricity savings for the Home Performance offer - electrically heated single family detached homes	What are the evaluated annual net electricity energy and demand savings for single family detached homes incented by the program? How prevalent is the installation of air source heat pumps to achieve an EnerGuide 80 rating in new homes built during the evaluation period? How much spillover was there from participants building energy-efficient single family detached homes that were not incented by the program? What are the main contributors to any variance found between reported and evaluated savings?
4. Net electricity savings for the Home Performance offer – electrically heated townhomes	What are the annual gross and net electricity and demand savings for townhomes incented by the program? How much free ridership and spillover occurred? What are the main contributors to any variance found between reported and evaluated savings?
5. Electricity savings for the Home Performance offer- non-participant spillover	How much electricity savings were generated by non-participant spillover for single family detached homes and townhomes?
6. Net electricity savings for the Energy Star Package offer	What are the annual gross and net electricity and demand savings for the Energy Star Package offer? How much free ridership and spillover occurred? What are the main contributors to any variance found between reported and evaluated savings?

* Assessment of market transformation and non-energy benefits focused on the Home Performance offer.

Table 2.2 summarizes, for each of the evaluation objectives, the evaluation data and methods used.

Table 2.2 Evaluation Objectives, Data and Methods

Evaluation Objectives	Data	Method
1. Market transformation	2014 survey of builders/developers (program participants, n=75; non-participants, n=70) Program tracking data Canada Mortgage and Housing Corporation statistics	Descriptive analysis (e.g., frequencies, cross-tabulations, means, etc.) Survey-based spillover analysis
2. Non-energy benefits to builder/developers	2014 survey of builder/developer program participants (n=75) Secondary research	Descriptive analysis (e.g., frequencies, cross-tabulations, means, etc.) Qualitative analysis
3. Net Electricity savings for the Home Performance offer-electrically heated single family detached homes	Program tracking data Participant electricity consumption and billing system data (i.e., region, housing type, heating fuel) (n=454) Non-participant electricity consumption and billing system data (i.e., region, housing type, heating fuel) (n=1,178) 2014 survey of builders/developers (program participants, n=75; non-participants, n=70) BC Assessment data (square footage and year of build) Greensheets Construction builders database Peak to energy ratio from residential space heating load shape	Quasi-experimental design Statistical testing Survey-based spillover analysis
4. Net electricity savings for the Home Performance offer-electrically heated townhomes	HOT2000 energy simulation models Program tracking data 2014 survey of builders/developers (program participants, n-75; non-participants, n=70) Peak to energy ratio from residential space heating load shape	Engineering calculations Survey based free ridership and spillover analysis
5. Electricity savings for the Home Performance offer – non-participant spillover	2014 survey of builders/developers (non-participants, n=70) Program tracking data Canada Mortgage and Housing Corporation statistics Results of Objectives 3 & 4	Survey-based spillover analysis
6. Net electricity savings for the Energy Star Package offer	Program tracking data Energy Star website 2009-2012 Annual Retailer Shelf Space/Stock Studies 2014 survey of builder/developer program participants (n=75) Interviews with major distributors (n=3) Cross effects factors from the Power Smart Standard Procedure for Cross Effects Peak to energy ratio from residential space heating load shape	Engineering calculations Survey-based free ridership and spillover analysis

2.3 Results

Results for Objective 1: Market Transformation

Program reach was limited to a portion of the new construction industry, focusing on larger scale builders, although companies of any size could participate in the program, including owner-builders. It is estimated that the program covered approximately 6 per cent of registered builders and 12 per cent of new electrically-heated single-family homes and townhouses built during the six-year evaluation period. The stated goal of the program was to capture around 11 per cent of the market by 2010.

Participant builders/developers (comprising 87 per cent of survey respondents) reported that, as a result of the New Home program, they were able to include and retain energy-efficient features in the final building plans that may have otherwise been dropped as a cost control measure. Builders indicated that the energy-efficient features of a home are important to homebuyers.

Survey results also indicate that participating companies were more likely to build energy-efficient homes than were non-participating companies. Survey respondents were asked to describe the amount of experience their companies had building energy efficient homes before and after the program was introduced in 2008. Thirty-nine per cent of participating builders surveyed reported their company had a fair amount or a great deal of experience building to EnerGuide 80 or higher prior to 2008. This proportion doubled to 79 per cent after 2008. In contrast, only 40 per cent of the non-participant builders surveyed indicated that they had experience building homes to EnerGuide 80 or higher after 2008.

Spillover from the Home Performance offer is another indicator of change to the new residential market. Participating builders indicated that the program had influenced approximately 3 per cent of the energy-efficient homes (i.e., above code) that they built without an incentive from New Home.[6] Builders who knew about, but did not participate in the program reported that the New Home program had influenced the building of 6 per cent of the homes they built to above code but below EnerGuide 80, and 2 per cent of the homes they built to EnerGuide 80 or higher.[7]

Results for Objective 2: Non-energy Benefits to Builder/Developers

Overall, builders/developers reported that their companies experienced positive effects in several areas as a result of participating in the New Home program, including: the design process, skills and knowledge of the workforce, and construction protocols and practices. Participants also found that the incented homes were more profitable and sold faster than homes that were less energy efficient. These results are supported by a high rate of satisfaction among participating builders and developers (85 per cent very or somewhat satisfied) with the New Home program.

---

6 This percentage was applied to the total electrically-heated single family detached homes (1,262 units) and townhomes (1,861 units) incented under the Home Performance offer.

7 These percentages were applied to the total electrically-heated single family detached homes (14,776 units) and townhomes (11,103 units) built in B.C., outside of the City of Vancouver, from 2008 to 2013 that were not incented by the Home Performance offer.

Results for Objectives 3 to 6: Net Electricity Savings

Reported and evaluated savings for the evaluated components of the New Home program are summarized in the table below. Evaluated net energy savings among participating builders/developers total 9.7 GWh per year over the six-year period, compared to reported savings of 15.2 GWh per year. Evaluated spillover savings among non-participating builders/developers total 1.9 GWh over the same timeframe. Evaluated savings from non-participant spillover should be considered with caution as the estimate is based on a small sample of survey respondents and may not be representative of the entire population of non-participating home builders/developers, particularly given the diversity of the industry. However, the survey results do suggest that some degree of spillover has occurred among some home builders/developers that did not participate in the program and represent the best available information on this question at the present time.

Table 2.3 Reported and Evaluated Energy and Peak Demand Savings

Builder Type	Fiscal Year	Energy Savings (GWh/year)		Peak Demand Savings (MW)	
		Reported[8]	Evaluated Net	Reported	Evaluated Net
Participant Builders	**F2008**	0.6	0.4	0.2	0.1
	F2009	2.9	1.8	0.8	0.6
	F2010	3.0	1.8	0.9	0.5
	F2011	2.2	1.5	0.5	0.5
	F2012	2.6	1.9	0.8	0.6
	F2013	4.0	2.3	1.3	0.7
	Sub-Total	**15.2**	**9.7**	**4.4**	**3.1**
Non-Participant Builders	**Non-Participant Spillover**	**N/A**	**1.9**	**N/A**	**0.7**
Participant & Non-Participant Builders	**TOTAL**	**15.2**	**11.6**	**4.4**	**3.8**

There are several reasons for the variance between reported and evaluated energy savings:

- The majority of incented single family detached homes and townhomes were located in the Lower Mainland and Vancouver Island regions, whereas the geographical distribution assumed for reported savings was more dispersed, including parts of the province where the climate is colder and there is greater potential for energy savings;
- Reported savings assumed a higher proportion of townhome end units than those that were incented. End units have more exposed walls, higher electricity consumption and, therefore, higher electricity savings potential from energy efficiency improvements;
- Smaller sized homes were built compared to the sizes assumed in reported savings. Smaller homes have lower energy consumption and tend to yield less energy savings;

[8] Reported savings are net of free-rider ship and include participant spillover. A net-to-gross ratio was used in the calculation of net savings for townhomes and the Energy Star Package offer included a net-to-gross.

- Adoption of heat-pumps as a space heating source in new homes was higher than assumed in reported savings. Heat pumps are more efficient than electric baseboards, thus decreasing comparison group consumption; and
- Reported savings for the Energy Star Package offer assumed that each package would include all products, which did not end up being the case. Evaluated savings are based only on the products that were incented. Since not every Energy Star Package incented contained all of the eligible products, evaluated savings were less than reported.

2.4 Findings and Recommendations

Findings

1. The program had expected to capture approximately 11 per cent of the new residential housing market (single-family detached homes and townhomes) by F2010 but the drop in the residential construction market due to the poor economy that occurred soon after the program was introduced interfered with achieving this goal. However, by F2013, when the economy had regained its strength, coverage of the electrically heated new home market outside of Vancouver reached 12 per cent.

2. There is evidence to suggest that the New Home program supported the market transformation process in the new residential construction industry. Spillover was identified for builders who responded to the participant survey (0.2 GWh/year) and the non-participant survey (1.9 GWh/year), and the proportion of respondents who were full free riders increased by 28 per cent from their first to last application, as would be expected with this type of program (i.e., multiple and repeated participations) and within a market transformation paradigm. Qualitative evidence collected in the surveys provided additional supporting evidence of market transformation.

3. Free ridership was high despite the estimates being based on the builder's first application to the program. The percentage of builders identified as full free riders increased from the first application to the last application to the program suggesting that previous participation in the program influenced future decision-making. The free ridership rate also could reflect changes to the residential construction market as most of the survey respondents first participated in the program in F2011 or later.

4. Net electricity savings of 3.5 GWh/year were generated by the 1,262 single family detached homes that participated in the Home Performance offer, representing 36 per cent of reported savings. The participating homes represented 9 per cent of the 14,776 electrically heated single family detached homes completed in the same period in British Columbia outside the City of Vancouver.

5. Net electricity savings of 1.0 GWh/year were realized by the 2,351 townhomes and multi-family building units that participated in the Home Performance offer, representing 10 per cent of reported savings. The participating townhomes represented 17 per cent of the 11,103 electrically heated townhomes completed in the same period in British Columbia, outside the City of Vancouver.

6. Net electricity savings realized from the Energy Star Package offer totaled 5.2 GWh/year, representing 54 per cent of reported savings.

7. Builders and developers experienced some non-energy benefits as a result of participating in the New Home program such as improved profitability and speed of sale of energy-efficient homes.

8. Builders and developers reported that BC Hydro and FortisBC have an important role in supporting the new residential construction industry to meet changing energy efficiency codes and standards.

Recommendations

Listed below are recommendations resulting from this study, starting with a recommendation for program management (#1) followed by recommendations that serve both program evaluation and program management purposes (#2, #3) and a recommendation for future evaluations (#4). Note that order of presentation does not necessarily reflect relative priority.

1. Review and adjust the process and assumptions used to calculate reported savings to improve accuracy.
    a. Periodically review and examine baseline energy consumption of new residential construction to ensure that the reported savings are realistic.
    b. Conduct market tracking to follow changes in the new residential construction market and industry.
2. Program management and evaluation teams should work together to design a program tracking system that captures the critical program data to support clear and accurate reporting of on-going program performance and facilitate future program evaluation (e.g., locate new construction accounts in the billing system). Develop documentation that defines and delineates data entry requirements (e.g., database dictionary; quality assurance procedures).

3. Implement regular data collection from builders/developers (and other relevant stakeholders, as appropriate) to inform program design and support evaluation requirements (e.g., free ridership and spillover estimates).

4. Review expectations and options for the treatment and measurement of free-ridership and spillover for this market transformation program that involves repeat participation (e.g., whether to assess it on the basis of individual housing units or multi-unit housing projects).

2.5 Conclusions

The New Home program achieved energy savings, but they were less than expected. The main reasons for the difference were the assumptions about housing characteristics used in reporting and the unit savings of key energy efficiency measures.

There is evidence that the New Home program supported the process of transforming the new residential construction market to higher levels of energy efficiency by changing builder practices and increasing the number of energy-efficient homes built in B.C.

Builders feel that BC Hydro and FortisBC have a role in supporting the industry to achieve higher levels of energy efficiency.

3.0 New Plant Design Program: F2009-F2014

3.1 Introduction

BC Hydro's New Plant Design (**NPD**) DSM program was a multi-year energy acquisition initiative that encouraged industrial customers to undertake energy-efficient investments in new facilities or facilities undergoing substantive expansion. The key program goal was to acquire cost-effective energy savings. The guiding principle was to avoid missed opportunities given that the incremental cost of energy-efficient equipment in a new industrial facility is lower than the full cost of a retrofit. The program provided resources such as customer recognition and funding for energy studies, as well as capital incentives. Starting in F2015, the NPD offer is still in market under BC Hydro's Leaders in Energy Management industrial programs.

For a sub-set of program participants, the NPD program worked in concert with BC Hydro's Transmission Service Rate (**TSR**). For these participants, the impacts evaluated are those of the combined effect of the program and rate. BC Hydro's TSR encouraged customers to implement energy savings projects at their own expense by providing energy bill savings for eligible customer-funded DSM projects at a rate that was higher than the customer's average unit cost of electricity. The NPD program was designed to work in concert with the TSR, by providing a range of enabling activities, such as energy studies, to support the implementation of customer funded DSM projects at TSR sites. These projects are referred to as program enabled projects throughout this report. Program enabled savings are further grouped into those that received support from program-funded enabling activities and those that only received expert consultation. These groups refer to the level of program support provided, with the former grouping indicating a higher level of support than the latter.

During the six-year evaluation timeframe, 37 energy efficiency and conservation projects completed by 29 customers at 30 unique sites were reported under the program. Program participants included the following industrial segments: chemicals, natural gas transportation, metal mining, food processing and refrigerated storage, wood products, manufacturing and agriculture. Similarly, the program reported energy efficiency projects in various end uses with a primary focus on industrial process energy efficiency improvements.

While one of the original program goals was to encourage industrial self-generation at new industrial plants, any self-generation opportunity was directed through the integrated customer solutions process. Therefore, no self-generation projects were ultimately reported by the NPD program and only energy efficiency and conservation projects were included in the scope of this evaluation.

Eight of the 37 projects reported by the NPD program in the evaluation timeframe were program enabled projects at transmission service sites. For these projects, net savings are defined as savings attributable to the combined effect of the TSR and NPD programs. However, this evaluation is not a comprehensive assessment of the impacts of the TSR. Outside the scope of this evaluation are savings attributable to the TSR alone, without program influence, as well as savings reported to the combined effects of the TSR and programs other than NPD, such as BC Hydro's industrial retrofit programs.

Twenty nine of the 37 projects reported by the NPD program in the evaluation timeframe occurred at distribution service sites. These customers were billed under BC Hydro's Large General Service (**LGS**) Rate. Unlike the TSR, evidence suggests that the LGS rate operated independently of the NPD program.[9] NPD program participants at distribution service sites received capital incentives directly from the NPD program. For these projects, net savings impacts are defined as savings attributable to the NPD program alone. This evaluation does not assess any of the effects of the Large General Service Rate.

3.2 Approach

The evaluation objectives and research questions are shown below, followed by the data sources and methods.

Table 3. 1 Evaluation Objectives and Research Questions

Evaluation Objectives	Research Questions
1. Assess customer awareness, knowledge and satisfaction	How aware are customers of key program components? What is their understanding of the components? How easy to work with/use are the components? What are the program specific barriers to participation, and can they be addressed through program design or implementation changes? How knowledgeable are customers of energy-efficient technologies?
2. Examine customer energy-related decision making processes	How important are various factors in investment decisions? What financial methods are used to evaluate capital expenditures? What are the barriers and drivers of energy management?
3. Examine market place trends in new industrial construction	What is the level of industrial investment in BC? What is the form of a basic model that could be used to forecast industrial new construction levels? Are new industrial plants becoming more efficient at converting capital to output, and if so, at what rate? Are there trends in industrial production levels that could lead to error in the estimation of program savings?
4. Estimate gross electricity and peak demand savings	What are gross electricity and peak demand savings among program participants?
5. Estimate net electricity and peak demand savings	How much free ridership and spillover occurred? What were the net electricity and peak demand savings that are attributable to the program, and to the combined effects of the program working with the TSR?

[9] Refer to BC Hydro 2015 *Evaluation of the Large and Medium General Service* Rates: F2014.

Table 3.2 summarizes, for each of the evaluation objectives, the evaluation data and methods used.

Table 3.2 Evaluation Objectives, Data Sources and Methods

Evaluation Objectives	Data sources	Method
1. Assess customer awareness, knowledge and satisfaction	Participant surveys (n=8 and n=15) Non-Participant survey (n=24)	Cross tabulations
2. Examine customer energy-related decision making processes	Participant surveys (n=8 and n=15) Non-participant survey (n=24)	Cross tabulations
3. Examine market place trends in new industrial construction	Statistics Canada BC Statistics	Cross tabulations Regression models
4. Estimate gross electricity and peak demand savings	Program tracking data TSR tracking data Site visits Measurement and Verification (n=19) Engineering feasibility studies	Engineering algorithms Extrapolation of M&V using ratio estimation Rate class average peak-to-energy factor
5. Estimate net electricity and peak demand savings	Results of objective 4 File reviews Participant surveys (n=17 projects) Case Studies (n=15 projects)	Triangulation of case study survey based free ridership estimates Survey based spillover algorithm Cross tabulations Rate class average peak-to-energy factor

The first two evaluation objectives, related to awareness, satisfaction and decision making, were completed using cross tabulation of participant and non-participant surveys. Twenty-three participant survey responses were received through two separate survey instruments, one that was fielded in 2011 and another that was fielded in multiple waves from 2012 to 2014. Additionally, 24 non-participant survey responses were received from the 2011 survey.

The third evaluation objective related to market trends was completed using cross tabulation of data from Statistics Canada and BC Statistics. In addition, regression modelling was used to build four basic models that could be used to forecast industrial new construction and economic improvement trends.

The fourth evaluation objective related to gross savings was completed using post implementation engineering analysis, as well as measurement and verification (**M&V**) results. Evaluated gross savings were determined directly from the results of M&V or post implementation engineering analysis, for the 85 per cent of expected savings with such results. For the 15 per cent of savings without such results, evaluated gross savings were calculated by applying a realization rate, which is an estimate of the ratio of verified to expected savings, from the other 85 per cent of expected savings. Data for this analysis were sourced from the NPD program tracking database and the TSR tariff administration tracking database.

Peak demand savings were estimated by applying an industrial rate class average peak-to-energy factor to evaluated energy savings.

The fifth evaluation objective, related to net savings, was completed by applying free ridership and spillover adjustments to the evaluated gross savings estimate. Free ridership was estimated by combining survey and case study results from individual projects, on a savings weighted basis. Survey results examined what the organization would have done at the site in the absence of the program (or the combined effect of the program and TSR as applicable) for 17 projects. Case studies examined the critical barriers and influences related to implementation for 15 projects. The combined case study and survey analysis results provided coverage of 88 per cent of evaluated gross savings used in the free ridership estimation.

Participant spillover was estimated using the survey results alone. Non-participant spillover was not estimated.

The net-to-gross ratio was then calculated as one – free ridership + spillover.

3.3 Results

Results for Objective 1: Customer Awareness, Knowledge and Satisfaction[10]

While awareness of individual program components – including the energy study, role of energy managers, role of Key Account Managers,[11] capital incentives and program literature – was moderate to high among both participants and non-participants, participants reported a much higher understanding of each component than non-participants (60 per cent to 100 per cent of participants reported an excellent or good understanding compared to 29 per cent to 50 per cent of non-participants).

In terms of being easy to work with and/or use, participants rated the role of energy managers[12] and the role of Key Account Managers most favourably, and the capital incentives least favourably (only 17 per cent rating it as excellent or good in the 2011 survey and 50 per cent in the 2012-2014 survey). However, when asked to consider the level of incentives offered, 92 per cent of participants rated them as excellent or good, as did 77 per cent when asked to consider the variety of products funded under the program.

Overall ratings of the individual program components were highest for training/funding of energy managers and the role of Key Account Managers and lowest for energy studies and program literature.

In terms of experience with the program, participants rated service provided by BC Hydro among the highest of all elements (85 per cent rating it as excellent or good), along with service provided by contractors (77 per cent). In contrast, ratings were lowest for aspects related to information about the program (54 per cent of participants rated as excellent or good information about the program on the website and direct mail about the program) and for aspects related to length of time (39 per cent rated as excellent or good the length of time for the project to be completed and the length of time to receive the incentive).

Overall satisfaction with the program was very high with 100 per cent of participants rating it as excellent or good in the 2011 survey and 92 per cent in the 2012-2014 survey.

---

10 Due to the small sample sizes for the customer surveys, no attempt was made to examine the levels of statistical significance for differences between participant and non-participant responses.

11 Key Account Managers manage BC Hydro's relationship with its largest accounts.

12 Energy managers are individuals, funded by the program to develop and implement energy management program for participating organizations.

Results for Objective 2: Customer Decision Making

For participants, the most important factors in their organization's decision making around capital expenditures on equipment, materials and design were (in order of importance) the cost of energy, incentive payments from BC Hydro, and advice and/or recommendations from engineering consultants. For non-participants, the most important factors were (in order of importance) the cost of energy, advice and/or recommendations from equipment vendors, and advice and/or recommendations from engineering consultants.

Simple payback emerged to be the most common financial method used for capital investment decisions on energy efficient equipment, or design features for a new or expanded facility. This method was relied on by 75 per cent of program participants and 50 per cent of non-participants.

Among program participants, the top drivers of energy management were the overall level of electricity prices and making operating costs as low as possible.

The top barriers to energy management among program participants were other operational priorities, lack of financial incentives, and lack of staffing.

Results for Objective 3: Market Place Trends

Four models of industrial new construction found that industrial new construction can be estimated as a function of GDP and a time trend representing economic efficiency. The models estimated that there was a 0.2 per cent reduction per year in the required investment to achieve a given level of industrial output.

The energy savings of some projects reported by the NPD program are dependent on plant production levels. The NPD program reports a constant annual average value of energy savings, for the duration of the expected savings persistence. Industrial new construction exhibited variability over the analysis timeframe, however, a systematic trend was not observed. This indicates that the practice of reporting a constant, annual savings estimate for NPD program participants is unlikely to introduce a systemic bias due to variations in production levels.

Results for Objective 4: Evaluated Gross Electricity and Peak Demand Savings

Evaluated gross savings provide a best estimate of the electricity savings among program participants, before considering attribution. The evaluated gross electricity savings were 196.9 GWh/year from F2009 to F2014, which was 94 per cent of the expected gross energy savings. The peak demand savings for the same program period were 23.6 MW based on the rate class peak-to-energy factor of 0.12 MW/GWh.

Results for Objective 5: Net Electricity and Peak Demand Savings

Free ridership was estimated separately for the three types of projects reported by the NPD program: capital incentive, program enabled with program-funded enabling activity and program enabled with expert consultation only. Free ridership provides an estimate of the proportion of savings that are not attributable to either of the NPD program alone (for distribution service program participants) or to the combined effect of the NPD and TSR (for transmission service program participants). Free ridership in this context may also be referred to as natural conservation due to market forces beyond the influence of BC Hydro. Spillover was estimated for the overall evaluation period only.

Table 3.3 Free Ridership, Spillover and Net-to-gross Ratio

Adjustment / Project Type	Capital Incentive (%)	Program Enabled with Program-funded Enabler (%)	Program Enabled with Expert Consultation Only (%)	Overall Weighted Mean (%)
Free ridership *	16	0	60	38
Spillover	3	3	3	3
Net-to-gross ratio	**87**	**103**	**43**	**65**

* The free ridership estimate of program enabled projects at transmission service sites included the combined effects of the TSR and the program.

The overall weighted mean net-to-gross ratio was estimated as 65 per cent, driven by a high level of free ridership among a few large program enabled projects with expert consultation only. Although the TSR had some influence on these projects, they either did not have a program-funded energy study or did not have an energy manager in place between project initiation, customer decision and implementation.

Reported and evaluated net electricity and peak demand savings for NPD are shown below. Electricity savings are presented as an incremental annual rate of savings achieved within the fiscal year. Evaluated net energy savings provide an estimate of verified savings that are attributable to either the NPD program alone (for distribution service program participants) or the combined effect of the NPD program and the TSR (for transmission service program participants). Evaluated net savings in each fiscal year were calculated using the gross savings of each project multiplied by the net-to-gross ratio of its project type. Because the distribution of project types varies year by year, so did the yearly net-to-gross ratio.

Table 3.4 Comparison of Reported and Evaluated Net Savings

Year	Energy Savings (GWh/year)		Peak Demand Savings (MW)	
	Reported	Evaluated Net	Reported	Evaluated Net
F2009	0.7	0.7	0.1	0.1
F2010	29.3	24.7	3.5	3.0
F2011	97.1	50.1	11.7	6.0
F2012	53.9	41.0	6.5	4.9
F2013	9.6	8.7	1.2	1.0
F2014	3.8	3.3	0.5	0.4
TOTAL F2009-F2014	**194.4**	**128.4**	**23.3**	**15.4**

Note: Numbers may not add due to rounding.

The evaluated net electricity savings are 128.4 GWh/year from F2009 to F2014, which is 66 per cent of reported savings. The variance between reported and evaluated savings is due to higher than expected free ridership.

3.4 Findings and Recommendations

Findings

Listed below are the main findings of this study.

1. Marketing efforts by the program appear to have been successful, with very high participant and non-participant awareness of the energy study component, the role of the Key Account Manager, and the capital incentive offer.

2. The program achieved very high customer satisfaction levels, with 100 per cent of participants rating it as excellent or good in the 2011 survey and 92 per cent in the 2012-2014 survey.

3. Given the low rating for the ease of use of the capital incentives, there appear to be improvement opportunities related to the capital incentive process, to better align it with the planning cycle and business needs of industrial new construction projects.

4. Among participants, the overall cost of energy, incentives from BC Hydro, and advice from engineering consultants emerged as their top three decision making criteria for energy efficiency related capital expenditures.

5. A total of 36 per cent of gross savings were linked to a capital incentive agreement, 26 per cent to a program-funded energy study and 13 per cent to a program-funded energy manager. Energy managers were a common enabler for projects involving plant expansions, but negligible for projects involving new plants. A total of 31 per cent of gross savings came from new plants, as opposed to plant expansions.

6. The gross realization rate was 94 per cent. This result provides evidence that many projects are achieving their expected level of savings, and that BC Hydro's reported estimates of expected savings are reliable.

7. The overall net-to-gross ratio was estimated at 65 per cent, made up of 38 per cent free ridership and 3 per cent spillover.

8. Total evaluated net energy savings were 128.4 GWh/year and 15.4 MW in F2009 to F2014. This is 66 per cent of reported savings.

9. The evaluation analysis tested and ultimately employed several methods that were not previously used in past BC Hydro industrial program evaluations. These were: utilizing project performance data from both the program tracking system and the TSR tariff administration process; utilizing two independent lines of evidence (surveys and case studies) to assess free ridership; and considering the combined effect of the TSR and program in the estimation of free ridership for program participants at TSR sites. These methods were successful in improving the reliability and comprehensiveness of the results.

Recommendations

Listed below are recommendations resulting from this study, starting with recommendations for program management followed by recommendations for future evaluations.

Recommendations for program management:

1. Consider reviewing the process for incentive application and approval, in light of poor participant ratings of ease of use and length of time to receive incentives, and reviewing the process for program enabled projects in light of the required evidence demonstrating the enabler eligibility.

2. The overall net-to-gross ratio estimated for this evaluation of 65 per cent reflects a number of factors, including the mix of three project types (capital incentive, program enabled with program-funded enabler, program enabled with expert consultation only) used for free ridership estimation that were in effect during the evaluation timeframe. If this evaluation is to be used to inform a forecast net-to-gross ratio, it is recommended that a new net-to-gross ratio be estimated based on the forecast mix of the three project types used for free ridership estimation, which may be different from the mix that was in place during the evaluation timeframe.

3. While energy managers played a role in plant expansions, they were not a common enabler of energy savings for new plants. To promote participation among new plants, continue to provide a process and support for program participation in the absence of an energy manager.

Recommendations for future evaluations:

4. Triangulating two independent lines of evidence (case study and survey) for the estimation of free ridership proved to be successful at improving the reliability of the estimate, as demonstrated by high levels of coverage and convergence. This approach is recommended for future evaluations of industrial new construction programs.

5. For some projects, the TSR tariff administration tracking data provided higher quality estimates of gross electricity savings than were available through the NPD program tracking data alone. It is recommended that TSR tracking data continue to be used as a complement to program tracking data during evaluation review of projects with significant variation in production.

6. The TSR played a role in influencing some NPD participants to implement energy efficiency projects, and this role was included in the attribution analysis of the combined effect of the TSR and NPD program. It is recommended that future evaluations of industrial programs for transmission service customers also consider the combined effect of the TSR and program.

3.5 Conclusions

The BC Hydro New Plant Design program achieved its primary objective of acquiring electrical energy savings in new or expanded industrial facilities. The program's capital incentive and program enabled offers achieved 128.4 GWh/year of net electrical energy savings from F2009 to F2014, which is equivalent to 66 per cent of reported savings. The NPD program also achieved high levels of customer awareness and satisfaction.

4.0 Television Market: F2013-F2014

4.1 Introduction

This market and impact evaluation examines changes in the market for new televisions in British Columbia. It also presents an estimate of gross electricity savings from changes in the efficiency of TVs sold during a period of time that encompasses the introduction of the TV regulation setting minimum efficiency levels for new TVs sold in the Province of British Columbia. Market trends analysis is presented for BC Hydro's fiscal years[13] F2011 to F2014, and energy savings estimates are presented for F2013 and F2014.

The B.C. TV regulation took effect in January 2012 (on power only) and January 2013 (on and standby power) and applies to most TVs, including combination TVs, TV monitors and component TVs, but excludes front projectors. The regulation is equivalent to the Energy Star 4.1 efficiency standard. It establishes a maximum limit on TV power draw in on, standby and off modes. The limit when the TV is on is dictated by the following equation:

Maximum power in watts = 25 + (0.12 * screen area in square inches)

The limits in standby and off modes are 1 and 0.5 watt, respectively.

The market for TVs is a global one that evolves over time in response to competition among manufacturers, technology developments and consumer preferences, as well as government policies like energy efficiency standards and regulations and utility energy conservation programs. The energy efficiency of TVs sold in B.C. is a product of this evolution and the underlying drivers. Some of the drivers are external to B.C., such as Energy Star standards that influence TV manufacturers and energy efficiency regulations in Canada, California and other U.S. states that influence the efficiency of TVs sold throughout North America. And some of the drivers are internal to B.C., such as BC Hydro's demand side management programs and the B.C. TV regulation.

BC Hydro forecasts and reports gross electricity savings associated with energy efficient product regulations in its DSM Plan and uses these estimates in its load forecast. BC Hydro supports the development and introduction of energy efficient product standards and regulations by funding market and technical research and implementing DSM programs to ready the market for regulations. To support the B.C. TV regulation, BC Hydro implemented a Consumer Electronics Program. This program aimed to ready the new TV market for energy performance regulation, by provided retailer incentives for the most energy efficient TVs, as well as promotional material and funding for electronics recycling. This evaluation estimates the electricity savings in BC Hydro's service territory due to changes in the efficiency of TVs sold in B.C., which reflects the impact of the DSM program and B.C. TV regulation operating in the context of external drivers and the evolving global TV market.

[13] BC Hydro's fiscal year runs April 1 through the following March 31.

This evaluation does not estimate what proportion of TV energy savings are specifically attributable to the passage of the TV regulation, the Power Smart Consumer Electronics program, or other utility actions.[14]

4.2 Approach

Shown below are the evaluation objectives and research questions, followed by the data sources and methods.

Table 4.1 Evaluation Objectives and Research Questions

Objectives	Research Questions
1. TV market analysis	What were average annual sales of TVs from F2011 to F2014? What were the trends in energy efficiency of TVs from F2011 to F2014? What were the trends in TV screen size from F2011 to F2014? What was the compliance rate with the regulation for TVs sold in F2013 and F2014?
2. Electricity savings	What were the overall electricity savings due to changes in the B.C. TV market in F2013 and F2014? Is there a variance between the evaluated and reported savings and if so what is the source?
3. Market actor views	How do retailers make stocking decisions around TVs? What are retailers' views on customers' TV purchase decisions? How important do they believe energy efficiency is for customers? What are the drivers behind introducing energy efficiency standards in BC?

Table 4.2 Evaluation Objectives, Data Sources and Methods

Objectives	Data sources	Method
1. TV market analysis	Quarterly sales data by model (January 2010 to October 2014) 2010 Residential Monitoring Study (n = 45 TVs) Power draw data by model from manufacturers and web searches	Cross tabulations Trends analysis
2. Electricity savings	Data and results from Objective 1 Power Smart Standard Procedure for Cross Effects	Engineering algorithms
3. Market actor views	2014 Market Actor Interviews (n = 4)	Content analysis

Objective 1 was addressed through several steps.

- Estimate TV sales in the BC Hydro service territory, by quarter for the period January 2010 through September 2014.

[14] Impact evaluations often include estimates of the attribution of impacts to various interventions and agencies. BC Hydro forecasts and reports gross electricity savings associated with energy efficient product regulations in its DSM plan and uses these estimates in its Load Forecast. As BC Hydro did not require an estimated attribution of these savings to different drivers, such estimates were excluded from the scope of this evaluation.

- Determine power draw by model for all TVs sold.
- Estimate hours of use from metered hours of use of a non-random sample of homes.
- Estimate unit electricity consumption by model for all TVs sold.
- Estimate average unit electricity consumption for the entire market, as well as various market subgroups.

Objective 2 was addressed using engineering algorithms that compared the market average energy consumption of TVs sold in the base period (defined as January to March 2010), to the market average energy consumption of TVs sold in each of F2013 and F2014. Electricity savings were adjusted for cross effects. As noted above, electricity savings are gross estimates, and do not include adjustments for attribution.

Objective 3 was addressed through qualitative analysis of four interviews. Three interviews were with retailers, and one was with government.

4.3 Results

Results for Objective 1: TV Market Analysis

Total annual TV sales in B.C. went from 496,303 TVs in F2011 to 410,210 in F2014. Sales peaked in F2012 at 530,336 units. The share of TVs that met or exceeded the minimum energy efficiency level specified by the B.C. Regulation rose from 76 per cent in F2011 to 95 per cent in F2014. The 5 per cent of TVs that did not meet the minimum energy efficiency level by F2014 appear to be non-compliant with it, as opposed to being TVs exempted from the regulation.

The market average TV unit electricity consumption (**UEC**) dropped rapidly in 2010 and continued to decline through to 2014, although at a more moderate rate. The market average UEC was 285 kWh/year in the first quarter of 2010 and 128 kWh/year in the third quarter of 2014.

The average UEC of TVs that just met the efficiency level specified in the B.C. Regulation rose somewhat, from 133 kWh/year in the first quarter of 2010 to 196 kWh/year in the third quarter of 2014. This trend is likely due at least in part to the moderate increase in average TV size over the same timeframe.

In contrast, the average UEC of TVs that exceed the regulated efficiency level steadily dropped over the time period analyzed, from 147 kWh/year in the first quarter of 2010 to 102 kWh/year in the third quarter of 2014. This trend appears to be the result of continuous improvements to the efficiency of the most efficient TVs. For example, 2014 saw the introduction and increasing sales of TVs meeting the Energy Star 6.1 standard, while the B.C. Regulation was maintained at the equivalent of the older and less efficient Energy Star 4.1 standard.

By the end of the analysis timeframe (third quarter of 2014), the average consumption of TVs that did not meet the minimum efficiency levels of the B.C. Regulation was almost five times the market average. Such TVs accounted for 3 per cent of TV sales in the third quarter of 2014.

Results for Objective 2: Electricity Savings

Electric energy and peak demand savings are presented below.

Table 4.3 Summary of Electric Energy and Peak Demand Savings

Fiscal Year	Energy Savings (GWh/year)		Peak Demand Savings (MW)	
	Reported	Evaluated	Reported	Evaluated
F2013	65	63	15	13
F2014	65	59	15	12
Sum of F2013 and F2014	**130**	**122**	**30**	**25**

Evaluated savings of 122 GWh/year include:

- Savings due to the Power Smart Consumer Electronics program,[15] and
- 44 GWh/year of savings from TVs that were more efficient than the B.C. Regulation.

BC Hydro reported 130 GWh/year of savings associated with the TV Regulation for F2013 and F2014. While the reported savings value of 130 GWh/year is similar to the evaluated savings of 122 GWh/year, there are variances in the inputs to the evaluated and reported savings estimates. These variances are:

- Evaluated TV power draw in early 2010 (139 watts) is lower than assumed in reported savings (218 watts). As the power draw in early 2010 set the baseline for savings calculations for both the reported and evaluated savings, lower power use in that time period results in lower savings. Reported savings relied on a point estimate derived from a survey of TV retailer shelf stocking practices, whereas the evaluation had the benefit of quarterly sales data.
- Evaluated hours of use (5.6 hours per day) are higher than assumed in reported savings (4.4 hours per day). The evaluated estimate used metered data, whereas the reported estimate used survey self-report data. Higher hours of use result in greater savings.
- Evaluated savings are based on the market average UEC of all TVs sold in each year, which includes TVs that are more efficient than the minimum level set by the B.C. Regulation. In contrast, reported savings assumed that all compliant TVs just met the B.C. Regulation efficiency levels. Because the market average TV was more efficient than the minimum efficiency level specified in the regulation, using the market average value results in greater savings.

Results for Objective 3: Market Actor Views

Retailers[16] were asked how their company decides which types of televisions to buy and stock. Features and prices were cited as key factors, as were market trends regarding new technology. Energy efficiency was also cited, along with customer expectations that available TVs be energy efficient and be Energy Star rated.

[15] The Power Smart Consumer Electronics program reported savings of 4 GWh/year over F2013 and F2014, based on known participation, expected unit savings, and expected free ridership and spillover.

[16] Retailer respondents were Merchandise Managers and Vice Presidents for large retail chains.

Retailers were asked about their views on customer preferences regarding new TVs. They reported that style, features, price and energy efficiency were all relevant factors in customer decision making regarding new TV purchases.

A provincial government representative was asked about the drivers behind the introduction of energy efficiency standards in B.C. The B.C. *Clean Energy Act*, increasing energy efficiency standards in California, and BC Hydro market transformation efforts related to energy efficient appliances and electronics were all cited as important drivers.

The provincial government representative reported that BC Hydro was very influential in the decision to introduce the B.C. TV Regulation and that market transformation due to the Power Smart Consumer Electronics Program played a key role. Aspects of BC Hydro's contribution that were important to government included direct incentives, retail floor information, advertising, and efforts to raise awareness of Energy Star, as well as research, analysis, market surveying and cost comparisons.

4.4 Findings and Recommendations

Findings

The findings are summarized below.

1. By the end of F2014, the average efficiency of TVs sold in B.C. had moved well beyond the minimum efficiency level set by the TV regulation that was implemented in January 2012.

2. Information from the market actor interviews suggests that the Power Smart Consumer Electronics Program was one of several drivers behind the introduction of the B.C. TV Regulation.

3. Total TV sales averaged 480,000 per year over the four years analyzed. Peak sales occurred in F2012 at 530,000 units sold. In addition, TV sales have a strong seasonal component, with sales peaking in the fourth quarter of each calendar year.

4. The share of TV sales that did not meet the minimum efficiency levels specified in the B.C. Regulation fell from 84 per cent in the first quarter of 2010 to just 3 per cent by the third quarter of 2014.

5. The market average unit electricity consumption of TVs fell rapidly over the time period analyzed. Unit electricity consumption went from 285 kWh/year in the first quarter of 2010 to 128 kWh/year by the third quarter of 2014.

6. Electric energy savings associated with improvements in TV efficiency since the first quarter of 2010 were 63 GWh/year in F2013 and 59 GWh/year in F2014 for a total of 122 GWh/year over the two fiscal years. Total electric energy savings include savings due to the Power Smart Consumer Electronics Program and 44 GWh/year of savings from TVs that exceeded the minimum efficiency levels specified in the B.C. Regulation.

7. Analysis of quarterly sales data reveals limitations in the approach previously used by BC Hydro to estimate the market share of TVs by efficiency level. That approach relied on data collected once annually through site visits of retailers. It was used up to 2011, when TV sales data for B.C. first

became available. Analysis of sales data indicate that annual shelf stock data was not ideal for estimating the market share of TVs by efficiency level for two reasons. First, the TV market moved too rapidly to be adequately characterized by a once annual data collection effort. Second, the distribution of TV sales by efficiency level did not closely align with their shelf space share.

Recommendations

Below are recommendations from this evaluation:

1. Despite improvements in TV energy efficiency, there appear to be opportunities for incremental electricity savings in this market, particularly among TVs with very large screens, as well as working towards 100 per cent compliance with the regulation. Consider changes to the Power Smart program to offer graduated incentives to promote the purchase of smaller sized televisions. Consider also how the program could help the market move towards 100 per cent compliance by either helping to monitor non-compliance or using incentives or program eligibility criteria to encourage retailers to stock only compliant TVs.
2. Understanding the evolution of the TV market requires detailed, high frequency data on TV sales and energy consumption by efficiency level. If future estimates of TV energy efficiency and energy savings are required, then it is recommended that quarterly sales data be purchased periodically.
3. Understanding the role of market actors in market transformation is a complicated and rapidly-evolving issue. If a deeper understanding of these issues is required, it is recommended that market actors be surveyed on an annual basis to understand their views on how the TV market is evolving and the role of DSM programs and government regulations in this evolution.

4.5 Conclusions

TV energy efficiency in B.C. improved rapidly between 2010 and 2014 resulting in electricity savings in the BC Hydro service territory of 122 GWh/year by the end of F2014. The average unit electricity consumption of new TVs went from 285 kWh/year in the first quarter of calendar year 2010 to 128 kWh/year by the third quarter of calendar year 2014. Over the same timeframe, the share of TVs sold in B.C. that did not meet the minimum energy efficiency specified by the B.C. TV Regulation introduced in January 2012 dropped from 84 per cent to just 3 per cent.

Glossary

Baseline: A baseline is the initial condition occurring when a DSM activity begins. It may be a market share for equipment, a current standard, or a current average behavior.

Cross Effects: Cross effects (also known as interactive effects) refer to the effect that some energy conservation measures (**ECMs**) have on other electricity end uses beyond what the ECM itself produces. An obvious example is building lighting. As more efficient lighting is installed, less heat is generated by the lighting system. This means that less heat must be removed from the building by the air conditioning system during the cooling season, but more heat needs to be supplied by the heating system during the heating season.

Demand Side Management (DSM): The definition of Demand Side Management is the same as the definition of "demand-side measures" set out in section 1 of the *Clean Energy Act*, which is "a rate, measure, action or program undertaken; (a) to conserve energy or promote energy efficiency, (b) to reduce the energy demand a public utility must serve, or (c) to shift the use of energy to periods of lower demand, but does not include (d) a rate, measure, action or program the main purpose of which is to encourage a switch from the use of one kind of energy to another such that the switch would increase greenhouse gas emissions in British Columbia, or (e) any rate, measure, action or program prescribed".

End Use: The final application or final use to which energy is applied. Recognition of the fact that electric energy is of no value to a user without first being transformed by a piece of equipment into a service of economic value. For example, office lighting is an end use, whereas electricity sold to the office tenant is of no value without the equipment (light fixtures, wiring, etc.) needed to convert the electricity into visible light. End use is often used interchangeably with energy service.

EnerGuide: The EnerGuide Rating System is a national initiative provided by Natural Resources Canada. An EnerGuide rating shows a standard measure of a home's energy performance; how energy-efficient a home is. The rating is calculated based on standard operation assumptions so that the energy performance of one house can be compared against another. The home's energy efficiency level is rated on a scale of 0 to 100. A rating of zero represents a home with major air leakage, no insulation and extremely high energy consumption. (Source: NRCan)

ENERGY STAR®: ENERGY STAR® is the mark of high-efficiency products in Canada that meet strict technical specifications for energy performance—tested and certified. These products save energy without compromising performance in any way. Typically, an ENERGY STAR® certified product is in the top 15 to 30 per cent of its class for energy performance.

Expected Savings: Estimate of gross energy savings based on customer initially reported savings, engineering review and site inspection. These estimates represent the unverified savings.

Free Riders: Free riders are program participants who would have taken the demand-side management (DSM) action, even in the absence of the DSM program. They are a part of the reference case. These actions are not attributable to the program.

Gigawatt Hour (GWh): One billion watt-hours; one million kilowatt hours.

Gross Savings : The change in energy consumption and/or associated demand that results directly from program-related action taken by the participants in the demand side management program irrespective of why they participated.

Market Changes: Market Changes refers to the changes in the structure or operations of markets during the course of an energy efficiency program that indicate increased levels of adoption of energy-efficient products and practices by customers and/or increased levels of promotion and delivery by suppliers.

Market Transformation: Market Transformation refers to a permanent change in the structure or functioning of markets, including more energy-efficient behaviour among customers and higher market penetration of energy-efficient products, as a result of demand-side management (DSM) programs that reduce barriers to energy efficiency. These market changes are likely to persist in the absence of continued program activity.

Net savings: The change in energy consumption and/or associated demand that is attributable to the utility DSM program. The change in consumption or associated demand may include the effects of free riders and spillover.

Net-to-gross ratio: A factor representing net demand side management program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts. The factor is made up of a variety of factors that create differences between gross and net savings, commonly including free riders and spillover. Other adjustments may include rebound, cross effects and measurement and verification results.

Non-energy benefits: Benefits that accrue to program participants (e.g., increased property values, decreased water and sewer bills, increased comfort, health and safety), to the utility (e.g., bill payment improvements, decreased service calls), or to society in general (e.g., improved environmental health, job creation).

Peak 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.

Persistence: Refers to how long the energy savings are expected to be attributable to the demand side management activity.

Realization Rate: The ratio of initial estimates of savings to savings adjusted for data errors and measurement and verification results. Does not reflect program attribution or influence on the savings achieved.

Reported Savings: Estimate of energy savings being recorded in the program tracking database. Reported savings are based on best information available from technical review of the initial engineering estimate, post implementation review of documentation and/or inspection, or measurement and verification results, as well as, a forecast net-to-gross ratio applied.

Spillover: Refers to program participants and non-participants whose energy savings measures occur through actions that are not part of a program, but which were influenced by the program (also called free drivers or tag-ons). Participant spillover is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy savings practices after having participated in the efficiency program, as a result of the program's influence. Non-participant

spillover refers to energy savings that occur when a program non-participant installs energy efficiency measures or applies energy savings practices as a result of a program's influence. Spillover is expressed as a fraction of the increase of energy savings due to spillover to the gross energy savings of the program participant. Spillover may not be permanent and may not continue in the absence of continued program activity.

UEC: Unit electricity consumption, in kWh/year.

BC hydro
powersmart

Refrigerator Buy-Back Program

Evaluation F2011 and F2012

February 25, 2013

Prepared by:
Power Smart Evaluation

ACKNOWLEDGEMENT

The lead author was Ken Tiedemann. Marc Pedersen, Ron Sahota and Shashi Maharaj contributed to data collection and analysis, and Michael Li shared his evaluation report for F2010. Ed Vine, Rafael Friedmann, Anthea Jubb, John Duffy and Oscar Ceron provided comments and suggestions.

TABLE OF CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

Introduction

This report provides an evaluation of the impacts and effects of BC Hydro Power Smart's Refrigerator Buy-Back program for BC Hydro's fiscal year 2011 and 2012 (F2011-12). The Refrigerator Buy-Back program is a multi-year energy acquisition initiative that encourages its customers to turn in unused or little used refrigerators for recycling in an environmentally friendly manner. The program offer has three main features: (1) free refrigerator pick-up from customers' homes; (2) free disposal of the refrigerator in an environmentally friendly manner; and (3) $30 incentive for each refrigerator collected with a maximum of two refrigerators per household. The program also offered limited freezer pick up.

The Refrigerator Buy-Back program objectives are to: (1) generate energy savings for BC Hydro by reducing the number of inefficient spare refrigerators in the market and by removing inefficient refrigerators from the resale market; (2) provide a specific opportunity for customers to reduce their electricity bills; and (3) increase consumer awareness of energy efficiency and home energy management by educating customers about the high electricity consumption associated with spare refrigerators.

Issues and Methods

For this study, there were six main issues: (1) conduct a program review; (2) undertake a supply side assessment; (3) undertake a demand side assessment; (4) produce and analyze on hours of use and load information; (5) estimate energy and peak demand savings; and (5) examine the extent of market transformation.

1. **Program Review.** To conduct the program review and develop the program logic model, we reviewed program documents, interviewed BC Hydro program staff, and conducted a literature review focussing on recent studies and reports on appliance recycling programs.

2. **Supply Side Assessment.** To conduct the supply side assessment we tabulated and examined relevant results of the four recent waves of the annual Showroom Presence Study of Appliances and Electronics. This survey visits 35-40 appliance retailers per year.

3. **Demand Side Assessment.** To conduct the demand side assessment we tabulated and examined relevant results of the participant and non-participant surveys. Each of these surveys included 401 respondents and provides accuracy of plus or minus five percent, nineteen times out of twenty.

4. **Metering Study.** To analyze refrigerator power consumption, we conducted extensive energy consumption testing at BC Hydro's Powertech Labs facility.

5. **Energy and Peak Demand Savings.** To estimate peak demand (kW) and energy (kWh) savings for recycled refrigerators and freezers, we used the algorithms (1) and (2) shown below.

   (1) ΔkWh = Program incented units · unit energy savings · operational rate · electricity cross effects adjustment · net to gross ratio.

   (2) ΔkW = Program incented units · unit demand savings · operational rate · electricity cross effects adjustment · net to gross ratio.

6. **Market Transformation.** To estimate the extent of market transformation, we estimated times-series models of the saturation rate for second refrigerators.

Table E.1 provides a summary of the evaluation issues, data sources and methods for this study.

Table E.1. Evaluation Issues, Data Sources and Methods

Issues	Data Sources	Methods
Program review	Program staff interviews Program documents review Literature review	File and document review
Supply side assessment	Showroom Presence Study of Appliances and Electronics (n = about 40 per year)	Cross tabulations
Demand side assessment	Participant Survey (n = 401) Non-participant Survey (n = 401)	Cross tabulations Z-tests Chi-squared test
Metering study	Powertech lab testing (n = 337)	Load analysis
Energy and peak demand savings	Powertech lab testing (n = 337) Participant Survey (n = 401) Non-participant survey (n = 401)	Engineering algorithms
Market transformation	Power Smart 2012 Residential End Use Survey BC Statistics data	Time-series regressions

Results

Program Review. We assessed program rationale by developing a program logic model which: (1) divides a program into its main activities; (2) examines the logic chain of inputs, outputs, purpose and goal for each activity; and (3) assesses the assumption which are required for the program logic to be sound. The program had three main activities: marketing; refrigerator pick-up and recycling. The rationale for the Refrigerator Buy-Back program was examined using this program logic model, which was developed from interviews with staff, a documents review and a literature review. This review and analysis confirmed that the basic program logic was valid. There were strong linkages among inputs, outputs, purposes and goal statements. Indicators for key components of the logic model were clear, well defined and measurable.

Supply Side Assessment. The assessment of the supply side of the market for refrigerators was based on the four most recent annual Showroom Presence Study of Appliances and Electronics surveys, conducted in about 40 appliance retail stores each year. Key supply trends were as follows:

- Capacity. For all refrigerator types, average capacity was 20.3 cubic feet in 2009, 20.3 cubic feet in 2010, 20.3 cubic feet in 2011 and increased slightly to 20.9 cubic feet in 2012.
- Energy Consumption of New Refrigerators. Average energy consumption has not changed significantly over the period 2009-2012, and for all refrigerator types, average energy consumption was 488 kWh per year in 2009, 471 kWh per year in 2010, 469 kWh per year in 2011 and 470 kWh per year in 2012.
- Price. The average price of a refrigerator was $1,613 in 2012, an increase of $85 from 2011 - the lowest price refrigerator was $290 and the highest price refrigerator was $14,350.

Demand Side Assessment. The assessment of the demand side of the market was based on a quasi-experimental design using a survey of 401 participants and 401 non-participants. Highlights of the demand side assessment are as follows:

- Refrigeration Saturation. Non-participants owned an average of 2.37 refrigerators compared to 1.48 refrigerators for participants, and the difference was statistically significant.
- Operational Rate. Participants were more likely to have disposed of a refrigerator that was operational at the time of disposal (91%) than were non-participants (74%), and the difference was statistically significant.
- Capacity of Refrigerator. There is no significant difference in refrigerator capacity between refrigerators recycled by program participants and non-participants.
- Age of Refrigerator. Participants recycled refrigerators which were significantly older than those recycled by non-participants, with an average age of 18.0 years for participants compared to 13.5 years for non-participants.
- Program Influence. Participants were more likely to be influenced by the program in their decision to recycle the refrigerator than non-participants, and the difference was statistically significant.
- Participant Satisfaction. Participants had high levels of satisfaction with the initial call to arrange a refrigerator pick-up, arranging a pick-uptime, and overall satisfaction with the program.
- Program Awareness. 71% of non-participant respondents had heard of the program before the survey was administered.

Metering Study. BC Hydro pick-up contractors delivered 400 refrigerators to the BC Hydro Powertech Labs testing facility. Of the 400 units, only 337 refrigerators were operative and were tested. The 63 units not included in the final data base did not operate for various reasons or developed problems soon after they were activated. Units are moved multiple times before reaching the Powertech Labs, resulting in damage to some units rendering them inoperable. Of the 337 operable units, only 319 refrigerators cooled below 8°C and 275 were able to achieve temperatures of 5°C or less. There were 16 groups of refrigerators tested with an average of 21 units per test group that provided meaningful data. The refrigerators operating between 1ºC and 5ºC consumed an average of 69.3 kWh per month, while the average for all the refrigerators that provided acceptable test data was 75.4 kWh per month or 905 kWh per year.

Energy and Peak Demand Savings. Gross unit refrigerator energy consumption was calculated based on the results of the metering study, while gross unit freezer energy consumption was calculated based on an industry standard refrigerator to freezer energy consumption ratio.

Free ridership was calculated using the destination approach with participant survey data as inputs. The destination approach is a standard framework for the evaluation of appliance recycling programs, and is used to assess the probability that a fridge would stay connected to the BC Hydro grid in the absence of the program recycling it. Non-participant spillover was calculated based on the outcome of the non-participant survey and market data. Free ridership and non-participant spillover were combined to generate a net to gross ratio.

An adjustment for electricity cross effects was applied to account for the space heating penalty and cooling system benefit associated with increased energy efficiency. A deduction was also applied to account for the operational rate, and to account for the proportion refrigerators that were not operational.

The program is not assumed to induce the purchase of new refrigerators and therefore no deduction is made for the energy consumption of new refrigerators. This assumption is supported by the program design, evaluation industry standard practice for appliance recycling programs, as well as evidence that the refrigerators recycled by the program are not substitutes for new fridges.

Net unit energy savings are the product of gross unit energy consumption, the net to gross ratio, electricity cross effects adjustment, and the operational rate. Net unit demand savings are the product of gross unit demand savings, the net to gross ratio, electricity cross effects adjustment, and the operational rate. The following table provides the net unit energy and peak demand savings for refrigerators and freezers.

Table E.2. Net Unit Energy and Peak Demand Savings

	Gross Unit Energy Savings (kWh/y)	Gross Unit Demand (W)	Net to Gross Ratio	Electricity Cross Effects Adjustment	Operational Rate	Net unit Energy Savings (kWh/y)	Net Unit Demand (W)
Refrigerator	905	109	0.74	0.94	0.85	535	63
Freezer	812	97	0.74	0.98	0.85	501	60

Net total energy savings are the product of net unit energy savings and the number of units picked up by the program. Net total peak demand savings are the product of net unit peak demand savings and the number of units picked up by the program.

Table E.3. Net Total Energy and Demand Savings

Year	Appliance	Net Unit Energy (kWh/y)	Net Unit Demand (W)	Units	Net Energy Savings (GWh/y)	Net Demand Savings (MW)
F2011	Refrigerator	535	63	33,573	18.0	2.1
	Freezer	501	60	625	0.3	0.0
	Total				18.3	2.2
F2012	Refrigerator	535	63	31,493	16.8	2.0
	Freezer	501	60	633	0.3	0.0
	Total				17.2	2.0

Reported and evaluated energy and peak demand savings for the Refrigerator Buy-Back Program in F2011 and F2012 are compared in the following table.

Table E.4. Reported and Evaluated Energy and Peak Demand Savings

Year	Energy Savings (GWh/y)		Peak Demand Savings(MW)	
	Reported	Evaluated	Reported	Evaluated
F2011	21.2	18.3	2.4	2.2
F2012	17.9	17.2	2.0	2.0

Market Transformation. The key findings are that: (1) presence of the program reduces the overall saturation rate of second refrigerators by about 1.4% per year; (2) presence of the program reduces the single family dwelling saturation rate of second refrigerators by about 2.2% per year; and (3) presence of the program reduces the duplex and row house saturation rate of second refrigerators by about 1.2% per year.

1.0 Introduction and Background

1.1 Introduction

This report provides an evaluation of the impacts and effects of BC Hydro Power Smart's Refrigerator Buy-Back (RBB) program for BC Hydro's fiscal year 2011 and 2012 (F2011-12). An outline of this evaluation study is as follows: Section 1 presents the program background and the literature review; Section 2 presents the approach including evaluation issues, data sources and methods; and Section 3 presents the results including those for the demand side assessment, supply side assessment, metering study, and energy and peak demand savings.

1.2 Program Background and Logic Model

Introduction. The Refrigerator Buy-Back program is a multi-year energy acquisition initiative that encourages its customers to turn in unused or little used refrigerators for recycling in an environmentally friendly manner. Since 2002, the Refrigerator Buy-Back program has removed over 300,000 older inefficient refrigerators from the market. The rationale for the program is that by removing older, inefficient and underused refrigerators produces energy savings in two ways: first, through the permanent removal of spare refrigerators from homes; and, second, through the reduction of the supply of inefficient refrigerators in the market by collecting primary refrigerators which would have been given away or resold after replacement.

The program has faced three main challenges in recent years. First, although the program targets unused or underused spare refrigerators, a significant share of the refrigerators picked up are primary units. Second, there has been a modest decline in program participation over the past five years. Third, unit energy savings have been declining over time.

The program offer has three main features: (1) free refrigerator pick-up from customers' homes; (2) free disposal of the refrigerator in an environmentally friendly manner; and (3) $30 for each refrigerator collected with a maximum of two refrigerators per household. The Refrigerator Buy-Back program objectives are to: (1) generate energy savings for BC Hydro by reducing the number of inefficient spare refrigerators in the market and by removing inefficient refrigerators from the resale market; (2) provide a specific opportunity for customers to reduce their electricity bills; and (3) increase consumer awareness of energy efficiency and home energy management by educating customers about the high electricity consumption associated with spare refrigerators. The program has three main activities which are: marketing, refrigerator pick-up, and refrigerator recycling.

A limited number of freezers were also recycled by the program as part of time bound promotional campaigns. Freezer pick up was based on the same program rationale as refrigerator pick up. No incentive was provided for freezers.

Marketing. Although previous Refrigerator Buy-Back phases had built up a high base level of customer awareness, the slight reduction in pick-up volumes by 2008, compared to previous years, led to a revitalization of program marketing efforts. Specifically, Power Smart developed and implemented a new refrigerator media campaign. The new advertising focussed specifically in the spare refrigerator market with a visual image of a spare refrigerator in a garage. Detailed customer profiles were used to: (1) target specific areas of participation; (2) address core markets; and (3) identify main areas of market opportunity. The communication strategy emphasized low-cost promotional channels including bill inserts, point of purchase material in

appliance stores, and cross promotional opportunities including BC Hydro Power Smart's loyalty program, Team Power Smart and with BC Hydro Power Smart's Energy Star Appliance Rebate program. As an example, the F2012 Refrigerator Buy-Back campaign included the following components, in addition to usual program activity:

- Power Smart Month. Refrigerator Buy-Back was heavily promoted during BC Hydro's Power Smart Month promotion in F2011. From October 1 - October 31, 2011 promotions included print ads, radio spots in English Chinese and Punjabi and promotion via social media.
- Partnership Promotion with Air Miles. Refrigerator Buy-Back worked with Air Miles to promote the program. Air Miles members were offered 175 additional air miles for turning in their inefficient spare refrigerator to the program.
- Team Power Special Promotion. From September 18 – September 30, 2011, Team Power Smart members were offered the opportunity to receive an enhanced reward of $50 for turning in their inefficient spare refrigerator.
- Contest. From February 21 – April 8, 2011, contestants could enter a contest for a chance to win up to $1,000 in groceries by scheduling a pick-up for their inefficient spare refrigerator.

Refrigerator Pick-up. The program process has four main steps: (1) The customer calls BC Hydro's agent to book an appointment to have their working spare refrigerator picked up by a contractor working in their neighbourhood; (2) the pick-up and disposal contractor picks up the refrigerator at the home and transports it to a dismantling facility; (3) appropriate paperwork is submitted by the pick-up and disposal contractor; and (4) a $30 incentive cheque is mailed to the customer. BC Hydro has used the same fulfillment house for several years to maintain service continuity, and has a series of one year contract renewals in place with agents including refrigerator pick-up companies, dismantling facilities, storage companies and long haul transport companies who implement the strategy.

Refrigerator Recycling. The dismantling facility removes and destroys the CFCs which are used as coolant and prepares the rest of the materials for recycling. In those cases where there is not a dismantling facility in the town where the refrigerator was collected, storage facilities are employed until there are enough refrigerators collected to justify long-haul transportation to an appropriate dismantling facility.

Program Rationale. Program rationale is concerned with the question "what is the rationale for the program and does this rationale make sense?" We assessed program rationale by reviewing the program logic model which: (1) divides a program into its main activities; (2) examines the logic chain of inputs, outputs, purpose and goal for each activity; and (3) assesses the assumption which are required for the program logic to be sound. This review and analysis confirmed that the basic program logic was valid. There were strong linkages among inputs, outputs, purposes and goal statements. Indicators for key components of the logic model were clear, well defined and measurable.

The following table provides a program logic model which focusses on the input, output, purpose and goal statements for each of the three main activities. It also describes key assumptions which must be met for the program to be effective. The program logic model was developed from interviews with staff, a documents review and a literature review.

Table 1.1. Program Logic Model

	Marketing	Pick-up	Recycling	Assumptions
Inputs	Program marketing and promotional activities including; regular advertising such as point of purchase material; Power Smart month print, radio and social media promotions; and Team Power Smart promotions	Customers contact BC Hydro about pick-up scheduling, put their refrigerator outside for pick-up, contractors check working condition, contractors pick-up and deliver refrigerators to recycling facility	Recycling facility removes refrigerator wiring, motors, compressors, CFCs and other materials, and materials are destroyed or recycled as appropriate	Despite previous program efforts and successes, a significant number of residential customers are interested in refrigerator recycling
Outputs	Achieve an awareness level of 55% in the non-participant customer population	Refrigerators are picked up and transported to a recycling centre, and RBB maintains a program satisfaction level of 99% among participating customers	Recycle 116,000 refrigerators by the end of F2013	The free rider rate does not significantly jeopardize the cost effectiveness of RBB
Purpose	Residential customers are interested in participating in the RBB program	Maintain a program satisfaction level of 99% among participating customers	Recycle the refrigerators in an environmentally appropriate manner	Rebound is not significant
Goals	Generate annual energy savings of 61.9 GWh per year by the end of F2013 Increase customer awareness of energy efficiency and home energy management Provide a specific opportunity for customers to reduce their electricity bills			

1.3 Methodology Review

Electricity utilities have used considerable resources to understand the impact of appliance recycling programs. Appliance recycling programs are unusual compared to most residential demand side management programs because they involve removing an old measure rather than putting in place a new measure. This has some implications for impact evaluation practice, particularly with respect the determination of an appropriate net to gross ratio. In most cases, simple engineering algorithms are employed to estimate the impact of these programs. In these engineering algorithms, gross savings are typically informed by some combination of in situ metering, laboratory metering and multivariate regressions where energy consumption is modelled as a function of appliance characteristics, customer demographics and weather-related variables. Net savings are typically informed by data from some combination of participant surveys, non-participant surveys and trade ally surveys.

To understand the scope, approach and results of recent evaluations of appliance recycling programs, a review of a number of recent studies was undertaken. The studies were identified through a search of the CEE and IEPEC websites as well as an internet search. To be included in this summary, the study had to meet the following criteria: (1) the study methods used to evaluate net and gross energy savings had to be clearly identified and transparent; (2) the study had to report on the number of participants for both refrigerators and freezers; and (3) the study had to report both unit gross and unit net savings or provide enough information so that these quantities could be calculated. For most utilities, the most recently published study of appliance recycling for the utility was used. However, for the California investor owned utilities (IOUs), the most recent available study was not used because it covered only refrigerator savings and not freezer savings and because of a change in state policy that only measures with savings of 1% or more of total savings would be evaluated. Also note, that for SCE there were three separate initiatives evaluated: SCE PGC; SCE Procurement; and SCE 2005 Summer Initiative. In addition, we reviewed the draft Refrigerator Recycling Evaluation Protocol of the Uniform Methods Project [Bruchs (2012)].

Table 1.2 provides a comparison of the evaluation scope and evaluation methods for these studies. Although there are some variations, the scope of the studies examined is quite similar from the impact study perspective. All studies place a major emphasis on estimating gross savings and the net to gross ratio. Three main methods are used to estimate gross savings: (1) laboratory testing where refrigerators are monitored under controlled conditions using the DOE (United States) or CSA (Canada) protocols; (2) in situ metering where refrigerators are monitored under actual use conditions; and (3) the American Home Appliance Manufacturers (AHAM) method where a large database of deemed energy use is used to calibrate individual program savings by unit. All studies use a variant of the destination approach to determine the net to gross ratio. In the destination approach, customers are asked a series of detailed questions about what would have happened to the appliance, if it had not been recycled through the recycling program.

Table 1.2. Recent Recycling Program Evaluation Summaries

Utility	Source	Period	Scope	Methods
Ameren Illinois	Cadmus (2010)	2010	Determine average annual gross savings, degradation of performance, and net to gross ratio	Regression models calibrating gross savings of participating units to existing energy consumption data base, participant survey for net to gross
Cape Light Compact	NMR (2011)	2010	Estimate/calibrate annual gross savings, calculate net to gross ratio	Two regression models relating savings in the units recycled to energy use recorded in a California database and to the AHAM database, participant survey to determine net to gross
Commonwealth Edison	Summit Blue (2009)	F2009	Determine average annual gross energy savings, calculate net to gross ratio	Regression modelling relating savings in the units recycled to energy use recorded in a California database using the DOE method, survey of participants to determine net to gross ratio
Connecticut Light and Power	NMR (2005)	2004	Measure and verify achieved levels of energy and peak savings, provide feedback on program effectiveness, analyze spare market	Augmented comparisons and regression modelling using participant and non-participant billing analysis to determine gross savings, participant survey to determine net to gross, mystery shopper calls and trade interviews

Table 1.2 Continued. Recent Recycling Program Evaluation Summaries

Utility	Source	Period	Scope	Methods
National Grid	NMR (2011)	2010	Estimate/calibrate annual gross savings, calculate net to gross ratio	Two regression models relating savings in the units recycled to energy use recorded in a California database and to the AHAM database, participant survey to determine net to gross
NSTAR	NMR (2011)	2010	Estimate/calibrate annual gross savings, calculate net to gross ratio	Two regression models relating savings in the units recycled to energy use recorded in a California database and to the AHAM database, participant survey to determine net to gross
PG&E (Pacific Gas and Electric)	ADM (2008)	2004 - 2005	Determine average annual gross energy savings, calculate net to gross ratio, investigate disparities between DOE and in situ metering	Dual metering of appliances including in situ and lab testing using DOE protocol, surveys with participants, non-participants and trade allies to determine net to gross ratio, surveys with trade allies to determine impact on availability of used appliances
Rocky Mountain Power Idaho	Cadmus (2012)	2009 - 2010	Determine average annual gross energy savings, calculate net to gross ratio	Regression modelling based on refrigerator database to determine unit savings, surveys with participants and non-participants to determine net to gross ratio
Rocky Mountain Power Utah	Cadmus (2010b)	2008	Determine average annual gross energy savings, calculate net to gross ratio	Regression modelling based on refrigerator database to determine unit savings, surveys with participants and non-participants to determine net to gross ratio
SCE (Southern California Edison)	ADM (2008)	2004 - 2005	Determine average annual gross energy savings, calculate net to gross ratio, investigate disparities between DOE and in situ metering	Dual metering of appliances including in situ and lab testing using DOE protocol, surveys with participants, non-participants and trade allies to determine net to gross ratio, surveys with trade allies to determine impact on availability of used appliances
SDG&E (San Diego Gas and Electric)	ADM (2008)	2004 - 2005	Determine average annual gross energy savings, calculate net to gross ratio, investigate disparities between DOE and in situ metering	Dual metering of appliances including in situ and lab testing using DOE protocol, surveys with participants, non-participants and trade allies to determine net to gross ratio, surveys with trade allies to determine impact on availability of used appliances
SMUD (Sacramento Municipal Utility District)	ADM (2007)	2006	Determine average annual gross energy savings, calculate net to gross ratio	In situ metering of refrigerators to determine gross savings, surveys with participants to determine net to gross ratio
United Illuminating Company	NMR (2005)	2004	Measure and verify achieved levels of energy and peak savings, provide feedback on program effectiveness, analyze spare market	Augmented comparisons and regression modelling using participant and non-participant billing analysis to determine gross savings, participant survey to determine net to gross, mystery shopper calls and trade interviews
Western Massachusetts	NMR (2010)	2010	Estimate/calibrate annual gross savings, calculate net to gross ratio	Two regression models relating savings in the units recycled to energy use recorded in a California database and to the AHAM database, participant survey to determine net to gross

2.0 Approach

2.1 Evaluation Issues and Data Sources

For this study, there were five main activities as follows:

1) conduct a program review;
2) undertake a supply side assessment;
3) undertake a demand side assessment;
4) analyze refrigerator energy use and demand using in-lab metered data;
5) estimate energy and peak demand savings; and
6) examine the extent of market transformation.

A summary of the activities, data and methods for this study is shown in Table 2.1. The study uses information collected from program files, program staff interviews, customer surveys, in-store surveys, metered data, and literature review to build a comprehensive database for the analysis. A key step was to determine the set of researchable questions for each issue, since this then determined the data collection requirements. To determine the researchable questions, the following procedure was used. First, previous evaluations of the Refrigerator Buy-Back program were reviewed to understand the researchable questions from these studies, the approach and data used to answer each question, and the present relevance of the question. Second, a literature review was undertaken to understand the scope, approach and findings of recent evaluations of appliance recycling programs undertaken by other utilities. Third, the proposed scope for the evaluation was developed and reviewed with the program manager. A summary of the main evaluation questions for each issue is shown in Table 2.1.

Table 2.1. Evaluation Activity, Data Sources and Methods

Issues	Data Sources	Methods
Program review	Program staff interviews Program documents review Literature review	File and document review
Supply side assessment	Showroom Presence Study of Appliances and Electronics (n = about 40 per year)	Cross tabulations
Demand side assessment	Participant Survey (n = 401) Non-participant Survey (n = 401)	Cross tabulations Z-tests Chi-squared test
Metering study	Powertech lab testing (n = 337)	Load analysis
Energy and peak demand savings	Powertech lab testing (n = 337) Participant Survey (n = 401) Non-participant survey (n = 401)	Engineering algorithms
Market transformation	Power Smart 2012 Residential End Use Survey BC Statistics data	Time-series regressions

Table 2.2. Evaluation Activity and Main Questions

Issue	Question
Program review	What are the key program components? Is the program logic sound? Has the program had an impact on saturation of second refrigerators?
Supply side assessment	What are refrigerator capacity trends by configuration? What are refrigerator energy consumption trends by configuration? What are refrigerator price trends by configuration?
Demand side assessment	How comparable are participant and non-participant survey samples? What are refrigeration saturation levels for participants and non-participants? How do refrigerator characteristics compare for participants and non-participants? How does program influence on the refrigerator disposal decision compare for participants and non-participants? What is the level of participant satisfaction with program components? Was the removed refrigerator replaced? What is the level of non-participant awareness of the program?
Load analysis	What is daily metered energy use? What is daily metered peak coincident demand? How is daily metered energy use affected by ambient temperature?
Energy and capacity savings	How large are gross unit energy savings? How large are gross unit demand savings? What is the free rider rate? What is the spillover rate? What are net total energy savings? What are net total demand savings?
Market transformation	Has the program had a measurable impact on the saturation rate of second refrigerators?

2.2 Methods

The evaluation method is a quasi-experiment with a comparison group.

Program Review. To conduct the program review and develop the program logic model, we reviewed program documents, interviewed BC Hydro program staff, conducted a literature review focussing on recent studies and reports on appliance recycling program, and built time-series regression models of saturation rates for second refrigerators.

Supply Side Assessment. To undertake the supply side assessment, we tabulated and examined relevant results of the four recent waves of the annual Showroom Presence Study of Appliances and Electronics. This survey visits 35-40 appliance retailers per year.

Demand Side Assessment. To undertake the demand side assessment, we tabulated and examined relevant results of the participant and non-participant Refrigerator Buy-Back surveys. Each of these surveys included 401 respondents and provides accuracy of plus or minus five percent, nineteen times out of twenty.

Metering Study. To produce and analyze hours of use by season, a study was conducted at BC Hydro's Powertech Labs. BC Hydro pick-up contractors delivered 400 refrigerators to the Powertech Labs testing facility, of which 337 units were operative and tested under controlled conditions using the Canadian Standards Association (CSA) protocol.

Energy and Demand Savings. To estimate capacity (kW) and energy (kWh) savings for recycled refrigerators, we used the algorithms (1) and (2) shown below.

(1) *ΔkWh = Program incented units · unit energy savings · operational rate · electricity cross effects adjustment · net to gross ratio.*

(2) *ΔkW = Program incented units · unit demand savings · operational rate · peak coincidence factor · electricity cross effects adjustment · net to gross ratio.*

Market Transformation. To estimate the extent of market transformation, we estimated time-series models of the saturation rate for second refrigerators.

3.0 Results

3.1 Supply Side Assessment

In this section, we examine details of the supply side of the market for refrigerators based on the four most recent annual Showroom Presence surveys summarized in Justason (2012). Although this evaluation focusses on recycled refrigerators and not on new ones, understanding the new refrigerator market is important for several reasons. First, point of purchase marketing material in appliance stores encourages customers to participate in the Refrigerator Buy-Back Program. Second, an understanding of the new fridge market is required to assess whether or not the program may be inducing the purchase of new refrigerators, and if so, the characteristics of new refrigerators is an input to the calculation of evaluated savings. The supply side analysis focusses on trends in refrigerator capacity, energy consumption and price.

Showroom Presence Study. The Showroom Presence study used an observational approach to understand the stock of residential appliances in stores in British Columbia. The researchers received detailed training about appliances and received clear reporting instructions in order to undertake a complete census of products of interest in the stores. Data collected was undertaken from January 24, 2012 through February 21, 2012 at 32 stores. The list of stores to be visited was drawn at random from a database of relevant stores

The purpose of this work was to measure the showroom presence of refrigerators. A census of information on the showroom floor was undertaken, but no information was available on the number of models out of public view. It should be noted that the presence of refrigerator units directly impacts customer exposure, but it is not a proxy for sales since even popular models may have only one display model on the floor.

Data collected at the store level were weighted to reflect each retailer's share of the market within the Lower Mainland and outside the Lower Mainland. The weighted calculations were based on the number of stores in each region by retail banner according to the information on company websites and the number of stores sampled in each region.

Table 3.1. Stores Visited for Refrigerators in 2012

Banner	Lower Mainland	Victoria	Kamloops	Prince George	Total
Canadian Tire	1				1
City Furniture			1		1
Coast	1	1			2
Costco	1	1	1	1	4
Future Shop	2	1	1	1	5
Home Depot	1		1	1	3
IKEA	1				1
Sears	3	1	1	1	6
The Bay	1	1	1	1	4
The Brick	1		1	1	3
Trail	1	1			2
Total	13	6	7	6	32

Capacity. Average refrigerator capacity in cubic feet varies by configuration but has not changed much over the period 2009-2012. For all refrigerator types, average capacity was 20.3 cubic feet in 2009, 20.3 cubic feet in 2010, 20.3 cubic feet in 2011 and increased slightly to 20.9 cubic feet in 2012. On average, side by side refrigerators have slightly higher capacity than freezer on top or freezer on bottom refrigerators.

Table 3.2. Average Capacity by Refrigerator Type (cubic feet)

	Top	Bottom	Side by side	All refrigerators
2009	18.0	20.9	23.4	20.3
2010	17.4	20.7	23.0	20.3
2011	16.5	21.4	23.2	20.3
2012	17.5	21.8	23.3	20.9

Energy Consumption. Estimated average energy consumption in kWh per year is based on the EnerGuide rating for each refrigerator. Average energy consumption has not changed significantly over the period 2009-2012. For all new refrigerator types, average energy consumption was 488 kWh per year in 2009, 471 kWh per year in 2010, 469 kWh per year in 2011 and 470 kWh per year in 2012.

Table 3.3. Average Energy Consumption by Refrigerator Type (kWh per year)

	Top	Bottom	Side by side	All refrigerators
2009	436	492	574	488
2010	415	473	549	471
2011	411	478	544	469
2012	409	479	548	470

Price. The average price of a refrigerator was $1,613 in 2012, an increase of $85 from 2011. The lowest price refrigerator was $290 and the highest price refrigerator was $14,350. The average prices in the following table exclude models which cost $4,500 or more, because of a concern that this would inappropriately skew the results. Freezer on the bottom refrigerators and side by side refrigerators had higher average prices than freezer on the top, which may be partially accounted for by the higher capacity of freezer on the bottom and side by side refrigerators.

Table 3.4. Average Price by Refrigerator Type (dollars)

	Top	Bottom	Side by side	All refrigerators
2009	766	1,961	1,895	1,501
2010	747	1,847	2,005	1,590
2011	689	1,851	1,870	1,528
2012	715	1,926	1,714	1,613

3.2 Demand Side Assessment

In this section, we examine details of the demand side of the market based on a survey of 401 participants and a comparison group of 401 non-participants. The demand side analysis focussed on sample comparability, refrigeration saturation, number of refrigerators removed, characteristics of refrigerators removed, program influence for program participants and non-participants. Customer satisfaction for various aspects of the program was examined for participants only, since non-participants, by definition, have no experience with the program.

Participant and Non-participant Surveys. The participant and non-participant refrigerator surveys were conducted from November 19, 2012 through December 1, 2012. The participant sample was a random sample of program participants, while the non-participant sample was a random sample of customers who met the screening criteria, which was that they did not participate in the program during the previous 12 months, owned at least one spare refrigerator with capacity 10-24 cubic feet, and which was operational and not located in the kitchen at the time of the interview. The surveys were administered by telephone, and the data was cleaned and processed by the survey contactor, Pollara, which provided an SPSS data set and top line reports.

A first step in the demand side analysis was to determine whether or not the participant sample and the non-participant sample were similar in terms of key demographics. Age of the survey respondent, educational level achieved by the respondent, and type of dwelling are not significantly different between participants and non-participants at the 5% level. But main space heating fuel and household income are significantly different between participants and non-participants.

Table 3.5. Survey Respondent Sample Characteristics (%)

Characteristic	Participants	Non-participants	Difference	z-value	Significance
Age 44 or younger	21	25	-4	-1.34	0.18
Grade 12 or less	31	34	-3	0.30	0.77
Single family dwelling	86	90	-4	-1.74	0.08
Main space heat fuel electricity	35	21	14	4.41	<0.0002
Household income under $60,000	33	25	8	2.49	0.01

Refrigerator Saturation. Participants were asked “excluding bar and wine coolers, how many fridges did you have in use in your home one month prior to having the fridge picked up by BC Hydro,” and non-participants were asked “do you currently have a second refrigerator in or around your home that is in working order” and if the response was yes they were also asked how many second refrigerators they had. The non-participant sample had a very high level of saturation of second refrigerators. As a check on this result, non-participants were asked where the second was located, and only 5% said they were in the kitchen with 53% located in the basement and 21% located in the garage. Non-participants owned 2.37 refrigerators compared to 1.48 refrigerators for participants, and the difference was significant at the 1 percent level

Table 3.6. Number of Refrigerators Owned and In Use (%)

Number Owned and In Use	Participants	Non-participants	Chi-squared	Significance
1	57	5	-	-
2	39	60	-	-
3	3	30	-	-
4	1	4	-	-
Mean	1.48	2.37	-	-
Significance of differences	-	-	574.6	<0.0001

Condition of Refrigerator and Refrigerator Use. Participants were asked "at the time you participated in BC Hydro's Refrigerator Buy-Back program, was the fridge in working order – regardless of whether you had it plugged in," and non-participants who had recently disposed of a spare refrigerator were asked "at the time of disposal, was the fridge in working order – regardless of whether it was plugged in." In addition, participants were asked "prior to being picked up by BC Hydro, how long had the fridge been unplugged and unused," and 89% of respondents indicated that it was zero years (89%) and 7% said they did not know.

Table 3.7. Refrigerator in Working Order at Time of Disposal (%)

Response	Participants	Non-participants	Chi-squared	Significance
Yes	90	70	-	-
No	9	26	-	-
Don't know	1	4	-	-
Significance of differences	-	-	18.1	<0.0001
Assumed working	91	74	-	-

Capacity of the Refrigerator. Participants and non-participants were asked about the capacity of the refrigerator that was disposed of. There was no significant difference in refrigerator capacity between program participants and non-participants.

Table 3.8. Capacity of the Refrigerator Picked Up (cubic feet)

Size in cubic feet	Participants	Non-participants	Chi-squared	Significance
10-14	17	16	-	-
15-17	19	22	-	-
18-20	26	19	-	-
21-25	8	13	-	-
25 +	2	3		
Don't know	28	27		
Significance of differences	-	-	5.3	0.25

Age of Refrigerator. Participants and non-participants were asked how old the fridge was when they disposed of it. Participants disposed of refrigerators which were significantly older than those recycled by non-participants, with an average age of 18.0 years for participants compared to 13.5 years for non-participants.

Table 3.9. Age of Refrigerator Picked Up (%)

Age in years	Participants	Non-participants	Chi-squared	Significance
1-5	3	9	-	-
6-10	19	28	-	-
10-15	18	22	-	-
16-20	21	16	-	-
20+	17	6	-	-
Don't know	22	19		
Significance of differences	-	-	47.3	<0.0001
Mean age	18.0	13.5		

Main Refrigerator. Participants were asked "was the refrigerator the main fridge in your home," and non-participants were asked "for the following questions, think about how the fridge was used during the year before it was disposed. Was the fridge the main fridge in your home?" There was no significant difference in the incidence of main refrigerators between participants and non-participants.

Table 3.10. Refrigerator Main Refrigerator in Home (%)

Response	Participants	Non-participants	Chi-squared	Significance
Yes	68	72	-	-
No	31	28	-	-
Don't know	1	-	-	-
Significance of differences	-	-	0.61	0.43

Program Influence. Participants were asked "overall, how influential was the Refrigerator Buy-Back program in your decision to dispose of this fridge" and non-participants were asked "even though you got rid of the fridge on your own, how influential – if at all – was BC Hydro, including Power Smart and possibly its Refrigerator Buy-Back program, on your decision to remove it." A four-point influence scale was used, with very influential and somewhat influential responses classified as influential and not very influential and not at all influential responses classified as not influential. Participants were much more likely to be influenced by the program in their decision to recycle the refrigerator

Table 3.11. Program Influence on Refrigerator Disposal (%)

	Participants	Non-participants	Chi-squared	Significance
Influential	73	29	-	-
Not influential	24	56	-	-
Don't know	3	15		
Significance of differences			91.9	0.0001

Participants were also asked "if the Refrigerator Buy-Back program had not existed, what would have happened to the refrigerator that you gave to BC Hydro?" About 28% of the refrigerators would have remained in the market and 67% of the refrigerators would have been removed from the market.

Table 3.12. What Would Have Happened to the Refrigerator (%)

Response	Stayed in the market	Removed from the market	Don't Know
Kept it in the home plugged in	3		
Kept it in the home – unplugged/in storage	2		
Trade it for a new one	1		
Had it picked up by community service	4		
Gave it away	11		
Sold it	7		
Hired someone to take the fridge away		7	
Disposed of it myself in a landfill		47	
Recycled it		13	
Total	28	67	5

Customer Satisfaction with Initial Call. Participants were asked "when you initially placed your call for pick-up, how would you rate the courtesy of the person on the phone." Some 90% of respondents rated the courtesy of the initial call as excellent or good.

Table 3.13. Customer Satisfaction with Initial Call (%)

Excellent	Good	Fair	Poor	Very Poor	Don't know
53	37	2	-	1	7

Ease of Arranging a Pick-up Time. Participants were asked "how would you rate the ease of arranging a time to have your fridge picked up." Some 87% of respondents aid that the ease of arranging a refrigerator pick-up was excellent or good.

Table 3.14. Ease of Arranging a Pick-up Time (%)

Excellent	Good	Fair	Poor	Very Poor	Don't know
45	42	8	1	1	2

Customer Satisfaction with Overall Program. Participants were asked "how satisfied are you with the program." Some 98% of respondents stated that they were very satisfied or somewhat satisfied with the program.

Table 3.15. Customer Satisfaction with Program (%)

Very satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very dissatisfied	Don't know
87	11	2	-	1	7

Replacement Behaviour. Participants were asked "did you replace the fridge that was picked up by BC Hydro." Some 83% of participants said that the refrigerator was replaced and 17% of participants said that it was not replaced.

Program Awareness. Non-participants were asked "BC Hydro has a program called the Refrigerator Buy-Back program whereby they pick up and recycle spare fridges that are in working condition, and then send out a $30 cheque to the fridge owner. Prior to this survey, had you heard of BC Hydro's Refrigerator Buy-Back Program." Some 71% of respondents had heard of the program.

Table 3.16. Program Awareness (%)

Response	Share
Yes	71
No	28
Don't know	2

3.3 Metering Study

In this section, we summarize the results of the refrigerator metering which was undertaken at BC Hydro's Powertech Labs.

Objective and Scope. The objective of the project was to meter the energy consumption of refrigerators that were recovered from service by BC Hydro contractors under the Refrigerator Buy-Back Program. The scope of the project was to test approximately 350 fridges in a controlled environment. The fridges were tested in 16 batches of 25 units. The refrigerators were delivered to Powertech Labs by the BC Hydro pick-up contractors on a weekly schedule. Upon completion of the tests, the fridges were removed from Powertech Labs by the pick-up contractor and shipped back to the dismantling facility to be disassembled.

Process. The test process was designed around an abbreviated form of the Canadian Standards Association's CSA standard "C300-2000 – Energy Performance and Capacity of Household Refrigerators, Refrigerator-Freezers, and Freezers". The purpose of this test was to focus on energy consumption of the actual refrigerators that were being removed from service rather than a model by model comparison. The following test conditions were focused on:

- Ambient temperature of the external environment. One factor that determines the energy consumption of the refrigerator is the external room temperature. The warmer the room, the more the refrigerator has to cycle thus using more energy. For this controlled test, it was decided that the refrigerator would operate at the nominal room temperature of 21°C found in most homes in this part of the country, while it was recognized that some of these refrigerators were operating in basements and in car ports.
- Ambient temperature of the Refrigerator. The refrigerator was adjusted to operate at 3.3°C in the main compartment as outlined in the CSA standard.
- Thermal Loading. Thermal loading was simulated by the opening and closing of the door once per hour for eight consecutive occasions for three days in a row. It was felt that this test regime most closely matched how refrigerators would be operated. The CSA standard "5.1.7.4 Variable Defrost Control – Optional Test" was used as a guide. The test performed had nothing to do with the defrost control but the test profile indicated the rate of door opening (0.6m/s), the amount of door opening (60° to 90°), and the length of time the door was open (12+/-2 seconds) as representative of actual refrigerator use.

Test Procedure. The refrigerators were tested in groups of 25 set up in one large air conditioned room. Ambient room temperature was monitored, as well as the temperature in the main compartment of each individual refrigerator. Brultech ECM 400 energy data loggers were installed on each of the tested refrigerators. The handling of a typical refrigerator proceeded as follows:

1) Refrigerators were received from the BC Hydro pick-up contractors, typically on the Thursday of each week. They were screened at the loading dock to ensure operation (i.e. if there was a proper electrical cord and the compressor seemed to operate).
2) Units were installed on the test stand. Thermocouple temperature sensors were installed in the main compartment and the data loggers installed on the power cord of each unit.
3) Temperature adjustments were made on Thursday and Friday to achieve the 3.3°C main compartment temperature (or as close as possible). The data loggers started recording energy consumption at the end of each Friday and the refrigerators were allowed to operate over the weekend.
4) On Monday morning, both internal and external environment temperatures readings were conducted for the 25 fridges. The thermal loading tests were commenced as per CSA specifications. The data results were recorded for three (3) days.

Test Results. BC Hydro pick-up contractors delivered 400 refrigerators, of which 337 units were operative. The 63 non-operative units were not included in the final data base. Units were non-operative for a variety of reasons, including some that were non-operative upon pick up, as reported in Table 3.7, as well as others damaged in transport. Transportation included at least three stages: home to truck, truck to dismantler, and dismantler to Powertech Lab site.

Of the 337 units, only 319 refrigerators cooled below 8°C and 275 were able to achieve temperatures of 5°C or less. There were 16 groups of refrigerators tested with an average of 21 units per test group that provided meaningful data. The refrigerators operating between 1ºC and 5ºC consumed an average of 69.3 kWh per month, while the average for all the refrigerators that provided acceptable test data was 75.4 kWh per month or 905 kWh per year.

The ratio of demand to energy of the replaced refrigerators was 0.120 and was taken from Powertech Labs (2010) and yielded peak demand impact of 109 W. To estimate gross energy consumption for freezers, we applied the ratio of 0.897 from the literature review so that estimated gross freezers consumption is 812 kWh per year the peak demand impact is 97 W.

Table 3.17. Metered Energy Test Results

Operating temperature (ºC)	-10 to 1	1 to 3	3 to 5	5 to 7	7 to 8	All
Units tested	59	114	102	38	6	337
kWh per month	90	73	66	73	69	75.4

3.4 Energy and Peak Demand Savings

In this section, we provide the impact results, including unit and total energy and demand savings. Determination of the net to gross ratio is often the most difficult element of an impact evaluation, and the determination of an appropriate net to gross ratio is particularly complicated for appliance recycling programs. In 2002, KEMA developed an influential approach, which estimated a net to gross ratio based on two main components, the attribution factors and the part use factor. In summary, "The attribution factor adjusts for the percentage of participants that would have disposed of the unit anyway; and gives partial credit to the program for destroying a unit that would otherwise have been transferred to another user. The part-use factor adjusts for the fraction of the time that participants would have used the unit if they had kept it [KEMA-XENERGY (2004)]." This approach defines free ridership in terms of whether or not the refrigerator would continue to be connected to the BC Hydro grid in the absence of the program, and is referred to as the destination approach. It assesses the impact of the program at the market, not household, level.

In our adaptation of the KEMA approach, the operational rate is considered to be equivalent to the part use factor. The operational rate is the survey reported proportion of refrigerators that were in working order at the time of pick up by Refrigerator Buy-Back contractors. It closely reflects the survey reported proportion of fridges that were unplugged and unused at the time of pick up. See Demand Side Assessment Section 3.2, Condition of Refrigerator and Refrigerator Use for the survey results, which suggest that the results of the refrigerator in working order at pick up is a reasonable proxy for the part-use factor used in the destination approach.

Free Ridership. To determine free ridership we utilized a telephone survey to solicit participant response to the counterfactual – what the household would have done with the spare fridge in the absence of the program. Participants were asked on a top-of-mind, unaided basis what would have become of the fridge they gave to BC Hydro. The logic and algorithm are described below:

Step 1. Action taken in the absence of the program

a. If the respondent makes no mention of recycling/disposing of the fridge on their own in the absence of the program, then they are assigned a final free rider score of 0.0.

b. If the respondent mentions that they would have recycled/disposed of the refrigerator on their own, then they are assigned an initial free rider score of 1.0. Given that this response involves an intention regarding a future action that cannot be verified (unlike the response in 1a, which confirms the status quo) we test the strength of the intention by asking about prior plans to recycle/dispose of the fridge on their own.

Step 2. Prior plans do dispose of the fridge

a. Respondents were asked at the beginning of the survey as to when they first had the idea of getting rid of the refrigerator – before ever becoming aware of BC Hydro's program or after becoming aware of it.

b. If the respondent mentions that they would have recycled/disposed of the refrigerator on their own, and they had the idea of getting rid of the fridge before becoming aware of the program, then their intent is deemed strong enough to have resulted in action, and they continue with a free rider score of 1.0.

Step 3. Influence of the Program in the absence of prior plans

a. If the respondent mentions that they would have recycled/disposed of the refrigerator on their own, but they first had the idea of getting rid of the fridge after becoming aware of the program, then the intent to dispose of the refrigerator in the absence of the program is deemed weak. We therefore take into account program influence to reflect the possibility of a causal relationship between awareness and their decision to recycle/dispose of the fridge, resulting in a deduction from the free rider score of 1.0

Step 4. Timing of disposal in the absence of the program

If the respondent mentions that they would have recycled/disposed of the fridge on their own, and that they had the intent to do so before hearing about the Refrigerator Buy-Bay program (situation 2b), then they are asked when they would have done so.

a. If the respondent says at about the same time as actually done so, then the respondent is deemed a full free rider.

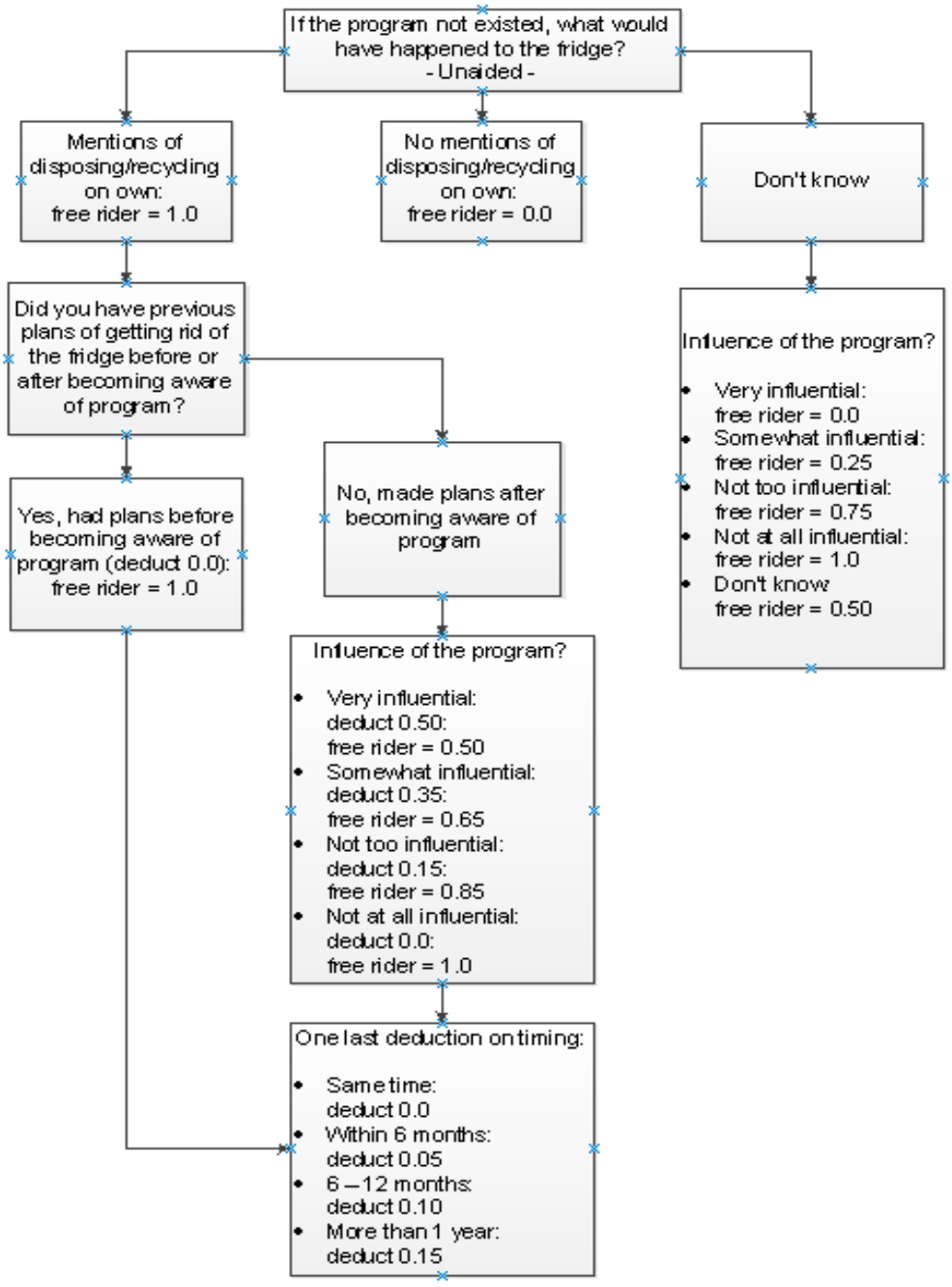
b. If the respondent says "within a year of when actually done so", then we deduct 0.05 points from the free ridership score, thereby partially crediting the program for early disposal. Likewise, if the respondent says more than a year later, then we deduct 0.15 points from their in-progress free rider score.

Step 5. Don't know responses

Respondents who indicate that they don't know what would have happened to the fridge in the absence of RBB are asked a five point program influence question. Free ridership is assigned according to the response to this question.

The mean free rider score for the program was calculated to be 52%.

Figure 3.1. Free Rider Analysis



Spillover. Our analysis also attempted to account for spillover, where spillover refers to non-participants who recycled a refrigerator, at least in part, because of the impact of the program promotional activity, but they were not program participants. Non-participant spillover is caused when customers respond to Power Smart's promotional activities by disposing of a refrigerator, but choose to do so outside of the program. Non-participant spillover is reasonable to observe for the Refrigerator Buy-Back Program given the modest program incentive level ($30), long standing market presence (continuously from 2002 to present) and the breadth of marketing efforts as described in section 1.2. The following table provides the spillover and the net to gross analysis, where the net to gross ratio is one minus the free rider rate plus the spillover rate.

Table 3.18. Spillover and Net to Gross Analysis

Component	Value	Source
1. No. of residential customers	1,671,412	BC Hydro (2012)
2. No. of second fridges per customer	0.28	BC Hydro (2010)
3. Disposal rate	0.074	Calculated as 1/(age at disposal) = 1/13.46 = 0.074 from Pollara (2012b) & Table 3.9
4. No. of second fridges disposed = 1*2*3	34,632	Calculated
5. Program fridges disposed	32,533	Average for F2011 and F2012 from Program Manager
6. Share of second fridges of program fridges	0.31	Pollara (2012a) & Table 3.10
7. No. of program second fridges disposed = 5*6	10,085	Calculated
8. Non program fridges disposed = 4 – 7	24,546	Calculated
9. Program influence rate	0.35	Pollara (2012a) & Table 3.11
10. Program influenced non program disposal = 8*9	8,591	Calculated
11. Spillover rate = 10/5	0.26	Calculated
12. Free rider rate	0.52	Discussion above
13. Net to gross = 1 – 13 + 12	0.74	Calculated

Program Impact on New Refrigerator Purchases. The program is not assumed to induce the purchase of new refrigerators and therefore the consumption of new refrigerators is not an input to the energy and peak demand savings calculation. This assumption is supported by the program design, evaluation industry standard practice for appliance recycling programs, as well as evidence from the Supply Side Assessment, Demand Side Assessment, and Metering Study. The program design includes a modest incentive level of $30. This amount is not considered adequate to motivate the purchase of a new refrigerator, the average prices of which is $1,613 as presented in the Section 3.1 Supply Side Assessment. The removal of the refrigerators from the market by the program is not expected to induce individuals who would have otherwise purchased or been given one of the refrigerators recycled by the program to now purchase a new refrigerator. The average age of the refrigerators recycled by the program is 18 years old, as described in Section 3.2 Demand Side Assessment. Many of the recycled refrigerators cannot operate at optimal levels, as described in Section 3.3 Metering Study. For these reasons, refrigerators recycled by the program are likely to have low resale value when compared to the average price of a new refrigerator ($1,613) and therefore the two are not considered substitutes. This approach is supported by methodology review of evaluations of

comparable programs, and by the US Department of Energy Uniform Methods Protocol for Appliance Recycling Program, see Bruchs (2012).

Electricity Cross Effects. Cross effects refer to the increase in space heating energy consumption and decrease in space cooling energy consumption, associated with increasing the energy efficiency of products in a conditioned space. Electricity cross effects were calculated in accordance with the Power Smart Standard for Cross Effects as 6% for refrigerators and 2% for freezers, as shown in the Appendix.

Operational Rate. As reported in Section 3.2, the operational rate is 0.91 for participants and 0.74 for non-participants. Due to the existence of non-participant spillover, both participant and non-participant recycled refrigerators are attributed to the program. Therefore a weighted average operational rate was used to estimate net unit energy savings. This average operational rate was calculated as 0.85 in the following manner: Operational Rate = {0.74 * Spillover Rate + 0.91 * (1-Free Riders)} / Net to Gross Ratio.

Net Unit Energy Savings. Net unit energy savings are the product of gross unit energy consumption, the net to gross ratio which is one minus free ridership plus spillover, the electricity cross effects adjustment, and the operational rate. Net unit demand savings are the product of gross unit demand savings, the net to gross ratio, the electricity cross effects adjustment, and the operational rate. The following table provides the net unit energy and demand savings.

Table 3.19. Net Unit Energy and Demand Savings

	Gross Unit Energy Savings (kWh/y)	Gross Unit Demand (W)	Net to Gross Ratio	Electricity Cross Effects Adjustment	Operational Rate	Net Unit Energy Savings (kWh/y)	Net Unit Demand Savings (W)
Refrigerator	905	109	0.74	0.94	0.85	535	63
Freezer	812	97	0.74	0.98	0.85	501	60

Net total program energy savings are the product of net unit energy savings and the number of units picked up by the program, and net total demand savings are the product of net unit demand savings and the number of units picked up by the program.

Table 3.20. Net Total Energy and Demand Savings

Year	Appliance	Net Unit Energy Savings (kWh/y)	Net Unit Demand Savings (W)	Units	Net Energy Savings (GWh/y)	Net Demand Savings (MW)
F2011	Refrigerator	535	63	33,573	18.0	2.1
	Freezer	501	60	625	0.3	0.0
	Total				18.3	2.2
F2012	Refrigerator	535	63	31,493	16.8	2.0
	Freezer	501	60	633	0.3	0.0
	Total				17.2	2.0

Reported and evaluated energy and demand savings for the Refrigerator Buy-Back Program are shown below.

Table 3.21. Reported and Evaluated Energy and Peak Demand Savings

Year	Energy Savings (GWh/y)		Demand Savings(MW)	
	Reported	Evaluated	Reported	Evaluated
F2011	21.2	18.3	2.4	2.2
F2012	17.9	17.2	2.0	2.0

3.5 Market Transformation

In this section, we provide the market transformation analysis. Economic theory suggests that consumer demand for second refrigerators should depend on disposable income, the price of second refrigerators and the prices of substitutes. Since time-series information on the price of second refrigerators is not available, we model the saturation of second refrigerators as a function of disposable income and a variable representing the RBB program. Saturation is defined as the share of households reporting presence of a second refrigerator in the Residential End Use Survey, BC Hydro (2011) disposable income is per capita disposable income in thousands of 2002 dollars as reported by BC Statistics, and the program variable is a spline which equals one in 2009, two in 2010, three in 2011 and four in 2012, representing the assumption that program activity has a cumulative impact on second refrigerator saturation. The expected sign of β is positive because a higher level of disposable income is expected to increase the saturation rate of second refrigerators, and the expected sign of γ is negative because the presence of the program is expected to reduce the saturation rate of second refrigerators.

(3) $Saturation_t = \alpha + \beta Dincome_t + \gamma Program_t + \varepsilon_t$

We have twelve observations covering the years 2001-2012. The regression analysis is done separately for all households (total share), for households in single family dwellings (single family share), and for households in duplexes and row houses (duplex and row share). The following table provides basic statistics for the data used in the regression models. Of particular note is the fact that the share of dwellings with second refrigerators varies substantially across the three groups: 27.8% for the total sample, 41.4% for single family dwellings, and 16.1% for duplexes and row houses.

Table 3.22. Impact of RBB on Spare Refrigerator Saturation: Sample Statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Total share	27.8	1.4	25.0	30.0
Single family share	41.4	3.0	37.0	45.0
Duplex and row share	16.1	1.9	13.0	20.0
Disposable income (2002 $000)	24,427	2,164	21,449	27,464
Program	0.83	1.4	0.0	4.0

The following table provides the results for the regression models. The models were estimated using both ordinary least squares (OLS) and maximum likelihood with a first-order auto-regressive scheme (ML). Standard errors for regression coefficients and the estimated auto-correlation corresponding to the Durbin-Watson statistic are shown in parentheses as appropriate. One, two or three asterisks means that the coefficient is significant at the 10%, 5% or 1% level respectively.

All six regressions are satisfactory. (1) They all have adjusted R-squared values of 0.8 or better, which means that each regression is explaining at least 80% of the variance in the saturation rate of second refrigerators. (2) All of the regression coefficients except for constant terms in two regressions are significant at the 1% level. (3) The signs of the regression coefficients are as expected, that is, a higher level of disposable income is associated with an increase in the saturation rate of second refrigerators, and the presence of the program is associated with a reduction in the saturation rate of second refrigerators. The key findings are that: (1) presence of the program reduces the overall saturation rate of second refrigerators by about 1.4% per year, (2) presence of the program reduces the single family dwelling saturation rate of second refrigerators by about 2.2% per year, and (3) presence of the program reduces the duplex and row house saturation rate of second refrigerators by about 1.2% per year.

Table 3.23. Impact of RBB on Second Refrigerator Saturation: Regression Results

Variable	Total		Single family		Duplex and row	
	OLS	ML	OLS	ML	OLS	ML
Constant	11.6*** (1.7)	12.4*** (2.1)	-3.6 (5.2)	-2.22 (6.3)	-11.4*** (3.7)	-11.5*** (4.1)
Disposable income	0.00071*** (0.000072)	0.00068*** (0.000091)	0.0019*** (0.00022)	0.0019*** (0.00027)	0.0012*** (0.00016)	0.0012*** (0.00017)
Program	-1.44*** (0.11)	-1.44*** (0.14)	-2.21*** (0.34)	-2.18*** (0.40)	-1.25*** (0.24)	-1.25*** (0.26)
Adj. R-sq.	0.94	0.94	0.87	0.87	0.83	0.83
D-W	1.37 (0.32)	1.56 (0.22)	1.46 (0.27)	1.67 (0.17)	1.66 (0.17)	1.75 (0.12)

The following table provides net energy and demand savings using the market transformation approach at the 90% confidence level.[1] Savings are estimated as the product of: the number of BC Hydro residential accounts, the calculated program impact on the saturation of spare refrigerators (1.4%), gross unit savings and savings adjustment factors presented in Section 3.4. This approach produces results that are similar and confirmatory to those calculated with the more detailed approach presented in Section 3.4.

Table 3.24. Regression Based Estimate of Program Impacts (Refrigerators Only)

Year	Accounts (mn)	ΔSat	Gross Unit Energy Savings (kWh/y)	Ratio of Demand to Energy	Electricity Cross Effects Adjustment	Operational Rate	Net Energy Savings (GWh/y)	Net Peak Demand (MW)
F2011	1.654	0.014	905	0.12	0.94	0.85	16.7	2.0
F2012	1.671	0.014	905	0.12	0.94	0.85	16.9	2.0

[1] (i.e. 90% t value for 12 – #parameters – 1 = 8 degrees of freedom)

4.0 References

ADM Associates Inc. (2006). Dual Metering Study to Support 2003 EM&V of Statewide Residential Appliance Recycling Program: Final report, June 2006.

ADM Associates Inc. (2007). Measure and Verify Savings of Refrigerator Recycling Program, prepared for Sacramento Municipal Utility District.

ADM Associates Inc. (2008). Evaluation Study of the 2004-2005 Statewide Residential Appliance Recycling Program, April 2008.

BC Hydro (2010). Refrigerator Buy-Back Evaluation.

BC Hydro (2011). Power Smart 2012 Residential End Use Survey.

BC Hydro (2012). BC Hydro 2012 Annual Report.

Brown, R., C. Webber and J. Koomey (2000). “Status and Future of the ENERGY STAR Program,” Proceedings of the 2000 ACEEE Summer Study on Energy Efficiency in Buildings.

Bruchs, D, (2012). Refrigerator Recycling Evaluation Protocol: Uniform Methods Project Draft, Cadmus Group Inc.

Cadmus Group Inc.(2010a). Residential Retrofit High Impact Measure Evaluation Report, Prepared for the California Public Utilities Commission Energy Division.

Cadmus Group Inc. (2010b). Utah Refrigerator and Freezer Recycling Program 2006-2008, Prepared for Rocky Mountain Power.

Cadmus Group (2010c). Appliance Recycling Program Evaluation – Year 2, Prepared for Ameren Illinois, September 2010.

Cadmus Group Inc. (2012). Rocky Mountain Power Idaho. See Ya Later, Refrigerator, 2009-2010 Program Evaluation.

Jaffe, A. and R. Stavins (1995). "Dynamic Incentives of Environmental Regulations: The Impact of Alternative Policy Instruments on Technology Diffusion," Journal of Environmental Economics and Environment, Vol. 29, 1995.

Justason Market Intelligence (2012). Tracking Study: Showroom Presence Study of Appliances, Report Prepared for BC Hydro Power Smart.

KEMA (2004). Final Report: Measurement and Evaluation Study of the 2002 Statewide Residential Appliance Recycling Program, February 2004.

KEMA-XENERGY Inc. (2004). Final Report: Measurement and Evaluation Study of 2002 Statewide Residential Appliance Recycling Program, prepared for Southern California Edison.

Nadel, S., J. Thorne, H., Sach, B. Prindle, and R. Elliott (2003). Market Transformation: Substantial Progress from a Decade of Work, ACEEE, Washington, D. C., Report No. 036, April 2003.

NMR (2005). Impact, Process and Market Study of the Connecticut Appliance Retirement Program: Overall Report, Submitted by Nexus Market Research and RLW Analytics Inc., December 23, 2005.

Peterson, John, et al. (2007). “Gross savings estimation for appliance recycling programs: the lab versus in situ measurement imbroglio and related issues,” 2007 Program Evaluation Conference, Chicago.

Pollara (2012a). BC Hydro Refrigerator Buy Back Program Participants Survey.

Pollara (2012b). BC Hydro Refrigerator Buy Back Program Non-participants Survey.

Pope, T., A. Chase, P. Eilert and G. Fernstrom (2008). “The New Landscape for Appliance Efficiency Standards,” Proceedings of the 2008 ACEEE Summer Study on Energy Efficiency in Buildings.

Powerteck Labs Inc. (2010). Refrigerator Buy-Back Program Energy Audit Project.

Powerteck Labs Inc. (2012). Refrigerator Buy-Back Program Energy Audit Project.

Research into Action (2010). Electronics and Energy Efficiency: A Plug Load Characterization Study - SCE0284.

Research into Action and EMI (2012). Program and Technology Review of Two Residential Product Programs: Home Energy Efficiency Rebate (HEER)/Business and Consumer Electronics (BCE), Final Report, August 30, 2012.

Rosenberg, M. (2003). “The Impact of Regional Programs on the Market Share of Energy Star Appliances,” in P. Bertoldi , F. Conti and R. Pagani, ed, Energy Efficiency in Domestic Appliances and Lighting, Softech: Turin, Italy.

Sampson Research (2011). Residential Monitoring Study: Analysis & Results, Report Prepared for BC Hydro Power Smart, November 30, 2011.

Summit Blue Consulting (2009). Commonwealth Edison Energy Efficiency/Demand Response Plan. Plan Year 1(6/1/2008-5/31/2009) Evaluation Report: Appliance Recycling.

Titus, E. and S. Feldman (2003). “Tracking the Effectiveness of Energy-Efficient Appliance Programs in the U.S.,” in P. Bertoldi , F. Conti and R. Pagani, ed, Energy Efficiency in Domestic Appliances and Lighting, Softech: Turin, Italy.

Vine, E., R. Prahl, S. Myers, and I. Turiel (2010). “An Approach for Evaluating the Market Effects of Energy Efficiency Programs,” Energy Efficiency, Vol. 3, 2010.

Webber, C., R. Brown, and J. Koomey. (2000). “Savings Estimates for the ENERGY STAR Voluntary Labelling Program,“ Energy Policy, Vol. 28, 2000.

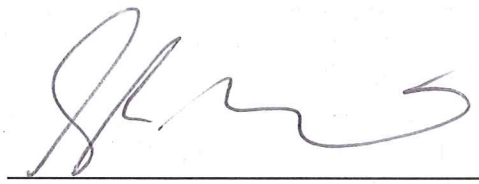
Yu, M. (2009). Review of Cross Effects for the Refrigerator Buy-Back Program, BC Hydro.

EVALUATION OVERSIGHT COMMITTEE SIGN-OFF

This evaluation was prepared for Program Management and the BC Hydro Evaluation Oversight Committee. The Evaluation Oversight Committee was established to represent various stakeholders in BC Hydro to ensure that evaluation findings are of value to the corporation.

The Refrigerator Buy-Back Program F2011-12 Evaluation meets the criteria for sign-off by the BC Hydro Evaluation Oversight Committee, as outlined below.

1. The evaluation complied with the defined scope.
2. The methodology used for both evaluation of results and analysis are appropriate given the available resources at the time of the evaluation.
3. The results are reasonable given the data and resources available at the time of the evaluation.



Evaluation Oversight Committee Chair

APPENDIX A: Recent Recycling Program Evaluation Results

The table below provides a summary comparison of findings of recent appliance program evaluations. Incentive levels vary from $25 per unit recycled to $30 per unit recycled. Several studies have used customer surveys to determine the most appropriate incentive levels given the trade-off between market take-up on the one hand and the cost of incentives on the other hand. Because some evaluation studies cover multiple years, the average number of recycled units per year is used to improve comparability across programs. Given the large variation in the size of the market base, the substantial differences in the annual number of recycled refrigerators is not surprising. Net savings per recycled unit have been generally falling for several years, however, net savings per recycled refrigerator are still substantial at 766 kWh per year for refrigerators and 687 kWh per year for freezers. One reason for the fall in energy savings is that from about 2006 onwards, recycling programs started to pick up refrigerators manufactured subsequent to the Department of Energy (DOE) first appliance efficiency standard of 1993.

The adoption of the DOE standard accelerated what had been a slow annual improvement in energy efficiency. Regression modelling used in some evaluation studies has found that the age of the refrigerator, its capacity, partial or intermittent use, and temperature in the space where the refrigerator is located are significant determinants of energy consumption. Net savings per recycled unit have also been falling for several years, but net unit savings are still significant, particularly if compared with the diminishing savings returns from some other residential DSM activities, such as spiral CFLs. Net to gross ratios are reasonably high, and some utilities have attempted to improve net to gross ratios by recycling only spare and not primary units through their programs. However, limiting pick-ups to spare units is logistically difficult.

Utility	Appliance	Incentive level ($)	Recycled (annual units)	Net unit savings (kWh/y)
Ameren Illinois	Refrigerator	$35	7,762	1,159
	Freezer	$35	3,422	1,091
Cape Light Compact	Refrigerator	$50	189	522
	Freezer	$50	67	391
Commonwealth Edison	Refrigerator	$25	8,437	994
	Freezer	$25	3,076	993
Connecticut Light & Power	Refrigerator	$50	4,729	413
	Freezer	$50	1,835	450
National Grid	Refrigerator	$50	3,808	522
	Freezer	$50	1,201	391
NSTAR	Refrigerator	$50	2,004	522
	Freezer	$50	697	391
PG&E	Refrigerator	$35	11,361	824
	Freezer	$35	1,597	745
Rocky Mountain Power Idaho	Refrigerator	$30	592	595
	Freezer	$30	167	406
Rocky Mountain Power Utah	Refrigerator	$30	17,969	878
	Freezer	$30	3,919	877
SCE:PGC	Refrigerator	$35	34,137	1,093
	Freezer	$35	4,790	911
SCE:Procurement	Refrigerator	$35	7,380	1,093
	Freezer	$35	873	911
SCE:2005 SI	Refrigerator	$35	11,210	1,093
	Freezer	$35	1,777	1,192
SDG&E	Refrigerator	$35	10,021	915
	Freezer	$35	8,292	944
SMUD	Refrigerator	$35	2,677	694
	Freezer	$35	861	462
United Illuminating Co.	Refrigerator	$50	2,738	413
	Freezer	$50	1,060	450
Western Massachusetts	Refrigerator	$50	187	522
	Freezer	$50	32	391
Mean All Utilities	Refrigerator	$39.40	7,825	766
	Freezer	$39.40	2,104	687
Ratio all Utilities	Freezer/ refrigerator	1.00	0.269	0.897

APPENDIX B: Electricity Cross Effects

The cross effects calculation below is consistent with the procedure prescribed in the Power Smart Standard for Cross Effects, 2013. The calculation is for a spare refrigerator. No adjustment is made for the fact an individual household may go on to replace the refrigerator recycled by the program with another refrigerator. This approach is consistent with Program theory and goals, which is to reduce the population of spare fridges, as well as the approach to the calculation of free ridership presented in Section 3, which is done at the overall BC Hydro grid level, not the level of the individual household. Freezer cross effects were calculated in a similar manner. As many freezers are located in unconditioned spaces, such as garages, the cross effects for freezers are lower than for refrigerators.

1	**Cross Effects - Heating Season**		Notes:
a)	Percentage of Spare Refrigerators installed indoors	0.54	Pollara 2012a (Participants Survey, Question QB7 on page 3).
b)	Percentage of Electrically Heated Homes	0.39	BC Hydro (2010). Power Smart 2010 Residential End Use Survey
c)	Share of Refrigerator annual electricity consumption during the heating season	0.54	Power Smart Engineering Estimate
d)	Heating system impact factor[2]	0.60	From Power Smart Engineering Estimate
"A"	Total = a) x b) x c) x d)	0.07	Heating system penalty
2	**Cross Effect - Cooling Season**		
a)	Percentage of Spare Refrigerators installed indoors	0.54	Pollara 2012a (Participants Survey, Question QB7 on page 3).
f)	Percentage of Air Conditioned Homes	0.09	BC Hydro (2010). Power Smart 2010 Residential End Use Survey
g)	Share of annual electricity use in the non-heating season	0.46	Calculated at 1 c)
d)	Heating system impact factor	0.60	From Power Smart Engineering Estimate
"B"	Total = 1/3 * a) x f) x g) x d)	0.00	Where 1/3 is the assumed, average air conditioning COP
3	**Total Cross Effects A - B**	0.06	May not sum due to rounding

[2] The heating system impact factor (also known as the heat loss factor) refers to the percentage of heat lost, as a result of the energy efficiency upgrade, which is registered on the thermostat.

APPENDIX C: Free Ridership Score Frequency Distribution

Shown below is the frequency distribution of participant responses by free ridership score. Free ridership scores were determined in accordance with the method presented in Section 3.4. 401 valid responses were obtained. The mean free ridership score was 0.52.

FR Score	Frequency	Percent	Valid Percent	Cumulative Percent
0	118	29.4	29.4	29.4
0.25	7	1.7	1.7	31.2
0.35	16	4	4	35.2
0.4	5	1.2	1.2	36.4
0.45	25	6.2	6.2	42.6
0.5	40	10	10	52.6
0.55	6	1.5	1.5	54.1
0.6	12	3	3	57.1
0.65	13	3.2	3.2	60.3
0.7	1	0.2	0.2	60.6
0.75	4	1	1	61.6
0.8	4	1	1	62.6
0.85	20	5	5	67.6
0.9	14	3.5	3.5	71.1
0.95	46	11.5	11.5	82.5
1	70	17.5	17.5	100
Total	401	100	100	

Summary Statistics	
Valid Responses	401
Mean Score	0.52

BC hydro
powersmart

NEW HOME PROGRAM EVALUATION: F2008-F2013

Final

November 22, 2015

Prepared by:

Power Smart Evaluation

This page left blank

TABLE OF CONTENTS

This page left blank

Executive Summary

Introduction

The main purpose of the Power Smart New Home program evaluation is to determine the program's impact on energy savings in the new residential construction market. A secondary goal is to examine how the New Home program has influenced building practices to improve energy efficiency in British Columbia's residential construction market. The impact evaluation covers the six-year period from April 2007 through March 2013 (BC Hydro's fiscal years F2008 through F2013).

During the evaluation period, the New Home program provided financial incentives to residential home builders and developers for adopting higher energy efficiency standards in new construction and for installing more energy-efficient technologies and products. The program had two main offers, Home Performance and the Energy Star Package.[1] Builders could participate in either offer multiple times.

The Home Performance offer focused on encouraging the design and construction of energy-efficient homes, defined as single family detached dwellings and townhomes[2] achieving an EnerGuide rating of 80 (EnerGuide 80) or higher.[3] There were no criteria as to how an EnerGuide 80 rating could be achieved. Prior to F2013, a maximum incentive of $1,500 per unit was available to builders of single family detached homes rated as EnerGuide 80. This amount was increased to $2,000 per home in F2013.[4] Townhomes could receive a maximum incentive of $200 per unit throughout the evaluation period.

The Energy Star Package offer was available to builders of new single family detached homes, townhomes and multi-unit residential buildings. From 2006 to 2009, four Energy Star products were included in the package: refrigerator, dishwasher, bathroom fan, and six CFLs.[5] From 2009 to September 2013, front load clothes washers were added to the Energy Star products covered by the program. Applicants could install any combination of the five products, from a minimum of two to a maximum of five, to receive incentives of $50 (two products) to $200 (all five products).

Approach

Five evaluation objectives were identified, each with specific researchable questions, as summarized in the following table:

[1] Since 2012, FortisBC has been a partner in delivering the program offering rebates of up to $1,000 per unit for high-efficiency natural gas water heaters, fireplaces and/or boilers.

[2] For this report, townhomes include semi-detached single family homes (e.g., duplexes) and row housing. For three of the evaluation years, multi-unit residential building units are also included in townhomes.

[3] The EnerGuide Rating System is a national initiative delivered by Natural Resources Canada. An EnerGuide rating is a standard measure of a home's energy performance; how energy-efficient a home is. http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/5061#rating1

[4] Program incentives were increased to help improve market penetration in the single family detached market and offset the incremental cost for builders aiming to achieve EG80 or higher.

[5] LEDs were introduced near the end of the evaluation period.

Table ES 1.1. Evaluation Objectives and Research Questions

Evaluation Objectives	Research Questions
1. Market transformation*	• Was program participation in line with expected market coverage? • To what extent has the New Home program addressed barriers faced by builders/developers to building more energy-efficient homes? • To what extent has the program influenced home builder attitudes and practices in terms of building energy-efficient homes? • Has there been a shift in demand from new home buyers for more energy-efficient homes? • Has the program created any spillover in the new construction market?
2. Non-energy benefits to builders/developers*	• Are there non-energy benefits of program participation? If so, what are they and what kind of value is added?
3. Net electricity savings for the Home Performance offer - electrically heated single family detached homes	• What are the evaluated annual net electricity energy and demand savings for single family detached homes incented by the program? • How prevalent is the installation of air source heat pumps to achieve an EnerGuide 80 rating in new homes built during the evaluation period? • How much spillover was there from participants building energy-efficient single family detached homes that were not incented by the program? • What are the main contributors to any variance found between reported and evaluated savings?
4. Net electricity savings for the Home Performance offer – electrically heated townhomes	• What are the annual gross and net electricity and demand savings for townhomes incented by the program? • How much free ridership and spillover occurred? • What are the main contributors to any variance found between reported and evaluated savings?
5. Electricity savings for the Home Performance offer- non-participant spillover	• How much electricity savings were generated by non-participant spillover for single family detached homes and townhomes?
6. Net electricity savings for the Energy Star Package offer	• What are the annual gross and net electricity and demand savings for the Energy Star Package offer? • How much free ridership and spillover occurred? • What are the main contributors to any variance found between reported and evaluated savings?

*Assessment of market transformation and non-energy benefits focused on the Home Performance offer.

Market transformation and non-energy benefits were examined through the descriptive analysis of the results of a survey of builders and developers. The net impact of the Home Performance offer was evaluated separately for electrically heated single family detached homes and for townhomes. The net electricity savings from electrically heated single family detached homes incented by the program was evaluated using a quasi-experimental design with a matched comparison group. Electricity savings for electrically heated townhomes were calculated using validated energy simulation models. The original input assumptions used in the models were adjusted to better reflect actual circumstances (e.g., region, size, building configuration). Free ridership, participant spillover and non-participant spillover were estimated based on results from the builder/developer survey. Free ridership was applied to the gross savings calculated for townhomes. Savings from spillover for participant builders are included in the net impact results for single family detached homes and townhomes. Spillover from non-participating builders was applied to the new residential market (electric heat) outside of Vancouver and excluding units incented by the program. Energy savings from non-participant spillover are reported separately. Gross savings for appliances and lightbulbs were estimated by comparing electricity consumption of incented products with baseline (i.e., non-Energy Star) models. An engineering calculation was

used to estimate gross savings for bathroom fans. Net savings for the Energy Star Package offer were calculated by adjusting gross savings with survey-based estimates of free-ridership and spillover.

The data sources and methods used to address each evaluation objective are summarized in Table ES 1.2.

Table ES 1.2. Evaluation Objectives, Data and Methods

#	Evaluation Objectives	Data	Method
1.	Market transformation	• 2014 survey of builders/developers (program participants, n=75; non-participants, n=70) • Program tracking data • Canada Mortgage and Housing Corporation statistics	• Descriptive analysis (e.g., frequencies, cross-tabulations, means, etc.) • Survey-based spillover analysis
2.	Non-energy benefits to builder/developers	• 2014 survey of builder/developer program participants (n=75) • Secondary research	• Descriptive analysis (e.g., frequencies, cross-tabulations, means, etc.) • Qualitative analysis
3.	Net Electricity savings for the Home Performance offer – electrically heated single family detached homes	• Program tracking data • Participant electricity consumption and billing system data (i.e. region, housing type, heating fuel) (n=454) • Non-participant electricity consumption and billing system data (i.e. region, housing type, heating fuel) (n=1,178) • 2014 survey of builders/developers (program participants, n=75; non-participants, n=70) • BC Assessment data (square footage and year of build) • Greensheets Construction builders database • Peak to energy ratio from residential space heating load shape	• Quasi-experimental design • Statistical testing • Survey-based spillover analysis
4.	Net electricity savings for the Home Performance offer – electrically heated townhomes	• HOT2000 energy simulation models • Program tracking data • 2014 survey of builders/developers (program participants, n-75; non-participants, n=70) • Peak to energy ratio from residential space heating load shape	• Engineering calculations • Survey based free ridership and spillover analysis
5.	Electricity savings for the Home Performance offer - non-participant spillover	• 2014 survey of builders/developers (non-participants, n=70) • Program tracking data • Canada Mortgage and Housing Corporation statistics • Results of Objectives 3 & 4	• Survey-based spillover analysis
6.	Net electricity savings for the Energy Star Package offer	• Program tracking data • Energy Star website • 2009-2012 Annual Retailer Shelf Space/Stock Studies • 2014 survey of builder/developer program participants (n=75) • Interviews with major distributors (n=3) • Cross effects factors from the Power Smart Standard Procedure for Cross Effects • Peak to energy ratio from residential space heating load shape	• Engineering calculations • Survey-based free ridership and spillover analysis

Results

Market Transformation

Program reach was limited to a portion of the new construction industry, focusing on larger scale builders, although companies of any size could participate in the program, including owner-builders. It is estimated that the program covered approximately 6% of registered builders and 12% of new electrically-heated single-family homes and townhouses built during the six year evaluation period. The stated goal of the program was to capture around 11% of the market by 2010.

Participant builders/developers (comprising 87% of survey respondents) reported that, as a result of the New Home program, they were able to include and retain energy-efficient features in the final building plans that may have otherwise been dropped as a cost control measure. Builders indicated that the energy-efficient features of a home are important to homebuyers.

Survey results also indicate that participating companies were more likely to build energy-efficient homes than were non-participating companies. Survey respondents were asked to describe the amount of experience their companies had building energy efficient homes before and after the program was introduced in 2008. Thirty-nine per cent of participating builders surveyed reported their company had a fair amount or a great deal of experience building to EnerGuide 80 or higher prior to 2008. This proportion doubled to 79% after 2008. In contrast, only 40% of the non-participant builders surveyed indicated that they had experience building homes to EnerGuide 80 or higher after 2008.

Spillover from the Home Performance offer is another indicator of change to the new residential market. Participating builders indicated that the program had influenced approximately 3% of the energy-efficient homes (i.e., above code) that they built without an incentive from New Home.[6] Builders who knew about, but did not participate in, the program reported that the New Home program had influenced the building of 6% of the homes they built to above code but below EnerGuide 80, and 2% of the homes they built to EnerGuide 80 or higher.[7]

Non-energy Benefits

Overall, builders/developers reported that their companies experienced positive effects in several areas as a result of participating the in the New Home program, including: the design process, skills and knowledge of the workforce, and construction protocols and practices. Participants also found that the incented homes were more profitable and sold faster than homes that were less energy efficient. These results are supported by a high rate of satisfaction (85% very or somewhat satisfied) with the New Home program.

Electricity Savings

Reported and evaluated savings for the evaluated components of the New Home program are summarized in the table below. Evaluated net energy savings among participating builders/developers total 9.7 GWh per year over the 6-year period, compared to reported savings of 15.2 GWh per year. Evaluated spillover savings among

[6] This percentage was applied to the total electrically-heated single family detached homes (1,262 units) and townhomes (1,861 units) incented under the Home Performance offer.

[7] These percentages were applied to the total electrically-heated single family detached homes (14,776 units) and townhomes (11,103 units) built in BC, outside of the City of Vancouver, from 2008 to 2013 that were not incented by the Home Performance offer.

non-participating builders/developers total 1.9 GWh over the same timeframe. Evaluated savings from non-participant spillover should be considered with caution as the estimate is based on a small sample of survey respondents and may not be representative of the entire population of non-participating home builders/developers, particularly given the diversity of the industry. However, the survey results do suggest that some degree of spillover has occurred among some home builders/developers that did not participate in the program and represent the best available information on this question at the present time.

Table ES 1.3. Reported and Evaluated Energy and Peak Demand Savings

Builder Type	Fiscal Year	Energy Savings (GWh/yr)		Peak Demand Savings (MW)	
		Reported[8]	Evaluated Net	Reported	Evaluated Net
Participant Builders	F2008	0.6	0.4	0.2	0.1
	F2009	2.9	1.8	0.8	0.6
	F2010	3.0	1.8	0.9	0.5
	F2011	2.2	1.5	0.5	0.5
	F2012	2.6	1.9	0.8	0.6
	F2013	4.0	2.3	1.3	0.7
	Sub-Total	**15.2**	**9.7**	**4.4**	**3.1**
Non-Participant Builders	**Non-Participant Spillover**	**N/A**	**1.9**	**N/A**	**0.7**
Participant & Non-Participant Builders	**TOTAL**	**15.2**	**11.6**	**4.4**	**3.8**

There are several reasons for the variance between reported and evaluated energy savings:

- The majority of incented single family detached homes and townhomes were located in the Lower Mainland and Vancouver Island regions, whereas the geographical distribution assumed for reported savings was more dispersed, including parts of the province where the climate is colder and there is greater potential for energy savings;
- Reported savings assumed a higher proportion of townhome end units than those that were incented. End units have more exposed walls, higher electricity consumption and, therefore, higher electricity savings potential from energy efficiency improvements;
- Smaller sized homes were built compared to the sizes assumed in reported savings. Smaller homes have lower energy consumption and tend to yield less energy savings;
- Adoption of heat-pumps as a space heating source in new homes than was higher than assumed in reported savings. Heat pumps are more efficient than electric baseboards, thus decreasing comparison group consumption; and
- Reported savings for the Energy Star Package offer assumed that each package would include all products, which did not end up being the case. Evaluated savings are based only on the products that were incented. Since not every Energy Star Package incented contained all of the eligible products, evaluated savings were less than reported.

[8] Reported savings are net of free-rider ship and include participant spillover. A net-to-gross ratio was used in the calculation of net savings for townhomes and the Energy Star Package offer included a net-to-gross.

Findings and Recommendations

Findings

1. The program had expected to capture approximately 11% of the new residential housing market (single family detached homes and townhomes) by F2010 but the drop in the residential construction market due to the poor economy that occurred soon after the program was introduced interfered with achieving this goal. However, by F2013, when the economy had regained its strength, coverage of the electrically heated new home market outside of Vancouver reached 12%.

2. There is evidence to suggest that the New Home program supported the market transformation process in the new residential construction industry. Spillover was identified for builders who responded to the participant survey (0.2 GWh/year) and the non-participant survey (1.9 GWh/year), and the proportion of respondents who were full free riders increased by 28% from their first to last application, as would be expected with this type of program (i.e., multiple and repeated participations) and within a market transformation paradigm. Qualitative evidence collected in the surveys provided additional supporting evidence of market transformation.

3. Free ridership was high despite the estimates being based on the builder's first application to the program. The percentage of builders identified as full free riders increased from the first application to the last application to the program suggesting that previous participation in the program influenced future decision-making. The free ridership rate also could reflect changes to the residential construction market as most of the survey respondents first participated in the program in F2011 or later.

4. Net electricity savings of 3.5 GWh/year were generated by the 1,262 single family detached homes that participated in the Home Performance offer, representing 36% of reported savings. The participating homes represented 9% of the 14,776 electrically heated single family detached homes completed in the same period in British Columbia outside the City of Vancouver.

5. Net electricity savings of 1.0 GWh/year were realized by the 2,351 townhomes and multi-family building units that participated in the Home Performance offer, representing 10% of reported savings. The participating townhomes represented 17% of the 11,103 electrically heated townhomes completed in the same period in British Columbia, outside the City of Vancouver.

6. Net electricity savings realized from the Energy Star Package offer totaled 5.2 GWh/year, representing 54% of reported savings.

7. Builders and developers experienced some non-energy benefits as a result of participating in the New Home program such as improved profitability and speed of sale of energy-efficient homes.

8. Builders and developers reported that BC Hydro and FortisBC have an important role in supporting the new residential construction industry to meet changing energy efficiency codes and standards.

Recommendations

Listed below are recommendations resulting from this study, starting with a recommendation for program management (#1) followed by recommendations that serve both program evaluation and program management purposes (#2, #3) and a recommendation for future evaluations (#4). Note that order of presentation does not necessarily reflect relative priority.

1. Review and adjust the process and assumptions used to calculate reported savings to improve accuracy.
    a. Periodic review and examination of baseline energy consumption of new residential construction to ensure that the reported savings are realistic.
    b. Conduct market tracking to follow changes to the new residential construction market and industry.

2. Program management and evaluation teams should work together to design a program tracking system that captures the critical program data to support clear and accurate reporting of on-going program performance and facilitate future program evaluation (e.g., locate new construction accounts in the billing system). Develop documentation that defines and delineates data entry requirements (e.g., database dictionary; quality assurance procedures).

3. Implement regular data collection from builders/developers (and other relevant stakeholders, as appropriate) to inform program design and support evaluation requirements (e.g., free ridership and spillover estimates).

4. Review expectations and options for the treatment and measurement of free-ridership and spillover for this market transformation program that involves repeat participation (e.g., whether to assess it on the basis of individual housing units or multi-unit housing projects).

Conclusions

The New Home program achieved energy savings, but they were less than expected. The main reasons for the difference were the assumptions about housing characteristics used in reporting and the unit savings of key energy efficiency measures.

There is evidence that the New Home program supported the process of transforming the new residential construction market to higher levels of energy efficiency by changing builder practices and increasing the number of energy-efficient homes built in BC.

Builders feel that BC Hydro and FortisBC have a role in supporting the industry to achieve higher levels of energy efficiency.

1 Introduction

1.1 Evaluation Scope

BC Hydro's Power Smart New Home Program was designed to encourage British Columbia's new residential construction industry to increase their investment in building energy-efficient homes. This report presents the results of the impact evaluation of the Power Smart New Home Program on energy consumption and examines changes to the new residential construction market for the six-year period from April 2007 through March 2013, covering BC Hydro's fiscal years F2008 through F2013. This is the first full evaluation of the New Home Program conducted since its introduction in 2006. An evaluation of the windows component of the program covering F2008 and F2009 had been completed previously.[9]

The New Home Program reported electricity savings based on the program offer and on different characteristics of incented homes, including type of unit, heating type and efficiency level, as summarized in Table 1.1.

Table 1.1. Program Eligibility and Reported Savings Groups

Program Offer	**Home Performance**				**Energy Star Package***	
Unit type	Single Family Detached		Townhomes		Single Family Detached, Townhomes, Multi-unit Residential Buildings	
Heating Type	Electric	Gas	Electric	Gas	Electric	Gas
Efficiency Level	EnerGuide77** EnerGuide 80***				N/A	

* Package includes appliances, bathroom fans and lamps
** Reported savings from F2008-F2010 for both gas & electric
***Reported savings from F2008-F2013 for both gas & electric

This evaluation estimates electricity savings for all offers summarized in the above table except gas heated homes (both EnerGuide 77 and EnerGuide 80) and electrically heated homes built to EnerGuide 77. Gas heated homes make up approximately 9% of reported program savings while electrically heated homes and townhomes built to EnerGuide 77 make up approximately 2%. It was not feasible to include them in this evaluation due to time, method and resource constraints.[10]

1.2 Organization of the Report

The organization of the report is as follows:

- Section 1 covers the evaluation scope and initiative description.
- Section 2 discusses the evaluation approach including evaluation objectives, methodology, data sources and limitations.

[9] BC Hydro. *Power Smart Renovation and New Home Windows Initiative*, 2011.
[10] Participation for EnerGuide 77 single family detached homes was very low; the numbers were insufficient for statistical testing or modelling. For townhomes, the energy model used to estimate savings was built to replicate EnerGuide 80 or greater; inputs could not be updated to reflect EnerGuide 77.

- Section 3 provides the results organized by evaluation objective.
- Section 4 presents the key findings and related recommendations, and
- Section 5 summarizes the overall conclusions.

The appendices contain additional details and evidence to support or supplement the results presented herein. Data collection instruments are also appended.

1.3 Initiative Description

The Power Smart New Home Program was launched in June 2006 to encourage the construction of energy-efficient housing and to prepare the residential construction industry for the introduction of more energy-efficient building codes[11] and energy performance labelling of buildings that was being planned by the provincial government. The New Home Program provided financial incentives to residential home builders (from owner-builders to large scale developers) to adopt higher energy efficiency standards and install more energy-efficient technologies and products in new homes. Large scale developers were specifically targeted in an effort to increase the supply of energy-efficient homes in the new residential construction market. Builders could participate in the program multiple times. There was no cap on the number of times a company could participate. Program staff directed builders/developers to industry training and educational opportunities for building energy-efficient homes and helped Certified Energy Advisors engage with the industry by providing them with contacts for interested builders.

The Power Smart New Home Program had two main offers, each of which is described below.

Home Performance

The overall energy performance of new homes is rated by a Certified Energy Advisor according to the Natural Resources Canada EnerGuide Rating Service. An EnerGuide rating is a standard measure of a home's energy performance based on a scale of 0 to 100. Prior to F2013, a maximum incentive of $1,500 per unit was available to builders of single family detached homes rated as EnerGuide 80 or higher. This amount was increased to $2,000 per home in F2013.[12] Duplexes, row houses and townhouses (hereinafter inclusively referred to as "townhomes") could receive a maximum incentive of $200 per unit for achieving EnerGuide 80, throughout the F2008 to F2013 period.[13] Building envelope improvements were encouraged as the primary energy conservation measure implemented; however, no criteria were set by Natural Resources Canada as to how the builder could achieve an EnerGuide 80 rating. The Home Performance offer was available for homes built outside the City of Vancouver which had already adopted an EnerGuide 80 building code requirement.

[11] In 2008, the provincial building code was updated to require that new single family detached homes and townhomes achieve EG77, and there were plans to increase the requirement to EnerGuide 80. The provincial building code remained at EnerGuide 77 during the evaluation period. Since then, the BC Building Code (section 9.36 for energy-efficiency) was updated in December 2014 to include more stringent requirements, specifically around insulation.

[12] Program incentives were increased to help improve market penetration in the SFD market and offset the incremental cost for builders aiming to achieve EG80 or higher.

[13] From F2009 to F2011, the program incented 490 units in multi-unit residential buildings that were not eligible for other programs, in particular the Commercial New Construction program. These units were tracked and reported as townhomes.

Energy Star Package

The Energy Star Package offer was available to builders of new single family detached homes, townhomes and multi-unit residential buildings. From 2006 to 2009, three Energy Star appliances (refrigerator, dishwasher, bathroom fan) and six CFL bulbs[14] were included in the package. For the first two years of the program, an applicant had to install all the products to qualify for a $150 incentive. In 2009, Energy Star front load clothes washers were added to the list of eligible appliances. Applicants could install any combination of the five products, from a minimum of two to a maximum of five, to receive incentives of $50 (two products), $100 (three products), $150 (four products), or $200 (all five products). The Energy Star Package offer was available to units built anywhere in the province.

Companies applied for the incentives by submitting proof of EnerGuide rating for the Home Performance offer and proof of purchase and details about make and model for the Energy Star Package offer. Program staff confirmed whether the applications met the program's eligibility criteria.

Since 2012, the program has been implemented in partnership with FortisBC, with incentives depending on the space heating fuel and domestic hot water heating technologies used. FortisBC offered rebates of up to $1,000 per unit for high-efficiency natural gas water heaters, fireplaces and/or boilers, but did not offer a parallel incentive to Power Smart's Home Performance offer.[15]

The logic model for the Power Smart New Home program is presented in Figure 1.1. The logic model is organized around the two program offers, Home Performance and Energy Star Package, and identifies the links between program inputs (financial and human resources; marketing and promotional activities) and outputs (incentives paid to eligible participants), and the expected program outcomes. Outcomes are organized in order of short-term to long-term. The short-term outcomes (decreased incremental costs; increased energy-efficient activities) are expected to occur within 6 to 12 months, and must be achieved in order to attain the medium-term outcome of energy savings for homebuyers in one to three years. The longer-term outcomes reflect changes in the new residential market (supply and demand) that start to occur three to five years after the program is fully operational. Assumptions that are critical to program success are listed along right side of the logic model and include: accessibility of qualified Certified Energy Advisors, sufficient incentive value and builder/developer knowledge.

[14] LEDs were introduced near the end of the evaluation period.

[15] Note that energy savings for the Fortis BC New Home program were not calculated for this evaluation as the program had only been implemented recently.

Figure 1.1. Logic Model of the New Home Program Offers

The Power Smart Retail and the Renovation Rebate programs offer incentives for the same or similar products and upgrades as does Power Smart New Home. There is no overlap in program participation because the Retail and Renovation Rebate programs target existing home owners, whereas New Home targets developers of new homes.

Power Smart New Home occupants are exposed to BC Hydro's Residential Inclining Block Conservation Rate.[16] The quasi-experimental design applied to evaluating single family detached homes controls for RIB impacts. The evaluation of the Residential Inclining Block Conservation Rate controls for overall Power Smart program impacts.

[16] BC Hydro. *Evaluation of the Residential Inclining Block Rate*. 2014.

The efficiency of new homes is influenced by the BC Building Code. This influence is controlled for through the quasi-experimental design method used for this evaluation. The City of Vancouver implemented a more energy-efficient building code for residential construction (i.e., EnerGuide 80) in September 2008. All evaluated savings estimates generated for the Home Performance offer are adjusted to exclude the City of Vancouver.

The Energy Star Package offer was available to builders/developers who build multi-unit residential buildings and might also participate in Power Smart's Commercial New Construction program. Energy savings associated with the Energy Star Package offer are only attributed to the New Home program so double counting is not a concern.

2 Approach

2.1 Evaluation Objectives

The evaluation was structured around five evaluation objectives and associated research questions, as summarized in the following table.

Table 2.1. Evaluation Objectives and Research Questions

Evaluation Objectives	Research Questions
1. Market transformation*	• Was program participation in line with expected market coverage? • To what extent has the New Home program addressed barriers faced by builders/developers to building more energy-efficient homes? • To what extent has the program influenced home builder attitudes and practices in terms of building energy-efficient homes? • Has there been a shift in demand from new home buyers for more energy-efficient homes? • Has the program created any spillover in the new construction market?
2. Non-energy benefits to builders/developers*	• Are there non-energy benefits of program participation? If so, what are they and what kind of value is added?
3. Net electricity savings for the Home Performance offer - electrically heated single family detached homes	• What are the evaluated annual net electricity energy and demand savings for single family detached homes incented by the program? • How prevalent is the installation of air source heat pumps to achieve an EnerGuide 80 rating in new homes built during the evaluation period? • How much spillover was there from participants building energy-efficient single family detached homes that were not incented by the program? • What are the main contributors to any variance found between reported and evaluated savings?
4. Net electricity savings for the Home Performance offer – electrically heated townhomes	• What are the annual gross and net electricity and demand savings for townhomes incented by the program? • How much free ridership and spillover occurred? • What are the main contributors to any variance found between reported and evaluated savings?
5. Electricity savings for the Home Performance offer - non-participant spillover	• How much electricity savings were generated by non-participant spillover for single family detached homes and townhomes?
6. Net electricity savings for the Energy Star Package offer	• What are the annual gross and net electricity and demand savings for the Energy Star Package offer? • How much free ridership and spillover occurred? • What are the main contributors to any variance found between reported and evaluated savings?

*Assessment of market transformation and non-energy benefits focused on the Home Performance offer

2.2 Methodology Review

This section provides a review of recent evaluations of similar programs from other jurisdictions and some discussion of research methodologies applicable to evaluating new residential construction programs. The studies reviewed included:

a. California New Construction: Evaluation of Residential New Construction Programs for the California Investor Owned Utilities for 2006 – 2008.

b. California New Homes: Evaluation of the Statewide Energy Star New Homes Programs for 2002 and 2003.

c. Ontario New Construction: Evaluation of New Construction Initiatives for the Ontario Power Authority, 2014

d. Ontario New Homes: Evaluation of the Energy Star for New Homes Pilot for the Ontario Power Authority.

e. BC Hydro Windows: Evaluation of the Windows Initiative for F2008-F2009.

f. BC Building Code: Evaluations of the BC Residential Building Code for F2009-F2010 and F2011.

The most rigorous impact evaluation method adopted in the reviewed evaluations was calibrated modelling of energy usage using a comparison group of non-participants to establish a baseline. This approach was applied in the California New Construction evaluation. Calibration was done at the account (whole house level) and end use levels. The primary data sources were billing data, electrical metering on three end uses for 162 homes (31 participants and 132 non-participants), and site inspection data for 425 homes (all non-participants).

A similar, but slightly less rigorous, approach was used for the evaluation of the BC Building Code. In this evaluation, energy modelling was completed based on the results of site audits, but without calibration (since no billing data were collected). A modelled baseline was used instead of a comparison group of non-participants. The primary data source was site inspection results for 800 homes.

Billing analysis was attempted for the evaluation of the California New Homes Program. However, the approach yielded limited results due to a lack of information on important demographic and building characteristics. In the end, the evaluators reverted to energy use modeling with calibration to evaluate the program.

The Ontario New Homes Evaluation assessed the deemed savings estimates used by the program and relied on survey research to calculate the net-to-gross ratio. For this evaluation, the Ontario study initially attempted to estimate net to gross using a survey of home buyers. However, upon finding low program awareness among home buyers, the evaluators determined that home builders (not home buyers) are the decision makers with respect to program participation.

In 1995, BC Hydro commissioned an evaluation of the Power Smart New Home pilot program, which targeted lighting, water heating and windows in new residential construction. The evaluation was based on interviews with program stakeholders (builders, trade allies, program staff), site visits and energy modelling of eight homes (six participants and two non-participants).

BC Hydro also conducted an evaluation of the windows component of the New Home Program for F2008 and F2009, which included a process evaluation component as well the net impact evaluation. The impact evaluation used econometric modelling to assess the program impact on the penetration of Energy Star qualified window installations in new homes.

The Ontario New Construction evaluation relied on an expert review and assessment of potential sources of variance and uncertainty associated with deemed savings in the engineering calculations. Where it was found to be necessary, corrections and adjustments were applied to the assumptions and inputs to obtain the

evaluated savings. The net-to-gross ratio used a survey-based free-rider rate for program participants, but spillover was not taken into account (for neither participants nor non-participants) due to lack of data.

Boerakker and Stoops (2012) looked at evaluation of new residential construction energy performance in four different countries (the Netherlands, the UK, Denmark and the US). They concluded that "predictions of consumption in buildings are almost always poorly related to actual consumption, indicating a fundamental weakness in the goal of actually achieving the predicted energy savings" due, in part, to inaccurate estimating techniques (i.e., incorrect modeling of physics and/or behavior). Membrino and Warren (2015) recommend "calibrated modeling" - comparing the modeled results to billing data, and adjusting the model as necessary to reflect the actual situation (e.g., weather, occupancy, size, and technology).

Another noteworthy topic to ensuring a rigorous evaluation approach is the treatment of self-selection into the program when using a quasi-experimental design with a comparison group. The U.S. Department of Energy Uniform Methods Project (2014) notes that self-selection bias can be controlled for by randomized control trials. The self-selection issue can also be controlled for with quasi-experimental design. As explained by Provencher et al. (2013), while certain non-observable factors might exist to impact self-selection differently between the comparison and treatment groups, matching the two groups on energy consumption over a period of time will account for these differences. In other words, self-selection and its impact are counterbalanced by other factors to the extent that there is no difference in energy consumption between the participant and comparison groups prior to the program intervention. Thus, a matched comparison group can be considered a reliable counterfactual against which program participants can be measured.

Non-energy Benefits

In a report commissioned by BC Hydro and Fortis BC, Dunsky (2012) reviewed several studies that included an evaluation or quantitative assessment of non-energy benefits associated with new energy-efficient homes, and used three different approaches to infer a reasonable range of values for non-energy benefits. The Dunsky report focused on non-energy benefits to new home buyers and not to builders/developers (the program participants). The author notes that non-energy benefits are most commonly assessed through a computational approach or through survey-based estimates, and that the latter appears to be the only method used to estimate non-energy benefits in the residential new construction sector. In practice, the survey-based estimates use either contingent valuation, where participants assign a monetary value to the benefit(s) experienced, or relative scaling, where participants make comparative judgments between the value of the benefit and some other known factor. Dunsky's review indicates that the preferred approach is relative scaling as there is typically less variation in the results. A survey was completed with a sample of recent buyers of new homes rebated through New Home to establish homebuyers' criteria for choosing their homes as well as expected payback. The report summarizes the monetary valuations of non-energy benefits from the different estimation approaches.

Based on the evaluations reviewed above, it is clear that jurisdictions have taken a wide range of approaches with varying degrees of rigour to measure net impacts of new construction programs. The most methodologically sound design was to calibrate an energy model using metered consumption data and compare the results to the baseline consumption. However, this was not the approach most often taken. In some cases, a comparison group was used as the counterfactual but without model calibration, while in others only the energy models were used with up-dated assumptions.

2.3 Methodology

The objectives, data sources and methods used for this evaluation are summarized in the table below, and further described in the remainder of this section.

Table 2.2. Evaluation Objectives, Data and Method

#	Evaluation Objectives	Data	Method
1.	Market transformation	• 2014 survey of builders/developers (program participants, n=75; non-participants, n=70) • Program tracking data • Canada Mortgage and Housing Corporation statistics	• Descriptive analysis (e.g., frequencies, cross-tabulations, means, etc.) • Survey-based spillover analysis
2.	Non-energy benefits to builder/developers	• 2014 survey of builder/developer program participants (n=75) • Secondary research	• Descriptive analysis (e.g., frequencies, cross-tabulations, means, etc.) • Qualitative analysis
3.	Net Electricity savings for the Home Performance offer – electrically heated single family detached homes	• Program tracking data • Participant electricity consumption and billing system data (i.e. region, housing type, heating fuel) (n=454) • Non-participant electricity consumption and billing system data (i.e. region, housing type, heating fuel) (n=1,178) • 2014 survey of builders/developers (program participants, n=75; non-participants, n=70) • BC Assessment data (square footage and year of build) • Greensheets Construction builders database • Peak to energy ratio from residential space heating load shape	• Quasi-experimental design • Statistical testing • Survey-based spillover analysis
4.	Net electricity savings for the Home Performance offer – electrically heated townhomes	• HOT2000 energy simulation models • Program tracking data • 2014 survey of builders/developers (program participants, n-75; non-participants, n=70) • Peak to energy ratio from residential space heating load shape	• Engineering calculations • Survey based free ridership and spillover analysis
5.	Electricity savings for the Home Performance offer - non-participant spillover	• 2014 survey of builders/developers (non-participants, n=70) • Program tracking data • Canada Mortgage and Housing Corporation statistics • Results of Objectives 3 & 4	• Survey-based spillover analysis
6.	Net electricity savings for the Energy Star Package offer	• Program tracking data • Energy Star website • 2009-2012 Annual Retailer Shelf Space/Stock Studies • 2014 survey of builder/developer program participants (n=75) • Interviews with major distributors (n=3) • Cross effects factors from the Power Smart Standard Procedure for Cross Effects • Peak to energy ratio from residential space heating load shape	• Engineering calculations • Survey-based free ridership and spillover analysis

2.3.1 Methodology for Assessing Market Transformation

A key goal of the New Home Program was to prepare the new residential construction industry for anticipated changes to the building code and provide support to build more energy-efficient homes. Therefore, several facets of market transformation were examined for the Home Performance offer.[17]

Two surveys were completed for the evaluation: one with builders who participated in the program and one with builders who did not. Both surveys included several questions pertaining to market transformation (see surveys contained in Appendix E). The survey of builders/developers who participated in the program was sent electronically to 216 companies in the fall of 2014. Seventy-five companies provided responses, representing a response rate of 35% and margin of error of ±9.8% at the 90% confidence interval. A sample frame of approximately 3,000 companies operating in BC that did not participate in the New Home Program was developed from several sources. The survey of non-participant builders/developers was administered online in December 2014. Seventy companies responded, resulting in a response rate of 2% and margin of error of ±11.6% at the 90% confidence interval. Given the low response rate for the survey of non-participating builders, results could be subject to non-response bias[18] and may not be representative of all builders/developers.[19]

Market effects such as changes in builder attitudes, builder practices and homebuyer demand were examined using descriptive analysis of the builders/developers participant and non-participant survey responses. Participant builder survey responses were used to explore changes in free-ridership from the first to the last time the builder participated in the program as well as participant spillover.[20] While these results serve as an indication as to whether changes occurred to the market, direct attribution of these changes to the program cannot be made on the basis of descriptive analysis.

Non-participant spillover was another indicator of market transformation used in the evaluation. A survey-based estimate of spillover for non-participating builders/developers was calculated. The steps and algorithm used to estimate the rate of non-participant spillover are contained in Appendix C.

2.3.2 Methodology for Assessing Non-Energy Benefits

Non-energy benefits that accrued to builder/developers who participated in the Home Performance offer were examined based on descriptive analysis of responses to the builder/developer survey. Non-energy benefits to homebuyers/occupants associated with buying an energy-efficient home were explored using results from the

[17] Since there are many other Power Smart offers that influence the supply and demand of Energy Star products, no attempt was made to isolate the extent to which the New Home program contributed to market transformation in this regard.

[18] Non-response bias occurs when there is a systematic difference between those who responded to a survey and those who did not. There is a greater risk of non-response bias occurring when the response rate is low.

[19] While the margins of error associated with the sample sizes for both participants and non-participants are acceptable, non-response bias poses a threat to validity due to the low response rates. Given that information about companies in the builder/developer population is not available, the extent of non-response bias cannot be determined nor corrected for in the analysis.

[20] Savings associated with participant spillover was included in the calculation of net savings and, therefore, not included in market transformation estimate. In the analysis of market transformation, participant spillover was examined as an indicator of market transformation.

participant builder survey in combination with findings from the Dunsky (2012) study conducted on behalf of BC Hydro and Fortis BC.[21] Societal level non-energy benefits were not examined.

2.3.3 Methodology for Estimating Net Electricity Savings from Electrically Heated Single Family Detached Homes in the Home Performance Offer

Energy savings from single family detached dwellings incented under the program's Home Performance offer were evaluated using a quasi-experimental design with a matched comparison group. The participant group consisted of electrically heated single family detached homes that had only been incented under the Home Performance offer (did not receive an incentive for the Energy Star Package offer). The comparison group, comprised of electrically heated single family detached homes that were not incented by the program (non-participants), was used as a baseline against which the treatment group was compared.

The comparison group was established by matching participant new homes to non-participant new homes on the following criteria:

- housing type (i.e., single family detached home);
- year of build, obtained from program tracking data for participant homes and from BC Assessment for non-participant homes;
- region (Lower Mainland, Vancouver Island, Southern Interior and North), obtained from the BC Hydro billing system;
- space heating source (electric), obtained from the BC Hydro billing system; and
- home size (within ±15 square feet), obtained from BC Assessment.

There was no pre-program billing history to compare program participants and the comparison group as the program only incented newly built homes. Therefore, the two groups could not be matched using energy consumption history, a standard energy program evaluation criterion. Nonetheless, the matching criteria helped to create comparable energy consumption profiles between the two groups.

In order to mitigate the impact of any extreme cases selected into the comparison group, each participant home was matched with up to three non-participant homes, so that the net program impact result for each participant home is based on the average of the different comparisons made between each participant and its matches. The one-to-many matching method is a standard approach used in the propensity score or nearest neighborhood matching in quasi experimental design. A sensitivity analysis was completed to confirm this as a more reliable approach than on-to-one matching.

This approach did not require gross savings to be calculated as an intermediate step to obtaining net energy savings. Since a quasi-experimental design and a matched comparison group were used to calculate the program savings, the analysis yielded net energy savings attributable to the Home Performance offer. Further, the use of actual electricity consumption data ensures that the results are net of electricity cross effects and direct rebound effects.

[21] Dunsky Energy Consulting. *Residential New Construction Non-Energy Benefits*. 2012

Total net energy savings for the Home Performance offer were calculated using the following steps:

Step 1. Calculate average monthly energy savings per participant

The monthly net energy savings due to the impact of the Home Performance offer was calculated for each matched participant as the difference between the energy consumption of participating and non-participating homes for each month in the evaluation period.

Equation 1. Monthly Net Energy Savings

$$Monthly\ Net\ Energy\ Savings_i = \left[\sum_{\substack{Participant- \\ Non-participant \\ match=1}}^{n} (Energy\ Consumption_{non-Participant} - Energy\ Consumption_{Participant}) \right] /\mathrm{n}$$

Where *Energy Consumption* is monthly consumption and *n* equals the total number of matched pairs.

The Student's t-test was performed among all participant and non-participant matches to determine whether the difference in monthly consumption was statistically different than zero at the 80% confidence level. If the difference between a given pair in a given month was statistically significant, it was included in evaluated savings. Average monthly savings per participant was calculated by dividing the sum of statistically significant differences between matched pairs by the total number of pairs.

Step 2. Adjust energy savings for weather

The calculation of net energy savings was based on actual billing data and, because the Home Performance offer was mainly related to the building envelope, energy savings were dependent on space heating requirements and weather. Therefore, a weather adjustment was made to understand monthly energy savings under normalized weather conditions.

Monthly heating degree days and cooling degree days were compared to the long run (10 year) average of heating and cooling degree days, obtained from Environment Canada. Then the average monthly savings was adjusted by the ratio of the long run average heating and cooling degree days to the actual monthly heating and cooling degree days.

Equation 2. Weather Adjusted Monthly Net Energy Savings

$$Weather\ Adjusted\ Monthly\ Net\ Energy\ Savings_i = (Long\ Run\ Average\ Monthly\ Heating\ and\ Cooling\ Degree\ Days_i / Actual\ Monthly\ Heating\ and\ Cooling\ Degree\ Days_i) * Monthly\ Net\ Energy\ Savings_i$$

This approach to weather normalization assumes a linear relationship between energy savings attributable to the Home Performance offer and weather. This assumption is supported by the fact that energy savings from this offer are due to space heating measures and previous work that demonstrated linearity in the relationship between residential energy consumption and heating and cooling degree days over a range of temperatures.[22]

Step 3. Calculate total energy savings attributable to the Home Performance Offer

Total energy savings attributable to the Home Performance offer was calculated by multiplying average annual energy savings per home by the number of participating homes per fiscal year. The number of participating homes was obtained from program tracking data.

It was not feasible to estimate the net energy savings by year for F2008 through F2010, as the period for participant consumption history was too short and the sample size was too small to conduct statistical analysis. Therefore, the weighted average unit savings across the three years of F2011 to F2013 was applied to F2008 through F2010.

Step 4. Participant Spillover

Participant spillover was not captured by the comparison group as builder/developers who participated in the program could have built energy-efficient homes that were not incented. A survey-based estimate for builders who had received a New Home incentive for at least one single family detached home from F2011 to F2013 was used to calculate participant spillover. The algorithm to calculate the participant spillover rate is presented in Appendix C. The survey-estimate of the spillover rate was applied to incented homes using the evaluated savings from the quasi-experimental analysis to calculate spillover energy savings. The energy savings associated with participant spillover were added to the net energy savings from the quasi-experimental analysis.

Step 5. Peak Demand Savings

Peak demand savings were calculated by multiplying total energy savings of the Home Performance offer by a ratio of 0.35 MW per GWh, based on a load shape for residential electric space heating.

Threats to Validity

The main threat to the validity of the method described above is the possibility that the sample of non-participating homes was systematically different from the population of participating homes on some other factor(s) not considered in the matching process. If these factors happen to be critical in determining energy consumption, then the systematic difference in these factors between participating homes and their matches would result in biased estimates of energy savings. However, this threat is believed to be mitigated by using up

[22] The linearity assumption is based on the analysis of overall residential electricity consumption in relation to heating and cooling degree days completed for the *Evaluation of the Residential Inclining Block Rate F2009-F2012"*(BC Hydro, June 2014). However, the linear relationship between energy savings and heating/cooling degree days may be weak considering that improved building shells lead to longer time lags between outside weather change and the activation of heating/cooling equipment. The linearity would likely be more noticeable in more extreme climates. In milder climates, non-linear relationships could exist.

to three matches for each participating home, which would help to attenuate differentials due to unmatched factors, such as occupancy.

On the other hand, it is reasonable to apply the results from the comparison group analysis to the whole program population because matches were found for 55% of the participant group, and the regional distribution of matched participants (26% from Vancouver Island and 74% from Lower Mainland) closely followed the regional breakdown of the population of participants (29% from Vancouver Island and 71% from Lower Mainland).

Since occupants of new residential homes covered by New Home program may participate in other Power Smart programs, there may be double-counting of energy savings between New Home and other Power Smart programs. However, it is reasonable to assume that the matching method used to construct the comparison group would have included, to a certain degree, homes with occupants who also participated in other Power Smart programs. Therefore, the impact of other Power Smart programs should exist in both groups and be cancelled out when calculating the difference between the two groups. Since New Home program participants are builders and not the final occupants of new homes, there is no strong reason to believe that the participation rates in other parallel DSM initiatives (e.g., lighting, behavior, appliance and electronics programs or the residential conservation rate) would be significantly different. The participation rates in the Power Smart Appliance Rebate program for the participant group (9.4%) and the comparison group (8.1%) were not statistically different.

Three additional analyses on the participant and comparison groups for single family detached homes were conducted to ensure the validity of the impact analysis. Each analysis is described below.

Sensitivity Analysis. Analysis was performed to examine the sensitivity of net savings estimates to the selection of different comparison group matches for each participating home. The same statistical test was employed as that used in the impact evaluation of single family detached home savings. The results from the three-to-one matching approach were compared to the results from using a one-to-one matching approach. The one-to-one matched comparison group was constructed in three different ways: randomly selecting one of the three matches and selecting the maximum or minimum consumption out of the three matches.

The sensitivity analysis indicated that using multiple matches for each participating home had less volatile results than matching just one comparison home, whether selected randomly, or based on maximum or minimum consumption. The variation in results was especially significant in the early evaluation period, where the participant sample size was small. The small sample size would amplify the impact of a single match with an extreme case being selected as a comparison. The multiple matches would mitigate such impact. The variation became much small or negligible in the later evaluation period between the random pick and the three-match being the comparison group as the participant group increased in size. Results of the sensitivity analysis can be found in Appendix D.

Differences due to Builder Size and Practice. Large (multiple units/year) home builders and small (single unit/year) home builders may have different practices in terms of constructing energy-efficient buildings. Therefore, the composition of the participating home and non-participating home groups was checked for differences in builder size and, if there was a difference, how much the difference would affect the net savings estimate. Results revealed a slight difference in builder size between the participating home and non-participating home groups. To explore differences in builder size on energy savings, large and small builders (both participants and non-participants) were pooled together and regression analysis was conducted to identify the impact of builder size.

Further analysis showed that, although the large and small builders may build homes with different levels of energy efficiency, the difference does not change the overall evaluation results significantly. The results indicated that builder size had little effect on the average savings per single family detached home; the results were very close to the average unit savings derived from the methodology adopted in the evaluation. Detailed results of this analysis can be found in Appendix D.

Comparison Group Contamination. To ensure that homes in the comparison group were not influenced by the New Home program, a random check of builders in the comparison group was completed using an historical data base of building permits containing construction and builder information. The results indicated that a negligible amount (i.e., less than 2%) of homes in the comparison group had been built by companies that had previously participated in the New Home program.

2.3.4 Methodology for Estimating Net Electricity Savings from Townhomes in the Home Performance Offer

Energy simulation models for townhomes were previously developed for the purpose of forecasting and reporting savings from the Home Performance offer. These models were reviewed to determine if they would yield valid estimates of gross savings for townhomes incented by the program. The validity of the model was confirmed, with adjustments made where necessary. Net energy savings were then obtained by adjusting the gross savings for free ridership and spillover.

Gross Savings

The basic steps to calculate gross savings were as follows:

1. Test the validity of the energy simulation models.
2. Review the models.
3. Identify key assumptions in the models that influence energy savings and that could be updated.
4. Obtain updated estimates for these assumptions.
5. Re-calculate modeled savings with updated estimates.
6. Apply an adjustment factor to modeled savings for townhomes to calculate gross savings for the units in the multi-unit residential buildings.

The validity of the energy models for townhomes was checked by comparing the results from the adjusted energy model for single family detached homes to results from the billing analysis for single family detached homes. The original assumptions for home size and region were up-dated with the actual values.[23] With these adjustments, the model for single family detached homes was found to predict savings that were reasonably close to the evaluated estimate obtained through billing analysis. Additional details on this analysis can be found in Appendix C. No comparable analysis was available to test the validity of the townhome models, because billing analysis for townhomes was not completed.

Once the model itself had been validated, it was reviewed to determine if there were differences between the assumptions made for reported savings and the actual townhomes that were incented. The townhome energy

[23] Note this work did not include re-running the energy models, calibrated to billing data. See Appendix D for details on the work.

models simulated yearly energy consumption and savings due to achieving EnerGuide 80 rating using Natural Resource Canada's HOT2000 model. The model was varied on some characteristics to account for different home characteristics, while other assumptions remained static across all simulations. The following assumptions were held constant across all models:

- two occupants per town home for all four regions;
- domestic hot water loads were assumed to be 155 litres/day at a delivered temperature of 55°C; and
- inside temperatures of 18.4°C for electrically heated homes.

The following parameters could be varied:

- heating fuel – electricity or natural gas;
- heating system – electric baseboards, gas furnaces, air source heat pumps, ground source heat pumps;
- region – Lower Mainland, Vancouver Island, Southern Interior, Northern Interior;
- size – 93 m^2, 140 m^2 and 232m^2; and
- type of unit: end or middle unit.

As described in the introduction to this report, the evaluation analysis was limited to townhomes with electricity as their heating fuel. The baseline townhome and energy-efficient townhome were similar in all respects except for walls, basement insulation levels and air tightness. Additional detail on the baseline and EnerGuide 80 measures can be found in Appendix C.

Analysis of the townhome model outcomes revealed that type of unit (end or middle) was the variable with the greatest impact on energy savings. Size of home was the next largest driver of energy savings. While there was little difference between the results for two of the regions (Vancouver Island and Lower Mainland), substantial differences were found between these two regions and the Northern and Southern Interior regions. Therefore, type of unit, size, and region variables were selected for potential update.

While four different regions were modeled, and a weighted average of these regions was used to inform the forecast and reported savings, actual participation was limited to two regions: Vancouver Island and Lower Mainland, with most participants (75%) located on the Lower Mainland. The Lower Mainland and Vancouver Island regions have very similar climate and energy model results. Therefore, the Lower Mainland models were used as the basis for the evaluation analysis.

Two different types of units were modeled, end and middle units. Modeled electricity savings for end units were approximately twice that for middle units. This difference is due to the fact that savings are largely from electric space heating, and space heating loads are smaller in middle units than in end units due to more shared walls. Reported savings assumed a building configuration of two middle and two end units. A review of a small sample of participants' building plans as well as information from an industry expert suggested that a more realistic (average) configuration would be three middle units and two end units. Therefore, the modelling assumptions were revised to reflect the more typical building configuration of three middle and two end units.

To adjust savings for size of home, the relationship between modeled energy consumption and size was estimated using the modeled energy use for the three different home sizes. The relationship was based on the weighted average annual electricity consumption of three middle units and two end units, electrically heated

in the Lower Mainland.[24] The relationship covered the range of sizes that were modelled (90 m^2 to 232 m^2) and their modeled energy consumption. Equations 3 and 4 below present the relationship between size and electricity consumption for baseline and EnerGuide 80 townhomes.

Equation 3. Energy consumption as a function of townhouse size for baseline homes

$$Annual\ Electricity\ Use\ (\frac{\text{kWh}}{\text{yr}})_{\ Baseline\ Home} = 28\ kWh/m^2 * (average\ town\ home\ size\ (m^2)) + 9{,}152\ kWh/yr$$

Equation 4. Energy consumption as a function of townhouse size for EG80 homes

$$Annual\ Electricity\ Use\ (\frac{kWh}{yr})_{(EG80)} = 26\ kWh/m^2 * (average\ town\ home\ size(m^2)) + 8{,}707\ kWh/yr$$

Actual average size of townhome was obtained from program tracking data, and electricity savings were calculated by taking the difference between annual consumption of the modeled baseline and modeled EnerGuide 80 home.

The per unit energy savings estimated for townhomes had to be adjusted to account for the lower energy consumption of the 490 units in multi-unit residential buildings that were incented in F2010, F2011 and F2012. It was assumed that the energy savings for these units would be proportionate to their average annual electricity consumption relative to townhomes, which was 36% (or a factor of 0.36).[25] The details of the factor calculation are contained in Appendix C.

Free-ridership and Spillover

Builders could apply to the program more than once and one application could cover more than one housing unit. As a result, some of the units in one application could have been free riders or spillover and others not. Also, the degree of free-ridership and spillover could have changed from the first to the last time the builder or developer participated in the program, which aligns with the program objective of contributing to market transformation. These factors were taken into consideration when deciding how to estimate free ridership and spillover.

A retrospective survey of builders/developers that participated in New Home was conducted in 2014. Participant free-ridership and spillover was estimated based on the survey responses of participating builders/developers that reported building townhomes (n=15).[26] Since survey respondents applied to the program in 2011 or later, and were not surveyed until 2014, it was decided that survey-based free rider and spillover estimates would only be applied to the last three fiscal years of the evaluation period (F2011-F2013).[27] In the absence of better information, assumptions for free-ridership and spillover that were used to

[24] Note this work draws on the modelled energy use values, not energy billing data.

[25] The adjustment factor was taken from the results from Power Smart Evaluation study completed in 2010, *Conditional Demand Analysis of Residential Energy Consumption*.

[26] The 15 builders received incentives for 119 units in their first applications. These companies reported building an average of 223 townhome units annually, approximately one-third of the number of units incented under the program in years with the highest number of incented townhomes.

[27] Since builders could apply to the program more than once, the free-ridership score is based on participants' decisions at the time of first applying to the program. The rationale for selecting the first application is that one goal of the program is to change industry

calculate forecast and reported savings were retained to calculate evaluated savings for the first three fiscal years (F2008-F2010). In F2008, free-ridership was assumed to be 5% and spillover was assumed to be 10%. In F2009 and F2010, it was assumed that free-ridership and spillover were the same (i.e., cancelled each other out; therefore, the net-to-gross ratio = 1).

Full free-riders for builders of townhomes who participated in the Home Performance offer were defined as those survey respondents who 1) had planned to build and 2) would have built the same homes to EnerGuide 80 without the program incentive. Partial free-ridership was based on survey respondents who would have built more efficient homes (i.e., EnerGuide 80 or higher) but not necessarily as many homes, or at the same time, without the program incentive. The free ridership score was derived from responses to five questions in the participant survey covering planning, time of installation, keeping the planned energy-efficient features, and influence on decision-making. The algorithm to estimate the rate of free ridership is contained in Appendix C.

Spillover occurred for builders of townhomes who had also built homes that were not incented under New Home. These builders were asked if they had intended to apply for the Home Performance incentive for any of these units (and, if so, what percent) as well as how much influence the program had on their decision to build these energy-efficient homes without an incentive. The complete participant spillover algorithm is contained in Appendix C.

Peak demand savings were estimated using a ratio of 0.35 MW per GWh, representing the average ratio of peak demand to energy consumption for residential electric space heating.

Threats to Validity

The method used to estimate energy savings for townhomes is generally considered to be less rigorous than experimental or quasi-experimental design because it does not control for other influencing factors and its validity is limited to the validity of the original energy models. Any bias present in the original models will also be present in the evaluated estimates. The method was chosen as it is commonly used in the DSM evaluation field to assess the net impact of new residential construction programs given the information and resource constraints. The validity of the original model was assessed for single family detached homes by comparing the adjusted modeled savings to the savings estimate based on billing analysis. It is believed that the original model is sound as the modeled results, after adjusting the assumptions, were similar to the savings estimate based on billing analysis. The savings estimate for townhomes used the same model, but with different inputs. Although the model has been found to be sound for single family detached homes, its validity for townhome energy consumption was not directly tested and confirmed.

The method used to estimate savings for townhomes relied on energy modeling, which does not consider potential effects from other programs. Therefore, if synergies did exist between the energy consumption of townhomes built through the program and parallel DSM initiatives, the effects of other programs on townhome electricity consumption would not be captured in the model.

---

practice; therefore, if the program is successful in achieving this, free ridership would be expected to increase over time. Therefore, the rate of free-ridership associated with the first application would most accurately represent applicants' original intent and original program assumptions.

2.3.5 Methodology for Estimating Electricity Savings from Non-participant Spillover for the Home Performance Offer

Electricity savings were also estimated for those homes that were built to above code by builders who did not participate in New Home but were influenced by the program to build more energy-efficient homes. Spillover savings were calculated for homes that were EnerGuide 80 or higher and for homes that were above code (EnerGuide 77) but did not achieve EnerGuide 80. The spillover rates estimated from the survey of builders/developers who did not participate in New Home were applied to the housing completions for electric heat single family detached homes and townhomes built in BC outside of Vancouver (less the homes incented by the program). The estimated spillover homes were multiplied by evaluated savings for each housing type.[28]

2.3.6 Methodology for Estimating Net Electricity Savings for the Energy Star Package Offer

Gross energy savings for the Energy Star Package offer were calculated for each of the product groups covered by the program. Free-ridership and spillover were calculated for each product group and used to calculate the net-to-gross ratio. Net savings were obtained by applying the net-to-gross ratios to gross savings. The methods used to estimate energy savings for appliances, bathroom fans and lighting are described below. Additional details are contained in Appendix C.

Appliances

Gross savings for the appliances were estimated by comparing energy consumption of the Energy Star models that were rebated with baseline consumption for non-Energy Star models, for each fiscal year. Consumption and capacity information was obtained from the Energy Star website.[29] Energy consumption was identified for each make and model from this source; therefore, the savings estimates completed for this evaluation are prone to any error associated with the deemed consumption levels. Energy consumption of non-Energy Star models from the annual shelf/floor stock surveys served as the baseline.

The difference between the average consumption for incented baseline refrigerator and clothes washer models was multiplied by average capacity and the number of incented units for each type of model in each fiscal year. Energy consumption for dishwashers did not require an adjustment for capacity.[30] The energy savings for refrigerators were adjusted for cross effects, using a factor of 0.02. This cross effect factor is based on the Power Smart Standard Procedures for Cross Effects and adjusts for the impact of energy-efficient technology on other energy uses. There is no requirement to adjust for cross effects for any of the other appliances.

Bathroom Fans

Gross energy savings for energy-efficient bathroom fans was estimated using engineering calculations. The original assumptions used to estimate energy savings were reviewed and adjusted by engineering experts to

[28] Note that, for between code and EG80 units, 50% of the evaluated per unit energy savings was used.

[29] http://www.energystar.gov/products/certified-products

[30] Energy consumption for dishwashers is related to the amount of water used and the energy required to heat the water, rather than to its size.

ensure applicability to the characteristics of the housing units where the fans were installed (e.g., size and type of unit), as well as to building code requirements for ventilation. The original unit energy savings estimate was 25 kWh per fan. After the assumptions were up-dated, the unit energy savings estimate changed to 41 kWh per fan. The increase was due, in a large part, to an increase in the assumed number of hours the fans would be on, to reflect new requirements in the building code. The assumptions applied in the revised engineering calculation are contained in Appendix C.

Annual gross energy savings was calculated by multiplying the total number of fans incented in each fiscal year by the estimated annual unit savings.

Lighting

CFLs were the main type of energy-efficient lighting incented during the evaluation period.[31] For F2008 and F2009, the engineering estimates from that time period were used as the baselines to estimate gross energy savings for lighting. For the remaining years, the baseline assumed that CFLs replaced incandescent and halogen lamps. In F2010, F2011 and F2012, the baseline wattage was assumed to be 60 watts, as the average wattage of bulbs incented through the program was approximately 14 watts.[32] The gross energy savings were based on 934 annual hours of use[33] and adjusted for a cross effect factor of 0.05. This cross effect factor is based on the Power Smart Standard Procedure for Cross Effects.

Free Ridership and Participant Spillover

Free ridership and participant spillover for the Energy Star Package offer were estimated using responses from the participant survey. The same limitations that apply to free-rider and spillover estimates for townhomes also apply to the Energy Star Package offer: the survey-based free-rider and spillover estimates are only applicable to the last three fiscal years. Therefore, assumptions for free-ridership and spillover that were used to calculate forecast and reported savings were retained to calculate evaluated savings for the first three fiscal years (F2008-F2010).

As already mentioned, builders could apply to the program more than once and one application could cover more than one housing unit. For the Energy Star Package offer, different combinations of incented products were also possible. Therefore, some of the products in one application could have been free riders or spillover and others not. The free ridership score for the Energy Star Package offer is based on participants' decisions at the time of first applying to the program. As with townhomes, the rate of free-ridership associated with the participants' first application was assumed to be a more accurate representation of their original intent. Free-ridership was calculated for the three appliances (as a group), for bathroom fans and for CFLs.

Full free riders for the Energy Star Package offer were defined as those survey respondents who 1) had planned to install and 2) had started to install the same number of the same Energy Star products before becoming aware of the program. Partial free-ridership was defined as survey respondents who would have installed a lesser number of Energy Star products without the program incentive. It was derived from

[31] Although LEDs became available in the latter part of the evaluation period, only 30 units were incented for LEDs in F2013.
[32] The typical replacement for 60 watt incandescent bulbs is 13 to 18 watt CFLs, as specified in the US DOE equivalent wattages.
[33] Sampson Research, 2011. *Residential Monitoring Study*.

responses to five questions in the participant survey covering: planning, time of installation, product cost, program influence on decision-making and proportion of installed products that would have been installed regardless of the program. The complete free ridership algorithms are presented in Appendix C.

Participant spillover for the Energy Star Package was calculated for companies that reported installing energy-efficient products for which they did not receive a rebate from the New Home program. Spillover was calculated for appliances (taken together as a group), bathroom fans and CFLs. The full spillover algorithms are presented in Appendix C.

Given that the program's direct target market is the new residential construction industry, the companies that make up the industry are the purchasers of the products, not the homeowners. Residential construction companies do not receive other rebates or offers for purchasing and installing Energy Star appliances, bathroom fans, CFLs or LED lamps. Therefore, there was no overlap between the Energy Star Package offer and other Power Smart DSM programs.

Net savings for the Energy Star Package offer were calculated using the gross estimated savings for appliances, bathroom fans and CFLs, and adjusting those for free ridership and spillover. A rebound adjustment was not made for the Energy Star Package offer, in accordance with the Power Smart Standard for Rebound Effects. The following equation depicts the calculation of net evaluated energy savings for the Energy Star Package offer.

Equation 5. Net Evaluated Energy Savings for Energy Star Package Offer

$$Net\ Evaluated\ kWh_{savings} = Gross\ Evaluated\ Savings * (1 - free\ rider\ rate + spillover\ rate)$$

Peak demand savings were calculated for refrigerators, clothes washers, dishwashers and lighting by multiplying the total energy savings for those appliances and lighting by ratios of 0.11 MW per GWh, 0.19, 0.30 and 0.36, respectively, based on available end-use load shapes. Peak demand savings for bathroom fans were calculated using a ratio of 0.21 MW per GWh based on the residential rate class load shape as there is no available end-use load shape for bathroom fans.

2.4 Alternative Methodologies

One alternative methodology considered for the estimation of energy savings was calibrated modeling. This alternative approach would have used end-use metering and whole home energy consumption for participating and non-participating homes, to produce estimates of net energy savings by technology and fuel type. This approach was not pursued due to the cost and time required for data collection.

Another alternative considered was an engineering review of non-calibrated building energy modeling results. This approach was considered for both single family homes and townhomes. Ultimately it was adopted for townhomes and not for single family dwelling. This methodology decision was based on the ability to use the relatively higher rigour, quasi-experimental design approach for single family dwellings.

A quasi-experimental design methodology was also considered for townhomes. This approach was not pursued because limited information was available on townhome characteristics affecting energy consumption, and there were too few townhome participants to support the assumption that participants and non-participants would be equivalent, on average, without controlling for these characteristics.

One methodology considered for the estimation of free ridership was to interview Certified Energy Advisors. This approach was not pursued because Certified Energy Advisors were not the primary decision makers regarding energy efficiency, and the free ridership results were stable under various scenarios (i.e., a sensitivity analysis). This information supported the validity of the approach that was ultimately used to estimate free ridership, which relied on builder survey results.

3 Results

3.1 Market Transformation

This section covers various aspects of market transformation in the new residential construction market including: program reach and coverage; barriers to meeting higher energy efficiency standards; practices in the residential construction industry (supply); availability of energy-efficient homes (supply); and attitudes of home buyers (demand). Non-participant spillover was also examined.

3.1.1 Program Reach

Unlike other provinces where the new residential construction industry is dominated by a few large construction companies that build most new homes in the province, the industry in BC consists of over 5,000 builders[34], including 50 to 100 companies that build 50 or more housing units each year, and only a handful of companies that build large-scale developments. In 2013, 71% of the industry consisted of micro businesses with fewer than five employees. Only 13 companies employed 100 people or more.[35] The number of builders and the range in size makes it challenging for the program to reach a significant portion of the new residential construction industry. The New Home program targeted large builders, to maximize coverage of the new home market and initiate a trend for building more energy-efficient homes.[36]

Information on residential home builders is maintained in a third party database. A total of 428 participants were identified in the database and classified based on their annual construction activities. Builders of a single home in a year accounted for 47% of participants and the remaining 53% built more than one home in a year (the average number built per year is not known).

Based on applicant information contained in the program tracking data, approximately 300 builders/developers (including owner-builders) had participated in the program during the evaluation period, representing approximately 6% of registered builders. The tracking shows that several of the builders/developers participated more than once over the evaluation period. Exact coverage of the industry by the program could not be accurately determined due to variation in how the applicant was recorded in the program tracking data (e.g., company name, owner name, partnerships, development name, applicant role) and the high rate of turnover in the residential construction industry (i.e., a registered builder from two years ago may no longer be a registered builder). Also, companies that only built in Vancouver were not eligible for the program, and this could not be discerned from the registry of home builders.[37]

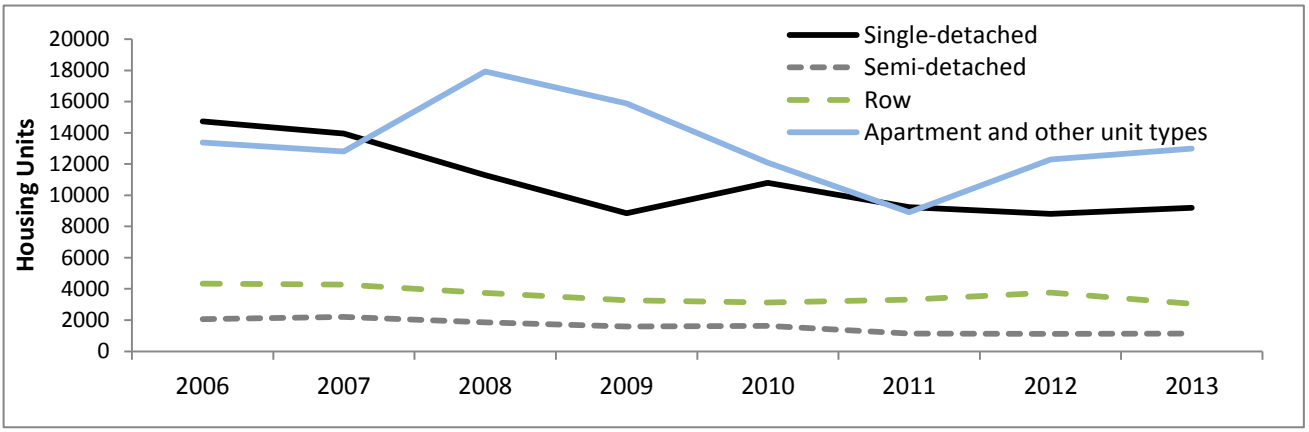
The original program goal was to capture around 11% of the new residential market by 2010. Overall, the program captured approximately 12% of the electrically heated new homes built outside of Vancouver over the six year evaluation period. The participating single family detached homes represented 9% of the 14,776

[34] Homeowner Protection Office Public Registry of Residential Builders; https://lims.hpo.bc.ca/prs/
[35] Source: Statistics Canada, Canadian Business Patterns Database, December 2013; http://www.opic.ic.gc.ca/app/scr/sbms/sbb/cis/establishments.html?code=2361&lang=eng
[36] Although the program was focused on large developers, small builders, including owner builders, were eligible for the program.
[37] The registry is maintained by the Canadian Home Builders Association of BC.

electrically heated single family detached homes completed in the same period in British Columbia outside the City of Vancouver. The participating townhomes represented 17% of the 11,103 electrically heated townhomes completed in the same period in British Columbia, outside the City of Vancouver.

A significant issue faced by the New Home program was that, shortly after its introduction, trends in housing starts were generally on the decline, most notably in the construction of single family detached homes and, until more recently, multi-unit residential buildings. In response to the decline in the new housing market, the program increased efforts to promote the Energy Star Package offer, which realized very high participation relative to the Home Performance offer. Since 2011, construction of multi-unit residential buildings was on the rise, while single family detached homes continued to decline, as summarized in Figure 3.1 below.

Figure 3.1. Housing Completion Trends in BC (2006 to 2012)



Source: Statistics Canada, Table 027-0009 Canada Mortgage and Housing Corporation

3.1.2 Addressing Barriers to Building More Energy-efficient Homes

Focus groups with builders conducted on behalf of FortisBC in 2011[38] indicated that the higher cost and the potential for delays associated with building energy-efficient homes represented the greatest concerns to builders and developers, respectively. Builders were also concerned about receiving proper information or training in order to meet higher energy efficiency standards. Survey results suggest that the Home Performance offer helped builders retain energy efficiency features in the building plans, which might otherwise have been dropped as a way to control costs. Close to nine out of ten (87%) of program participants who responded to the survey indicated that the rebate allowed the company to keep energy efficiency features in the final plan.

All but one survey respondent who participated in New Home and 82% of respondents that did not participate considered it to be important or extremely important for BC Hydro and/or FortisBC to provide support to the residential construction industry when building code changes require improved energy efficiency. Survey results reveal that builders value not only the financial incentives to build more energy-efficient homes, but also communications about the program and the training available.

[38] Participant Research, 2011. *FortisBC: EnerGuide80 Focus Groups.*

Lack of availability of qualified Certified Energy Advisors was not a barrier to building EnerGuide 80 homes or participating in the program for most of the companies surveyed. Seventy-five percent (75%) of builders/developers that participated in the program and 60% of non-participating companies surveyed indicated there are sufficient qualified Certified Energy Advisors to conduct EnerGuide assessments in a timely manner, not interfering with project schedules. In interviews with program staff it was noted that, at the beginning of the program, there were very few Certified Energy Advisors. With the introduction of New Home, demand for the service increased and the number of Certified Energy Advisors grew to more than 40 with support from the program, such as providing new entrants with quality leads in the new construction industry.

3.1.3 Changing Attitudes and Practices toward Building Energy-efficient Homes

The majority (83%) of builders/developers surveyed that participated in New Home reported that the program had led to increased support within the industry for designing and constructing more energy-efficient homes. Only 3% of participating companies indicated that the program had no effect at all on the industry's support for improving energy efficiency in new homes. Almost two-thirds (64%) of builder/developer participants who responded to the survey reported that, since 2008, a greater proportion of all homes built by their companies are rated as at least EnerGuide 80 as compared to 33% of the non-participants surveyed.

Survey results also indicate that experience with building more energy-efficient homes increased for builders/developers that participated in the program and increased to a greater extent than for non-participating companies. Prior to 2008, 39% of the participant companies surveyed reported their company had a fair amount or a great deal of experience building to EnerGuide 80 or higher. This proportion doubled to 79% after 2008. In contrast, only 40% of the non-participant companies surveyed indicated that they had experience building homes to EnerGuide 80 or higher after 2008. Prior to 2008, 30% of companies in both respondent groups indicated that they had no experience building to EnerGuide 80. The amount of experience building EnerGuide 80 homes before and after 2008 reported by builders/developers that participated in the program and those that did not participate is summarized in Table 3.1.

Table 3.1. Experience Building Energy-efficient Homes Pre- and Post-2008

Amount of Experience	Builder Survey Group	Pre-2008	Post 2008	Difference
No experience	Participant builders	30%	3%	-27%
	Non-participant builders	30%	15%	-15%
A great deal/fair amount of experience	Participant builders	39%	79%	+40%
	Non-participant builders	23%	40%	+17%

Source: Participant survey (n=57); Non-participant survey (n=66)
Note: Excludes those who reported little experience and don't know responses, therefore does not sum to 100%

Approximately 9 out of 10 builders/developers who built houses to EnerGuide 80 and had participated in the program (91%) reported that they also built to higher levels of energy efficiency. This was true of non-participating builders/developers as well, although to a lesser extent (54%).

3.1.4 Spillover

Spillover can also be considered an indication of program influence on the market, and survey results provide evidence of participant spillover. Thirty-seven percent (37%) of surveyed companies that had participated in the Home Performance offer indicated that they had built other homes to EnerGuide 80 or higher, or had built to a lower rating but higher than code, without an incentive from the program. Sixty percent (60%) of those

who had built at least one home higher than code without an incentive reported that the New Home program was somewhat or very influential on their decision to build more energy-efficient homes. Seven of these 15 builders/developers had intended to apply for the Home Performance incentive.[39] Approximately 3% of energy-efficient homes built by participating builders/developers that were not incented by New Home were influenced by the program.

The survey of non-participating builders/developers was used to estimate non-participant spillover associated with building energy-efficient homes. Builders who never participated in the New Home program were asked to report on their practices with respect to building energy-efficient homes and indicate the degree of program influence on their decision to build these homes. Of the 13 builders in the final sample of non-participants who were aware of the program and had built homes to EnerGuide 80 or higher, seven reported that the New Home program was very or somewhat influential in the company's decision to build energy-efficient homes, and five had built some or all of the homes with the intention of getting the Home Performance incentive. Similarly, six out of the eleven builders who had built homes above code but lower than EnerGuide 80 indicated that the program had been influential to building above code, and two companies had intended to apply for a Home Performance incentive. In summary, 2% of new homes built in BC to EnerGuide 80 or higher during the evaluation period and 6% of homes that were above code but did not achieve the EnerGuide 80 level of efficiency were influenced by the New Home program.

Incidental to market transformation is increased free-ridership; as markets become transformed, free-rider levels increase reflecting changes in the supply-side of the market and/or in the demand side. In this case, the supply side of the market is being affected by the program, by changing industry practice. Furthermore, builders/developers could apply for the Home Performance incentive multiple times thus increasing the influence of previous participation on future decisions. Survey results show that the percentage of builders/developers that were full free-riders (i.e., those who would have built the same number of homes to EnerGuide 80 without the program incentive) increased by 28%, from 52% the first time they participated to 80% the last time they participated.

3.1.5 Home Buyer Demand

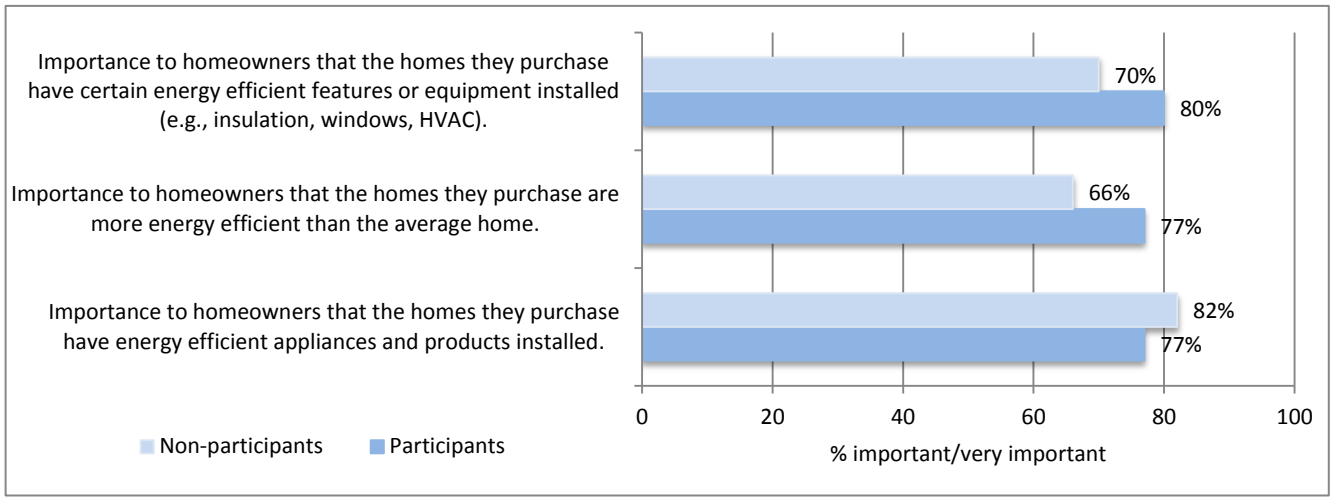
Participating builders/developers that responded to the survey indicated that demand from new home buyers for more energy-efficient homes has increased (70% of respondents) and that demand/expectations of buyers for energy-efficient homes was positively affected by the program (62% of respondents). Non-participant companies surveyed viewed homebuyers' demand for energy-efficient homes differently, with 56% indicating that demand has increased.

As illustrated in Figure 3.2, builders that participated in the program reported that homebuyers consider energy-efficient features to be important or extremely important to their decision to purchase. Participating builders were more likely than non-participating builders to expect homebuyers to consider the energy-efficient features of the building to be important. In contrast, non-participating companies were more likely than participant companies to report that homebuyers value the energy-efficient products installed. However,

[39] The reason why they did not actually apply was not asked in the survey.

there was no statistical difference between the two groups for any of the questions pertaining to homeowner demand.

Figure 3.2. Builder Opinion on the Importance of Energy-efficient Features to New Home Buyers



Participant survey, n=60; Non-participant survey, n = 71; excludes Don't Know responses

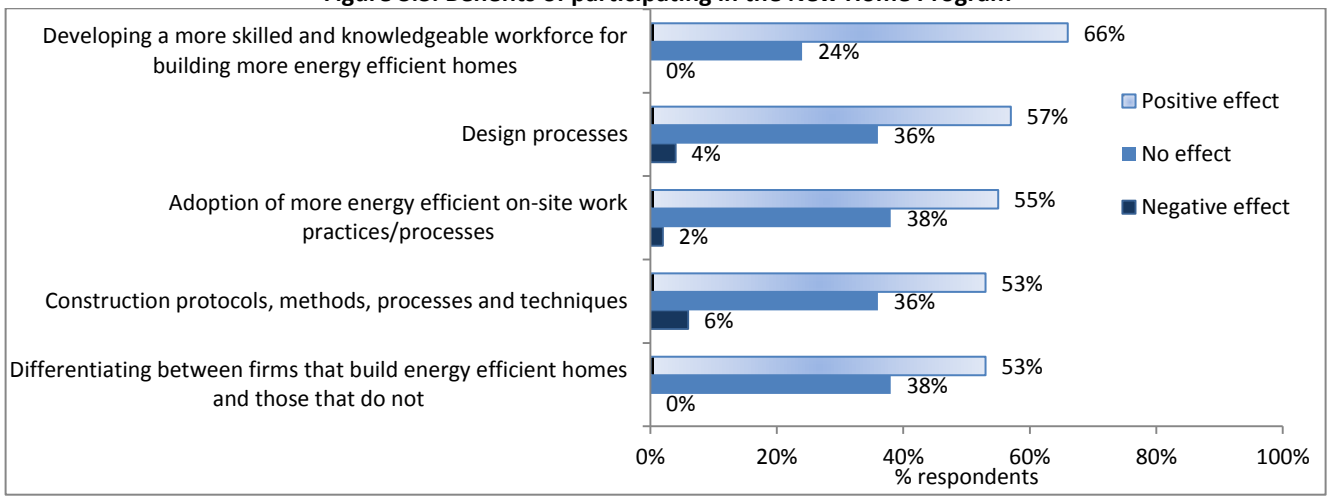
3.2 Non-energy Benefits

Overall, builders/developers reported experiencing several non-energy benefits as a result of participating in the New Home program. However, data were insufficient to accurately estimate the dollar value of these benefits to the respondent sample or to the new home construction industry as a whole.

Forty per cent (40%) of builders who responded to the survey indicated that the New Home program had a positive effect on maintaining competitive pricing for energy-efficient homes. More than half (54%) of the respondents indicated their company experienced improved profitability from energy-efficient homes as compared to homes with average energy performance. Most respondents (74%) could not provide an average percentage increase in profit; those who did (n=9) reported an 8% increase in average profit for energy-efficient homes relative to standard efficiency homes. While respondents were less likely to report an increase in sales than profits due to the New Home program, 40% of respondents did experience some growth in sales. Fifty-three percent (53%) reported that participating in the New Home program helped the company sell energy-efficient homes faster than homes with fewer energy-efficient features. Respondents were unable to estimate how much growth in sales or how much faster the homes had sold.

The New Home program had a positive effect on many elements of the construction process, with very few respondents reporting negative impacts. As can be seen in Figure 3.3, the most recognized benefits to the industry was developing a more skilled and knowledgeable workforce (66%) and better design processes for building more energy-efficient homes (57%).

Figure 3.3. Benefits of participating in the New Home Program



Source: Participant survey, N= 53; Excludes don't know responses, therefore, totals do not sum to 100%

Builders/developers also reported that participating in the program had positive effects on their relationships with BC Hydro and/or Fortis BC (55%), with only one respondent reporting a negative effect. These results are supported by the satisfaction levels, with 85% of participant companies reporting they were very (47%) or somewhat (38%) satisfied with the New Home program. None were dissatisfied.

Results from a survey of new homebuyers who purchased homes incented by the New Home program conducted on behalf of BC Hydro and Fortis BC in 2011 revealed that non-energy benefits impacted the decision of new home buyers to purchase an energy-efficient home. Although floor plan and location were cited as the most influential factors in buying a new home, respondents also valued staying warm in winter (68%), quiet appliances (57%), staying cool in summer (54%), and helping the environment (52%). Some new home buyers also felt that an energy-efficient house would sell faster (42%) than one of average efficiency and would sell at a higher price (54%), if sold within the next five years. When asked about energy savings, survey respondents reported an estimated 6.1 years payback period.

3.3 Net Electricity Savings for Electrically Heated Single Family Detached Homes in the Home Performance Offer

A total of 1,262 electrically heated single family detached homes were incented under the Home Performance offer during the evaluation period. Table 3.2 summarizes the annual net energy savings per unit and the weather-adjusted unit energy savings for each fiscal year.

Table 3.2. Home Performance Participation and Per-Unit Energy Savings (F2011 - F2013)

Annual Consumption (kWh/year)	F2011	F2012	F2013	Weighted Average (by participation)
Baseline	20,330	17,685	16,891	--
Participant Annual Consumption	15,919	15,020	14,189	--
Annual Net Energy Savings per Participating Home				
Actual	4,007	2,665	2,242	**2,644**
Weather Adjusted	4,261	2,875	2,427	**2,837**

As described in Section 2.3.2, since the average annual energy savings per home was based on analysis of F2011 through F2013, the three-year weighted average of annual savings (2,644 kWh/year for actual savings and 2,837 kWh/year for weather adjusted savings) was applied to the F2008 to F2010 period. The weather adjusted savings are greater than actual savings for each year evaluated, indicating that weather was generally warmer during the evaluation period than the 10 year average.

Participant spillover amounted to an estimated savings of 0.12 GWh/year for single family detached homes over the F2008 to F2013 period. Details of the spillover analyses can be found in Appendix D.

Table 3.3 lists the reported and evaluated (actual and weather-adjusted) net energy savings and peak demand savings for single family detached homes for each fiscal year, inclusive of participant spillover.

Table 3.3. Summary of Home Performance Energy and Demand Savings for Single Family Detached Homes (F2008 – F2013)

Fiscal Year	Units	Annual Energy Savings (GWh/year)			Peak Demand Savings (MW)		
		Reported*	Evaluated		Reported	Evaluated	
			Actual	Weather-Adjusted		Actual	Weather-Adjusted
F2008	1	0.0	0.0	0.0	0.0	0.0	0.0
F2009	333	1.3	0.9	0.9	0.5	0.3	0.3
F2010	103	0.4	0.3	0.3	0.1	0.1	0.1
F2011	125	0.5	0.5	0.5	0.2	0.2	0.2
F2012	263	1.0	0.7	0.8	0.4	0.3	0.3
F2013	437	1.9	1.0	1.1	0.7	0.4	0.4
TOTAL	**1,262**	**5.1**	**3.5**	**3.7**	**1.8**	**1.2**	**1.3**

*Reported savings pertain to home performance savings only

The difference between evaluated and reported savings is due to three factors. First, the unit savings per home were smaller than expected because the actual size of homes built under the program was smaller than assumed in reported savings ($180m^2$ vs $205m^2$) and second, the regional mix of program participation was different than assumed in reported savings (i.e., all participants were located on Vancouver Island and the in the Lower Mainland rather than dispersed across the province, so that unit savings are less due to climate). Lastly, non-participant homes built during the program period were more energy-efficient than assumed in reported savings as many of them adopted heat-pumps as a space heating source, which are more efficient than electric baseboards, and heat pump penetration was not accounted for in reported savings. Air source heat pump penetration was estimated to be approximately 50% based on results of the participant and non-participant surveys. This results in a lower than anticipated baseline energy consumption and lower energy savings.

3.4 Net Electricity Savings for Electrically Heated Townhomes in the Home Performance Offer

A total of 1,861 townhomes and 490 units in multi-unit residential buildings were incented under the Home Performance offer during the evaluation period. After adjusting the average modeled annual electricity consumption for region and configuration, a baseline townhome was estimated to consume 12,600 kWh/year and the average annual electricity consumption of the energy-efficient townhome was estimated to be 11,900

kWh/year. The average unit savings per townhome was estimated to be 700 kWh/year. Evaluated gross savings were calculated as number of units multiplied by 700 kWh/year. As outlined in Section 2, energy savings for the 490 units in multi-unit residential buildings were adjusted by a factor of 0.36 to account for their lower space-heating energy consumption resulting in estimated unit savings of 255 kWh/year. Table 3.4 summarizes the number of units and evaluated gross savings for the townhome portion of the Home Performance offer.

Table 3.4. Evaluated Gross Energy Savings for Townhomes and Multi-unit Residential Building Units (F2008 - F2013)

Fiscal Year	Units	Evaluated Gross Energy Savings (GWh/year)
2008	274	0.19
2009	259	0.18
2010	685	0.36
2011	133	0.05
2012	486	0.16
2013	514	0.36
Total	**2,351**	**1.30**

Evaluated net electricity savings for townhomes incented under the Home Performance offer was based on the gross savings estimate adjusted for free ridership and spillover. Table 3.5 summarizes the free rider rates, spillover rates and net-to-gross ratios used to estimate net savings for each fiscal year. The rates assumed by the program were used from F2008 to F2010 as it is expected that the rates increased over time due to repeat participation, and that the higher rates in the later years were not an accurate reflection of free ridership for the earlier years of the program.

Table 3.5. Free Rider Rate, Spillover Rate and Net-To-Gross Ratios (F2008-F2013)

Fiscal	2008	2009	2010	2011	2012	2013
Free ridership	0.05	0.10	0.10	0.58	0.58	0.58
Spillover	0.10	0.10	0.10	0.03	0.03	0.03
Net-to-Gross	1.05	1.00	1.00	0.45	0.45	0.45

Reported and evaluated energy savings for electrically heated townhomes are summarized in Table 3.6.

Table 3.6. Reported and Evaluated Home Performance Savings for Townhomes (F2008-F2013)

	Annual Energy Savings (GWh/year)		Peak Demand Savings (MW)	
Fiscal Year	**Reported**	**Evaluated Net**	**Reported**	**Evaluated Net**
2008	0.35	0.20	0.12	0.07
2009	0.33	0.18	0.12	0.06
2010	0.88	0.36	0.31	0.13
2011	0.17	0.02	0.06	0.01
2012	0.62	0.07	0.22	0.03
2013	0.60	0.16	0.21	0.06
Total	**2.95**	**1.00**	**1.03**	**0.35**

The variance between reported and evaluated savings is primarily driven by the difference in unit savings and by the application of townhome unit savings to multi-unit residential building units in reported savings.

Reported savings assumed annual energy savings of 1,281 kWh per townhome, while evaluated annual savings are 700 kWh for townhomes and 255 kWh for multi-unit residential building units. In addition, evaluated free ridership is substantially higher than assumed in the savings forecast (58% vs. 5% in F2008, 10% in F2009-F2012, and 12-18% in F2013). As described earlier in the report, other factors that contribute to the variance are the regional distribution of participating homes; instead of being evenly distributed throughout the province, participation was concentrated in the Lower Mainland and Vancouver Island. There was also a higher proportion of middle units (with smaller savings relative to end units) than assumed in reported savings (60% instead of 50%). For additional details on the variance between reported and evaluated savings see Appendix D.

3.5 Energy Savings for Home Performance from Non-participant Spillover

The program did not include estimates of non-participants spillover in its calculation of reported savings. The rate of non-participant spillover calculated from the survey responses (see Appendix D) was used to estimate energy savings across the evaluation period. Two per cent (2%) of homes built per year to EnerGuide 80 or higher by non-participating builders were influenced by the New Home program and 6% of homes built per year by non-participant builders/developers that were above code but did not achieve EnerGuide 80 were influenced by the program. These percentages were applied to the total electrically-heated single family detached homes (14,776 units) and townhomes (11,103 units) built in BC, outside of the City of Vancouver, from 2008 to 2013 that were not incented by the Home Performance offer.

Estimated energy savings from non-participant spillover totaled 1.9 GWh/year for single family detached homes (1.5 GWh/year) and for townhomes (0.4 GWh/year). Energy savings for single family detached homes and for townhomes for each fiscal year are presented in Table 3.7 below.

Table 3.7. Home Performance Energy Savings from Non-Participant Spillover (F2008-F2013)

	Single Family Detached (MWh/year)		Townhomes (MWh/year)	
	Rating ≥ EnerGuide 80	Code<Rating< EnerGuide 80	Rating ≥ ENERGUIDE 80	Code<Rating<EnerGuide 80
F2008	204	102	38	50
F2009	139	69	31	41
F2010	185	92	27	36
F2011	229	114	33	43
F2012	132	66	33	44
F2013	104	52	23	30
TOTAL (GWh/year)	**1.0**	**0.5**	**0.2**	**0.2**

3.6 Net Electricity Savings for the Energy Star Package Offer

The Energy Star Package offer incented any of the five products covered by the program that had an Energy Star rating at the time of application. The number of incented units and average savings per unit are summarized below for each fiscal year in the evaluation period.

Table 3.8. Units Incented and Unit Savings by Product Type (F2008-F2013)

	Refrigerators		Clothes Washers		Dishwashers		Bathroom Fans		Light Bulbs	
Fiscal Year	Units Incented	Unit Savings (kWh/yr)	Units Incented	Unit Savings (kWh/yr)	Units Incented	Unit Savings (kWh/yr)	Units Incented	Unit Savings (kWh/yr)	Units Incented	Unit Savings (kWh/yr)
2008	503	64	300	173	459	33	498	41	2,838	49.5
2009	1,922	63	788	114	2,120	34	1,683	41	7,842	49.5
2010	4,297	50	1,954	78[40]	4,832	23	3,281	41	13,908	43.9
2011	3,855	48	3,324	186	4,642	19	4,238	41	17,334	43.9
2012	3,992	47	2,794	127	3,912	14	3,914	41	18,678	43.0
2013	4,775	36	3,124	149	4,644	13	4,640	41	21,882	39.2
Total	**19,344**	--	**12,282**	--	**20,609**	--	**18,261**	--	**82,482**	--

Evaluated unit energy savings for the Energy Star Package offer were calculated as the difference between baseline consumption and consumption of the incented models. Refrigerators and CFLs were adjusted for cross effects. Baselines, engineering estimates and other details of the unit savings calculations are contained in Appendix D. Gross energy savings for each type of product are summarized in the following table.

Table 3.9. Evaluated Gross Annual Electricity Savings by Product Type (F2008-F2103)

Fiscal Year	Refrigerators MWh/yr	Clothes Washers MWh/yr	Dishwashers MWh/yr	Bathroom Fans MWh/yr	Light Bulbs MWh/yr	Total MWh/yr
2008	31	15	15	20	134	**216**
2009	119	30	73	69	369	**660**
2010	235	53	113	135	580	**1,116**
2011	221	212	89	174	723	**1,419**
2012	320	136	54	160	763	**1,433**
2013	185	140	60	190	816	**1,391**
Total GWh/yr	**1.1**	**0.6**	**0.4**	**0.7**	**3.4**	**6.2**

Evaluated net electricity savings for the Energy Star Package offer was based on the gross savings estimate adjusted for free ridership and spillover. As previously mentioned, for the first three fiscal years of the program, the assumptions used for reported savings were applied and for the last three fiscal years, the survey-based free-ridership and spillover scores were applied. The survey-based estimates of free rider and spillover, and the resulting net-to-gross ratios for each of the Energy Star products covered by the program are summarized in Table 3.10 below.

[40] The lower unit savings for clothes washers in F2010 was the result of a more energy-efficient baseline relative to the other years. As noted in section 2.3.4, baseline information was taken from annual floor stock surveys.

Table 3.10. Energy Star Package Free Rider and Spillover Estimates by Product Type (F2011-F2013)

Adjustments	Appliances	Bathroom Fans	Light Bulbs
Free rider	0.46	0.55	0.28
Participant Spillover	0.10	0.05	0.16
NTG Ratio (1-FR+SO)	**0.64**	**0.50**	**0.88**

Net electricity savings were estimated by applying the net-to-gross ratio for each product to the gross savings in each fiscal year. The Energy Star Package offer resulted in net savings of 5.2 GWh/year for the evaluation period. Net savings by product type for each fiscal year is presented in Table 3.11.

Table 3.11. Net Electricity Savings by Product Type (F2008-F2013)

Fiscal Year	Appliances MWh/yr	Bathroom Fans MWh/yr	Light Bulbs MWh/yr	FY Total MWh/yr
2008	65	21	141	**227**
2009	222	69	369	**660**
2010	402	135	580	**1,116**
2011	332	87	636	**1,055**
2012	324	80	671	**1,076**
2013	245	95	718	**1,058**
Total (GWh/yr)	**1.6**	**0.5**	**3.1**	**5.2**

Reported and evaluated net savings for the Energy Star Package offer as a whole are presented in Table 3.12.

Table 3.12. Summary of Energy Star Package Energy and Peak Demand Savings (F2008 - F2013)

Fiscal Year	Annual Energy Savings (GWh/year)		Peak Demand Savings (MW)	
	Reported	Evaluated Net	Reported	Evaluated Net
2008	0.2	0.2	0.0	0.1
2009	1.3	0.7	0.2	0.2
2010	1.7	1.1	0.5	0.3
2011	1.5	1.0	0.3	0.3
2012	1.0	1.1	0.2	0.3
2013	1.5	1.1	0.4	0.3
TOTAL	**7.2**	**5.2**	**1.6**	**1.5**

Evaluated energy savings for the Energy Star Package offer are lower than reported. One reason for the variance is that evaluated savings are based on the actual mix of incented units whereas reported savings assume a fixed combination of products per incented Energy Star Package. In addition, the survey-based estimate for free ridership in the last three years is higher than assumed in the reported savings.

3.7 Total Net Energy Savings for the New Home Program

Reported and evaluated energy savings are shown below for electrically heated single family detached homes, electrically heated townhomes, and the Energy Star Package offer. Evaluated energy savings from non-participant spillover is also presented in the table.

Table 3.13. Reported and Evaluated Energy and Peak Demand Savings (F2008 - F2013)

Builder Type	Fiscal Year	Energy Savings (GWh/yr)		Peak Demand Savings (MW)	
		Reported	Evaluated Net	Reported	Evaluated Net
Participant Builders	F2008	0.6	0.4	0.2	0.1
	F2009	2.9	1.8	0.8	0.6
	F2010	3.0	1.8	0.9	0.5
	F2011	2.2	1.5	0.5	0.5
	F2012	2.6	1.9	0.8	0.6
	F2013	4.0	2.3	1.3	0.7
	Sub-Total	**15.2**	**9.7**	**4.4**	**3.1**
Non-Participant Builders	**Non-Participant Spillover**	**N/A**	**1.9**	**N/A**	**0.7**
Participant & Non-Participant Builders	**TOTAL**	**15.2**	**11.6**	**4.4**	**3.8**

Evaluated net energy savings among participating builders/developers total 9.7 GWh per year over the 6-year period, compared to reported savings of 15.2 GWh per year. Evaluated spillover savings among non-participating builders/developers total 1.9 GWh over the same timeframe.

As discussed with the results presented throughout this section, there are several reasons for the variance between reported and evaluated energy savings:

- The majority of incented single family detached homes and townhomes were located in the Lower Mainland and Vancouver Island regions whereas the geographical distribution assumed for reported savings assumption was more dispersed, including parts of the province where the climate is colder and there is greater potential for energy savings;
- Reported savings assumed a higher proportion of townhome end units than what was incented by the program. End units have more exposed walls, higher electricity consumption and, therefore, higher electricity savings can be realized from efficiency improvements;
- Smaller sized homes were built compared to the sizes assumed in reported savings. Smaller homes have lower energy consumption;
- Adoption of heat-pumps as a space heating source in new homes than was higher than assumed in reported savings. Heat pumps are more efficient than electric baseboards, thus decreasing comparison group consumption; and
- Reported savings for the Energy Star Package offer assumed that each package would include all products, which did not end up being the case. Evaluated savings are based only on the products that were incented. Since not every Energy Star Package incented contained all of the eligible products, evaluated savings were less than reported.

As discussed in the introduction, electricity savings from all gas heated homes and from electrically heated homes built to EnerGuide 77 were reported by the program but were not included in the scope of this evaluation and, therefore, not included in the evaluated savings.

3.8 Confidence and Precision

A confidence level of 80% was set for defining a significant difference in energy consumption between participants the Home Performance offer and the comparison group. Consumption differences were compared at the monthly level and the annual energy savings are equal to the sum of the statistically significant differences in monthly consumption. However, since there were different numbers of participants in each month (i.e., new participants are added to the BC Hydro grid each month), and the size of savings and the associated standard errors varied between months, it was impossible to calculate the precision level for the annual energy savings.

Sample error for the participant survey was ±9.8% at the 90% confidence interval and for the non-participant survey was ±11.6% at the 90% confidence interval, both of which are considered acceptable margins of error for this type of research.

3.9 Limitations

Energy savings for gas heated homes were not covered and, therefore, not included in the evaluated net energy savings. These homes accounted for approximately 9% of reported savings from the Home Performance offer.

It was not feasible to conduct statistical analysis to estimate the net energy savings for the Home Performance offer for single family detached homes between F2008-F2010. The period for participant consumption history was too short and the sample size was too small. Therefore, the average unit savings across the three years with evaluated results (F2011 to F2013) was applied to F2008 through F2010. Differences in weather between the two periods were examined which could introduce some bias into the results, although the size and direction of bias is unknown.

Variations in some factors, such as occupancy and occupant energy consumption behaviours, that could affect energy consumption could not be fully controlled by the evaluation design for single family detached homes.

Representativeness of the builder survey samples could be an issue because of non-response bias. As with most survey research, self-selection bias is also a concern. Results for the non-participant builder survey, in particular, should not be considered to be representative of all non-participating builders. Non-response bias is less of a concern for the participant builder survey group, which had a higher response rate, but bias could still exist.

Evaluated energy savings from non-participant spillover should be considered with caution as the estimate is based on a small sample of survey respondents and may not be representative of the entire population of non-participating home builders/developers, particularly given the diversity of the industry. However, the survey results do suggest that some degree of spillover has occurred among some home builders/developers that did not participate in the program and represent the best available information on this question at the present time.

Like many evaluations of DSM programs, survey-based free-rider and spillover estimates were used. Due to characteristics of the respondent sample, these estimates were only applicable to the last three fiscal years of the evaluation period. In the absence of survey-based free-rider and spillover estimates for the first three years of the evaluation period, historical free ridership and spillover assumptions were retained in the calculation of evaluated savings for the first three years. There are considerable differences between the historical assumptions for the first three years and the survey-based estimates for the last three years. Further,

the validity of the survey-based free-rider and spillover estimates could be affected by the amount of time between the builder or developer's participation in the program and the subsequent survey.

Finally, it should be noted that the free ridership estimate for townhomes was generated on a per-unit basis rather than on a per-project basis, when it is believed that builders make decisions and plan on a project by project not unit by unit basis. This could have skewed the estimated free rider rate by giving more weight to the free ridership scores from projects with more units relative to others. The per-unit free ridership estimate may not accurately reflect the decision-making process for building multi-home developments.

4 Findings and Recommendations

This section presents the overall findings of the evaluation, based on the evidence presented previously.

4.1 Findings

1. The program had expected to capture approximately 11% of the new residential housing market (single family detached and townhomes) by F2010 but the drop in residential construction that occurred soon after the program was introduced interfered with achieving this goal. However, by F2013, when the economy had regained its strength, coverage of the electrically heated new home market outside of Vancouver reached 12%. Coverage of the new residential construction industry (builders/developers) was difficult to estimate because of the nature of the industry but also because program tracking practices made it difficult to identify the building company name in all applications.

2. There is evidence to suggest that the New Home program supported changes in the energy efficiency of new homes and in the new residential construction industry. Participant (0.2 GWh/year) and non-participant (1.9 GWh/year) spillover was identified from responses to the builder/developer survey. In addition, the proportion of respondents who were full free riders increased by 28% from their first to last application, as would be expected with this type of program (i.e., multiple, repeat participations). Qualitative evidence collected in the surveys provided additional supporting evidence of market transformation in that participating builder practices had changed as a result of the program and they had changed more than the non-participating builders. Builders in both groups reported an increase in demand from homebuyers for energy-efficient homes and products in new homes.

3. Free ridership was high despite basing the estimates on the builder's first application to the program. The percentage of builders that were identified as full free riders increased from the first application to the last application to the program suggesting that previous participation in the program influenced future decision-making. The high rate of free ridership could have been influenced by the fact that survey respondents were mainly builders/developers that participated later in the program life cycle, after changes in building practices had already occurred within the new construction industry. In addition, the free ridership rate could have been affected by the fact that the survey of builders/developers was not implemented until long after the point of decision-making.

4. Builders and developers experienced some non-energy benefits as a result of participating in the New Home program such as improved profitability and speed of sale of energy-efficient homes. The program also benefits the industry itself by creating a more skilled and knowledgeable workforce in terms of building energy-efficient homes.

5. Net energy savings of 3.5 GWh/year were realized by single family detached homes incented under the Home Performance offer, representing 36% of reported savings. Several factors interfered with achieving higher energy savings, including a prolonged and unanticipated drop in construction activity, smaller sized homes being built and better performance of homes built by non-participants. The gap between reported and evaluated savings was also the result of maintaining a static baseline and unadjusted assumptions in the calculation of reported savings across several years of the program.

6. Net energy savings (1.0 GWh/year) were realized by incented townhomes, representing 10% of reported savings. Some of the savings were the result of participant spillover; however, those were eclipsed by the high free ridership among townhomes. Similar to single family detached homes, the gap between reported

and evaluated savings was due, in part, to the original assumptions in program design and savings calculation not aligning with the actual home construction data. In addition, the type of housing covered by the offer was expanded to include units with lower consumption levels and less capacity for energy savings (i.e., multi-unit residential building units), and this change was not accounted for in the reported savings. The characteristics of the new construction industry and the New Home program make the calculation and interpretation of free ridership challenging, as large builders and builders of townhomes typically plan and build multiple units at one time, and they can build and apply to the program many times.

7. Net energy savings realized from the Energy Star Package offer was 5.2 GWh/year, representing 54% of reported savings. Light bulbs accounted for the greatest amount of energy savings (3.1 GWh/year), had the least free ridership and the most spillover. Free ridership was higher for bathroom fans and appliances which could be related to trends in the supply-side of the market. Overall, evaluated savings were lower than expected. One reason for the variance was the difference in how energy savings were calculated for reported savings (assuming all units received the full package of products) and how the offer was actually delivered (builders could install any combination of products).

8. Builders and developers reported that BC Hydro and FortisBC have an important role in supporting the new residential construction industry to meet changing energy efficiency codes and standards. In the surveys, builders and developers noted that financial assistance helps them deal with the incremental cost of improved energy efficiency and keeps energy-efficient features from being dropped from the building plans. Survey respondents also reported that they benefit from information and educational activities about cost-effective practices and technologies and would like BC Hydro and FortisBC to provide comprehensive and current information about the programs/offers available to the construction industry.

4.2 Recommendations

Listed below are recommendations resulting from this study, starting with recommendations for program management (#1) followed by a recommendation that could serve both program evaluation and program management purposes (#2, #3) and a recommendation for future evaluations (#4). Note that order of presentation does not necessarily reflect relative priority.

1. Review and adjust the process and assumptions used to calculate reported savings to improve accuracy.

    a. Periodic review and examination of baseline energy consumption of new residential construction to ensure that the reported savings are realistic.

    b. Conduct market tracking to follow changes to the new residential construction market and industry.

2. Program management and evaluation teams should work together to design a program tracking system that captures the critical program data to support clear and accurate reporting of on-going program performance and facilitate future program evaluation (e.g., locate new construction accounts in the billing system). Develop documentation that defines and delineates data entry requirements (e.g., database dictionary; quality assurance procedures).

3. Implement regular data collection from builders/developers (and other relevant stakeholders, as appropriate) to inform program design and support evaluation requirements (e.g., free ridership and spillover estimates).

4. Review expectations and options for the treatment and measurement of free-ridership and spillover for this market transformation program that involves repeat participation (e.g., whether to assess it on the basis of individual housing units or multi-unit housing projects).

5 Conclusions

The New Home program achieved energy savings, but they were less than expected. The main reasons for the difference were the assumptions about housing characteristics used in reporting and the unit savings of key energy efficiency measures.

There is evidence that the New Home program supported the process of transforming the new residential construction market to higher levels of energy efficiency by changing builder practices and increasing the number of energy-efficient homes built in BC.

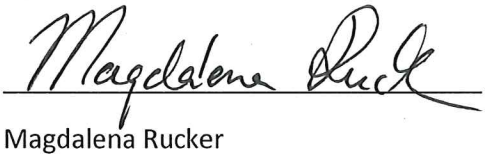
Builders feel that BC Hydro and FortisBC have a role in supporting the industry to achieve higher levels of energy efficiency.

Evaluation Oversight Committee Sign-Off

BC Hydro's Evaluation Oversight Committee is made up of DSM stakeholders from various parts of the company and is mandated to ensure that BC Hydro's DSM evaluations are objective, unbiased and of sufficient quality.

The Evaluation of the New Home Program meets the following criteria for approval by the Evaluation Oversight Committee:

- The evaluation complied with the defined scope.
- The evaluation methodology is appropriate given the available resources at the time of the evaluation.
- The evaluation results are reasonable given the available data and resources at the time of the evaluation.



Magdalena Rucker

Evaluation Oversight Committee Chair

References

Alison & Associates. “Power Smart New Home Program Pilot Evaluation”, prepared for BC Hydro Power Smart, 1995

BC Hydro. “Evaluation of the Residential Inclining Block Rate, F2009-F2012”, 2014.

BC Hydro. “Power Smart Renovation and New Home Windows Initiative”, 2011.

BC Hydro. “BC Hydro Power Smart Residential Energy Code Evaluation F2009-F2010”, 2010.

Boerakker, Yvonne and Stoops, John. “Building Energy Standards Can Fail to Deliver Expected Savings – The Importance of Code Compliance”, International Energy Program Evaluation Conference, Rome, Italy, 2012

California Public Utilities Commission. “Evaluation, Measurement and Verification of the 2002 & 2003 California Statewide Energy Star New Homes Programs”.

Dunsky Energy Consulting. “Residential New Construction Non-energy Benefits”, for BC Hydro and FortisBC, 2012

Energy Protection Agency. “ENERGY STAR® for New Homes Sponsor and Utility Partner Guide”, 2007 http://www.energystar.gov/ia/partners/reps/pt_reps_new_construction/New_Homes_Sponsor_Utility_Partner_Guide.pdf

Frischmann, Michael; and Kroll, Ryan. “On-site Measurement and Verification versus Project File Desk Review”, International Energy Program Evaluation Conference, Rome, Italy, 2012

Frontier Associations. “Final Evaluation Report: High Performance New Construction and Residential New Construction Initiatives”. Prepared for Ontario Power Authority, 2014

KEMA, “The Residential New Construction Programs Impact Evaluation for the California Investor Owned Utilities for 2006 – 2008”. Prepared for the California Public Utilities Commission, 2010

Membrino, C. & Warren, K. *Real Life Options for New Construction Evaluation.* Broadening our Horizons: International Energy Program Evaluation Conference, Long Beach CA, 2015.

Participant Research. “FortisBC; EnerGuide80 Focus Groups”, prepared for FortisBC, 2011

Provencher, Bill et al. “Some Insights on Matching Methods in Estimating Energy Savings for an Opt-In, Behavioral-Based Energy Efficiency Program”, International Energy Program Evaluation Conference, Chicago, USA, 2013

Sampson Research. “Residential Monitoring Study: Analysis & Results, Report”. Prepared for BC Hydro Power Smart, November 30, 2011

U.S. Department of Energy. State and Local Energy Efficiency Action Network. “Energy Efficiency Program Impact Evaluation Guide”. Prepared by Steven R. Schiller, Schiller Consulting, Inc., 2012 http://www.energy.gov/eere/downloads/energy-efficiency-program-impact-evaluation-guide

U.S. Department of Energy. “About the Uniform Methods Project”. 2014 http://www.energy.gov/eere/about-us/initiatives-and-projects/uniform-methods-project-determining-energy-efficiency-progr-0

Abbreviations and Glossary

Certified Energy Advisor (CEA): A Certified Energy Advisor is a trained and certified professional, often with a background in engineering, architecture or home inspection. An advisor can recommend improvements and help plan retrofits, as well as apply for grants on your behalf once you have completed retrofits and your home has been reassessed.

Cross Effects: Cross effects (also known as interactive effects) refer to the effect that some energy conservation measures (ECMs) have on other electricity end uses beyond what the ECM itself produces. An obvious example is building lighting. As more efficient lighting is installed, less heat is generated by the lighting system. This means that less heat must be removed from the building by the air conditioning system during the cooling season, but more heat needs to be supplied by the heating system during the heating season.

Demand Side Management (DSM): The definition of Demand Side Management is the same as the definition of "demand-side measures" set out in section 1 of the Clean Energy Act, which is "a rate, measure, action or program undertaken; (a) to conserve energy or promote energy efficiency, (b) to reduce the energy demand a public utility must serve, or (c) to shift the use of energy to periods of lower demand, but does not include (d) a rate, measure, action or program the main purpose of which is to encourage a switch from the use of one kind of energy to another such that the switch would increase greenhouse gas emissions in British Columbia, or (e) any rate, measure, action or program prescribed".

EnerGuide: The EnerGuide Rating System is a national initiative provided by Natural Resources Canada. An EnerGuide rating shows a standard measure of a home's energy performance; how energy-efficient a home is. The rating is calculated based on standard operation assumptions so that the energy performance of one house can be compared against another. The home's energy efficiency level is rated on a scale of 0 to 100. A rating of 0 represents a home with major air leakage, no insulation and extremely high energy consumption. (Source: NRCan)

ENERGY STAR®: ENERGY STAR® is the mark of high-efficiency products in Canada that meet strict technical specifications for energy performance—tested and certified. These products save energy without compromising performance in any way. Typically, an ENERGY STAR® certified product is in the top 15 to 30 percent of its class for energy performance.

Free Riders: Free riders are program participants who would have taken the demand-side management (DSM) action, even in the absence of the DSM program. They are a part of the reference case. These actions are not attributable to the program.

Gigawatt Hour (GWh): One billion watt-hours; one million kilowatt hours.

Market Changes: Market Changes refers to the changes in the structure or operations of markets during the course of an energy efficiency program that indicate increased levels of adoption of energy-efficient products and practices by customers and/or increased levels of promotion and delivery by suppliers.

Market Transformation: Market transformation refers to a permanent change in the structure or functioning of markets, including more energy-efficient behaviour among customers and higher market penetration of energy-efficient products, as a result of demand-side management (DSM) programs that reduce barriers to energy efficiency. These market changes are likely to persist in the absence of continued program activity. The reference case is used to establish the level of market transformation overtime.

Non-energy benefits: Benefits that accrue to program participants (e.g., increased property values, decreased water and sewer bills, increased comfort, health and safety), to the utility (e.g., bill payment improvements, decreased service calls), or to society in general (e.g., improved environmental health, job creation).

Net-to-gross ratio: A factor representing net demand side management program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts. The factor is made up of a variety of factors that create differences between gross and net savings, commonly including free riders and spillover. Other adjustments may include rebound, cross effects and measurement and verification results.

Peak Demand: Peak demand is the amount of power required to meet the customer's load at a given instant or averaged over any designated interval of time, expressed in kilowatts (kW) or megawatts (MW).

Precision: the degree to which repeated measurements under unchanged conditions show the same results

Randomized Control Trial (RCT): a research design, or experiment, where the units in the target group are randomly allocated to receive the treatment under study or not. The RCT design is generally considered the gold standard for evaluation.

Run Rate: Run rate is the rate at which the Power Smart programs or projects are saving electricity at a given point in time. This is usually expressed as GWh/yr at the end of the month or year being reported.

Spillover: refers to program participants and non-participants whose energy savings measures occur through actions that are not part of a program, but which were influenced by the program (also called free drivers or tag-ons).

Participant spillover is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy savings practices after having participated in the efficiency program, as a result of the program's influence. Non-participant spillover refers to energy savings that occur when a program non-participant installs energy efficiency measures or applies energy savings practices as a result of a program's influence. Spillover may not be permanent and may not continue in the absence of continued program activity.

Appendix A Results Summary

Total reported and evaluated energy savings are shown below for electrically heated single family detached homes, electrically heated townhomes, and the Energy Star Package offer.

Table A.1. Total Energy and Peak Demand Savings (F2008 - F2013)

Builder Type	Fiscal Year	Energy Savings (GWh/yr)		Peak Demand Savings (MW)	
		Reported	Evaluated Net	Reported	Evaluated Net
Participant Builders	F2008	0.6	0.4	0.2	0.1
	F2009	2.9	1.8	0.8	0.6
	F2010	3.0	1.8	0.9	0.5
	F2011	2.2	1.5	0.5	0.5
	F2012	2.6	1.9	0.8	0.6
	F2013	4.0	2.3	1.3	0.7
	Sub-Total	**15.2**	**9.7**	**4.4**	**3.1**
Non-Participant Builders	**Spillover**	**N/A**	**1.9**	**N/A**	**0.7**
Participant & Non-Participant Builders	**TOTAL**	**15.2**	**11.6**	**4.4**	**3.8**

Table A.2 contains a summary of results for all program components evaluated. Cross effect or rebound effect factors were not applied to single family detached homes savings as these effects were accounted for by the use of a quasi-experimental design and billing data analysis. Adjusting for rebound effects was not required for the Energy Star Package offer and cross effect adjustments were only required for refrigerators and light bulbs, as per the Power Smart Stand Procedures.

Table A.2. Key Evaluation Results Summary by Program Component

Program Component	Fiscal	F2008	F2009	F2010	F2011	F2012	F2013
Single Family Detached and Townhomes	**Participant Spillover:** ≥EnerGuide 80	2.5%[41]					
	> code < EnerGuide 80	2.8%[42]					
	Non-participant spillover ≥EnerGuide 80	2%[43]					
	> code < EnerGuide 80	6%[44]					
Townhomes only	**Free ridership**	Planning assumptions used			58%		
Appliances	**Free ridership**	Planning assumptions used			46%		
	Participant Spillover				10%		
	Cross Effects	1.8% (refrigerators only)					
Bathroom Fans	**Free ridership**	Planning assumptions used			55%		
	Participant Spillover				5%		
Lightbulbs	**Free ridership**	Planning assumptions used			28%		
	Participant Spillover				16%		
	Cross Effects	5%					

It was assumed that the evaluated energy savings for single family detached homes and townhomes would persist for the full evaluation period, but persistence was not calculated beyond this time period due to the numerous and unknown variables that could affect whole home performance over time (e.g., occupancy-related factors). Persistence of savings was not taken into account for the Energy Star products.

[41] This percentage was applied to program incented units.
[42] This percentage was applied to program incented units.
[43] These percentages were applied to relevant units constructed outside the program.
[44] These percentages were applied to relevant units constructed outside the program.

Appendix B Evaluation Advisor Memos

BC Hydro's DSM evaluation reports are subject to external review to ensure that they utilize appropriate methodologies and align with industry practice. Draft reports are reviewed by two external evaluation advisors. BC Hydro considers their feedback carefully and addresses their comments to the extent practicable. Final reports are reviewed by the same advisors, who prepare the following memos summarizing their assessment of the final report.

November 19, 2015

To: **BC Hydro**

From: **Ed Vine**

Evaluation Advisor

Berkeley, CA

Re: New Home Program Evaluation: F2008-F2013, October 16, 2015

1. What is your assessment of the quality of the research design? If you identify any shortcomings, what is your assessment of their potential risk for the validity of the evaluation results?

    - Overall, the quality of the research design was very good and appropriate given BC Hydro's budget.

2. What is your assessment of the quality of the input data? If you identify any shortcomings, what is your assessment of their potential risk for the validity of the evaluation results?

    - Overall, the quality of the input data was very good and appropriate given BC Hydro's budget.

3. What is your assessment of the quality of the analytical methods? If you identify any shortcomings, what is your assessment of their potential risk for the validity of the evaluation results?

    - Overall, the quality of the analytical methods was very good and appropriate given BC Hydro's budget.

4. How does the methodology compare to common industry practice for evaluations of similar initiatives?

    - The methodology compares well with common industry practice and was appropriate given BC Hydro's budget.

5. What are your suggestions for future evaluations of this DSM initiative?

    - Provide a larger budget for:
        - Designing a program tracking system that captures the critical program data that will facilitate future program evaluations. Similarly, regular data collection from builders/developers will help to support evaluation requirements, especially those related to free ridership, spillover, and other aspects of market transformation.

6. Do you have any other comments that you would like to make?

    - This is a well-written report, and the authors should be commended for providing a concise and understandable presentation of the research methodology, results, findings and conclusions.

November 22, 2015

To: **BC Hydro**

From: **Rafael Friedmann**

EM&V Advisor

Oakland, California, USA

Re: New Home Program Evaluation: F2008-F2013. October 16, 2015

7. What is your assessment of the quality of the research design? If you identify any shortcomings, what is your assessment of their potential risk for the validity of the evaluation results?

The research design was a well thought out, thorough approach, that in a cost-effective way was able to estimate how much energy was saved in the residential new construction program in the 2008-2013 period. This was not an easy task—as this is a long period of time, during which there were varying macro-economic conditions affecting building starts, the type of homes being built, and of course, the quality of the data that could be collected for carrying out the energy savings analysis (especially net savings).

I was pleased that the authors explained the threats to validity to the approaches taken as well as why they discarded other approaches. The new construction market is always very hard to assess as there are no pre-existing energy use data for developing a baseline. For this evaluation, gross savings methods were determined by participation rates and physical characteristics of single-family detached and townhouses. A quasi-experimental and simulation modelling approach was used for the single-family detached component; whereas only modelling was possible for the townhouse component due to mostly insufficient participation rates to allow for a quasi-experimental approach.

Evaluators also estimated spillover and free ridership using self-report interviews and building starts tracking data. The main threat here is the length of time that has elapsed since the earlier years, making self-report data more likely to be inaccurate.

8. What is your assessment of the quality of the input data? If you identify any shortcomings, what is your assessment of their potential risk for the validity of the evaluation results?

Input data is generally good. Building starts data is typically available from various sources and it appears to be solid here. Size of buildings data also seems good.

9. What is your assessment of the quality of the analytical methods? If you identify any shortcomings, what is your assessment of their potential risk for the validity of the evaluation results?

Methods seem appropriate to the data available and program participation rates. Some concerns with the methods used to estimate residential new construction programs success are well known and noted here:

- Modelling software, even when calibrated to billing data, still has uncertainty.
- Quasi-experimental design using non-participants approximates the counterfactual and for situations like this one is the best you can do.
- Free ridership and spillover are very hard to determine. Often spillover from previous years' interventions is unknown or conservatively estimated and can thus mistakenly be counted as free ridership. Many jurisdictions also use the self-report survey methodology used here as there are not clear alternatives to it; despite misgivings about its accuracy. The questions, length of the survey, and how and when these surveys are done vary across jurisdictions. In this effort, my main concerns are the length of time that may have transpired between the intervention and the fielding of the NTG survey, and the very long survey used.

10. How does the methodology compare to common industry practice for evaluations of similar initiatives?

Methods used are comparable to those used in California.

11. What are your suggestions for future evaluations of this DSM initiative?

Depends on the objective of the research as noted below:

- If you want to estimate savings, need to track better who is participating in the program (e.g., townhouse configurations), and carry on surveys regularly with participants and market actors to develop more real-time assessments of NTG.
- If you want to see how to design programs and/or policies to get broader uptake (you seem to have touched only about 6% of builders and 10% of homes constructed), you will need to redirect the research to better understand and quantify the NEBs and EE benefits that builders, lenders and homeowners care about. The results of that research could end up modifying significantly current program offerings and result in reduced free ridership concerns and more market activity.

6. Do you have any other comments that you would like to make?

I found the report to be easy to follow and clear. This was not an easy task given the complexity of both the program being studied and the methods required to estimate the savings. I commend the evaluation team for the job they've done and the report they've written.

Appendix C Approach Details

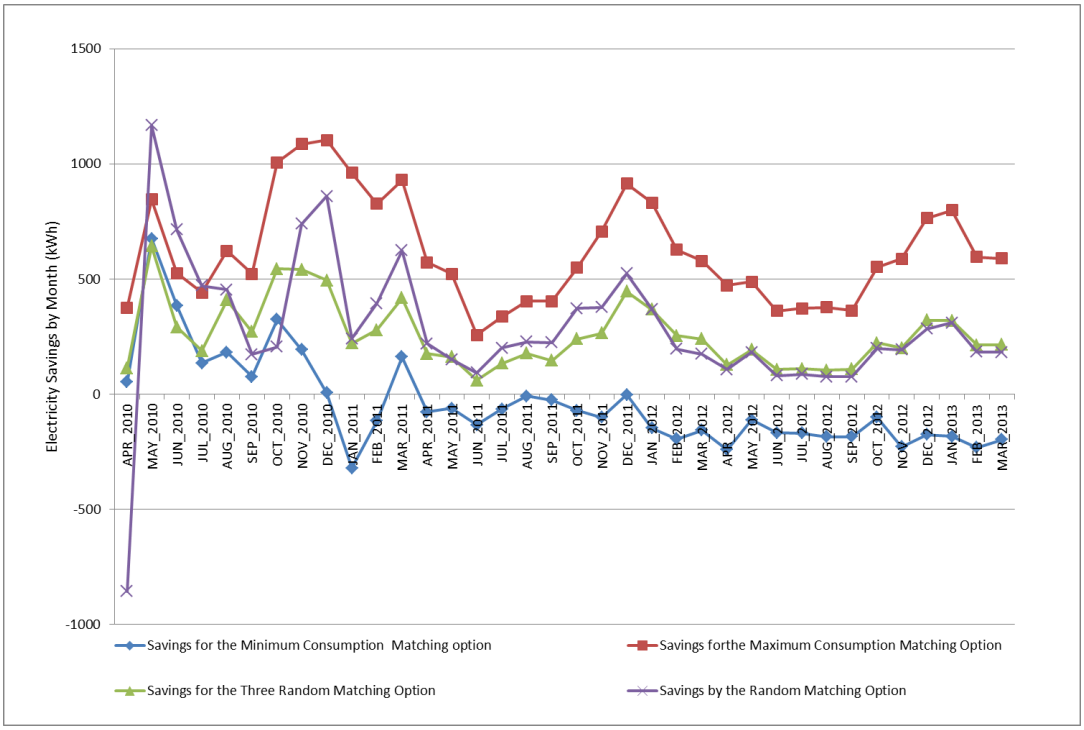
C.1 Control Group Setup and the Sensitivities of Non-participant Selection for the Home Performance Offer: Single Family Detached

A comparison group was constructed for the net impact analysis where each participant in the sample had up to three matches. The purpose of using more than one match per participant is to minimize the possibility of randomly selecting an extreme case as the baseline comparator, thus improving the accuracy of results. The reason for using multiple matches is that the matching criteria were limited to the data available for defining home energy consumption including: region, space heating type, square footage and year of build. Beyond these variables, the method did not have control over other factors that could influence home energy consumption.

Once the non-participant matches were selected, a test was conducted to show the sensitivity of different group construction on the results. Four different non-participant groups were tested: the three-match group that was used in this evaluation, a single-match randomly selected, a group containing the highest (maximum) consumption homes of the three matches, and a group containing the lowest (minimum) consumption homes of the three matches.

The results, as shown in the graph below, indicated that the extreme non-participant groups (maximum and minimum consumption groups) predicted a much higher variance of energy saving results. Between the three- and one-match groups, there was a difference in the results for the early evaluation period, but they started to converge in the later period. This is most likely due to the increased size of sample for comparison in the later analysis period. Given the small participant numbers in the early evaluation period, it is more prudent and reliable to derive the results with a bigger comparison group comprised of three-to-one matches instead of the one-to-one match comparison group.

Figure C.1. Impact on Energy Savings Results by Comparison Group



C.2 Energy Efficiency Differences due to Builder Size and Practice for the Home Performance Offer: Single Family Detached

Large (multi-unit) home builders and small (single-unit) home builders may have different practices in terms of constructing energy-efficient buildings. The selection and composition of large and small builders in the comparison group may influence the energy savings results for single family dwellings as the method for this evaluation is a quasi-experiment design based on pair matching.

Information on residential home builders is maintained in a third party database. A total of 428 participants and 714 non-participants were identified in the database and classified as large or small builders based on their construction activities over one-year periods. As shown in the table below, the composition of large builders and small builders in the participant and comparison groups was not the same: There is a larger share of large builders in the participant group than in the comparison group (53% vs 31%).

Table C.1. Composition of Large- and Small Builders in Participant and Comparison group

Participant Group			Comparison Group		
	Number	Percent		Number	Percent
Large-home builders	227	53%	Large-home builders	219	31%
Small home builders	201	47%	Small home builders	495	69%

Three analyses were then conducted to identify the impact of builder size on energy efficiency for the period from F2011 to F2013.

The first analysis was to identify the program participation and size of builder's impact on energy consumption. This was conducted using the following model to show the impact of two factors—program participation and the builder size –as fixed effects in monthly energy consumption:

Equation C.1. Electricity Consumption as a Function of Builder Size

$$Energy\ Consumption_i = a + b(Builder) + c(Participant) + error,$$

Where *i* represents the house built by builder *i;*
Participant indicates whether builder *i* participates in New Home program;
Builder indicates the size—whether builder *i* is a large (multi-unit) builder or a small (single-unit) builder.

A third factor—the cross impact of the participant being a large builder—was tested together with the two variables above. Results indicated that the cross impact was not significant in explaining the consumption difference.

The above model was tested on the data consisting of both the program participants and the comparison group. Since the two groups were matched on a set of criteria, the impacts of other factors not included in the model were controlled. Hence, the difference in consumption was then attributed to effects of the New Home program and the builder's size.

The results from the above model are shown in the table below. They indicate that, on average, homes built by large builders consume 42kWh/month (504kWh/year) less than a home built by a small builder. Program participants' home energy consumption is about 205kWh/month (2460kWh/year) more efficient than energy consumption of non-participants' homes, regardless of home size.

Table C.2. Results of Builder and Program Effect

Parameter Estimates				
Variable	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1441.02432	8.96398	160.76	<.0001
Builder	-41.78497	13.50680	-3.09	0.0020
Participant	-204.80258	13.49156	-15.18	<.0001

The second and third analyses examined the program's energy saving effect on large and small builders. The analyses were completed using the following equation:

Equation C.2. Electricity Consumption as a Function of Participation

$$Energy\ Consumption_i = a + b \times Participant + error,$$

Where *Participant* indicates whether the house under analysis was built by a program participant or not.

The results from these analyses, as shown in the following table C.3 and C.4 for both the large and small builder group, indicated that large builder's program saving effect is about 222kWh/month compared to 181kWh/month for small builders.

Table C.3. Energy Savings Estimates for Large Builders

Parameter Estimates (N=446)				
Variable	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1446.017797	10.41695642	138.81	<.0001
Participant	-221.731164	19.18005204	-11.56	<.0001

Table C.4. Energy Savings Estimates for Small Builders

Parameter Estimates (N=693)				
Variable	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1387.172378	12.28634853	112.90	<.0001
Participant	-180.767102	17.34003664	-10.42	<.0001

If the composition of large and small builders in the participant group (53% vs.47%) were applied to obtain a weighted average savings, it would be 203kWh.

In the evaluation, the weighted average monthly savings over the period from F2011 to F2013 is about 220kWh/month. It was based on the analysis of a larger sample (a total of 1,178 matched houses) compared to 446 houses in the large builder analysis presented above, and 696 houses in the small builder analysis (some of the builders could not be identified from the database). The discrepancy between these two sets of analysis might arise from the different samples or the different weight of large and small builders in the two samples.

However, the difference is within the acceptable range as it is about one standard error. Therefore, the original quasi-experimental design was used to report net impact for SFDs.

C.3 Validation of the Original Engineering Models for the Home Performance Offer: Single Family Detached

Work was conducted to validate the original engineering model used to produce the energy savings estimates reported by the New Home program. This validation exercise held two main objectives. The first was to identify the source of the variance between the evaluated energy savings for single family detached dwellings (SFDs) and the reported savings estimate. The second objective was to determine whether learnings from the SFD variance analysis could be used to inform or update the model assumptions and energy savings estimates for townhomes.

Original Model Assumptions

The Fortis BC *New Home Energy Modeling Report (2011)* was developed to provide technical and costing information on new B.C. residential construction with a view to achieving higher energy efficiency. The report models different home archetypes for four B.C. regions (Lower Mainland, Vancouver Island, Southern Interior and Northern), two housing types (single detached and townhome), two fuel types (electricity and natural gas) and three home sizes (small-130m^2, medium-280m^2 and large-385m^2) and simulates yearly energy consumption. Over 330 configurations of homes were simulated using NRCan's HOT2000. Packages of measures were modeled for all possible configurations changing the following variables[45]:

- Heating fuel – Electricity or natural gas;
- Heating system – Electric baseboards, gas furnaces, air source heat pumps, ground source heat pumps;
- Region – Lower Mainland, Vancouver Island, Southern Interior, Northern Interior;
- Size – 130, 280 and 385 m^2; and
- Measures to enable the medium-sized homes to reach EG80 , EG82-83 and EG86.

Simulations were performed under the following assumptions:

- SFDs were assumed to have 3 occupants in all four regions;
- Domestic hot water loads were assumed to be 190 Litres/day (L/day) at a delivered temperature of 55°C; and
- Inside temperatures of 18.4°C for electrically heated homes.

The medium-sized home was configured to achieve approximately EG80. Small and large homes were simulated with the same measure changes, which resulted in slightly higher EG rating for small homes and slightly lower EG rating for large homes.

Table C.5 is taken from the *Modelling Report* and summarizes energy savings for SFD's in all four regions in British Columbia. According to the report, the difference in measure would focus mostly on envelope upgrades. Usually only EG86 cases had air source heat pumps, as opposed to electric baseboard heaters for the base case EG80 and EG82.

[45] Fortis BC New House Modeling Final Report, April 12, 2011, Ken Cooper, SAR engineering ltd.

Table C.5. Results for All Four Regions Electrically Heated Single Family Detached Homes in kWh/yr

		Lower Mainland		Vancouver Island		Southern Interior		Northern Interior	
			Savings		Savings		Savings		Savings
Small Home 130 m^2	Base	17,417		17,389		19,361		23,417	
	ERS 80	14,000	**3,417**	14,167	**3,222**	16,361	**3,000**	18,889	**4,528**
Medium Home 280m^2	Base	23,028		23,444		25,639		33,111	
	ERS 80	17,472	**5,556**	17,972	**5,472**	20,556	**5,083**	25,528	**7,583**
Large Home 386m^2	Base	26,333		26,889		29,667		39,389	
	ERS 80	19,917	**6,417**	20,444	**6,444**	23,139	6,528	29,639	**9,750**

The New Home program reported electricity savings assumptions for SFDs and townhomes were developed based on the Fortis BC *New Home Energy Modeling Report (2011)* using the following assumptions:

- The difference in annual energy consumption between homes that are built to building code standards (EG77 or its prescriptive equivalent) and those that include upgrade measures that would achieve an EG80;
- The weighted average of the energy savings for each dwelling type in each of the four regions, based on the forecasted number of housing starts for each dwelling type in each region;
- Average yearly savings for small (130m^2) and medium sized (280m^2) dwellings;
- Average size of 205 m^2 ; and
- Gross energy savings of 4,800 kWh/yr.

Actual Home Characteristics and Evaluation Estimates

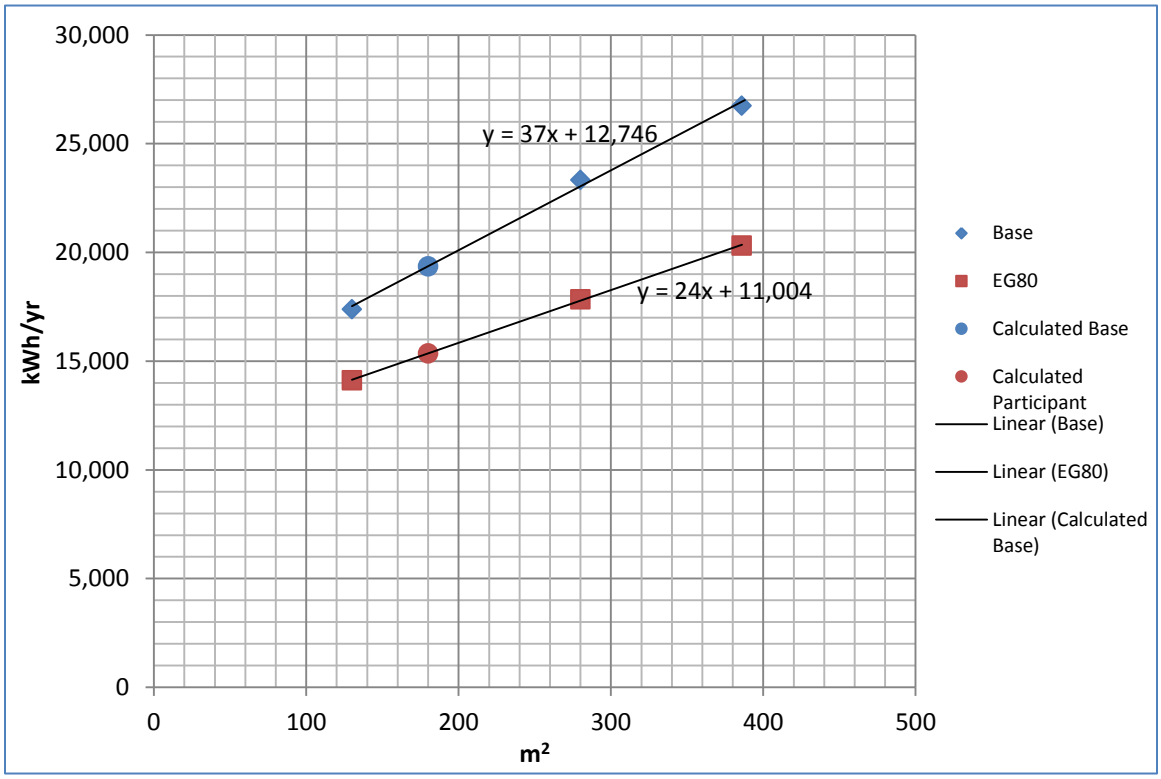
The evaluation estimate for SFDs provided the following information about home incented under the Home Performance offer:

- The average home size is 180m^2;
- 75% of the participants are located on Vancouver Island and the other 25% are located in the Lower Mainland. Participation in the interior was negligible; and
- Energy savings per household ranged from 2,200 – 4,000 kWh/yr.

Through this analysis it was evident that the evaluation estimate of energy savings per SFD differed from the program's reported estimate of 4,800 kWh/yr.

Figure C.2 shows the relationship between modeled electricity use for single family homes and home size, based on the results of the *New Home Energy Modeling Report (2011).* The relationships are for the baseline home and the EG 80 home, and use the actual regional distribution of participation (75% Vancouver Island and 25% Lower Mainland).

Figure C.2. Single Family Detached Energy Consumption for Baseline and EnerGuide 80 Homes



For both the baseline and the EG80 home, there is a linear correlation between the size of home and its electricity consumption. As a result, the following two linear equations can be defined:

Equation C.3. SFD Modelled Baseline Consumption as a Function of Home Size

$$Energy\ Consumption_{Base} = 37kWh * (Size\ of\ Home\ in\ m^2) + 12{,}746kWh$$

Equation C.4. SFD Modelled EG80 Consumption as a Function of Home Size

$$Energy\ Consumption_{EG80} = 24kWh * (Size\ of\ Home\ in\ m^2) + 11{,}004kWh$$

Taking equations C.3 and C.4 and solving for a 180m^2 home will give the following results:

$$Energy\ Consumption_{Base} = 19{,}400$$
$$Energy\ Consumption_{EG80} = 15{,}400$$

Energy savings is the difference between consumption of the EG80 home and the baseline home.

Equation C.5. Adjusted Model SFD Savings

$$Energy\ Savings\ per\ Single\ Family\ Home = Energy\ Consumption_{Base} - Energy\ Consumption_{EG80}$$

Therefore, using these results:

$$Energy\ Savings\ per\ Single\ Family\ Home = 19{,}400 - 15{,}400 = 4{,}000\ kWh/yr$$

Summary of Findings

The three methods explained above are summarized in Table C.5. Adjusting the original model estimate for size of home and regional mix corrects average energy savings from 4,800 to 4,000 kWh/yr. The overall energy consumption for the base case and EG80 homes drops to 19,400 and 15,400, respectively.

Table C.6. Comparison of Energy Savings Results for Single Family Detached by Model

	Original Estimate New Home Energy Modeling Report (2011)	Original Estimate Adjusted for Size and Region	Evaluation Estimate
Size	205m^2	180m^2	Avg 180m^2
Base Case Consumption	~22,900 kWh/yr	19,400 kWh/yr	17,700 kWh/yr
Participants/EG 80 Consumption	~18,100 kWh/yr	15,400 kWh/yr	15,000 kWh/yr
Savings	4,800 kWh/yr	4,000 kWh/yr	2,700 kWh/yr
% of total energy consumption	**~21%**	**21%**	**15%**

There is still a variance in energy consumption and energy savings between the adjusted estimate and the evaluation estimate. This variance can be at least partially explained by the fact that air source heat pump penetration was estimated to be approximately 50% for respondents to the participant and non-participant surveys, and no heat pump penetration accounted for in the program assumptions. Heat pumps are more efficient than electric baseboards. This results in a lower than anticipated baseline energy consumption, and therefore lower energy savings.

As modeled in the *New Home Energy Modeling Report*, an air source heat pump decreases energy consumption by 6,700 kWh/yr in the medium sized base home (280 m^2)[46]. If we consider that 50% of participants and non-participants of the Home Performance offer are installing heat pumps, therefore energy consumption of a medium sized home for the baseline would decrease by ~3,350 kWh/yr.

[46] Fortis B.C. New Home Modeling Final Report, April 12, 2011, Ken Cooper, SAR engineering ltd

C.4 Algorithms for Gross Savings Estimates for the Energy Star Package Offer

Refrigerators

Annual gross savings for refrigerators was calculated using the following formula:

Equation C.6. Refrigerator Gross Savings

$$Gross\ Evaluated\ kWh_{savings} = (kWh/cuft_{baseline} - kWh/cuft_{model}) * Average\ Capacity * Units_{model} * (1 - cross\ effect)$$

Where $kWh/cu\ ft_{model}$ is the annual consumption per cubic foot for each Energy Star model rebated through the program, and

$kWh/cu\ ft_{baseline}$ is the average annual consumption per cubic foot for baseline models.

Clothes Washers

Annual gross savings for clothes washers was calculated using the following equation:

Equation C.7. Clothes Washer Gross Savings

$$Gross\ Evaluated\ kWh_{savings} = (kWh/cuft_{baseline} - kWh/cuft_{model}) * Average\ Capacity * Units_{model}$$

Where $kWh/cu\ ft_{model}$ is the annual consumption per cubic foot for each Energy Star model rebated through the program, and

$kWh/cu\ ft_{baseline}$ is the average annual consumption per cubic foot for baseline models.

Dishwashers

Annual gross savings for dishwasher was calculated using the following formula:

Equation C.8. Dishwasher Gross Savings

$$Gross\ Evaluated\ kWh_{savings} = (kWh_{baseline} - kWh_{model}) * Units_{model}$$

Light bulbs

Annual gross savings for light bulbs was calculated using the following formula:

Equation C.9. Light bulb Gross Savings

$$Gross\ Evaluated\ kWh_{savings} = kW_{savings} * Lamps * Hours\ of\ Use * (1 - cross\ effect)$$

Bathroom Fans

The original model used to forecast savings was reviewed and adjusted to better reflect actual code requirements during the evaluation period, which affected assumed hours of use and fan size. Since the original model was produced, BC Building Code requirements changed to include total operating time of 8 hours per day. The original and up-dated modelling assumptions are summarized in the table below.

Table C.7. Original and Adjusted Assumptions for the Bathroom Fans Engineering Model

	Original Assumptions			Adjusted Assumption		
Hours of Use						
Hours/day	1			6		
Annual Hours of Operation	350			2,128		
Size (Power)	**10-80 cfm**	**90-130 cfm**	**140-500 cfm**	**10-80 cfm**	**90-130 cfm**	**140-500 cfm**
Baseline Watts	80	98	286	31	41	65
Energy Star Watts	32	39	114	11	23	40
Annual Energy Savings (kWh/yr)	17	21	60	44	38	52
Distribution of fan sizes	37%	50%	13%	26%	60%	14%
Per unit savings (kWh/yr)		**25**			**41**	

Annual gross savings for bathroom fans was calculated using the following equation:

Equation C.10. Bathroom Fans Gross Savings

$$Gross\ Evaluated\ kWh_{savings} = kWh_{savings\ per\ unit} * Units$$

C.5 Non-Participant Spillover Algorithms for Home Performance Offer: Single Family Detached and Townhomes

Definition: Homes that were built to above code by builders who did not participate in New Home (i.e., DID NOT receive an incentive) but were influenced by the program to building more energy-efficient homes

For builders of single family detached and for townhomes aware of the program:

SFD homes: 65 respondents built 278 SFDs

Townhomes: 15 respondents built 223 units

BASE: # units built annually for SFD and townhomes *(Based on the past 2 to 3 years, approximately how many homes or housing units does your company complete in an average year for each of the following types of housing in British Columbia?)*

Questions used for Spillover calculation

Since first learning about the New Home Program, approximately what percentage of homes has your company built here in BC, but outside the City of Vancouver, that …

a. % homes rated as EnerGuide 80 that did not receive a rebate from the New Home Program? ____%
b. % homes higher than EnerGuide 80 that did not receive a rebate from the New Home Program? ____%
c. % homes more energy-efficient than required by code but less than EnergGuide 80? ____%
d. % homes built to code requirements? ____%

Equation C.11. Home Performance Offer Non-Participant Influence Score

Influence Score (IS) = degree of influence(.5) + intended to incent(.5)

% Intended to get rebate (.5)	% Intended to get rebate (.5)
Influence (.5)	Influence (.5)
Very [0.75] Somewhat [0.5] Not too [0.25] Not at all [0.0]	Very [0.75] Somewhat [0.5] Not too [0.25] Not at all [0.0]

Equation C.12. Home Performance Offer Non-Participant Spillover Homes

*# SO homes = IS * avg # homes built per year*

Equation C.13. Home Performance Offer Non-Participant Spillover Rate

(ΣSO homes)/total homes built by survey respondents

Equation C.14. Home Performance Offer Total Non-Participant Spillover Savings

[*(Total new single family detached homes built in BC outside of Vancouver*SO rate*Evaluated per single family detached unit energy savings)*[47] *+ (Total new townhomes built in BC outside of Vancouver*SO rate*Evaluated per townhome unit energy savings)] * (electric heat adjustment=.3)*

[47] Note that, for between code and EG80 units, 50% of the evaluated per unit energy savings was used.

C.6 Participant Spillover Algorithms for Home Performance Offer: Single Family Detached and Townhomes

Definition: EG80 (or higher) homes that were built by participants in the Home Performance offer that DID NOT receive an incentive but the program had some influence on building more energy-efficient homes than required by code

Single family detached: 54 respondents built 278 homes

Townhomes: 18 respondents > 273 units (includes 3 Don't Know responses)

BASE: # units built annually for SFD and townhomes *(Based on the past 2 to 3 years, approximately how many homes or housing units does your company complete in an average year for each of the following types of housing in British Columbia?)*

Questions used for Spillover calculation (Questions 37-43)

Since first learning about the New Home Program, approximately what percentage of homes has your company built here in BC, but outside the City of Vancouver, that …

a. % homes rated as EnerGuide 80 (or higher) that received a rebate? ____%
b. % homes rated as EnerGuide 80 that did not receive a rebate from the New Home Program? ____%
c. % homes higher than EnerGuide 80 that did not receive a rebate from the New Home Program? ____%
d. % homes more energy-efficient than required by code but less than EnergGuide 80? ____%
e. % homes built to code requirements? ____%

Equation C.15. Home Performance Offer Total Un-incented Efficient Homes Built per Year

Apply % for b+c, and for d to the BASE (total # built per year)

Equation C.16. Home Performance Offer Participant Influence Score

if b+c > 0; d > 0

Influence Score (IS) = degree of influence(.5) + intent to incent(.5)

b+c (≥EG80)	d. (code < EG rating < EG80)
% Intended to get rebate (.5)	% Intended to get rebate (.5)
Influence (.5)	Influence (.5)
Very [0.75] Somewhat [0.5] Not too [0.25] Not at all [0.0]	Very [0.75] Somewhat [0.5] Not too [0.25] Not at all [0.0]

Equation C.17. Home Performance Offer Participant Spillover Homes

*# SO homes = IS * # homes not incented*

Equation C.18. Home Performance Offer Participant Spillover Rate

(ΣSO homes)/total incented homes

Equation C.19. Home Performance Offer Participant Total Spillover Savings

*(Total # single family detached units incented*SO rate*Evaluated per single family detached unit savings) + (Total townhome units incented *SO rate*Evaluated per townhome unit savings)*[48]

[48] Note that, for between code and EG80 units, 50% of the evaluated per unit energy savings was used.

C.7 Free Ridership Algorithms for Home Performance Offer: Townhomes

Sample

Eighteen companies in the participant survey that had built townhomes. The average # of units built per year based on the past 2 to 3 years was more than 273 per year (based on n=15; 3 reported don't know).

Step 1. Calculate Free-ridership Score

Full free riders for builders of townhomes who participated in the Home Performance offer were defined as those survey respondents who 1) had planned to build and 2) would have built the same homes to EnerGuide 80 without the program incentive. Full free-riders accounted for 60% of the units built per year.

Partial free-ridership was derived from responses to five questions in the participant survey covering: planning (A), time of installation (B), including the energy-efficient features (C), and influence on decision-making (D). Each component in the calculation was assigned a weight to reflect relative importance to the concept of free-ridership for this program and likely accuracy of the responses[49].

Shown below is the algorithm used to estimate partial free-ridership for townhomes.

Equation C.20. Townhome Partial Free Ridership

$$FR_{participant} = .2(A) + .2(B) + .3(C) + .3(D)$$

Step 2. Calculate the proportion of townhomes that were free-riders for each participant

As noted earlier, free-ridership was calculated for the first application as indicative of the situation when participants first became aware of the program. Therefore, the participant free-rider score was applied to the number of homes covered by each participant's first application, as presented in in the next equation.

Equation C.21. Townhome Number of Free Rider Homes per Participant

$$\#\ Free\text{-}rider\ homes\ per\ participant = \#\ incented\ homes\ in\ first\ application * Participant\ FR\ Score$$

Step 3. Calculate the overall rate of free-ridership

The overall rate of free-ridership for the participant population is the proportion of total rebated homes that were free-riders. The sum of homes identified as free-riders for each participant were summed and divided into the total products rebated in the first application, as depicted in Equation 10.

Equation C.22. Townhome Overall Free Rider Rate

$$FR\ Rate = \sum_{i=1}^{n} total\ FR\ homes / \sum_{i=1}^{n} total\ incented\ in\ first\ application$$

[49] Based on the possibility of recall bias/inaccuracy as decisions were made a few years prior to the survey.

C.8 Free Ridership and Spillover Algorithms for the Energy Star Package Offer

The free ridership score for the Energy Star Package offer is based on participants' decisions at the time of first applying to the program. As with row/town houses, the rate of free-ridership associated with the first application was assumed to be a more accurate representation of applicants' original intent. Free-ridership was calculated for the three appliances (as a group), for bathroom fans and for CFLs.

Step 1. Calculate participant free-ridership

Full free riders for the Energy Star Package offer were defined as those survey respondents who 1) had planned to install and 2) had started to install the same number of the same energy star products before becoming aware of the program.

Partial free-ridership was derived from responses to five questions in the participant survey covering: planning (A), time of installation (B), product cost (C), program influence on decision-making (D) and proportion of installed products that would have been installed regardless of the program (E). Each component in the calculation was assigned a weight to reflect relative importance to the concept of free-ridership for this program[50] and likely accuracy of the responses[51].

Equation C.23. Energy Star Package Partial Free Ridership Score

$$FR_{participant} = .1(A) + .3(B) + .2(C) + .2(D) + .2(E)$$

Step 2. Calculate the proportion of rebated products that were free-riders for each participant

As noted earlier, free-ridership was calculated for the first application as indicative of the situation when participants first became aware of the program. Therefore, the participant free-rider score was applied to the number of rebated products covered by each participant's first application, as presented in in the next equation.

Equation C.24. Energy Star Package Number of Free Rider Products per Participant

*# Free-rider products per participant = # rebated products in first application*Participant FR Score*

Step 3. Calculate the overall rate of free-ridership

The overall rate of free-ridership for the participant population is the proportion of total rebated products that are free-riders. The sum of products identified as free-riders for each participant were summed and divided into the total products rebated in the first application, as depicted in Equation 3.

Equation C.25. Energy Star Package Overall Free Rider Rate

$$FR\ Rate = \sum_{i=1}^{n} total\ FR\ products / \sum_{i=1}^{n} total\ rebates\ in\ first\ application$$

[50] All weighting schemes were reviewed with program staff to ensure that significant factors were provided appropriate weights relative to less influential factors.

[51] Based on the possibility of recall bias/inaccuracy as decisions were made a few years prior to the survey.

The method used to calculate participant spillover for the Energy Star package is described by the equations below.

Equation C.26. Energy Star Package Spillover Score

$$SO = \sum_{i=1}^{n} NR\ ratio * IS * weight$$

Where,

NR ratio is the ratio of non-rebated products to rebated products for each participant:

NR ratio = # non-rebated/# rebated

IS is the influence score for each participant:

IS = intent to get rebate(.6) + program influence(.4)

Weight is the proportion of rebated products accounted for by each participant:

Weight = # rebated products for participant/total rebated products for sample

Appendix D Result Details

D.1 Actual Monthly and Annual Net Energy Savings for Home Performance Offer: Single Family Detached

Table D.1 presents the monthly energy savings for the Home Performance offer based on the methodology for estimating net electricity savings for single family dwellings" described in Section 2.3.1

Table D.1. Actual Monthly Net Energy Savings (kWh per participant SFD)

Fiscal Year	Month_Year	Avg Savings	Pr > |t|	Std Dev	Sig @ 80%
F2011	APR_2010	113	0.7994	434.5	
F2011	MAY_2010	642	0.0374	284.4	Yes
F2011	JUN_2010	292	0.2197	229.5	
F2011	JUL_2010	188	0.1677	132.4	Yes
F2011	AUG_2010	408	0.0004	105.2	Yes
F2011	SEP_2010	271	0.0091	100.7	Yes
F2011	OCT_2010	544	0.0003	144.7	Yes
F2011	NOV_2010	541	0.0004	147.8	Yes
F2011	DEC_2010	494	0.0041	169.2	Yes
F2011	JAN_2011	221	0.1622	157.3	Yes
F2011	FEB_2011	278	0.0342	130.3	Yes
F2011	MAR_2011	418	0.0001	107.7	Yes
F2012	APR_2011	175	0.0261	78.2	Yes
F2012	MAY_2011	161	0.0219	69.9	Yes
F2012	JUN_2011	60	0.1790	44.3	Yes
F2012	JUL_2011	133	0.0005	37.7	Yes
F2012	AUG_2011	178	<.0001	35.8	Yes
F2012	SEP_2011	147	0.0001	38.3	Yes
F2012	OCT_2011	240	<.0001	49.3	Yes
F2012	NOV_2011	265	<.0001	58.2	Yes
F2012	DEC_2011	445	<.0001	59.3	Yes
F2012	JAN_2012	368	<.0001	57.5	Yes
F2012	FEB_2012	253	<.0001	48.1	Yes
F2012	MAR_2012	240	<.0001	44.2	Yes
F2013	APR_2012	127	0.0004	36.0	Yes
F2013	MAY_2012	193	<.0001	28.2	Yes
F2013	JUN_2012	107	<.0001	24.7	Yes
F2013	JUL_2012	110	<.0001	24.6	Yes
F2013	AUG_2012	104	<.0001	23.8	Yes
F2013	SEP_2012	108	<.0001	23.6	Yes
F2013	OCT_2012	223	<.0001	27.2	Yes
F2013	NOV_2012	201	<.0001	32.2	Yes
F2013	DEC_2012	321	<.0001	37.3	Yes
F2013	JAN_2013	319	<.0001	37.2	Yes
F2013	FEB_2013	213	<.0001	31.4	Yes
F2013	MAR_2013	215	<.0001	31.2	Yes

The statistically significant monthly results from the above table were aggregated to derive the Actual Annual Net Energy Savings for each fiscal year from F2011 to F2013.

Table D.2. Actual Annual Net Energy Savings (kWh per Participant)

	F2011	F2012	F2013	3 Year Average (unweighted)
Actual Annual Net Energy Savings	4007	2665	2242	2971

D.2 Weather Adjusted Net Electricity Savings for Home Performance Offer: Single Family Detached

The weather-adjusted Monthly Net Energy Savings for month *i* was the actual monthly net electricity saving multiplied by the weather factor, which is the ratio of the 10 year average HDD and CDD to the actual HDD and CDD in month, as expressed by the following formula:

Equation D.1. SFD Savings Weather Adjustment

$$\textit{Weather Adjusted Monthly Net Electricity Savings}_i = \textit{Actual Monthly Net Energy Savings}_i * (\textit{10year AVG HDDCDD}_i / \textit{Actual HDDCDD})_i$$

Weather-adjusted net energy savings for each month in F2010 to F2013 are presented below.

Table D.3. Actual and Weather Adjusted Monthly Net Electricity Savings (kWh per Participant)

Month/Year	Actual Monthly Net Energy Savings	Actual HDDCDD	10year AVG HDDCDD	Factor =10year AVG HDDCDD / Actual HDDCDD	Weather Adjusted Monthly Net Energy Savings
APR10	0	300	328	0.92	0
MAY10	642	228	194	1.18	546
JUN10	0	124	107	1.17	0
JUL10	188	52	80	0.65	289
AUG10	408	73	74	0.98	418
SEP10	271	150	135	1.11	245
OCT10	544	248	304	0.82	666
NOV10	541	464	441	1.05	514
DEC10	494	471	564	0.84	592
JAN11	221	529	614	0.86	256
FEB11	278	493	523	0.94	295
MAR11	418	428	453	0.95	442
APR11	175	361	328	1.10	159
MAY11	161	238	194	1.23	131
JUN11	60	127	107	1.19	50
JUL11	133	88	80	1.11	120
AUG11	178	56	74	0.76	235
SEP11	147	108	135	0.80	184
OCT11	240	303	304	1.00	240
NOV11	265	450	441	1.02	260
DEC11	445	507	564	0.90	495
JAN12	368	551	614	0.90	410
FEB12	253	451	523	0.86	294
MAR12	240	367	453	0.81	296
APR12	127	300	328	0.91	139
MAY12	193	220	194	1.13	170
JUN12	107	147	107	1.37	78
JUL12	110	54	80	0.67	164
AUG12	104	56	74	0.76	137
SEP12	108	139	135	1.03	105
OCT12	223	330	304	1.09	205
NOV12	201	425	441	0.96	209
DEC12	321	520	564	0.92	348
JAN13	319	550	614	0.90	357
FEB13	213	402	523	0.77	278
MAR13	215	410	453	0.91	238

The actual and weather adjusted annual net electricity savings for each fiscal year from F2011 to F2013 are summarized below.

Table D.4. Actual and Weather Adjusted Annual Net Electricity Savings (kWh per Participant)

	F2011	F2012	F2013	3 Year Weighted Average (by participating homes)
Actual Annual Net Energy Savings	4007	2665	2242	2644
Weather Adjusted Annual Net Energy Savings	4261	2875	2427	2837

Summarized below are the actual and weather adjusted annual net electricity savings for electrically heated single family dwellings for the full evaluation period.

Table D.5. Actual and Weather Adjusted Net Electricity Savings Attributed to Home Performance (GWh/year)

	F2008*	F2009*	F2010*	F2011	F2012	F2013
Home Performance Participants	1	333	103	125	263	437
Actual Annual Net Energy Savings per Participant (kWh/year)	2644	2644	2644	4007	2665	2242
Weather Adjusted Annual Net Energy Savings per Participant (kWh/year)	2837	2837	2837*	4261	2875	2427
Actual Annual Net Energy Savings (Run-rate Saving/Year in GWh)	0.0	0.9	0.3	0.5	0.7	1.0
Weather Adjusted Annual Net Energy Savings (Run-rate Saving/Year in GWh)	0.0	0.9	0.3	0.5	0.8	1.1

*****The actual net energy savings from F2008 to F2010 could not be statistically estimated as the total sample was consisted of just 31 pair-matches of home-performance-only participants. The weighted (by number of participating homes) average over three year's savings (from F2011 to F2013) were applied to the F2008-F2010 savings results.

D.3 Gross Electricity Savings Results for Home Performance Offer: Townhomes

Shown below are the original energy model estimates from the *New Home Energy Modeling Report (2011)* that were used to inform program reported savings for townhomes.

Table D.6. Townhome Energy Model Results for Lower Mainland by Size and Unit Type

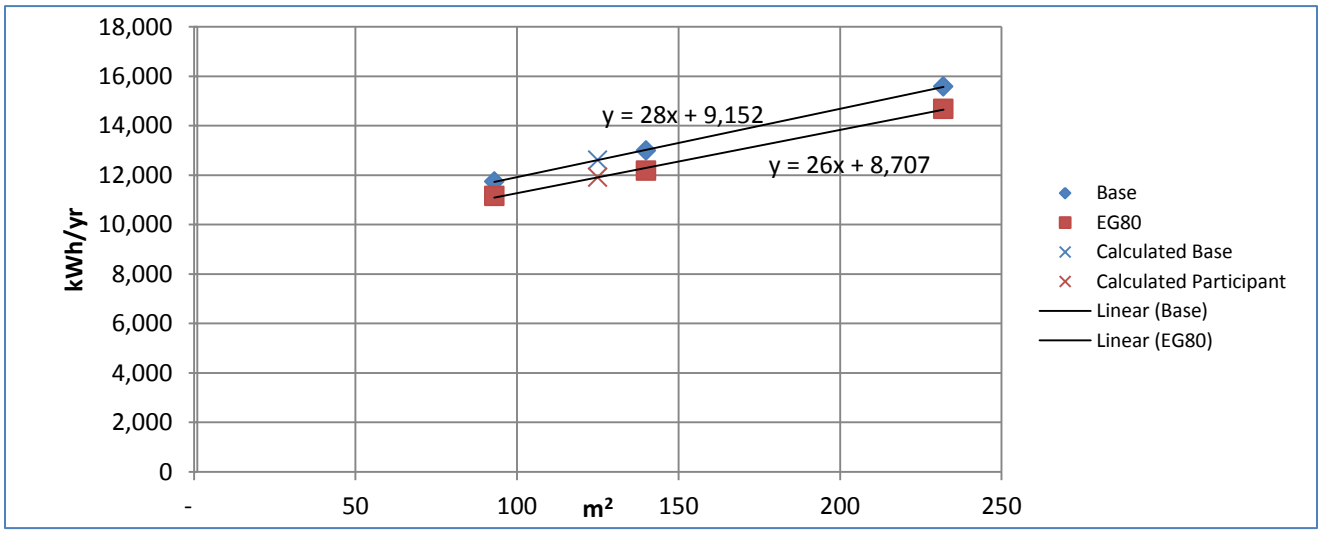
	Total Electricity Consumption		Savings	
	End Unit	Mid Unit	End Unit	Mid Unit
	Small 93m^2			
Base	12,444	11,278		
ERS 80	11,694	10,806	750	472
	Medium 140m^2			
Base	14,000	12,333		
ERS 80	12,889	11,722	1,139	611
	Large 232 m^2			
Base	17,000	14,639		
ERS 80	15,889	13,889	1,111	750

Inputs required to adjust the original model estimates for the purpose of this evaluation were as follows:

- The difference in annual energy consumption between homes that were built to building code standards (EG77 or prescriptive equivalent) and those that include upgrade measures that would achieve an EG80, obtained from the original engineering model;
- Average actual size of program participants (125m^2), obtained from program staff;
- Townhome complex configuration – two end units and three mid units, obtained from program staff; and
- Regional participation distribution Lower Mainland (75%) and on Vancouver Island (25%), based on historical program participants.

Figure D.1 shows the relationship between modeled electricity use for townhomes and home size from the New Home Energy Modeling Report (2011). The relationships are for the base home and the EG 80 home, and use the actual regional distribution of participation (75% Vancouver Island and 25% Lower Mainland), and updated configuration assumption of two end units and three mid units.

Figure D.1. Electricity Consumption by Townhome Size



The average electricity savings per townhome were calculated using the following equations.

Equation D.2. Savings per Townhome

$$Annual\ Energy\ Savings\ per\ Townhome\ Participant = Annual\ energy\ consumption_{Base\ Case\ Home} - Annual\ Energy\ Consumption_{EG80}$$

Equation D.3. Annual Electricity Consumption for the Baseline Townhome

$$Annual\ Energy\ Consumption_{\ Base\ Case\ Home} = 28\ kWh/m2^{*}\ (average\ townhome\ size\ in\ m2) + 9{,}152kWh$$

Equation D.4. Annual Electricity Consumption for the EG 80 Townhome

$$Annual\ Energy\ Consumption_{EG80} =$$

$$26\ kWh/m2^{*}\ (average\ townhome\ size\ in\ m2) + 8{,}707kWh$$

Shown below are the results of the adjusted model for townhomes and the comparison with initial program assumptions.

Table D.7. Original and Adjusted Model for Townhomes

	Original Estimate Base on the New Home Energy Modeling Report (2011)	Original Estimate Adjusted for Size, Region and Configuration
Size	117m²	125m²
Base Case Consumption	13,300 kWh/yr	12,600 kWh/yr
Participants/EG 80 Consumption	12,075 kWh/yr	11,900 kWh/yr
Savings	1,225 kWh/yr	700 kWh/yr
% of Total Energy Consumption	9%	6%

Taking the average home size of 125m^2, based on historical program participation, the average energy consumption for the base and the EG80 home is 12,600 kWh/yr and 11,900 kWh/yr, respectively. As a result, the average energy savings per town house is 700 kWh/yr.

D.4 Gross Electricity Savings Results for Home Performance Offer: Multi-Unit Residential

From F2009 to F2011 the New Home program incented 490 units in certain multi-unit residential buildings (MURBs) that were not eligible for other offers, in particular the Commercial New Construction program. These MURB units were tracked as townhomes, and reported electricity savings using the same assumptions applied to townhomes.

Gross energy savings for townhomes were adjusted for the 490 units in MURBs that were incented across the three evaluation years. The results of the Power Smart Evaluation study completed in 2010, *Conditional Demand Analysis of Residential Energy Consumption Study (CDA Report),* were used to make this adjustment.

The results of the CDA Report were used to estimate the proportion of space heating for a MURB vs. a townhome. According to this report, on average, townhomes were found to use 5,630 kWh/yr for space heating and apartments were found to use 2,050 kWh/yr. Given that building envelope measures save on space heating only, the simplifying assumption was made that envelope savings are directly proportional to space heating consumption. These results were used to scale townhome savings by 2.0/5.6, to estimate MURB unit savings. This calculation resulted in a factor of 0.36, which when multiplied by the evaluated energy savings for townhomes, equates to 255 kWh/yr for each MURB unit. The equation is provided below.

Equation D.5. Annual Electricity Savings per MURB

*Annual Energy Savings per MURB Unit Participant = (2,050 kWh/5,630 kWh) * 700 kWh*

D.5 Gross Electricity Savings Analysis Results Energy Star Package

The total number of each product incented during the evaluation period is summarized below.

Table D.8. Number of Incented Products by Product Type (Fiscal Years 2008-2013)

Fiscal Year	Refrigerators	Clothes washers	Dishwashers	Bathroom Fans	Light Bulbs (6 per unit)
2008	503	300	459	498	2,838
2009	1,922	788	2,120	1,683	7,842
2010	4,297	1,954	4,832	3,281	13.908
2011	3,855	3,324	4,642	4,238	17,328
2012	3,992	2,794	3,912	3,914	18,678
2013	4,775	3,124	4,644	4,640	21,882
Total Units	**19,344**	**12,282**	**20,609**	**18,261**	**82,476**

Shown below is the annual consumption on a per unit basis for the incented (i.e., Energy Star) products and respective baseline (i.e., non-Energy Star) products in each fiscal year covered by the evaluation. Gross savings for bathroom fans was calculated through an engineering model which is presented below.

Table D.9. Annual Electricity Consumption of Baseline and Incented Appliances and CFLs (Fiscal Years 2008-2013)

	Fridges		Clothes Washers		Dishwashers		Light Bulbs	
Fiscal Year	Incented (kWh/cuft)	Baseline (kWh/cuft)	Incented (kWh/cuft)	Baseline (kWh/cuft)	Incented (kWh)	Baseline (kWh)	Incented (Wattage)	Baseline (Wattage)
2008	23	26	44	95	308	341	13.4	66
2009	23	26	57	95	307	341	12.7	66
2010	23	26	58	85	294	317	13.0	60
2011	25	28	55	119	298	317	13.3	60
2012	25	28	59	108	292	306	14.4	60
2013	23	25	44	89	286	299	17.8	60

Shown below is the annual gross savings for Energy Star dishwashers that were incented in each fiscal year covered by the evaluation.

Table D.10. Gross Savings for Incented Dishwashers

Fiscal Year	Quantity Incented	Avg Annual Energy Use (kWh/yr)	Baseline Energy Use kWh/yr	Per Unit Savings (kWh/yr)	Gross Savings (kWh/yr)	Gross Savings (GWh/yr)
2008	459	308	341	33	15,045	0.015
2009	2,120	307	341	34	72,992	0.073
2010	4,832	294	317	23	113,071	0.113
2011	4,642	298	317	19	88,798	0.089
2012	3,912	292	306	14	53,508	0.054
2013	4,644	286	299	13	59,696	0.060

Shown below are the annual gross savings for Energy Star front load clothes washers that were incented in each fiscal year covered by the evaluation.

Table D.11. Gross Savings for Incented Clothes Washers

Fiscal Year	Quantity Incented	Avg Volume (cu. ft.)	Avg Energy Use (kWh)	Baseline Energy Use (kWh)	Energy Star kWh/cuft	Baseline kWh/cuft	Average Energy Savings (kWh/yr)	Per Unit Savings	Gross Savings (kWh)	Gross Savings (GWh)
2008	300	3.4	145	329	44	95	51	173	15,397	0.015
2009	788	3.0	172	329	57	95	38	114	30,106	0.030
2010	1,954	2.9	159	292	58	85	27	78	53,451	0.053
2011	3,324	2.9	156	391	55	119	64	186	211,556	0.212
2012	2,792	2.6	148	387	59	108	49	127	135,809	0.136
2013	3,124	3.3	143	311	44	89	45	149	139,749	0.140

Shown below are the annual gross savings for Energy Star refrigerators that were incented in each fiscal year covered by the evaluation.

Table D.12. Gross Savings for Incented Refrigerators

Fiscal Year	Quantity Incented	Avg Energy Use (kWh)	Avg Capacity (cuft)	Avg kWh/cuft	Baseline kWh/cuft	Avg Savings kWh/cuft	Per Unit Savings (kWh)	Gross savings Fridges (kWh)	Gross savings Fridges (GWh)
2008	503	469	20.5	23	26	3.1	63.6	31,7678	0.032
2009	1,922	448	19.7	23	26	3.2	63.0	121,485	0.121
2010	4,297	430	18.6	23	26	2.7	50.2	239,717	0.240
2011	3,855	438	17.7	25	28	2.7	47.8	224,774	0.225
2012	3,992	427	18.1	25	28	2.6	47.1	325,807	0.326
2013	4,775	441	19.2	23	25	1.9	36.5	187,904	0.188

Shown below are the annual gross savings for CFLs that were incented in each fiscal year covered by the evaluation. These results are adjusted for cross effects.

Table D.13. Gross Savings for Incented CFL Lamps

Fiscal Year	Number of Units Incented	Quantity of Bulbs Incented	Avg Energy Use (Wattage)	Energy Savings per bulb (Wattage)	Hours of Use	Total kWh savings	GWh savings	Adjusted for CE (1-CE=.95)
2008	473	2,838	13.4	49.5	934.4	140,547	0.140547	0.134
2009	1,307	7,842	12.7	49.5	934.4	388,361	0.388361	0.369
2010	2,318	13,908	13.0	43.9	934.4	610,795	0.610795	0.580
2011	2,888	17,334	13.3	43.9	934.4	760,990	0.760990	0.723
2012	3,113	18,678	14.4	43.0	934.4	802,825	0.802825	0.763
2013	3,647	21,882	17.8	39.2	934.4	858,755	0.858755	0.816

Appendix E Survey Samples and Completions

The participant survey was administered in October 2014 and the non-participant survey was conducted in December 2014. A prize draw was offered as an incentive to complete the survey. Four survey respondents were randomly selected to receive a $500 gift certificate to a home improvement store of their choice.

A total of 216 developers and construction companies that participated in the program[52] during the evaluation period were identified from the program tracking data. The participant survey was administered on-line via an email invitation.

The non-participant sample had to be created from external sources. The initial list of approximately 2,500 construction companies was developed using an extract from a commercial database provider firm. Due to the extremely low response rate and concerns about the quality of the contact list, additional sources, including the internet, were used to augment the initial list by approximately 300 more companies. The final sample frame of non-participants consisted of approximately 2,800. Not all companies in the non-participant sample frame could be confirmed as builders of new homes or as being in business.

The majority of non-participant surveys were administered online with a few surveys completed via telephone.

The number of responses and response rates for each survey are summarized in the table below.

	Sample Frame	Completions	Response Rate[2]
Participant Survey	216	75	35%
Non-participant Survey	2,800	70	3%[3]

[1]This includes full and partial completes

[2]This is the gross response rate as accuracy of the information contained in the sample frame ca not be determined through on-line survey mode (e.g., non-qualifier, incorrect contact information, no longer in business)

[52] Owner-builders were excluded due to privacy legislation.

Appendix F Participant Survey Questionnaire

New Home Program Participant Online Survey

ABOUT YOU

1. **How knowledgeable would you say you are in regards to your company's decision making around designing and building new homes to a certain level of energy efficiency or EnerGuide rating?** [Rollover: An EnerGuide rating is a standard measure of a home's energy performance. The energy efficiency level is rated on a scale of 0 to 100.]
   - ☐[1] Very knowledgeable
   - ☐[2] Somewhat knowledgeable
   - ☐[3] Not too knowledgeable
   - ☐[4] Not at all knowledgeable
   - ☐[99] Don't know

2. **How knowledgeable would you say you are in regards to your company's decision making around the appliances that will be installed in the new homes?**
   - ☐[1] Very knowledgeable
   - ☐[2] Somewhat knowledgeable
   - ☐[3] Not too knowledgeable
   - ☐[4] Not at all knowledgeable
   - ☐[99] Don't know

FOR SURVEY ID 100,000-199,999: IF Q1=<2, THEN PROCEED TO Q3; ELSE SHOW MESSAGE AND TERMINATE:

Thank you for taking the time to complete this survey. However, we kindly ask you to forward the email invitation for this survey to the appropriate person in terms of who makes the decisions for the company about designing and building new homes to a certain level of energy efficiency or EnerGuide rating.

FOR SURVEY ID 200,000-299,999: IF Q2=<2, THEN PROCEED TO Q3; ELSE SHOW MESSAGE AND TERMINATE:

Thank you for taking the time to complete this survey. However, we kindly ask you to forward the email invitation for this survey to the appropriate person in terms of who makes the decisions for the company about the appliances that will be installed in the new homes.

FOR SURVEY ID 300,000-399,999: IF Q1=<2 OR Q2=<2, THEN PROCEED TO Q3; ELSE SHOW MESSAGE AND TERMINATE:

Thank you for taking the time to complete this survey. However, we kindly ask you to forward the email invitation for this survey to the appropriate person in terms of who makes the decisions for the company about designing and building new homes to a certain level of energy efficiency or EnerGuide rating and/or about the appliances that will be installed in the new homes.

3. For how many years have you been associated with this company?

_____ years ☐[999] Don't know

ABOUT YOUR COMPANY

These next few questions are designed to learn a little about your company's involvement in the residential construction industry.

4. Based on the past 2 to 3 years, approximately how many homes or housing units does your company complete in an average year for each of the following types of housing?

Enter '0' if you do not build this type of dwelling. Please make sure responses are the number of individual houses or housing units and not the number of buildings/developments.

a) Single family dwellings	_____ homes	☐[999] Don't know
b) Town/row housing units; duplexes	_____ housing units	☐[999] Don't know
c) Multi-unit residential buildings	_____ housing units	☐[999] Don't know
d) Other (specify): _____		

5. How many years has your company been in the business of new residential construction?

☐[1] Less than 2 years

☐[2] 2 to 5 years

☐[3] 6 to 10 years

☐[4] 11 to 25 years

☐[5] More than 25 years

☐[99] Don't know

6. Approximately what percentage of your company's new residential construction falls within each of the following price point ranges for a single home or housing unit?

_____% of units that are under $400,000

_____% of units that are $400,000 to $599,999

_____% of units that are $600,000 to $799,999

_____% of units that are $800,000 to $1,299,999

_____% of units that are $1,300,000 to $1,999,999

_____% of units that are $2,000,000 or more

[Programming check: total = 100%]

☐[999] Don't know

7. In what parts of British Columbia does your company build new homes or housing developments? (select all that apply)

☐[1] Lower Mainland/South Coast

☐[2] Vancouver Island

☐[3] Okanagan/Thompson

☐[4] East Kootenays

☐[5] Northern BC

☐[6] Unsure – please specify region or town_____

☐[99] Don't know

8. Has your company participated in any of the following Green Building programs or initiatives? (select all that apply)

☐[1] LEED® for Homes

☐[2] BUILT GREEN®

☐[3] EnerGuide for New Houses (EGNH)

☐[4] ENERGY STAR® for Homes

☐[5] Power Smart New Home

☐[6] Fortis BC New Home

☐[7] Power Smart's New Construction Program for Commercial, Institutional, Multi-unit residential buildings

☐[8] Other (specify):_____

☐[99] Don't know

THE HOUSING INDUSTRY

We are interested in understanding your company's perspective on energy efficiency in the housing industry.

9. How important is it that BC Hydro and/or FortisBC provide support to the residential construction industry when building code changes require improved energy efficiency?

- ☐[1] Extremely important
- ☐[2] Important
- ☐[3] Neutral
- ☐[4] Not too important
- ☐[5] Not at all important
- ☐[99] Don't know

10. What kind of help is most useful for the industry? _____

11. Given the current circumstances in the new construction industry, what could BC Hydro or FortisBC do to continue to support the construction of more energy efficient homes? _____

12. To what extent, if any, has participating in the New Home Program increased your company's support of the industry designing and building more energy efficient homes with more energy efficient features?

- ☐[1] A great extent
- ☐[2] Some extent
- ☐[3] A little extent
- ☐[4] No extent at all
- ☐[99] Don't know

13. In your company's experience, how important is it to homebuyers in your target market that …
[RANDOMIZE]

	Extremely important	Important	Neutral	Not too important	Not at all important	DK
a) the homes they purchase are more energy efficient than the average home?	☐[1]	☐[2]	☐[3]	☐[4]	☐[5]	☐[99]
b) the homes they purchase have certain energy efficient features or equipment installed (e.g., insulation, windows, HVAC)?	☐[1]	☐[2]	☐[3]	☐[4]	☐[5]	☐[99]
c) the homes they purchase have energy efficient appliances and products installed (e.g., lighting, fans, refrigerator, clothes washer, dishwasher)?	☐[1]	☐[2]	☐[3]	☐[4]	☐[5]	☐[99]

14. In your company's experience, has there been any change in demand for more energy efficient homes by new home buyers over the past 5 or 6 years?

- ☐[1] Yes, there is now a greater demand for more energy efficient homes
- ☐[2] Yes, there is now less demand for more energy efficient homes
- ☐[0] No, the demand for more energy efficient homes has stayed the same
- ☐[99] Don't know

ENERGUIDE 80 PRACTICES AND HOME PERFORMANCE

The next questions are about your company's experiences and practices building to EnerGuide 80 or higher, in general, followed by questions specific to the Home Performance part of the Power Smart New Home Program (where builders could receive a rebate for providing proof of obtaining an EnerGuide rating of 80, or higher).

15. How much experience did your company have with building homes to the EnerGuide rating of 80 (or higher) prior to 2008? *[Rollover: An EnerGuide rating is a standard measure of a home's energy performance. The energy efficiency level is rated on a scale of 0 to 100.]*

- ☐[1] A great deal of experience
- ☐[2] A fair amount of experience
- ☐[3] A little experience
- ☐[4] No experience at all
- ☐[99] Don't know
- ☐[98] Not applicable (company did not build any single family dwellings, duplexes or row/townhouses at that time)

16. How much experience has your company had with building homes to an EnerGuide rating of 80 (or higher) since 2008?

- ☐[1] A great deal of experience [SKIP TO Q18]
- ☐[2] A fair amount of experience [SKIP TO Q18]
- ☐[3] A little experience [SKIP TO Q18]
- ☐[4] No experience at all [CONTINUE]
- ☐[99] Don't know [SKIP TO Q23]
- ☐[98] Not applicable (company did not/does not build single family dwellings, duplexes or row/townhouses) *[Programming check: this response should not be selected by anyone in Group 1 or Group 3]* [SKIP TO RULE FOR Q18]

IF Q15= 98 AND Q16= 98, SKIP TO RULE FOR Q46; ELSE CONTINUE

17. Why has your company not built any homes to the EnerGuide 80 rating since 2008? (select all that apply) [RANDOMIZE]

- ☐[1] We don't build beyond what's required by the building code.
- ☐[2] It costs too much to build a more energy efficient home.
- ☐[3] Higher energy efficiency does not create a competitive advantage in the market.
- ☐[4] There is a lack of technical expertise in the industry to design more energy efficient homes.
- ☐[5] There is a lack of technical expertise in the industry to build more energy efficient homes.
- ☐[6] There is low demand for homes that are more energy efficient.
- ☐[7] The company has not built any single family dwellings, duplexes or row/townhouse units since 2008.
- ☐[8] Other: please specify_____
- ☐[99] Don't know

IF Q16=4, SKIP TO Q23; ELSE CONTINUE

18. Has your company ever built any homes that are rated higher than EnerGuide 80?

- ☐[1] Yes [SKIP TO Q20]
- ☐[0] No [CONTINUE]
- ☐[99] Don't know [SKIP TO Q20]

19. Why has your company never built any homes that are rated higher than EnerGuide 80? (select all that apply) [RANDOMIZE]

- ☐[1] We don't build beyond what's required by the building code.
- ☐[2] It costs too much to build a more energy efficient home.
- ☐[3] Higher energy efficiency does not create a competitive advantage in the market.
- ☐[4] There is a lack of technical expertise in the industry to design more energy efficient homes.
- ☐[5] There is a lack of technical expertise in the industry to build more energy efficient homes.
- ☐[6] There is low demand for homes that are more energy efficient.
- ☐[7] There is no financial incentive available to build homes that are more energy efficient than EnerGuide80.
- ☐[8] Other: please specify_____
- ☐[99] Don't know

20. Which of the following energy efficient products were installed in order to achieve an EnerGuide rating of 80 or higher? (select all that apply)

- ☐[1] Air source heat pump (central system)
- ☐[2] Ground source heat pump
- ☐[3] Ductless heat pump
- ☐[4] Roofing products
- ☐[5] Windows, doors, skylights
- ☐[6] Air Conditioning (central)
- ☐[7] Furnaces
- ☐[9] Other: please specify_____
- ☐[0] None of the above
- ☐[99] Don't know

IF Q20=1, 2 OR 3 ASK Q21; ELSE SKIP TO Q22

21. In approximately what percentage of homes built did you install:

ASK IF Q20=1: a) Air source heat pump (central system)	_____ %	☐[999] Don't know
ASK IF Q20=2: b) Ground source heat pump	_____ %	☐[999] Don't know
ASK IF Q20=3: c) Ductless heat pump	_____ %	☐[999] Don't know

22. Has the proportion of EnerGuide 80 single family dwellings or row/town houses built by your company changed since 2008?

- ☐[1] Yes, a greater proportion of homes built by the company are EnerGuide 80.
- ☐[2] Yes, a smaller proportion of homes built by the company are EnerGuide 80.
- ☐[0] No, the proportion of EnerGuide 80 homes built by the company has stayed the same.
- ☐[99] Don't know

ASK Q23 IF SURVEY IDS 200,000-299,999; ALL OTHERS SKIP TO RULE FOR Q24

23. Has your company ever had an EnerGuide assessment completed for any of the new homes it has built in the past 5 or 6 years?

- ☐[1] Yes [CONTINUE]
- ☐[0] No [SKIP TO RULE FOR Q46]
- ☐[99] Don't know [SKIP TO RULE FOR Q46]

ASK Q24 IF SURVEY IDS 100,000-199,999; 300,000-399,999; OR IF Q23=YES; ALL OTHERS SKIP TO RULE FOR Q46]

24. In your company's experience, is there currently a sufficient number of qualified Certified Energy Advisors available to conduct EnerGuide assessments in a timely manner?

☐[1] Yes

☐[0] No

☐[99] Don't know

FIRST ENERGUIDE 80 APPLICATION: ASK SECTION IF SURVEY ID RANGE=100,000-199,999; 300,000-399,999; ELSE SKIP TO RULE FOR Q37

The New Home Program offered builders/developers a rebate for building homes to an EnerGuide rating of 80 or higher. [Rollover: An EnerGuide rating is a standard measure of a home's energy performance. The energy efficiency level is rated on a scale of 0 to 100.]

BC Hydro records indicate that your company applied for and received a rebate, the first time was for <INSERT: ENERGUIDE FIRST NUMBER OF HOUSING UNITS> **in** <INSERT: ENERGUIDE FIRST DATE> **in regards to its development** <INSERT: ENERGUIDE FIRST DEVELOPMENT NAME>.

25. Do you recall that application?

☐[1] Yes [CONTINUE]

☐[0] No [SKIP TO RULE FOR Q33]

☐[99] Don't know [SKIP TO RULE FOR Q33]

26. When did your company start planning to build homes in that development to an energy efficiency rating of EnerGuide 80 (or higher)?

☐[1] We started planning before learning about the New Home rebate [IF ENERGUIDE FIRST NUMBER OF HOUSING UNITS=1, GO TO RULE FOR Q33; IF ENERGUIDE FIRST NUMBER OF HOUSING UNITS >1 SKIP TO Q28]

☐[0] We started planning after learning about the New Home rebate [IF ENERGUIDE FIRST NUMBER OF HOUSING UNITS =1, GO TO Q27; IF ENERGUIDE FIRST NUMBER OF HOUSING UNITS >1 SKIP TO Q28]

☐[99] Don't know [CONTINUE]

[ASK Q27 IF ENERGUIDE FIRST NUMBER OF HOUSING UNITS=1; ELSE SKIP TO Q28]

27. Thinking of that first house that your company received a New Home rebate for achieving the EnerGuide 80 rating, would your company have built it to the EnerGuide 80 rating anyway if the rebate had not been available?

☐[1] Yes, we would have built it to the EnerGuide 80 rating. [SKIP TO RULE FOR Q33]

☐[0] No, we would not have built it to the EnerGuide 80 rating. [SKIP TO Q29]

☐[99] Don't know [SKIP TO Q29]

ASK Q28 IF ENERGUIDE FIRST NUMBER OF HOUSING UNITS>1; ELSE SKIP TO Q29

28. Of the <INSERT: ENERGUIDE FIRST NUMBER OF HOUSING UNITS> **housing units that your company received a New Home rebate for achieving the EnerGuide 80 rating, how many units would your company have built to the EnerGuide 80 rating if the rebate had not been available?**

- ☐[1] All of these units would have been built to the EnerGuide 80 rating. [SKIP TO RULE FOR Q33]
- ☐[2] About three-quarters of these units would have been built to the EnerGuide 80 rating.
- ☐[3] About one-half of these units would have been built to the EnerGuide 80 rating.
- ☐[4] About one-quarter of these units would have been built to the EnerGuide 80 rating.
- ☐[0] None of these units would have been built to the EnerGuide 80 rating.
- ☐[99] Don't know

29. Without the rebate from the New Home Program, would the full cost of building EnerGuide 80 homes have met your company's investment criteria for those homes/units?

- ☐[1] Yes
- ☐[0] No
- ☐[99] Don't know

30. To what extent did the rebate allow your company to include the intended energy efficient home design features (i.e., keep those features from being dropped in order to maintain cost-effectiveness)?

- ☐[1] A great extent
- ☐[2] Some extent
- ☐[3] A little extent
- ☐[4] No extent at all
- ☐[99] Don't know

IF Q26=1, SKIP TO Q32

31. If the New Home Program rebate had not been available, when would your company have started building homes to a rating of EnerGuide 80 (or higher)?

- ☐[1] At about the same time as this development
- ☐[2] Within about 2 years after this development
- ☐[3] Between 2 and 5 years this development
- ☐[4] More than five years after this development, but before the building code changed
- ☐[5] Not until the build code changed
- ☐[99] Don't know

32. Overall, how influential was the New Home rebate on your company's decision to build the <INSERT: ENERGUIDE FIRST NUMBER OF HOUSING UNITS> **housing unit(s) to the EnerGuide 80 rating that first time your company participated in the program?**

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not too influential
- ☐[4] Not at all influential
- ☐[99] Don't know

LAST ENERGUIDE 80 APPLICATION: ASK SECTION IF SURVEY ID RANGE=150,000-150,999; 350,000-399,999; ELSE, SKIP TO RULE FOR Q46

The next few questions refer to the last time your company applied for and received a rebate from the New Home Program for Home Performance (EnerGuide 80) up to 2013.

BC Hydro records indicate that – up to 2013 – your company had last applied for and received a rebate for <INSERT: ENERGUIDE LAST NUMBER OF HOUSING UNITS> **in** <INSERT: ENERGUIDE LAST DATE> **in regards to its development** <INSERT: ENERGUIDE LAST DEVELOPMENT NAME>.

33. Do you recall that application?

- ☐[1] Yes, [CONTINUE]
- ☐[0] No, [SKIP TO PREAMBLE FOR Q37]
- ☐[99] Don't know [SKIP TO PREAMBLE FOR Q37]

[ASK Q34 IF ENERGUIDE LAST NUMBER OF HOUSING UNITS=1; ELSE SKIP TO Q35]

34. Thinking of this last housing unit that your company received a New Home rebate for achieving the EnerGuide 80 rating, would your company have built it to the EnerGuide 80 rating anyway if the rebate had not been available?

- ☐[1] Yes, we would have built it to the EnerGuide 80 rating. [SKIP TO Q36]
- ☐[0] No, we would not have built it to the EnerGuide 80 rating. [SKIP TO Q36]
- ☐[99] Don't know [SKIP TO Q36]

ASK Q35 IF ENERGUIDE LAST NUMBER OF HOUSING UNITS>1; ELSE SKIP TO Q36

35. Of the <INSERT: ENERGUIDE LAST NUMBER OF HOUSING UNITS> **housing units that your company received a New Home rebate for achieving the EnerGuide 80 rating, how many units would your company have built to the EnerGuide 80 rating anyway if the rebate had not been available?**

- ☐[1] All of these units would have been built to the EnerGuide 80 rating.
- ☐[2] About three-quarters of these units would have been built to the EnerGuide 80 rating.
- ☐[3] About one-half of these units would have been built to the EnerGuide 80 rating.
- ☐[4] About one-quarter of these units would have been built to the EnerGuide 80 rating.
- ☐[0] None of these units would have been built to the EnerGuide 80 rating.
- ☐[99] Don't know

36. Overall, how influential was the New Home Program on your company's decision to build the <INSERT: ENERGUIDE LAST NUMBER OF HOUSING UNITS> **housing unit(s) to the EnerGuide 80 rating this last time your company participated in the program?**

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not too influential
- ☐[4] Not at all influential
- ☐[99] Don't know

ENERGUIDE 80 APPLICATION – OTHER SPILLOVER SINCE FIRST PARTICIPATION: ASK SECTION IF SURVEY ID RANGE=100,000-199,999; 300,000-399,999; ASK FOR 200,000-299,999 IF THEIR ANSWER FOR Q23=1 (YES); ELSE, SKIP TO RULE FOR Q46.

We would now like to learn about any homes your company built to the EnerGuide 80 rating for which it did not receive a rebate through the New Home Program. For these questions, please refer to the period since your company first learned about the New Home Program.

37. Since first learning about the New Home Program, approximately what percentage of homes has your company built here in BC, but outside the City of Vancouver, that …

f.	Were rated as EnerGuide 80 (or higher) and received a rebate from the New Home Program?	____%	☐[99] Don't know
g.	Were rated as EnerGuide 80 and did not receive a rebate from the New Home Program?	____%	☐[99] Don't know
h.	Were rated higher than EnerGuide 80 and did not receive a rebate from the New Home Program?	____%	☐[99] Don't know
i.	Were more energy efficient than required by code but less than EnergGuide 80?	____%	☐[99] Don't know
j.	Were not any higher than code requirements?	____%	☐[99] Don't know

[Programming check: total should sum to 100%]

ASK Q38 to Q40 IF Q37b >0 or Q37c >0

38. Thinking about those homes you built that were EnergGuide 80 (or higher) and did not receive a rebate, how influential was your company's experience with the New Home Program on your its decision to build homes to that level of energy efficiency?

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] A little influential
- ☐[4] Not at all influential
- ☐[99] Don't know

39. Were any of these EnerGuide80 homes built with the intention of getting the New Home rebate?

- ☐[1] Yes
- ☐[0] No [GO TO Q41]
- ☐[99] Don't know [GO TO Q41]

40. Approximately what percentage of those EnerGuide 80 homes were built with the intention of receiving the EnerGuide 80 rebate, but did not get the rebate? _____%

ASK Q41 to Q43 IF Q37d >0

41. Thinking about those homes you built that were above code but lower than EnerGuide 80, how influential was your company's experience with the New Home Program on its decision to build homes to a greater level of energy efficiency than required by the building code?

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] A little influential
- ☐[4] Not at all influential
- ☐[99] Don't know

42. Were any of these homes built with the intention of getting the New Home rebate?

- ☐[1] Yes
- ☐[0] No [GO TO Q44]
- ☐[99] Don't know [GO TO Q44]

43. Approximately what percentage of those homes were built with the intention of receiving the EnerGuide 80 rebate, but did not achieve an EnerGuide rating of 80? _____%

44. Is your company familiar with the City of Vancouver Building Bylaw?

- ☐[1] Yes [CONTINUE]
- ☐[0] No [SKIP TO RULE FOR Q46]
- ☐[99] Don't know [SKIP TO RULE FOR Q46]

45. Overall, how influential has the City of Vancouver Building Bylaw been on your company's decision to build EnerGuide 80 homes outside of the City of Vancouver?

☐[1] Very influential

☐[2] Somewhat influential

☐[3] A little influential

☐[4] Not at all influential

☐[99] Don't know

☐[98] Not applicable

ENERGY STAR APPLIANCES

ENERGY STAR COMPONENT OF THE NEW HOME PROGRAM: ASK SECTION IF SURVEY ID RANGE=200,000-299,999; 300,000-399,999; ELSE SKIP TO PREAMBLE FOR Q65

The New Home Program offered builders/developers a rebate for installing refrigerators, dishwashers and front-load clothes washers rated as Energy Star in terms of their energy efficiency, as well as energy efficient bathroom fans and light bulbs in newly constructed homes/housing units. Builders/developers had to install any 2 of the 5 types of items to qualify for a rebate.

BC Hydro records indicate that your company has applied for and received such a rebate, the first time was for in <INSERT: ENERGYSTAR FIRST NUMBER OF HOUSING UNITS> **in** <INSERT: ENERGYSTAR FIRST DATE> **in regards to its development** <INSERT: ENERGYSTAR FIRST DEVELOPMENT NAME>.

46. Do you recall that application?

☐[1] Yes, [CONTINUE]

☐[0] No, [SKIP TO PREAMBLE FOR Q65]

☐[99] Don't know [SKIP TO PREAMBLE FOR Q65]

ASK Q47 IF FLAG1 (FRIDGE)=YES AND/OR FLAG2 (DISHWASHER)= YES AND/OR FLAG 3 (CLOTHES WASHER)=YES; ELSE SKIP TO RULE FOR Q53

47. BC Hydro records indicate that as part of that first application, your company installed a total of <INSERT: FIRST COUNT OF APPLIANCES> **Energy Star rated** <INSERT 'refrigerator(s)' IF FLAG1=YES>, <INSERT 'dishwasher(s)' IF FLAG2=YES, <INSERT 'front-load clothes washer(s)' IF FLAG3=YES> **in that development.**

Had your company been planning to install the same energy efficient models in the same number of housing units before learning about the rebates offered by the New Home Program?

- ☐[1] Yes, we had been planning to install the same models in the same number of units before learning about the rebates. [CONTINUE]
- ☐[0] No, we had not been planning to install the same models in the same number of units until after learning about the rebates. [SKIP TO PREAMBLE FOR Q49]
- ☐[99] Don't know [CONTINUE]

48. And had your company actually started installing those energy efficient models before or after learning about the rebates offered by the New Home Program?

- ☐[1] We had started installing the same appliance models before learning about the rebates.
- ☐[0] We did not install those appliances until after learning about the rebates.
- ☐[99] Don't know

IF Q48=1 SKIP TO RULE FOR Q53

ASK Q49 IF ENERGYSTAR FIRST NUMBER OF HOUSING UNITS=1; ELSE SKIP TO RULE FOR Q50

49. Thinking of the <INSERT 'refrigerator' IF FLAG1=YES>, <INSERT 'dishwasher' IF FLAG2=YES, <INSERT 'front-load clothes washer' IF FLAG3=YES> **that your company installed in that housing unit, how many would your company have chosen to be rated as Energy Star if the rebates had not been available?**

- ☐[1] All 3 of the appliances would have been rated as Energy Star. [SUPPRESS CODE IF ONLY 1-2 FLAGS=YES [SKIP TO Q51]
- ☐[2] 2 of the appliances would have been rated as Energy Star. [SUPPRESS CODE IF ONLY 1 FLAG=YES [SKIP TO Q51]
- ☐[3] 1 of the appliances would have been rated as Energy Star. [SKIP TO Q51]
- ☐[0] None of the appliances would have been rated as Energy Star. [SKIP TO Q51]
- ☐[99] Don't know [SKIP TO Q51]

ASK Q50 IF ENERGYSTAR FIRST NUMBER OF HOUSING UNITS>1; ELSE SKIP TO Q52

50. Thinking of the <INSERT: FIRST COUNT OF APPLIANCES> <INSERT 'refrigerators' IF FLAG1=YES>, <INSERT 'dishwashers' IF FLAG2=YES, <INSERT 'front-load clothes washers' IF FLAG3=YES> **that your company installed in those housing units, approximately how many would your company have chosen to be rated as Energy Star if the rebates had not been available?**

- ☐[1] All of these appliances would have been rated as Energy Star.
- ☐[2] About three-quarters of these appliances would have been rated as Energy Star.
- ☐[3] About one-half of these appliances would have been rated as Energy Star.
- ☐[4] About one-quarter of these appliances would have been rated as Energy Star.
- ☐[0] None of these appliances.
- ☐[99] Don't know

51. Without the New Home rebates, would the cost of installing these more energy efficient appliances have met your company's investment criteria for those homes/units?

- ☐[1] Yes
- ☐[0] No
- ☐[99] Don't know

52. Overall, how influential were the New Home rebates on your company's decision to install appliances rated as Energy Star in the <INSERT: ENERGYSTAR FIRST NUMBER OF HOUSING UNITS**> housing unit(s) that first time your company participated in the program?**

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not too influential
- ☐[4] Not at all influential
- ☐[99] Don't know

FIRST ENERGY STAR APPLICATION – REBATE INCLUDED BATHROOM FANS: ASK THIS SECTION IF FLAG4 (BATHROOM FANS) =YES; ELSE SKIP TO RULE FOR Q59

[SHOW ONLY IF FLAG1=NO AND FLAG2=NO AND FLAG3=NO] **The next few questions specifically refer to that first time your company applied for and received an Energy Star rebate from the New Home Program in** <INSERT: ENERGYSTAR FIRST DATE> **in regards to its development** <INSERT: ENERGYSTAR FIRST DEVELOPMENT NAME>.

53. BC Hydro records indicate that, as part of that first application, your company installed at least <INSERT: FIRST NUMBER OF HOUSING UNITS WITH FANS> **Energy Star rated bathroom fans in that development.**

Had your company planned to install the same number of energy efficient bathroom fans in that development before or after learning about the rebates offered by the New Home Program?

- ☐[1] Yes, we were already planning to install the same number of energy efficient bathroom fans before learning about the rebate. [CONTINUE]
- ☐[0] No, we did not plan to install the same number of energy efficient bathroom fans until after learning about the rebate. [SKIP TO Q55]
- ☐[99] Don't know [CONTINUE]

54. And had your company actually installed the energy efficient bathroom fans before or after learning about the rebates offered by the New Home Program?

- ☐[1] We had installed the same bathroom fans before learning about the rebate. [SKIP TO RULE FOR Q59]
- ☐[0] We did not start installing those bathroom fans until after learning about the rebate. [CONTINUE]
- ☐[99] Don't know [CONTINUE]

IF Q54=1 SKIP TO RULE FOR Q59

ASK Q55 IF FIRST NUMBER OF HOUSING UNITS WITH FANS=1; ELSE SKIP TO RULE FOR Q56

55. Thinking of the bathroom fan that your company installed in that housing unit, would your company have chosen it to be rated as Energy Star if the rebates had not been available?

- ☐[1] Yes, the bathroom fan would have been rated as Energy Star. [SKIP TO Q57]
- ☐[0] No, the bathroom fan would not have been rated as Energy Star. [SKIP TO Q57]
- ☐[99] Don't know [SKIP TO Q57]

ASK Q56 IF FIRST NUMBER OF HOUSING UNITS WITH FANS>1; ELSE SKIP TO Q57

56. Thinking of those bathroom fans that your company installed in those housing units, approximately how many would have been an Energy Star rated model if the rebates had not been available?

- ☐[1] All of the bathroom fans would have been rated as Energy Star.
- ☐[2] About three-quarters of the bathroom fans would have been rated as Energy Star.
- ☐[3] About one-half of the bathroom fans would have been rated as Energy Star.
- ☐[4] About one-quarter of the bathroom fans would have been rated as Energy Star.
- ☐[0] None of the bathroom fans
- ☐[99] Don't know

57. Without the New Home rebates, would the cost of installing these more energy efficient bathroom fans have met your company's investment criteria for those homes/units?

- ☐[1] Yes
- ☐[0] No
- ☐[99] Don't know

58. Overall, how influential were the New Home rebates on your company's decision to install bathroom fans rated as Energy Star in the <INSERT: FIRST NUMBER OF HOUSING UNITS WITH FANS> **housing unit(s) that first time your company participated in the program?**

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not too influential
- ☐[4] Not at all influential
- ☐[99] Don't know

FIRST ENERGY STAR APPLICATION – REBATE INCLUDED CFL BULBS: ASK THIS SECTION IF FLAG5 (CFL BULBS) =YES; ELSE SKIP TO PREAMBLE FOR Q65

The next few questions also refer to that first time your company applied for and received an Energy Star rebate from the New Home Program in <INSERT: ENERGYSTAR FIRST DATE> **in regards to its development** <INSERT: ENERGYSTAR FIRST DEVELOPMENT NAME>.

59. BC Hydro records indicate that, as part of that first application, your company received a rebate for installing at least 6 CFL bulbs in <INSERT: FIRST NUMBER OF HOUSING UNITS WITH CFLS> **housing units in that development.**

Had your company been planning to install 6 (or more) CFL bulbs in the same number of units in that development before learning about the rebates offered by the New Home Program?

☐[1] Yes, we were planning to install the same number of CFL bulbs in that development before learning about the rebate. [CONTINUE]

☐[0] No, we were not planning to install the same number of CFL bulbs in that development until after learning about the rebate. [SKIP TO Q61]

☐[99] Don't know [CONTINUE]

60. And had your company actually installed 6 or more CFL bulbs in those homes before or after learning about the rebates offered by the New Home Program?

☐[1] Yes, we had installed 6 or more CFL bulbs before learning about the rebate. [SKIP TO PREAMBLE TO Q65]

☐[0] We did not start to install CFL bulbs until after learning about the rebate. [CONTINUE]

☐[99] Don't know [CONTINUE]

IF Q60=1 SKIP TO PREAMBLE FOR Q65

ASK Q61 IF FIRST NUMBER OF HOUSING UNITS WITH CFLS =1; ELSE SKIP TO RULE FOR Q62

61. Thinking of the 6 CFL bulbs that your company received a rebate for, how many of CFL bulbs would your company have installed in that house if the rebates had not been available?

☐[1] All 6 of these bulbs (or more) would have been CFL bulbs. [SKIP TO Q63]

☐[2] 4-5 of these bulbs would have been CFL bulbs. [SKIP TO Q63]

☐[3] 2-3 of these bulbs would have been CFL bulbs. [SKIP TO Q63]

☐[4] 1 of these bulbs would have been CFL bulbs. [SKIP TO Q63]

☐[0] None of these bulbs would have been CFL bulbs. [SKIP TO Q63]

☐[99] Don't know [SKIP TO Q63]

ASK Q62 IF FIRST NUMBER OF HOUSING UNITS WITH CFLS >1; ELSE SKIP TO Q63

This means that the total amount of your company's first rebate cheque reflected the fact that your company installed a total of at least <VALUE OF FIRST NUMBER OF HOUSING UNITS WITH CFLS x 6> **CFL bulbs in those** <INSERT: FIRST NUMBER OF HOUSING UNITS WITH CFLS > **housing units.**

62. Thinking of those CFL bulbs that your company installed in those housing units, approximately how many of those <VALUE OF FIRST NUMBER OF HOUSING UNITS WITH CFLS x 6> **CFL bulbs would your company have installed if the rebates had not been available?**

- ☐[1] All of these bulbs would have been CFL bulbs.
- ☐[2] About three-quarters of these bulbs would have been CFL bulbs.
- ☐[3] About one-half of these bulbs would have been CFL bulbs.
- ☐[4] About one-quarter of these bulbs would have been CFL bulbs.
- ☐[0] None of these bulbs would have been CFL bulbs.
- ☐[99] Don't know

63. Without the New Home rebates, would the cost of installing more of these CFL bulbs have met your company's investment criteria for those homes/units?

- ☐[1] Yes
- ☐[0] No
- ☐[99] Don't know

64. Overall, how influential was the New Home rebates on your company's decision to install at least 6 CFL bulbs in the < INSERT: FIRST NUMBER OF HOUSING UNITS WITH CFLS> **housing unit(s) that first time your company participated in the program?**

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not too influential
- ☐[4] Not at all influential
- ☐[99] Don't know

ENERGY STAR APPLICATION – APPLIANCE SPILLOVER SINCE FIRST PARTICIPATION (IN EITHER OF THE STREAMS)

ASK ALL

Now we would like to know about any appliances rated as Energy Star that your company installed for which it did not receive a rebate through the New Home Program. For these questions, please refer to the period since your company first participated in the New Home program.

65. Since first participating in the New Home Program in <INSERT: EARLIEST NEW HOME PARTICIPATION DATE>**, has your company installed any Energy Star rated refrigerators, dishwashers or front-load clothes washers in any of the new homes/units it has built for which your company did not receive a rebate?**

☐[1] Yes [CONTINUE]

☐[0] No [SKIP TO PREAMBLE FOR Q69]

☐[99] Don't know [SKIP TO PREAMBLE FOR Q69]

66. Approximately how many of each type of Energy Star rated appliances, in total, has your company installed – without a rebate – in all of the new homes/units it has built since first participating in the New Home Program?

Note that your best estimate will suffice, and you may round your estimate (e.g., 10, 20, 50, 100, 200, etc.)

a. Refrigerators _____ ☐[999] Don't know

b. Dishwashers _____ ☐[999] Don't know

c. Front-end clothes washers _____ ☐[999] Don't know

[Programming sum and check total] TOTAL _____

67. What percentage of these appliances were installed with the intention of getting New Home rebates, but did not meet the program's requirements?

☐[0] 0% - None

☐[1] 1% to 24%

☐[2] 25% to 49%

☐[3] 50% to 74%

☐[4] 75% to 99%

☐[5] 100% - All

☐[99] Don't know

68. Overall, how influential was your company's experience with the New Home Program on your company's decision to install appliances rated as Energy Star without a rebate?

☐[1] Very influential

☐[2] Somewhat influential

☐[3] Not very influential

☐[4] Not at all influential

☐[99] Don't Know

ENERGY STAR APPLICATION – BATHROOM FAN SPILLOVER SINCE FIRST PARTICIPATION (IN EITHER OF THE STREAMS)

ASK ALL

Now we would like to know about any bathrooms fans rated as Energy Star that your company installed for which it did not receive a rebate through the New Home Program. For these questions, please refer to the period since your company first participated in the New Home Program.

69. Since first participating in the New Home Program in <INSERT: EARLIEST NEW HOME PARTICIPATION DATE >, **has your company installed any bathroom fans rated as Energy Star in any of the new homes/units it has built for which your company did not receive a rebate?**

☐[1] Yes [CONTINUE]

☐[0] No [SKIP TO PREAMBLE FOR Q73]

☐[99] Don't know [SKIP TO PREAMBLE FOR Q73]

70. Since first participating in the New Home Program, approximately how many bathroom fans rated as Energy Star has your company installed – without a rebate – in all of the new homes/units it has built?

Note that your best estimate will suffice, and you may round your estimate (e.g., 10, 20, 50, 100, 200, etc.)

_____ ☐[999] Don't know

71. What percentage of these bathroom fans were installed with the intention of getting New Home rebates, but did not meet the program's requirements?

☐[0] 0% - None

☐[1] 1% to 24%

☐[2] 25% to 49%

☐[3] 50% to 74%

☐[4] 75% to 99%

☐[5] 100% - All

☐[99] Don't know

72. Overall, how influential was your company's experience with the New Home Program on your company's decision to install those additional bathroom fans rated as Energy Star without a rebate?

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not very influential
- ☐[4] Not at all influential
- ☐[99] Don't Know

ENERGY STAR APPLICATION – CFL BULB SPILLOVER SINCE FIRST PARTICIPATION (IN EITHER OF THE STREAMS)

Now we would like to know about any CFL bulbs your company installed for which it did not receive a rebate through the New Home Program. For these questions, please refer to the period since your company first participated in the New Home Program.

ASK ALL

73. Since first participating in the New Home Program in <INSERT: EARLIEST NEW HOME PARTICIPATION DATE >**, has your company installed any additional energy efficient light bulbs (i.e., CFLs, LEDs) in any of the new homes for which your company did not receive a rebate?**

- ☐[1] Yes [CONTINUE]
- ☐[0] No [SKIP TO Q76]
- ☐[99] Don't know [SKIP TO Q76]

74. Since first participating in the New Home Program, approximately how many energy efficient light bulbs in total has your company installed – without a rebate – in all of its new homes?

Note that your best estimate will suffice, and you may round your estimate (e.g., 10, 20, 50, 100, 200, etc.)

_____ ☐[999] Don't know

75. Overall, how influential was your company's experience with the New Home Program on your company's decision to install these additional energy efficient light bulbs without a rebate?

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not very influential
- ☐[4] Not at all influential
- ☐[99] Don't Know

ENERGY STAR APPLICATION – OTHER SPILLOVER SINCE FIRST PARTICIPATION

ASK ALL

76. Since first participating in the New Home Program in <INSERT: EARLIEST NEW HOME PARTICIPATION DATE >**, has your company installed any other certified energy efficient products or equipment – that were not covered by the New Home Program – in any of the new homes/units it has built ?**

- ☐[1] Yes [CONTINUE]
- ☐[0] No [SKIP TO PREAMBLE FOR Q80]
- ☐[99] Don't know [SKIP TO PREAMBLE FOR Q80]

77. What other kinds of certified energy efficient products or equipment has your company installed in its new homes that were not covered by the New Home rebates? _____

78. Were any of these products covered by a rebate under another program?

- ☐[1] Yes
- ☐[0] No
- ☐[99] Don't know

79. Overall, how influential was your company's experience with the New Home Program on your company's decision to install these additional energy efficient products not covered by the program?

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] Not very influential
- ☐[4] Not at all influential
- ☐[99] Don't Know

PROGRAM OUTCOMES

ASK ALL

The following questions ask about how the New Home Program may have impacted or had an effect on your company, or the residential construction industry.

80. To what extent did participating in the New Home Program improve the profitability of selling more energy efficient homes for you company?

- ☐[1] A great extent
- ☐[2] Some extent
- ☐[3] A little extent
- ☐[4] No extent at all [SKIP TO Q82]
- ☐[99] Don't know [SKIP TO Q82]

81. By approximately what percentage did the average profit for an energy efficient home increase?

_____ % ☐99 Don't know

82. To what extent did participating in the New Home Program help your company to sell the energy efficient homes faster than homes with fewer energy efficient features?

☐1 A great extent

☐2 Some extent

☐3 A little extent

☐4 No extent at all [SKIP TO Q84]

☐99 Don't know [SKIP TO Q84]

83. Approximately how much faster, on average, was your company able to sell the more energy efficient homes?

_____ % fewer weeks ☐999 Don't know

84. To what extent did your company experience any growth (in terms of increased sales revenue) as a result of participating in the New Home Program?

☐1 A great extent

☐2 Some extent

☐3 A little extent

☐4 No extent at all [SKIP TO Q86]

☐99 Don't know [SKIP TO Q86]

85. By approximately what percentage did sales revenue increase?

_____ % ☐99 Don't know

86. Please indicate whether the New Home Program has had a positive effect, a negative effect or no effect on each of the following based on the experience of your company: [RANDOMIZE]

	Positive Effect	No Effect	Negative Effect	Don't know
a. Design processes	☐1	☐2	☐3	☐99
b. Construction processes (e.g., protocols, methods, processes, techniques)	☐1	☐2	☐3	☐99
c. Overall construction costs to the industry (e.g., materials; specialists/experts; technologies; equipment)	☐1	☐2	☐3	☐99
d. Demand/expectations of buyers for energy efficient homes	☐1	☐2	☐3	☐99
e. Adoption of more energy efficient on-site work practices/ processes	☐1	☐2	☐3	☐99
f. Developing a more skilled and knowledgeable workforce (trades, designers, etc.) for building more energy efficient homes	☐1	☐2	☐3	☐99
g. Differentiating between firms that build energy efficient homes and those that do not	☐1	☐2	☐3	☐99
h. Maintaining competitive pricing for energy efficient homes	☐1	☐2	☐3	☐99
i. Your company's relationship with BC Hydro	☐1	☐2	☐3	☐99
j. Your company's relationship with FortisBC	☐1	☐2	☐3	☐99

87. Overall, how satisfied has your company been with the New Home Program?

☐1 Very satisfied

☐2 Somewhat satisfied

☐3 Neither satisfied nor dissatisfied

☐4 Somewhat dissatisfied

☐5 Very dissatisfied

☐99 Don't Know

ASK Q88 IF Q87=4 OR 5

88. Please explain why your company has not been satisfied with Power Smart's New Home Program.

_____

BUILDING PRACTICES/CODE CHANGES

These last few questions explore industry experiences in meeting the 2008 changes to the BC Building code for improving energy efficiency.

89. Was your company involved in any new residential construction (outside the City of Vancouver) prior to the addition of the Part 10 energy efficiency requirements in the BC Building Code in 2008 (i.e., prescriptive insulation requirements or EnerGuide rating of 77)?

- ☐[1] Yes [ASK Q90 to Q93]
- ☐[0] No [SKIP TO RULE FOR Q94]
- ☐[99] Don't know [SKIP TO RULE FOR Q94]

90. How did your company need to change its usual design and building practices when the 2008 amendments to the building code came into effect? Check all that apply. [RANDOMIZE LIST]

- ☐[1] We incorporated computer simulation modeling (including HOT2000) into the design process.
- ☐[2] We made significant changes to heating and ventilation designs.
- ☐[3] We made significant changes to the building envelope (including windows).
- ☐[4] Made significant changes to insulation levels.
- ☐[5] We began conducting a blower door test at completion.
- ☐[6] We made no significant changes because we were already meeting all the 2008 code requirements.
- ☐[7] Other: please specify_____
- ☐[99] Don't know

91. Outside of the City of Vancouver, how did your company <u>most frequently</u> document meeting the energy efficiency requirements of the 2008 amendments to the BC Building Code? Select one only.

- ☐[1] By meeting the prescriptive requirements for insulation (i.e., Table 10.2.1.1.A) [CONTINUE]
- ☐[2] By using computer simulation modeling to demonstrate equivalent performance to the prescriptive requirements in Table 10.2.1.1.A [SKIP TO Q93]
- ☐[3] By achieving an EnerGuide Rating System rating of 77 [SKIP TO Q93]
- ☐[99] Don't know [SKIP TO Q93]

92. What were the main challenges in meeting the Building Code's prescriptive requirements for insulation?

Using the appropriate columns, check one as the primary challenge and then check each secondary challenge experienced by your company. [RANDOMIZE]

	Primary	Secondary
It required significant changes to existing construction practices.	☐[1]	☐[1]
The insulation requirements added too much to the cost/the insulation levels required weren't economical.	☐[2]	☐[2]
We weren't sure how to meet the requirements.	☐[3]	☐[3]
Building inspectors weren't sure how to check compliance.	☐[4]	☐[4]
Other: please specify_____	☐[5]	☐[5]
None / No others	☐[0]	☐[0]
Don't know	☐[99]	☐[99]

93. How often did your company typically meet all the energy efficiency requirements of the revised 2008 building code? (Please be assured that you and your company's identity will remain completely confidential.)

☐[1] All of the time

☐[2] Most of the time

☐[3] Sometimes/occasionally

☐[4] Rarely/infrequently

☐[5] Never

☐[99] Don't know

ASK Q94 IF Q4a>0 OR Q4b>0 OR Q23=1; ELSE SKIP TO Q95

94. What, if any, have been the main challenges faced by your company in meeting EnerGuide rating targets (e.g., EnerGuide 80 for the New Home Program or the City of Vancouver Building Bylaw or the BC building code EnerGuide 77 option)? (select all that apply) [RANDOMIZE]

- ☐[1] It was too difficult find a CEA to conduct the EnerGuide assessment.
- ☐[2] The EnerGuide assessment process takes too much time.
- ☐[3] The EnerGuide assessment costs too much.
- ☐[4] The requirements to meet the EnerGuide rating target costs too much.
- ☐[5] We weren't sure how to meet the requirements.
- ☐[6] Building inspectors weren't skilled in assessing the construction practices required to meet the requirements
- ☐[7] Other: please specify_____
- ☐[0] None
- ☐[99] Don't know

Appendix G Non-Participant Survey Questionnaire

New Home Construction Program Non-Participant Telephone Survey

INVITATION [ALL]

Hello, I am calling from _____, an independent research company in Vancouver. Our firm is assisting BC Hydro and FortisBC in conducting a survey about industry practices building energy efficient homes in British Columbia. BC Hydro and FortisBC are inviting developers and builders from across BC to participate in the survey.

S1: We are looking to speak with companies that have designed or built new homes or housing developments in British Columbia between April 2007 and March 2013? This would include, single family dwellings, duplexes, town/row housing, and low-rise or high-rise residential buildings. Did your company build any new homes during that period of time?

- ☐ Yes *[Go to S2]*
- ☐ No *[Go to NQ1 closing]*
- ☐ Don't Know *[Go to NQ1 closing]*

S2: Were any of those homes/developments built outside the City of Vancouver?

- ☐ Yes *[Continue]*
- ☐ No *[Go to NQ1 closing]*
- ☐ Don't Know *[Go to NQ1 closing]*

[NON-QUALIFIER CLOSING (NQ1): Thank you for your time and interest. BC Hydro is looking to speak to companies in the new residential construction industry that built homes in BC, outside of Vancouver, during the 2007-2013 period.

Participating in this survey is completely voluntary. Your and your company's identities will remain anonymous. The information you provide will be used for research purposes only. Y

Upon completing the survey, you will be invited to participate in a draw for one of four (4) prizes for a $500 gift certificate from Canadian Tire, RONA, Home Depot or Home Hardware.

The survey will take about 5 to 15 minutes to complete, depending on your company's activities. Do you have time to complete the survey now? [Surveyor: If no:] *The survey can also be completed online, would you prefer to do it that way* [IF YES: ASK FOR & CONFIRM EMAIL SO UNIQUE LINK CAN BE SENT. IF NO: TRY TO SCHEDULE CALLBACK]

Before we get started, I'm obliged to tell you that the information gathered through this survey is being collected in furtherance of BC Hydro's electricity conservation mandate under the Clean Energy Act and adheres to the provisions of Section 26 of the Freedom of Information and Protection of Privacy Act.

Please do not identify yourself or other specific individuals in your comments.

[Surveyor Note: Any self-or other-identifying information should be discarded.

Do you have any questions before we begin?

[If respondent has any questions regarding the survey, please contact _____, of BC Hydro at _____.]

RESPONDENT SCREENING

1. How knowledgeable are you in terms of your company's decision making around designing and building new homes to a certain level of energy efficiency or EnerGuide rating?

[SURVEYOR NOTE: If respondent does not know what EnerGuide ratings are, provide the following definition: *An EnerGuide rating is a standard measure of a home's energy performance. The energy efficiency level is rated on a scale of 0 to 100.] READ LIST*

- ☐[1] Very knowledgeable
- ☐[2] Somewhat knowledgeable
- ☐[3] Not too knowledgeable
- ☐[4] Not at all knowledgeable
- ☐[99] Don't know *DO NOT READ*

2. How knowledgeable are you in regards to your company's decision making around the appliances and other products that will be installed in the new homes? *READ LIST*

- ☐[1] Very knowledgeable
- ☐[2] Somewhat knowledgeable
- ☐[3] Not too knowledgeable
- ☐[4] Not at all knowledgeable
- ☐[99] Don't know *DO NOT READ*

[IF Q1=3, 4 OR 99, **OR** Q2=3, 4 OR 99, REQUEST TO FORWARD: Could I please speak to the person who makes those decisions? OR Could you provide me with that person's name and telephone number (if different)?]

*Name:*_____

*Telephone:*_____

3. a) For how many years have you been associated with this company?

_____ years ☐[999] Don't know

b) What is your current position/title? _____

The New Home program is designed to provide support to the new residential construction industry in British Columbia to build more energy efficient homes. BC Hydro and Fortis BC provide incentives to builders and developers to meet an EnerGuide rating of 80 and to install energy efficient Energy Star products and equipment in the homes or housing units they build.

4. Our records show that your company has <u>not</u> participated in the Power Smart New Home program since 2007. Is this correct?

☐[1] Yes
☐[0] No [GO TO NQ2 CLOSING]
☐[99] Don't know [GO TO NQ2 CLOSING]

*[*NQ2 CLOSING*:* Thank you for your time and interest. BC Hydro is looking to speak to companies that have not yet participated in the New Home program.]

AWARENESS OF THE NEW HOME PROGRAM

5. Had your company ever heard of the Power Smart New Home program before this survey?

☐[1] Yes [CONTINUE]

☐[0] No [GO TO PREAMBLE FOR Q10]

☐[99] Don't know [GO TO PREAMBLE FOR Q10]

In what year did the company become aware of the New Home program?

20__ __ ☐[99] Don't know

[PROGRAMMING NOTE: must be greater than 2005 and less than 2015]

6. Was your company ever contacted by BC Hydro or Fortis BC about the New Home program (e.g., introducing program; providing information; encouraging participation)?

☐[1] Yes

☐[0] No

☐[99] Don't know

7. Was the New Home program ever mentioned to your company by anyone else? [SELECT ALL THAT APPLY. DO NOT READ LIST]

☐[1] Certified Energy Advisor/CEA (the person who does the EnerGuide rating)

☐[2] Appliance distributor/retailer

☐[3] Another residential design or construction company

☐[4] A commercial design or construction company

☐[5] Other (specify):_____

☐[0] No

☐[99] Don't know

8. Why has your company never participated in the Power Smart New Home program?
RANDOMIZE LIST [SELECT ALL THAT APPLY. DO NOT READ LIST]

- ☐[1] Need more information about the program/didn't know enough about the program
- ☐[2] Benefits are not worth the additional costs
- ☐[3] Too much paperwork to apply
- ☐[4] Takes too long to get the rebate
- ☐[6] Applied, but was not eligible for the rebate(s)
- ☐[7] Could not find a qualified person to conduct the EnerGuide assessment
- ☐[8] Could not get the EnerGuide assessment done within the program's time requirements
- ☐[9] Other: please specify_____
- ☐[99] Don't know

ABOUT THE COMPANY

These next few questions are designed to learn a little about your company's involvement in the residential construction industry.

9. Based on the past 2 to 3 years, approximately how many homes or housing units does your company complete in an average year for each of the following types of housing? *READ LIST*

[Surveyor note: Enter '0' if respondent does not build this type of dwelling. Ensure responses are the # of houses or housing units and not the number of multi-unit buildings or developments.]

a) Single family dwellings	_____ homes	☐[999] Don't know
b) Town/row housing units; duplexes	_____ housing units	☐[999] Don't know
c) Multi-unit residential buildings	_____ housing units	☐[999] Don't know
d) Other (specify): _____		

10. How many years has your company been in the business of new residential construction? *READ LIST IF NECESSARY*

- ☐[1] Less than 2 years
- ☐[2] 2 to 5 years
- ☐[3] 6 to 10 years
- ☐[4] 11 to 25 years
- ☐[5] More than 25 years
- ☐[99] Don't know *DO NOT READ*

11. Approximately what percentage of your company's new residential construction falls within each of the following price point ranges for a single home or housing unit? *READ LIST*

_____% of units that are under $400,000

_____% of units that are $400,000 to $599,999

_____% of units that are $600,000 to $799,999

_____% of units that are $800,000 to $1,299,999

_____% of units that are $1,300,000 to $1,999,999

_____% of units that are $2,000,000 or more

[PROGRAMMING CHECK: TOTAL = 100%]

☐[999] Don't know *DO NOT READ*

12. In what parts of British Columbia does your company build new homes or housing developments? *READ LIST [*SELECT ALL THAT APPLY]

☐[1] Lower Mainland/South Coast

☐[2] Vancouver Island

☐[3] Okanagan/Thompson

☐[4] East Kootenays

☐[5] Northern BC

☐[6] Unsure – please specify region or town_____

☐[99] Don't know *DO NOT READ*

13. Has your company participated in any of the following Green Building programs or initiatives? [READ LIST. SELECT ALL THAT APPLY]

☐[1] LEED® for Homes

☐[2] BUILT GREEN®

☐[3] EnerGuide for New Houses (EGNH)

☐[4] ENERGY STAR® for Homes

☐[5] Power Smart New Home

☐[6] Fortis BC New Home

☐[7] Power Smart's New Construction Program for Commercial, Institutional, Multi-unit residential buildings

☐[8] Other (specify):_____

☐[99] Don't know *DO NOT READ*

THE HOUSING MARKET

14. In your company's experience, how important is it to homebuyers in your target market that …
[RANDOMIZE, *READ LIST*

	Extremely important	Important	Not too important	Not at all important	DK
d) the homes they purchase are more energy efficient than the average home?	☐1	☐2	☐4	☐5	☐99
e) the homes they purchase have certain energy efficient features or equipment installed such as, insulation, windows, HVAC?	☐1	☐2	☐4	☐5	☐99
f) the homes they purchase have energy efficient appliances and products installed (e.g., lighting, fans, refrigerator, clothes washer, dishwasher)?	☐1	☐2	☐4	☐5	☐99

15. In your company's experience, has there been any change in demand for more energy efficient homes by new home buyers over the past 5 or 6 years? *READ LIST*

☐1 Yes, there is now a greater demand for more energy efficient homes

☐2 Yes, there is now less demand for more energy efficient homes

☐0 No, the demand for more energy efficient homes has stayed the same

☐99 Don't know DO NOT READ

ENERGUIDE 80 PRACTICES

Now I'm going to ask about your company's experiences and practices building to EnerGuide 80 or higher.

[SURVEYOR NOTE: If respondent does not know what an EnerGuide rating is, provide the following definition: *An EnerGuide rating is a standard measure of a home's energy performance. The energy efficiency level is rated on a scale of 0 to 100.]*

16. How much experience did your company have with building homes to the EnerGuide rating of 80 (or higher) before 2008? *READ LIST*

☐1 A great deal of experience

☐2 A fair amount of experience

☐3 A little experience

☐4 No experience at all

☐99 Don't know *DO NOT READ*

☐98 Not applicable (company did not build any single family dwellings, duplexes or row/townhouses at that time) *DO NOT READ*

17. How much experience has your company had with building homes to an EnerGuide rating of 80 (or higher) since 2008? *READ LIST*

- ☐[1] A great deal of experience [SKIP TO Q20]
- ☐[2] A fair amount of experience [SKIP TO Q20]
- ☐[3] A little experience [SKIP TO Q20]
- ☐[4] No experience at all [CONTINUE]
- ☐[99] Don't know [SKIP TO Q25] *DO NOT READ*
- ☐[98] Not applicable (company did not/does not build single family dwellings, duplexes or row/townhouses) [SKIP TO RULE FOR Q40] *DO NOT READ*

IF Q17= 4 OR 98 AND Q18= 98, SKIP TO PREAMBLE FOR Q40; ELSE CONTINUE

18. Why has your company not built any homes to the EnerGuide 80 rating since 2008?

RANDOMIZE LIST; SELECT ALL THAT APPLY; DO NOT READ LIST

[SURVEYOR NOTE: If they only give one reason PROBE with: "*Any other reasons?*"]

- ☐[1] We don't build beyond what's required by the building code.
- ☐[2] It costs too much to build a more energy efficient home.
- ☐[3] Higher energy efficiency does not create a competitive advantage in the market.
- ☐[4] There is a lack of technical expertise in the industry to design more energy efficient homes.
- ☐[5] There is a lack of technical expertise in the industry to build more energy efficient homes.
- ☐[6] There is low demand for homes that are more energy efficient.
- ☐[7] The company has not built any single family dwellings, duplexes or row/townhouse units since 2008.
- ☐[8] Other: please specify_____
- ☐[99] Don't know

IF Q18=4, SKIP TO Q25; ELSE CONTINUE

19. Has your company ever built any homes that are rated higher than EnerGuide 80?

☐[1] Yes [SKIP TO Q22]

☐[0] No [CONTINUE]

☐[99] Don't know [SKIP TO Q22]

20. Why has your company never built any homes that are rated higher than EnerGuide 80? (select all that apply)

RANDOMIZE LIST *[SELECT ALL THAT APPLY; DO NOT READ LIST]*

☐[1] We don't build beyond what's required by the building code.

☐[2] It costs too much to build a more energy efficient home.

☐[3] Higher energy efficiency does not create a competitive advantage in the market.

☐[4] There is a lack of technical expertise in the industry to design more energy efficient homes.

☐[5] There is a lack of technical expertise in the industry to build more energy efficient homes.

☐[6] There is low demand for homes that are more energy efficient.

☐[7] There is no financial incentive available to build homes that are more energy efficient than EnerGuide80.

☐[8] Other: please specify_____

☐[99] Don't know

21. Which of the following energy efficient products did your company install in order to achieve an EnerGuide rating of 80 or higher?

[SELECT ALL THAT APPLY, READ LIST]

☐[1] Air source heat pump (central system)

☐[2] Ground source heat pump

☐[3] Ductless heat pump

☐[4] Roofing products

☐[5] Windows, doors, skylights

☐[6] Air Conditioning (central)

☐[7] Furnaces

☐[9] Other: please specify_____

☐[0] None of the above *DO NOT READ*

☐[99] Don't know *DO NOT READ*

IF Q22=1, 2 OR 3 ASK Q23; ELSE SKIP TO Q24

22. In approximately what percentage of homes built did you install: *READ*

ERROR MSG: PLEASE ANSWER A VALUE BETWEEN 1% AND 100%

ASK IF Q20=1: a) Air source heat pump (central system)	_____ %	☐[999] Don't know
ASK IF Q20=2: b) Ground source heat pump	_____ %	☐[999] Don't know
ASK IF Q20=3: c) Ductless heat pump	_____ %	☐[999] Don't know

23. Has the proportion of EnerGuide 80 single family dwellings or row/town houses built by your company changed since 2008? *READ LIST IF NECESSARY*

☐[1] Yes, a greater proportion of homes built by the company are EnerGuide 80.

☐[2] Yes, a smaller proportion of homes built by the company are EnerGuide 80.

☐[0] No, the proportion of EnerGuide 80 homes built by the company has stayed the same.

☐[99] Don't know *DO NOT READ*

24. Has your company ever had an EnerGuide assessment completed for any of the new homes it has built in the past 5 or 6 years?

☐[1] Yes [CONTINUE]

☐[0] No [SKIP TO RULE FOR Q27]

☐[99] Don't know [SKIP TO RULE FOR Q27]

25. In your company's experience, is there currently a sufficient number of qualified Certified Energy Advisors available to conduct EnerGuide assessments in a timely manner?

☐[1] Yes

☐[0] No

☐[99] Don't know

IF Q5 = 0 OR 99 SKIP TO PREAMBLE FOR Q58

ENERGUIDE 80 –SPILLOVER

The next series of questions are about the energy efficiency of homes your company has built since first learning about the New Home program.

26. The Home Performance part of the Power Smart New Home program provided a rebate for homes that achieve an EnerGuide rating of 80. Was your company aware of this part of the Power Smart New Home program?

☐[1] Yes

☐[0] No

☐[99] Don't know

27. Approximately how many new homes and/or housing units has your company built since becoming aware of the New Home program in <ENTER YEAR FROM Q6>?

_____ new homes ☐99 Don't know

[SURVEYOR NOTE: RESPONDENT'S BEST ESTIMATE IS SUFFICIENT]

28. Approximately what percentage of homes has your company built here in BC, but outside the City of Vancouver, that … *READ*

k. Were rated as EnerGuide 80? ____% ☐99 Don't know

l. Were rated higher than EnerGuide 80? ____% ☐99 Don't know

m. Were more energy efficient than required by code but less than EnerGuide 80? ____% ☐99 Don't know

n. Were not any higher than code requirements? ____% ☐99 Don't know

[Programming check: total should sum to 100%]

ASK Q30 to Q32 IF Q29a >0 or Q29b >0; IF Q29D = 100%, SKIP TO Q40

29. Thinking about those homes that were built to an EnerGuide rating of 80 or higher, how influential was knowing about the New Home program on your company's decision to build homes to that level of energy efficiency? *READ LIST*

☐1 Very influential

☐2 Somewhat influential

☐3 A little influential

☐4 Not at all influential

☐99 Don't know *DO NOT READ*

30. Were any of these EnerGuide80 (or higher) homes built with the intention of getting the New Home rebate?

☐1 Yes

☐0 No [GO TO RULE FOR Q33]

☐99 Don't know [GO TO RULE FOR Q33]

31. Approximately what percentage of those homes were built with the intention of receiving the New Home rebate, but did not get the rebate? _____% ☐99 Don't know

ERROR MSG: PLEASE ANSWER A VALUE BETWEEN 1% AND 100%

ASK Q33 to Q35 IF Q29c >0; IF Q29c=0/DK, GO TO Q36

32. Thinking about those homes that were above code but lower than EnerGuide 80, how influential was knowing about the New Home program on your company's decision to build homes to a greater level of energy efficiency than required by the building code? *READ LIST*

☐[1] Very influential

☐[2] Somewhat influential

☐[3] A little influential

☐[4] Not at all influential

☐[99] Don't know *DO NOT READ*

33. Were any of these more energy efficient homes built with the intention of getting the New Home rebate?

☐[1] Yes

☐[0] No [GO TO Q36]

☐[99] Don't know [GO TO Q36]

34. Approximately what percentage of those homes were built with the intention of receiving the New Home rebate, but did not achieve an EnerGuide rating of 80? _____% ☐[99] Don't know

ERROR MSG: PLEASE ANSWER A VALUE BETWEEN 1% AND 100%

35. Is your company aware of other residential construction companies that received rebates from the New Home program for building more energy efficient homes?

☐[1] Yes

☐[0] No [GO TO Q38]

☐[99] Don't know [GO TO Q38]

36. How influential has it been knowing that other builders were building energy efficient homes on your company's decision to build more energy efficient homes? *READ LIST*

☐[1] Very influential

☐[2] Somewhat influential

☐[3] A little influential

☐[4] Not at all influential

☐[99] Don't know *DO NOT READ*

☐[98] Not applicable *DO NOT READ*

37. Is your company familiar with the City of Vancouver Building Bylaw?

☐[1] Yes

☐[0] No [SKIP TO PREAMBLE FOR Q40]

☐[99] Don't know [SKIP TO PREAMBLE FOR Q40]

38. Overall, how influential has the City of Vancouver Building Bylaw been on your company's decision to build EnerGuide 80 homes outside of the City of Vancouver? *READ LIST*

- ☐[1] Very influential
- ☐[2] Somewhat influential
- ☐[3] A little influential
- ☐[4] Not at all influential
- ☐[99] Don't know *DO NOT READ*
- ☐[98] Not applicable *DO NOT READ*

ENERGY STAR APPLIANCES

ENERGY STAR – APPLIANCE SPILLOVER

Now I'd like to ask you about the appliances your company has installed for the period since your company first heard about the New Home program in < INSERT YEAR FROM Q6 >**.**

39. The Energy Star Package part of the Power Smart New Home program provided rebates for a combination of eligible refrigerators, dishwashers, clothes washers, bathroom fans and lighting. Did your company know about the Energy Star package component of the program?

- ☐[1] Yes
- ☐[0] No
- ☐[99] Don't know

40. Has your company installed any Energy Star rated refrigerators, dishwashers or front-load clothes washers in any of the < INSERT # FROM Q28 > **new homes/units it has built since learning of the New Home program in** < INSERT YEAR FROM Q6 >**?**

- ☐[1] Yes [CONTINUE]
- ☐[0] No [SKIP TO PREAMBLE FOR Q45]
- ☐[99] Don't know [SKIP TO PREAMBLE FOR Q45]

41. Approximately how many of each type of Energy Star rated appliances, <u>in total</u>, did your company install in those < INSERT # FROM Q28 > **new homes/units?** *READ*

[SURVEYOR NOTE: RESPONDENT'S BEST ESTIMATE IS SUFFICIENT]

a. Refrigerators _____ ☐999 Don't know

b. Dishwashers _____ ☐999 Don't know

c. Front-end clothes washers _____ ☐999 Don't know

[PROGRAMMING: sum & check total with respondent] _____

42. What percentage of those appliances were installed with the intention of getting New Home rebates?

_____ % ☐0 0% - None ☐999 Don't know

43. Overall, how influential was your company's awareness of the New Home program on the company's decision to install these energy efficient appliances? *READ LIST*

☐1 Very influential

☐2 Somewhat influential

☐3 Not very influential

☐4 Not at all influential

☐99 Don't Know *DO NOT READ*

ENERGY STAR – BATHROOM FAN SPILLOVER

Next questions are about any energy efficient bathrooms fans that your company installed.

44. Since first hearing about the New Home program in < INSERT YEAR FROM Q6 >, **has your company installed any bathroom fans rated as Energy Star in any of the new homes/units it has built?**

☐1 Yes [CONTINUE]

☐0 No [SKIP TO PREAMBLE FOR Q49]

☐99 Don't know [SKIP TO PREAMBLE FOR Q49]

45. Thinking of the < INSERT # FROM Q28 > **new homes/units your company has built since** < INSERT YEAR FROM Q6 >**, approximately how many bathroom fans rated as Energy Star did your company install?**

[SURVEYOR NOTE: RESPONDENT'S BEST ESTIMATE IS SUFFICIENT]

_____ ☐9999 Don't know

46. What percentage of those bathroom fans were installed with the intention of getting New Home rebates?

_____ % ☐[0] 0% - None ☐[999] Don't know

47. Overall, how influential was your company's awareness of the New Home program on the decision to install bathroom fans rated as Energy Star? *READ LIST*

☐[1] Very influential

☐[2] Somewhat influential

☐[3] Not very influential

☐[4] Not at all influential

☐[99] Don't Know *DO NOT READ*

ENERGY STAR – CFL BULB SPILLOVER

And now I'm going to ask about energy efficient lights bulbs and any other energy efficient equipment or products your company installed since your company first learned of the New Home program.

48. Has your company installed any energy efficient CFLs or LEDs in any of the new homes built since < INSERT YEAR FROM Q6 >**?**

☐[1] Yes [CONTINUE]

☐[0] No [SKIP TO Q52]

☐[99] Don't know [SKIP TO Q52]

49. Thinking of all the light bulbs installed in all < INSERT # FROM Q28 > **of the new homes built by your company, approximately what percentage were energy efficient CFLs or LEDs?**

[SURVEYOR NOTE: RESPONDENT'S BEST ESTIMATE IS SUFFICIENT]

_____% ☐[9999] Don't know

ERROR MSG: PLEASE ANSWER A VALUE BETWEEN 1% AND 100%

50. Overall, how influential was knowing about the New Home program on your company's decision to install energy efficient light bulbs in those new homes? *READ LIST*

☐[1] Very influential

☐[2] Somewhat influential

☐[3] Not very influential

☐[4] Not at all influential

☐[99] Don't Know *DO NOT READ*

OTHER PRODUCTS SPILLOVER

51. Has your company installed any other certified energy efficient products or equipment in any of the new homes/units built since hearing about the New Home program?

☐[1] Yes [CONTINUE]

☐[0] No [SKIP TO PREAMBLE FOR Q58]

☐[99] Don't know [SKIP TO PREAMBLE FOR Q58]

52. What other kinds of certified energy efficient products or equipment has your company installed?

_____

☐ **No Comment**

53. Were any of these products covered by a rebate under another program?

☐[1] Yes

☐[0] No

☐[99] Don't know

54. Overall, how influential was knowing about the New Home program on your company's decision to install other energy efficient products? *READ LIST*

☐[1] Very influential

☐[2] Somewhat influential

☐[3] Not very influential

☐[4] Not at all influential

☐[99] Don't Know *DO NOT READ*

55. Was your company aware of other residential construction companies that received rebates from the New Home program for installing energy efficient products?

☐[1] Yes

☐[0] No [GO TO PREAMBEL FOR Q58]

☐[99] Don't know [GO TO PREAMBLE FOR Q58]

56. How influential was knowing that other builders were installing Energy Star appliances and other energy efficient products on your company's decision to install energy efficient products? *READ LIST*

☐[1] Very influential

☐[2] Somewhat influential

☐[3] A little influential

☐[4] Not at all influential

☐[99] Don't know *DO NOT READ*

☐[98] Not applicable *DO NOT READ*

BUILDING PRACTICES/CODE CHANGES

We are almost finished—just a few more questions to go!

These last few questions explore industry experiences in meeting the 2008 changes to the BC Building code for improving energy efficiency.

57. Was your company involved in any new residential construction (outside the City of Vancouver) prior to the addition of the Part 10 energy efficiency requirements in the BC Building Code in 2008 (i.e., prescriptive insulation requirements or EnerGuide rating of 77)?

- ☐[1] Yes [ASK Q59 to Q62]
- ☐[0] No [SKIP TO RULE FOR Q63]
- ☐[99] Don't know [SKIP TO RULE FOR Q63]

58. How did your company need to change its usual design and building practices when the 2008 amendments to the building code came into effect?. [RANDOMIZE LIST] *DO NOT READ LIST*

- ☐[1] We incorporated computer simulation modeling (including HOT2000) into the design process.
- ☐[2] We made significant changes to heating and ventilation designs.
- ☐[3] We made significant changes to the building envelope (including windows).
- ☐[4] Made significant changes to insulation levels.
- ☐[5] We began conducting a blower door test at completion.
- ☐[6] We made no significant changes because we were already meeting all the 2008 code requirements.
- ☐[7] Other: please specify_____
- ☐[99] Don't know

59. Outside of the City of Vancouver, how did your company <u>most frequently</u> document meeting the energy efficiency requirements of the 2008 amendments to the BC Building Code? Select one only. *READ LIST*

- ☐[1] By meeting the prescriptive requirements for insulation (i.e., Table 10.2.1.1.A) [CONTINUE]
- ☐[2] By using computer simulation modeling to demonstrate equivalent performance to the prescriptive requirements in Table 10.2.1.1.A [SKIP TO Q62]
- ☐[3] By achieving an EnerGuide Rating System rating of 77 [SKIP TO Q62]
- ☐[99] Don't know [SKIP TO Q62] *DO NOT READ*

60. What were the main challenges for your company in meeting the Building Code's prescriptive requirements for insulation?

[*DO NOT READ LIST.* SELECT ALL THAT APPLY]

- ☐[1] It required significant changes to existing construction practices.
- ☐[2] The insulation requirements added too much to the cost/the insulation levels required weren't economical.
- ☐[3] We weren't sure how to meet the requirements.
- ☐[4] Building inspectors weren't sure how to check compliance.
- ☐[5] Other: please specify_____
- ☐[0] None / No others
- ☐[99] Don't know

61. How often did your company meet all the energy efficiency requirements of the revised 2008 building code? (Please be assured that you and your company's identity remain completely confidential.) *READ LIST*

- ☐[1] All of the time
- ☐[2] Most of the time
- ☐[3] Sometimes/occasionally
- ☐[4] Rarely/infrequently
- ☐[5] Never
- ☐[99] Don't know *DO NOT READ*

ASK Q63 IF Q10a>0 OR Q10b>0 OR Q25=1; ELSE SKIP TO Q64

62. What, if any, have been the main challenges faced by your company in meeting EnerGuide rating targets (e.g., EnerGuide 80 for the New Home program or the City of Vancouver Building Bylaw or the BC building code EnerGuide 77 option)? [RANDOMIZE] *DO NOT READ LIST*

- ☐[1] It was too difficult find a CEA to conduct the EnerGuide assessment.
- ☐[2] The EnerGuide assessment process takes too much time.
- ☐[3] The EnerGuide assessment to costs too much.
- ☐[4] The requirements to meet the EnerGuide rating target costs too much.
- ☐[5] We weren't sure how to meet the requirements.
- ☐[6] Building inspectors weren't skilled in assessing the construction practices required to meet the requirements
- ☐[7] Other: please specify_____
- ☐[0] None
- ☐[99] Don't know

63. How important is it that BC Hydro and/or FortisBC provide support to the residential construction industry when building code changes require improved energy efficiency? *READ LIST*

☐[1] Extremely important

☐[2] Important

☐[3] Not too important

☐[4] Not at all important

☐[99] Don't know *DO NOT READ*

64. What kind of help is most useful for the industry? _____

☐ **No Comment**

65. Given the current circumstances in the new construction industry, what could BC Hydro or FortisBC do to continue to support the construction of more energy efficient homes? _____

☐ **No Comment**

THAT COMPLETES THE SURVEY!!

THANK YOU SO MUCH FOR YOUR TIME.

INTERESTED IN PARTICIPATING IN FURTHER RESEARCH? (asked of both groups)

66. BC Hydro is tentatively planning to conduct some in-depth telephone discussions with builders. This effort can be most effectively done by selecting customers from the original survey data.

Are you interested in participating?

☐[1] Yes

Name: _____

Company Name: _____

Business phone: _____

Business email: _____

Business address: _____

☐[0] No thank you

INCENTIVE PRIZE DRAW

67. If you would like to participate in a draw for one of four (4) prizes for a $500 gift certificate from the winner's choice of Canadian Tire, RONA, Home Depot or Home Hardware, please see the details below. Participation in the draw is completely voluntary. If you chose to participate, you will be asked to provide your name and your business contact information.

This information will be removed from all survey responses and used for the purpose of the survey contest only. It will be destroyed upon completion of the draw and prize delivery. Official Rules and Regulations of the contest are provided here (POST WITH LINK).

Would you like to be included in the prize draw?

☐[1] Yes

Name: _____

Company Name: _____

Business phone: _____

Business email: _____

Business address: _____

☐[0] No thank you

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY ("BC Hydro")
SURVEY CONTEST

OFFICIAL Rules and Regulations

Eligibility

No purchase necessary. Contest open to survey recipients only. The contest ("Contest") is open only to residents of British Columbia age nineteen (19) years or older, who have received the Contest survey from BC Hydro's Power Smart Evaluation department. Contest is not open to employees, and members of the immediate families and/or household members of employees, of BC Hydro.

How to Enter

No purchase required. Limit two (2) entries per eligible entrant. To automatically receive one (1) entry in the contest, complete and submit the electronic version of the survey, available at http://www(to be added once programmed), or complete the survey by telephone. All online entries must be submitted by September 00, 2014 at 11:59 pm Pacific Time.

Early Bird entries: all entries received by September 00, 2014 will receive one (1) additional entry.

LIMIT two (2) entries for surveys completed online and one (1) entry for surveys completed by telephone. All survey responses must include required contact information. No purchase necessary: to enter without completing all survey questions, eligible entrants may submit their survey document with all contact information completed and receive contest entry(ies) based on method of delivery and date submitted, as set out above.

Prizes/Odds

There are four (4) prizes available to be won, each consisting of one (1) five-hundred dollar (CDN.$500) gift certificate for the winner's choice of Canadian Tire, RONA, Home Depot or Home Hardware. The chances of winning depend upon the total number of eligible survey responses received. Prize must be accepted as offered; there is no cash alternative. BC Hydro reserves the right, in its sole discretion, to substitute a prize of equivalent value if any component of the prize cannot be awarded as described and to offer a gift certificate for a different hardware products retailer. All decisions of BC Hydro are final in all matters relating to this contest.

*CANADIAN TIRE, RONA, HOME DEPOT and HOME HARDWARE are trademarks of their respective owners, none of which are sponsors of, nor participants in, this Contest.

Administration

A random draw will be held on or around October 31, 2014. Each selected entrant, before being declared a winner, will be contacted by telephone or email within two (2) weeks of the draw, and will be required to correctly answer a mathematical skill-testing question and sign a standard Declaration, Release and Waiver of Liability form, confirming compliance with the contest rules, acceptance of prize as offered, acknowledging that BC Hydro and its agents are not responsible for any injury, accident, loss or misfortune relating to the prize.

Conditions

By participating in the contest, the participant accepts and agrees to these rules and the decisions made by BC Hydro, which shall be final and legally binding. Contest prize must be accepted as awarded.

BC Hydro and its agents are not responsible for survey responses lost or misplaced for any reason, including negligence, or for illegible, incomplete, or late entries, which will be void, or for any problems or technical malfunction of any telephone network or lines, computer online systems, servers, access providers, computer equipment, software, failure of any email or entry to be received by BC Hydro on account of technical problems or traffic congestion on the Internet or at any website, or delay in mail service or any combination thereof, including any injury or damage to an entrant's or any other person's computer, related to or resulting from downloading any materials in this promotion. BC Hydro reserves the right, in its sole discretion, to cancel or suspend this contest should a virus, bug or other cause beyond the reasonable control of BC Hydro or its agents corrupt the security or proper administration of the contest. Any attempt to deliberately damage any website or to undermine the legitimate operation of this promotion is a violation of criminal and civil laws, and should such an attempt be made, BC Hydro reserves the right to seek remedies and damages to the fullest extent permitted by law, including criminal prosecution.

All entries become the property of BC Hydro and will not be returned. This contest is subject to all applicable federal, provincial and municipal laws.