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January 22, 2021

Mr. Patrick Wruck
Commission Secretary and Manager
Regulatory Support
British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Mr. Wruck:

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

In compliance with Directive 66 of the BCUC Decision on BC Hydro's 2004/05 to 2005/06 Revenue Requirements Application, dated October 29, 2004, BC Hydro writes to submit its F2020 Demand Side Management Milestone Evaluation Summary Report dated December 2020.

Directive 66 directs BC Hydro to file the executive summaries of its milestone evaluation reports and full final evaluation reports for all its DSM programs.

The F2020 Demand Side Management Milestone Evaluation Summary Report summarizes the impact evaluations completed during F2020 for the following:

1. Commercial New Construction Program: F2012-F2016 (Final Full Evaluation Report is included in Attachment 1);
2. Leaders in Energy Management Industrial Transmission Program: F2015-F2017; and
3. Load Displacement Initiatives Impact Evaluation: F2021-F2018 (Final Full Evaluation Report included in Attachment 2).

For further information, please contact Chris Sandve at 604-974-4641 or by email at bchydroregulatorygroup@bchydro.com.

Yours sincerely,

Fred James
Chief Regulatory Officer

ls/ma

Enclosure

Demand Side Management Milestone Evaluation

Summary Report F2020

December 2020

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1.0 Introduction

This report summarizes the milestone evaluations of demand-side management (**DSM**) initiatives completed by BC Hydro in fiscal year 2020 (**F2020**). 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:

- Commercial New Construction Program: F2012-F2016
- Leaders in Energy Management Industrial Transmission Program: F2015-F2017
- Power Smart Partners – Load Displacement Initiatives Impact Evaluation: F2012-F2018

2.0 Commercial New Construction Program: F2012-F2016

2.1 Introduction

This report presents an impact evaluation of the BC Hydro Commercial New Construction (**CNC**) program for BC Hydro fiscal years 2012 to 2016 (April 2011 to March 2016). The CNC program was targeted at developers and the building design community who play a role in building and expanding commercial buildings in BC Hydro's service territory. Market actors included developers, building owners, architects, engineers, energy modellers and consultants.

The program's key objective is to obtain electricity energy savings by supporting the design and implementation of cost-effective energy conservation measures beyond applicable building code requirements. There are associated capacity savings (MW) with this program that are derived from the energy savings resulting from the program's energy-focused DSM activities. These savings are not a result of capacity-focused DSM. The CNC program provides direct savings for BC Hydro by supporting the following:

- Energy Efficient Design: identify energy savings by promoting and funding the design of energy efficient buildings (i.e., more energy efficient than the minimum building code legislation requires);
- Energy Efficient Construction: acquire energy savings by promoting and funding the construction of energy efficient buildings and offer training and education on the efficient operation of new buildings; and
- Training and Recognition: enable transformation of the market by training a team of industry professionals to act as energy conservation "ambassadors" (i.e., advocates) on all new construction projects that they work on in the future. In addition, to publicly recognize energy efficient design teams and projects and create a market where consumers highly desire energy efficient buildings.

The program had four offerings:

1. Whole Building Design
    - Targeted at buildings over 50,000 square feet
    - Energy Modelling/Computer simulation of the whole building energy use
2. System Design
    - Targeted at improving the energy efficiency of selected building systems in buildings typically over 50,000 square feet
    - Energy use analysis of a specific system (e.g., lighting, refrigeration, HVAC)
3. Energy Efficient Lighting Design
    - Targeted at buildings typically over 10,000 square feet; and
    - Energy use analysis for lighting - reduction of light power density requirement from building code through design and controls

4. Program Enabled
    - Projects in which the customer engaged with BC Hydro, undertook a funded Energy Study and through this engagement the building design/equipment was influenced leading to energy savings
    - These measures did not receive a program incentive due to not meeting BC Hydro cost effectiveness ratios or due to failing to comply with program incentive offer timing and process

The CNC program is winding down, with all remaining applications scheduled to be completed in F2022. BC Hydro will continue to support the transformation of the commercial new construction market through codes and standards activities that support the B.C. Energy Step Code.

2.2 Approach

The evaluation objectives and research questions are shown below in Table 2.1, followed by the data sources and methods (Table 2.2).

Table 2.1. Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Assess the participant experience	• What is the level of participant awareness of the various CNC program components? • How do participants rate their program experience and overall satisfaction? • How influential is the CNC program on participant decisions around energy efficiency?
2. Assess practices and opinions related to market transformation	• What are the most common types of design studies being conducted in view of helping to make new construction projects perform better than code? (e.g., whole building energy modelling, a refrigeration system design study, and/or a lighting design study) • What are the most common measures being implemented to help make new construction projects perform better than code? • To what extent do market actors believe the commercial new construction market in the province has improved over the last 10-15 years? • How much electricity do market actors believe new construction projects are saving relative to the energy efficiency requirements in the B.C. Building Code?
3. Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements	• To what extent has the CNC program developed support for design and construction of more energy efficient buildings (beyond code requirements) among commercial new construction market actors (designers, builders, mechanical engineers, architects etc.)? • To what extent and through which activities is the CNC program influencing building design practices and the new construction market beyond incented projects?
4. Estimate gross energy and peak demand savings	• What are the gross and peak demand savings?
5. Estimate net energy and peak demand savings	• What are the net energy and peak demand savings for the overall CNC program? • What are the free ridership, participant spillover and non-participant spillover rates?

The data sources and analytical methods used to address the objectives are summarized in Table 2.2, followed by a description for each objective.

Table 2.2. Evaluation Objectives, Data and Methods

Evaluation Objective	Data	Methods
1. Assess the participant experience	• Participant Survey (n=57)	• Cross tabulations
2. Assess practices and opinions related to market transformation	• Market Actor Survey (n=13-30)	• Cross tabulations
3. Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements	• Market Actor Survey (n=13-30)	• Cross tabulations
4. Estimate gross energy and peak demand savings	• Program tracking data • Measurement and verification (n=12)	• International Performance Measurement and Verification Protocol (IPMVP) Option A, B and D • Ratio estimation • Peak demand savings based on peak-to-energy factor
5. Estimate net energy and peak demand savings	• Statistics Canada data on commercial new construction activity, F2012-F2016 • Participating building area (square metres) • Conservation Potential Review (**CPR**) Energy Use Intensity (**EUI**) inputs • Results from Objective 4 • Participant survey (n=51) • Market actor survey (n=13-30)	• Survey based free ridership and participant spillover algorithms • Market Actor Survey based non-participant spillover algorithm

2.3 Results

The results of the evaluation are presented by each evaluation objective, below.

Results for Objective 1: Assess the participant experience

Among program participants, 79 per cent reported being aware of the CNC program offer by name. Of the individual program components, awareness, understanding and rating score was highest for the role that key account managers play as liaisons between the CNC program and participants.

Overall satisfaction was high for the CNC program at 80 per cent, comprised of 41 per cent stating they were very satisfied and 39 per cent stating they were somewhat satisfied. When asked the likelihood of recommending the program to others, 95 per cent indicated that they definitely (53 per cent) or probably (42 per cent) would, and 49 per cent reported that they had in fact already done so.

A total of 80 per cent of participants indicated that the CNC program was very (33 per cent) or somewhat (47 per cent) influential on the decision to implement the energy efficient measures at their site. Looking more broadly at conservation motivators, 60 per cent of participants indicated that the CNC program was a 'major factor' in the organization's effort to manage electricity use over the past year. In terms of barriers to managing electricity use, lack of funds for energy efficient retrofits/projects was noted as a 'major barrier' by 33 per cent of participants, followed by other operational priorities (29 per cent) and lack of financial incentives for conservation programs and energy efficiency (26 per cent).

Results for Objective 2: Assess practices and opinions related to market transformation

With regards to buildings that did not participate in the CNC program, but that market actors reported were performing better than the energy efficiency requirements of the B.C. Building Code, the most common type of design study conducted to help these buildings perform better than code was whole building design. On average, approximately two-thirds of respondents confirmed that at least some floor area of their ‘better than code, non-participating projects’ had come through this study type. This was followed by lighting design studies, with about 44 per cent of respondents, on average, confirming at least some floor area had come through this study type.

Again, with regards to buildings that did not participate in the CNC program but that were performing better than code, by far the most common measure being implemented to help make these buildings perform better than code was highly efficient lighting, with 83 per cent of respondents reporting that the measure was at least sometimes implemented in their ‘better than code, non-participating projects. This was followed by HVAC measures at 64 per cent.

Market actors, including electrical engineers, mechanical engineers, energy modellers, architects and project managers, were asked how much they thought energy efficiency had improved in the entire commercial new construction market in B.C. over the past 10 to 15 years. All respondents thought that there had been some improvement over the past 10 to 15 years – although not necessarily beyond code – with the majority (55 per cent) reporting a 20 per cent improvement. Additionally, all thought that both their own buildings and those constructed by other firms were performing better than code specifically in regards to electricity savings. Savings were reported in the 1 per cent to 30 per cent range, with about half of respondents perceiving that their own buildings had 20 per cent to 30 per cent electricity savings relative to code, compared to only about one-third feeling the same way about buildings constructed by others.

Results for Objective 3: Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements

A total of 91 per cent of respondents had experience with at least one of the energy efficiency resources or touchpoints provided by the program. The most common were “discussions about projects with BC Hydro staff” (70 per cent) and “reviewing case studies/resource literature” (64 per cent). This was followed by 60 per cent who had “attended a program workshop or training session” and 40 per cent who had “reviewed the Building Envelope Thermal Guide”. The least used resource was the “Enhanced Thermal Performance Spreadsheet”, with only 21 per cent of respondents indicating they had reviewed it.

Market actors were asked to consider all of their various touchpoints with the program and the influence that these had on their design decisions to have non-participating projects perform better than the building code. A total of 60 per cent indicated that these program touchpoints were ‘very’ or ‘somewhat’ influential on their decisions to do so.

In order to understand program influence relative to other factors in the broader new construction context, market actors were asked to credit various factors for making non-program projects perform better than the B.C. Building Code, such that the factors summed to 100 per cent. On average, BC Hydro ‘drivers’ were given a net of 24 per cent of the credit for making projects perform better than code. It follows that non-BC Hydro drivers were given 76 per cent of the credit for buildings performing better than code.

Another approach to assessing program influence was to query market actors on how much of the improvement in the energy use over time – although not necessarily beyond code – could be attributed to BC Hydro's CNC program. About half (49 per cent) felt it was in the 20 to 30 per cent range, with the most common answer at 20 per cent.

Results for Objective 4: Estimate gross energy and peak demand savings

The evaluated gross savings in fiscal year covered by the evaluation period are presented in Table 23. Evaluated gross electricity savings ranged from 9.2 GWh/year to 24.2 GWh/year from F2012 to F2016, with the most savings occurring in F2014 and the least occurring in F2012.

Table 2.3. Summary of Evaluated Gross and Net Energy and Peak Demand Savings

Year	Evaluated Gross Energy Savings (GWh/year)	Evaluated Gross Peak Demand Savings (MW)	Calculated Net-to-Gross Ratio	Evaluated Net Energy Savings (GWh/year)	Evaluated Net Peak Demand Savings (MW)
F2012	9.2	1.3	0.91	8.4	1.2
F2013	19.9	2.8	0.96	19.2	2.8
F2014	24.4	3.5	0.93	22.7	3.2
F2015	18.8	2.7	0.95	17.9	2.6
F2016	20.6	3.0	0.99	20.4	2.9
CNC (F12-F16)	**92.9**	**13.3**	**0.95**	**88.6**	**12.7**

Results for Objective 5: Estimate net energy and peak demand savings

The evaluated net savings in fiscal year covered by the evaluation period are presented in Table 2.4. Evaluated net electricity savings ranged from 8.4 GWh/year to 22.7 GWh/year from F2012 to F2016, with the most savings occurring in F2014 and the least occurring in F2012.

Table 2.4. Summary of Net Energy and Peak Demand Savings

	Net Energy Savings (GWh/year)		Net Peak Demand Savings (MW)	
Fiscal Year	**Reported**	**Evaluated**	**Reported**	**Evaluated**
F2012	8.1	8.4	1.1	1.2
F2013	15.3	19.2	2.2	2.8
F2014	20.7	22.7	3.0	3.2
F2015	14.0	17.9	2.0	2.6
F2016	15.3	20.4	2.2	2.9
CNC (F12-F16)	**73.4**	**88.6**	**10.5**	**12.7**

The cumulative variance between the reported net energy savings and evaluated energy savings was 15.2 GWh/year. The largest variance occurred in F2016 with a difference of 5.1 GWh between reported and evaluated savings.

Overall, the program achieved 121 per cent of reported savings during fiscal years F2012 to F2016, showing the program performed better than reported. The variance between reported and evaluated net savings is primarily due to the impact of non-participant spillover which was estimated in the evaluation.

2.4 Findings and Recommendations

Findings

Participant Experience

1. Overall satisfaction was high for the CNC program at 80 per cent, comprised of 41 per cent stating they were very satisfied and 39 per cent stating they were somewhat satisfied.

2. The highest scores related to aspects of service/communications from BC Hydro, as well as service provided by contractors. Mid-range scores typically related to aspects of the program offer (variety of products and level of incentives) and the overall application procedures. The lowest scores were for length of time to receive the incentive, length of time for the project/process to be completed and direct mail/email about the program (which was not relied on heavily by this program).

3. Participants reported that the program had been influential on their decision to implement the energy-efficient measures, with 33 per cent indicating that it had been very influential and 47 per cent indicating it had been somewhat influential.

Market Transformation

4. All market actors thought that there had been some improvement in the entire commercial new construction market in B.C. over the past 10 to 15 years – although not necessarily beyond code – with the majority reporting a 20 per cent improvement in terms of energy use over time.

5. The most common types of design study conducted to help new construction projects perform better than code were whole building design and lighting design. The most common measures implemented to help projects perform better than code were lighting and HVAC.

Influence on Adoption of Energy Efficiency Measures Beyond Building Code Requirements

6. On average, BC Hydro 'drivers' were given a net of 24 per cent of the credit for making projects perform better than code, with the largest credit given to previous learnings and experience with the CNC program. The remaining 76 per cent of credit was given to non-BC Hydro drivers, with the largest given to general industry innovation/good practices and to clients directing the projects to be built as such.

Gross Electrical Energy Savings

7. The evaluated gross energy savings were 93 GWh/year.

8. The program gross realization rate calculated using the inspected and verified results, including cross effects, was 1.06, indicating that the energy conservation measures largely performed better than expected. The realization rates by program offer were 1.17, 1.04, 0.89 and 0.89 for whole building design, system design, lighting design and program enabled projects, respectively.

9. Expected energy savings averaged 18 per cent of site energy consumption across all participants during the five-year evaluation period.

Net Electrical Energy Savings

10. The evaluated net energy savings were 89 GWh/year.

11. The net-to-gross ratio was 95 per cent based on free ridership of 20 per cent, participant spillover of 1 per cent and non-participant spillover of 14 per cent.

12. Evaluated net savings during the evaluation period from F2012 to F2016 averaged 121 per cent of reported savings.

Recommendations

The following two recommendations are for future new construction initiatives:

1. Support and enabling activities for whole building energy modelling and integrated system approach to estimate a project's energy savings should continue and include the Building Envelope Thermal Bridging Guide and the Enhanced Thermal Performance Spreadsheet.

2. Future Market Actor surveys could be done more frequently so that respondents are better able to recall the projects they are being surveyed about.

2.5 Conclusions

BC Hydro's Commercial New Construction Program achieved high participant satisfaction. Evaluated net savings were 89 GWh/year, which is 121 per cent of reported savings. Evidence suggests that the program has supported the market in complying with and exceeding the energy efficiency requirements of the B.C. Building Code.

3.0 Leaders in Energy Management Industrial Transmission Program: F2015-F2017

3.1 Introduction

This report presents the results of an impact evaluation of the BC Hydro Leaders in Energy Management – Industrial Transmission (**LEM-T**) program for fiscal years F2015 to F2017 (April 2014 to March 2017).

The LEM-T program captures energy savings at large industrial facilities through energy efficiency retrofits, operational and maintenance changes, and behavioural changes. LEM-T program participants are large industrial customers receiving service at transmission voltages (> 60 kV) who belong to a variety of sectors, including pulp and paper, wood products, mining, oil and gas, chemical, cement and manufacturing.

The LEM-T program was built on a foundation of strategic energy management by providing training, energy managers, energy studies, audits, and other resources to enable large industrial customers to implement facility changes and benefit from the Transmission Service Rate (**TSR**) or leverage capital incentives. The main program components covered by this evaluation are described below.

- **Strategic Energy Management**: LEM-T provides funding to industrial transmission customers for a specially trained Industrial Energy Manager to embed strategic energy management (**SEM**) practices into their organizations. The energy managers conduct energy assessments to help customers gain energy insights, build executive support for energy efficiency and define the energy opportunity and value proposition for their company. They also have access to additional funding and resources to implement employee awareness initiatives and enhanced energy monitoring and targeting systems. In F2017, additional deemed savings for selected SEM participants were claimed for the first time. Prior to that, the program promoted and supported the implementation of SEM activities as a program influence factor but no additional savings were claimed for them.
- **Energy Studies**: LEM-T offers funding to identify energy-saving opportunities through plant-wide audits and end use assessments and to quantify opportunities and build the business case for implementing energy improvement projects through feasibility studies.
- **Custom Project Incentives:** Custom project incentives are financial incentives provided to large industrial customers to implement energy efficiency projects. These projects typically involved "hard-wired" changes to electrical equipment.
- **Self-serve Incentive Program (SIP):** The self-serve incentive component of LEM-T is designed to allow large industrial customers to apply for incentives for improvements to compressed air and lighting systems. The online application makes it quick and easy to apply.
- **Program Enabled (PE) Projects:** Program enabled projects are custom projects that did not receive direct capital incentive funding from BC Hydro, but were enabled by other BC Hydro resources and supports, such as energy managers and energy studies. Customers can claim savings from these projects by providing the appropriate documentation and project details.
- **New Plant Design:** The New Plant Design initiative offers industry expertise to provide an energy base line and energy-efficiency design support for new or expanding facilities. These projects are combined with custom project incentives or program enabled projects to encourage efficient designs that surpass industry standards.

3.2 Approach

The evaluation objectives and research questions are shown in the table below, followed by another table summarizing the data sources and methods for each objective.

Table 3.1. Evaluation Objectives and Research Questions

	Evaluation Objectives	Research Questions
1.	Examine participant and non-participant experience with the program	What was participant and non-participant awareness and understanding of the various program offers? What was participant satisfaction with the various program offers?
2.	Assess outcomes influenced by SEM activities among BC Hydro's large industrial customers	What have been the trends and outcomes associated with strategic energy management over time (e.g., changes in sustainability management, capability, commitment, expectations, application of knowledge)? Were energy managers associated with increased project activities? What was the coverage of energy savings of facilities with energy managers compared to those without? To what extent did SEM lead to additional savings beyond project-based activities? Were the savings achieved in the form of a reduction in energy consumption or reduced energy use intensity? What have been the main barriers to and drivers of adopting and integrating strategic energy management into industrial organizations?
3.	Evaluate deemed energy savings of SEM participants	What were the gross energy and peak demand savings from SEM participants with deemed savings? What were the net energy and peak demand savings from SEM participants with deemed savings?
4.	Estimate gross electrical energy and peak demand savings due to the incentive offers and program enabled projects (excluding deemed savings of SEM participants)	What were the most common energy conservation measures by end use and customer site type among custom and prescriptive incentive projects, and program enabled projects? What were the evaluated gross energy and peak demand savings realized by custom and prescriptive incentive projects, and program enabled projects?
5.	Estimate net electrical energy and peak demand savings due to the incentive offers and program enabled projects (including deemed savings of SEM participants)	How much free ridership occurred for custom and prescriptive incentive projects, and program enabled projects? How much participant and non-participant spillover occurred for the program overall? What were the evaluated net energy and peak demand savings for the combined effect of the LEM-T program and the TSR for custom and prescriptive incentive projects, and program enabled projects?

The following table summarized the data sources and methods used to address each evaluation objective and associated research question.

Table 3.2. Evaluation Objectives, Data and Methods

Evaluation Objective	Data	Method
1. Examine participant and non-participant experience with the program	• 2015, 2016, 2017 Participant surveys (n=59) • 2015, 2018 Non-participant survey (n=16)	• Cross tabulations; frequencies
2. Assess outcomes influenced by SEM activities among BC Hydro's large industrial customers	• Program administrative data • Project files (including energy manager reports, Energy, Monitoring and Targeting (**EMT**) reports, etc.) • Interviews: Energy managers; corporate sponsors / representatives (n=9)	• Cross tabulations; frequencies • Portfolio or sample level modeling • Qualitative analysis
3. Evaluate deemed energy savings of SEM participants	• Account billing data and TSR records (n=60) • Program administrative data	• Quasi-experimental design comparing SEM participants and non-participants
4. Estimate gross electrical energy and peak demand savings due to the incentive offers and program enabled projects (excluding deemed savings of SEM participants)	• Project tracking data • Measurement and verification results • Account billing data and TSR records (n=60) • Project files & energy study reports	• Measurement and verification results based on the application of International Performance Measurement and Verification Protocol • File reviews and engineering desk review for projects without Measurement & Verification • Development of realization rates using stratified ratio estimation • Extrapolation of case study findings
5. Estimate net electrical energy and peak demand savings due to the incentive offers and program enabled projects (including deemed savings of SEM participants)	• Results of Objective 4 • File review and case study results (n=14) • 2015, 2016, 2017 Participant surveys (n=59) • 2015, 2018 Non-participant surveys (n=16)	• Estimation of free ridership by triangulating results of participant surveys and case study reviews • Estimation of spillover for participants and non-participants from survey results and decision tree

3.3 Results

The results of the evaluation are presented by each evaluation objective, below.

Results for Objective 1: Examine participant and non-participant experience with the program

Overall awareness of BC Hydro's conservation programs for industrial customers was high among custom participants at 96 per cent and among SIP participants at 95 per cent. Among non-participants, overall awareness was lower at 75 per cent. In terms of individual program components, awareness, understanding and overall ratings were highest for the role that Key Account Managers play as liaisons for the program, energy studies, and the incentive structures.

Overall satisfaction with the program was very high with 100 per cent of both custom and SIP respondents reporting that they were very or somewhat satisfied. This sentiment was very strong with 71 per cent of custom participants and 78 per cent of SIP participants reporting to be 'very satisfied'. Likewise, 100 per cent of both groups reported that they definitely or probably would recommend the program to others and in fact, 56 per cent of custom participants and 65 per cent of SIP participants reported that they had already done so.

In terms of program experience, 'service provided by BC Hydro personnel' and 'knowing how/who to contact at BC Hydro' were rated very favourably by both custom and SIP participants. Among custom participants, the 'variety of products funded under the program' and service provided by both suppliers/distributors and by contractors received strong ratings. Among SIP participants, the 'level of incentives' and 'service provided by suppliers/distributors' were rated highly. Aspects with the lowest rating scores for custom participants included those related to 'length of time to receive incentive' and 'length of time to receive project approval' as well as for 'overall application procedures'. For SIP, the aspects with the lowest scores were 'length of time to receive project approval' and 'length of time for the project to be completed' as well as 'clarity of communications from BC Hydro about the project'.

Results for Objective 2: Assess outcomes influenced by SEM activities among BC Hydro's large industrial customers

Based on the interviews with Energy Managers and corporate sponsors, cost reduction was named as the main driver for adopting and integrating SEM into their respective organizations. Cost was also raised as one of the main barriers in implementing SEM, in addition to competition with other initiatives and overloaded resources.

Since the adoption of SEM, interviewees reported that corporate commitment and expectations regarding energy consumption have resulted in a number of positive developments, including more involvement and buy-in from senior management, more reporting and awareness of energy use, and more discussion about energy management throughout all levels of staff. Additionally, SEM principles were reported to be integrated into capital projects more often and some interviewees felt that there had been cultural shifts in their organizations in terms of conservation-mindedness. Most of the Energy Managers interviewed felt that in the absence of BC Hydro, SEM would not be implemented at their company.

On average, sites with Energy Managers completed over four times the number of projects per site relative to those without energy managers (4.6 projects per site compared to 1). Also, sites with an energy manager completed larger projects and achieved 1.7 times more energy savings per project. Overall, sites with Energy Managers achieved a 3.7 per cent reduction of site energy consumption through capital projects, compared to 0.9 per cent for sites without Energy Managers. Sites with Energy Managers and with active strategic energy management had over 5 per cent energy savings from capital projects implemented between F2015 and F2017.

Results for Objective 3: Evaluate deemed energy savings of SEM participants

Expected savings claimed by the program for this component were based on a deemed value of 2 per cent of site energy consumption for sites that met a pre-qualifying threshold of SEM practices. The average site gross realization was estimated at 0.8 and the net to gross ratio at 0.9. The evaluated net energy savings from strategic energy management in F2017 ranged from a lower estimate of 0.7 per cent of site energy consumption (16 GWh/year) to an upper estimate of 2.0 per cent (43 GWh/year), with an average of 1.4 per cent for 30 GWh per year energy and 3.5 MW of peak demand savings. The following table summarizes the evaluated net SEM energy savings.

Table 3.3. Net Realization Rates and Lower and Upper Estimates of SEM Energy Savings

	Average Estimate	Lower Estimate	Upper Estimate
Expected energy savings (GWh/year)	43.4		
Net realization rate	0.7	0.4	1.0
Per cent savings of site energy consumption in F2017	1.4%	0.7%	2.0%
Evaluated net energy savings (GWh/year)	30	16	43
Peak demand savings (MW)	3.5	1.9	5.0

Results for Objective 4: Estimate gross electrical energy and peak demand savings due to the incentive offers and program enabled projects (excluding deemed savings of SEM participants)

The overall LEM-T program realization rate for the period F2015-F2017 was estimated as the ratio of evaluated to expected gross savings for all measures included in the evaluation analysis, but not including savings from strategic energy management. The gross realization rates of the two incentive program offers ranged from 0.90 to 0.96. The overall realization rate for capital projects was calculated at 94 per cent. This means that, on average, measures in the realization rate sample achieved 94 per cent of their expected savings. The following table provides the expected and evaluated gross energy and peak demand savings by fiscal year for capital projects.

Table 3.4. Expected and Evaluated Gross Energy and Peak Demand Savings from Capital Projects by Fiscal Year

Period	Number of Projects	Number of Measures	Expected Gross Energy Savings (GWh/year)	Calculated Realization Rate	Evaluated Gross Energy Savings (GWh/year)	Evaluated Gross Peak Demand Savings (MW)
F2015	115	175	145.2	0.98	142.2	16.6
F2016	123	197	102.7	0.90	92.6	10.8
F2017	107	142	145.8	0. 92	133.5	15.6
LEM-T (F15-F17)	**345**	**514**	**393.7**	**0.94**	**368.3**	**43.1**

Results for Objective 5: Estimate net electrical energy and peak demand savings due to the incentive offers and program enabled projects (including deemed savings of SEM participants)

Capital Projects

The overall level of free ridership was estimated at 20 per cent for the program, ranging from 5 to 52 per cent between program offers. Participant spillover was estimated at 11 per cent and non-participant spillover was estimated at 2 per cent, for a total estimated spillover effect of 13 per cent.[1] Together they result in a net-to-gross ratio from capital projects of 93 per cent as shown in Table 3.6. Results are summarized in the table below, where free ridership, spillover and the net-to-gross ratio are presented by offer.

1 Spillover of SEM participants was estimated at zero per cent as it is included in the estimate of energy savings from strategic energy management.

Table 3.5. Free Ridership, Spillover, and Net-to-Gross Ratios by Program Offer

Program Offer	Incentive Custom	Incentive SIP	Program Enabled - Retrofit	Program Enabled - New Plant Design
Evaluated Gross Energy Savings (GWh/year)	94.6	21.9	149.8	101.9
Free Ridership (**FR**)	6%	5%	10%	52%
Spillover (**SO**)	13%	13%	13%	13%
Net-to-Gross Ratio (1 – FR + SO)	**107%**	**108%**	**103%**	**61%**
Evaluated Net Energy Savings (GWh/year)	101.3	23.7	154.3	62.2

Evaluated net energy savings from capital projects in each fiscal year were calculated using the evaluated gross energy savings of each project multiplied by the net-to-gross ratio of its program offer. These results are summarized in the following table.

Table 3.6. Evaluated Gross and Net Energy and Peak Demand Savings from Capital Projects

Year	Evaluated Gross Energy Savings (GWh/year)	Evaluated Gross Peak Demand Savings (MW)	Calculated Net-to-Gross Ratio	Evaluated Net Energy Savings (GWh/year)	Evaluated Net Peak Demand Savings (MW)
F2015	142.2	16.6	0.85	121.4	14.2
F2016	92.6	10.8	0.88	81.1	9.5
F2017	133.5	15.6	1.04	138.9	16.2
LEM-T (F15-F17)	**368.3**	**43.1**	**0.93**	**341.4**	**39.9**

Total Program Reported and Evaluated Net Savings

Reported and evaluated net energy and peak demand savings for LEM-T are shown below. Reported savings included the results of the best available estimate from either M&V, post-implementation review, and expected savings, as well as the deemed savings estimate for strategic energy management, and were adjusted by a forecast net-to-gross ratio of 0.908.

Table 3.7. Summary of Energy and Peak Demand Savings

	Net Energy Savings (GWh/year)		Net Peak Demand Savings (MW)	
Fiscal Year	Reported	Evaluated	Reported	Evaluated
F2015	134.2	121.4	15.7	14.2
F2016	91.3	81.1	10.7	9.5
F2017	163.0	169.4	19.1	19.8
LEM-T (F15-F17)	**388.5**	**371.9**	**45.5**	**43.5**

3.4 Findings and Recommendations

Findings

Below are the main evaluation findings.

Participant and Non-Participant Experience

1. Approximately two-thirds of all industrial transmission sites participated in the LEM-T program during the three-year evaluation period (F2015-F2017). Highest participation came from the pulp and paper, mining and wood products industry sectors.
2. Self-reported awareness and understanding of the various program components was high among participants, with the exception of the New Plant Design offer. Awareness and understanding among non-participants were expectedly lower, particularly for the incentive offers.
3. Overall satisfaction was very high with 100 per cent of both custom and SIP survey respondents reporting that they were very or somewhat satisfied with the program.
4. Among both custom and SIP participants, service provided by BC Hydro personnel and knowing how/who to contact at BC Hydro were the highest rated aspects of customer experience. Among custom participants, the variety of products funded under the program was also rated highly, as was the level of incentives among SIP participants. The lowest rated elements for both program offers were generally related to length of time aspects (length of time to receive project approval, length of time to receive incentive and length of time for the project to be completed).

Outcomes Influenced by Strategic Energy Management (SEM) Activities

5. The main motivator for organizations to participating in SEM was energy cost reduction. Costs were also cited as a main barrier to implementing SEM, in addition to competition with other corporate initiatives and overloaded resources.
6. Companies adopting SEM reported a number of positive developments in energy management, including more involvement and buy-in from senior management, increased reporting and awareness of energy use, SEM principles being integrated into capital projects, and cultural shifts in terms of conservation-mindedness. In the absence of BC Hydro support, most organizations felt that SEM would not have been implemented, resulting in sites having higher energy bills, being less successful at energy management and having less employee engagement around energy use.
7. Energy Managers played an important role in program participation. Energy Managers covered 83 per cent of projects among program participants. On average, sites with Energy Managers completed over four times as many projects than sites without Energy Managers.
8. Overall, from F2015 to F2017, sites with Energy Managers achieved a 3.7 per cent reduction of site energy consumption through capital projects, compared to only 0.9 per cent for sites without Energy Managers. Sites with Energy Managers and with active strategic energy management had the highest per cent reduction in site energy consumption, at over 5.5 per cent, when looking at the combined impact of capital projects and SEM.

Deemed energy savings for SEM participants

9. Evaluated net energy savings from strategic energy management were incremental to energy savings from capital projects and estimated in the range of 0.7 per cent to 2 per cent (average of 1.4 per cent) of energy consumption of participants with one year persistence. Energy savings from strategic energy management were weighted by site energy consumption.

Gross Electrical Energy Savings from Capital Projects

10. The realization rate among gross energy savings was 94 per cent, indicating that the energy conservation measures largely performed as expected. The most common reason why measures did not perform as expected was changes in operating conditions identified during post-implementation review.

11. Evaluated gross energy savings per year averaged 4.3 per cent of site energy consumption across all participants between F2015 and F2017, and capital project savings per site ranged from less than 0.1 per cent to over 16 per cent.

12. By including additional data sources in the evaluation review, such as TSR records and customer post-implementation data, the coverage of the gross realization rate sample was doubled from what it would have been using measurement and verification (**M&V**) results alone. However, the results of evaluation reviews are considered less rigorous than those of M&V analysis conducted in accordance with the IPMVP.

Net Electrical Energy Savings

13. The overall level of free ridership was estimated at 20 per cent for the program, ranging from 5 to 52 per cent between program offers. Participant spillover was estimated at 11 per cent and non-participant spillover was estimated at 2 per cent for a total of 13 per cent. Together they result in a net-to-gross ratio of 93 per cent.

14. Free ridership for program enabled new plant design projects was the highest at 52 per cent because case studies found that four of the six projects considered the existing older technology for the equivalent service alternative, although industry standard practice for new equipment had improved in energy efficiency, and there was potential for substantial non-energy benefits as a business driver.

15. Evaluated net energy savings for LEM-T were 121.4 GWh/year in F2015, 81.1 GWh/year in F2016, and 169.4 in F2017 which averaged 96 per cent of reported savings.

16. The average weighted persistence of all capital measures (i.e., the length of time that the savings are reported by the program) was 11.5 years during the evaluation period. When including savings from SEM participants, the average weighted persistence of all savings reported in LEM-T was 10.6 years.

Recommendations

Recommendations #1 and #2 are for program management:

1. In order to better estimate energy savings and document program influence in program enabled new plant design projects, consider the market baseline option of the process technology and include the relevant energy study or energy savings estimation in the project file prior to equipment purchase and project implementation.
2. In consultation with the evaluation department, consider ways to improve the evaluability of the strategic energy management initiative through documentation of the energy conservation measures leading to SEM savings with initial energy savings estimates.

Recommendations # 3 and #4 are for the evaluation team:

3. Work with the program to improve the evaluability of the strategic energy management initiative by developing standardized methods to monitor the progress of program participants for benchmarking impact of SEM activities and determining SEM energy savings.
4. Continue working with industry associations to explore energy savings methods to include natural conservation, market forces and business drivers, and persistence of SEM savings.

3.5 Conclusions

BC Hydro’s Leaders in Energy Management – Transmission program achieved 96 per cent of reported savings during fiscal years F2015 to F2017. The program also achieved high levels of customer awareness and satisfaction. Strategic energy management contributed to significantly higher levels of program activity and additional energy savings among participants.

4.0 Power Smart Partners – Load Displacement Initiatives Impact Evaluation: F2012-F2018

4.1 Introduction

This report presents the results of an impact evaluation covering the eight load displacement projects implemented during the period from F2012 to F2016. Since the program has ended and no new projects were implemented in F2017 and F2018 and operational data was available for all the projects, the evaluation period covers F2012 to F2018.[2] The projects were funded through the Power Smart Partners-Transmission (PSP-T) Integrated Power Offer (IPO) or Load Displacement (LD) program offers and were not included in the scope of any previous impact evaluations.

Load displacement projects are customer-based generation projects that self-supply part of the customer's site electrical load. For these projects, industrial, commercial and institutional customers received BC Hydro funding and program support to generate their own electricity for self-supply and offset their electricity purchases from BC Hydro. All customer-based generation projects over 50 kW were reviewed through the Integrated Customer Solutions (ICS) process. The load displacement project enabling activities were specifically designed to operate under the ICS framework and remove technical and financial barriers specific to self-generation projects. Load displacement projects were treated as having reduced customer energy purchases similar to energy conservation project initiatives for industrial transmission customers.

4.2 Approach

The evaluation objectives and research questions are summarized in the following table.

Table 4.4 Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Estimate gross electricity generation and peak demand impacts.	What were the evaluated gross electricity generation and demand impacts realized by load displacement projects aggregated by fiscal year and, to the extent possible, disaggregated by relevant factors*?
2. Estimate net electricity generation and peak demand impacts.	What were the relative magnitude of parasitic loads[3] and their energy use as related to the load displacement projects?
	What were the evaluated net electricity generation and demand impacts realized by load displacement projects aggregated by fiscal year and, to the extent possible, disaggregated by relevant factors?
	To what extent did parallel energy procurement initiatives[4] impact the net electricity generation of the load displacement projects?

* Relevant factors may include technology type, primary energy source, seasonal operating mode and operating strategy with other on-site process heat requirements that impact the net electricity generation.

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2 The Load Displacement initiative was no longer available after F2017.

3 Parasitic load is the electrical energy that is required for the operation of the load displacement project.

4 Other energy procurement initiatives include electricity purchase agreements, contracted generation baseline loads, and tariff treatments.

The objectives, data sources and methods used for this evaluation are shown in Table 4.2.

Table 4.1. Evaluation Objectives, Data and Method

Evaluation Objectives	Data	Method
1. Estimate gross electricity generation and peak demand impacts.	• Project files • Self-generation eMetering • Customer process requirements • Billing records and Customer Baseline Load (CBL) Statements[5]	• Annual measurement and verification results and evaluation review • Self-generation load shapes, capacity factors and peak-to-energy factors • Engineering calculations
2. Estimate net electricity generation and peak demand impacts.	• Load displacement feasibility studies • Reported savings • Project files	• Engineering estimates of parasitic loads • Annual measurement and verification results and evaluation review

Electricity self-generation impacts were evaluated over the period from F2012 to F2018 based on hourly interval data through annual measurement and verification or annual reconciliation of the site's total generation energy.

Objective 1: Estimate Gross Electricity Generation and Peak Demand Impacts

Evaluated gross electricity generation is the energy generated due to the program and estimated from the annual measurement and verification (M&V) results and billing records by fiscal year. Four of the eight projects underwent an annual measurement and verification process for the estimation of gross and net electricity generation. These four projects with M&V are load displacement projects where a new generator was installed. They are grouped in this evaluation under 'New Power Generation' and M&V results were used as the basis of the gross generation energy for evaluation review. The other four load displacement projects were due to refurbishment and upgrading of existing steam turbo-generators which resulted in incremental generation to already existing generation. These are grouped in this evaluation under 'Rebuilt Turbo Generator'. The annual gross incremental generation energy from the rebuilt units was verified by BC Hydro based on revenue metering data for each fiscal year and provided in the customer's billing records. For these projects, the customer's billing records were used as the basis of the gross generation energy for evaluation review.

The gross peak demand impact by the load displacement projects was estimated using the peak-to-energy factor of the total self-generation system at each site. These were evaluated based on hourly interval data during steady-state operations in winter by dividing the average generation power during peak periods by the load displacement project's annual generation energy.

Objective 2: Estimate Net Electricity Generation and Peak Demand Impacts

The net electricity generation is the difference between the energy delivered by the generator and the parasitic energy requirements. The evaluated parasitic energy was estimated based on recent actual performance as the most likely indicator of future performance of the load displacement project.

The parasitic energy estimate for the four New Power Generation projects with M&V was verified by the M&V group using engineering calculations and spot measurements when available. No M&V results were available for the four Rebuilt Turbo Generator projects and a deemed estimate of the incremental parasitic energy was applied based on the default assumption of 3 per cent of incremental gross generation energy[6] of the load displacement project.

5 CBL Statements are issued annually by BC Hydro for each customer on stepped rate schedule (RS1823B) that includes any adjustment made to a customer's energy bill for the purpose of Customer Baseline Load (CBL) administration.

6 U.S. Department of Energy (2017). *Uniform Methods Project, Chapter 23: Combined Heat and Power Evaluation Protocol.*

The evaluated net generation peak demand impact of the program was estimated using the same peak-to-energy factors determined for Objective 1, applied to the project-based M&V estimates for parasitic energy and metered load shapes of the generation energy. This assumed that the load shape of the parasitic energy is the same as the load shape of the generation energy.

It was not an objective of this evaluation to attribute changes in generation energy to the load displacement initiatives, which would take into consideration free ridership and spillover. In this evaluation, the term 'net generation impact' refers to the gross generation energy less parasitic energy and does not imply attribution to any intervening initiative. These load displacement projects were assumed to have no free ridership and non-existent spillover, for a net-to-gross ratio of one, for two reasons. First, all self-generation projects had to apply to BC Hydro for generator inter-connection and go through the integrated customer solutions process for review and evaluation. All of the eight load displacement projects in this evaluation were then directed to the load displacement capital incentive offer by BC Hydro and each project had its own business case developed with BC Hydro executive approval of the incentive amount. As a result of this process, BC Hydro does not expect that there was any free ridership with regard to the capital incentive. Second, all generation energy is metered and customers were required to service their self-generation contracts in a prescribed order which was verified by BC Hydro for billing purposes. As a result, any spillover of unreported generation energy is not considered to be possible.

4.3 Results

Results for Objective 1: Estimate Gross Electricity Generation and Peak Demand Impacts

Table 4.3 shows the number of load displacement projects implemented by fiscal year, as well as the cumulative rated capacity, the evaluated gross generation energy, and the evaluated gross peak demand impact. Results are given as cumulative due to the variation of project results with annual review through measurement and verification.

The peak-to-energy factor was evaluated for each project from hourly interval data based on the average power generated between December and February. Peak-to-energy factors are usually determined using winter weekday evening loads, to correspond with the BC Hydro system peak, but the variations of generated power between winter days of the week (weekday versus weekend) and winter hours of the day (evenings versus other hours of the day) were found to be negligible. The average evaluated peak-to-energy factor was found to be 0.126 MW per GWh, almost 8 per cent higher than the industrial transmission rate class average of 0.117 MW per GWh which is typically applied to energy conservation measures. This higher peak-to-energy factor resulted in a higher estimate of peak demand impact for load displacement projects.

A number of other factors were examined to assess the performance of load displacement projects in terms of system availability and capacity utilization. Detailed results discussed in the report indicate that all load displacement projects had excess capacity to potentially increase generation power and energy.

Table 4.3 Evaluated Cumulative Gross Generation Energy and Peak Demand Impact

Fiscal Year	Number of New Projects	Load Displacement Project Type	Cumulative Rated Capacity (MW)	Cumulative Evaluated Gross Generation Energy (GWh/year)	Cumulative Evaluated Gross Peak Demand Impact (MW)
F2012	2	2x Rebuilt Turbo Generator	26	167	21
F2013	1	1x New Power Generation	28	181	23
F2014	0	-	28	181	23
F2015	2	1x Rebuilt Turbo Generator 1x New Power Generation	31	204	25
F2016	3	1x Rebuilt Turbo Generator 2x New Power Generation	41	263	33
F2017	0	-	41	263	33
F2018	0	-	41	263	33

Objective 2: Estimate Net Generation Energy and Peak Demand Impacts

Table 4.4 summarizes key results by project type and shows the evaluated net generation energy after adjustment for parasitic energy.

Table 4.4. Net Generation Results by Project Type

	Group 1 Rebuilt Turbo Generator	Group 2 New Power Generation
Number of Projects	4	4
Rated Capacity (MW)	32.1	8.9
Evaluated Gross Generation Energy	204	59
Evaluated Net Generation Energy (GWh/year)	198	55
Parasitic Energy Factor	3%	6.5%
Peak-to-Energy Factor (MW/GWh)	0.129	0.117
Realization Rate[7]	91%	98%
Load displacement to facility energy ratio[8]	18%	14%
LD energy to total self-generation energy	25%	100%

Table 4.5 shows a summary of reported and evaluated net generation energy and peak demand by fiscal year. Year over year reporting of load displacement generation energy improved as the operation of the systems reached steady-state. However, there was a time lag because measurement and verification results or billing reconciliation for a given reporting year only became available after fiscal year-end and were then used as the best available estimate for the next year. Considering this time lag in reporting of variations in performance between fiscal years, the evaluated net generation energy was estimated on average to have achieved 96 per cent of the reported generation energy. The variance is primarily due to inconsistency in reporting of Rebuilt Turbo Generator projects, using their expected generation energy instead of the actual generation energy, and the lack of accounting of parasitic energy in reported savings for these projects. If the reported generation energy were adjusted for actual generation energy and estimated parasitic energy, the overall variance between reported and evaluated net generation energy of all eight load displacement projects would be reduced to less than one per cent.

7 Realization rate is the ratio of evaluated net energy generation to the expected generation energy, which is the contracted generation energy of the incentive agreement.

8 The load displacement to facility energy ratio indicates the proportion of site energy consumption that was displaced by the load displacement project on an annual basis.

9 The load displacement to total self-generation ratio indicates the proportion of total self-generation energy at the site that was contributed by the load displacement project on an annual basis.

Table 4.5. Summary of Net Generation Energy and Peak Demand Impact

Fiscal Year	Net Generation Energy (GWh/year)		Net Peak Demand Impact (MW)	
	Reported	Evaluated	Reported	Evaluated
F2012	254	162	30	20
F2013	254	176	30	22
F2014	195	176	23	22
F2015	215	196	25	25
F2016	271	253	32	32
F2017	260	253	30	32
F2018	262	253	31	32

4.4 Findings and Recommendations

Findings

1. Eight load displacement projects were evaluated for a total of 263 GWh per year in gross generation energy and 253 GWh per year in net generation energy. This resulted in 33 MW of gross peak demand impact and 32 MW of net peak demand impact.
2. Seven of the eight load displacement projects ranged from 1 MW to 5 MW in size and one exceeded 25 MW in rated capacity. Seven of the load displacement projects were considered combined heat and power and used biomass and bioenergy as the primary energy source.
3. The four Rebuilt Turbo Generator projects were found to have average availability, capacity and utilization factors of 94 per cent, 78 per cent and 72 per cent respectively. The other four projects were of the New Power Generation type and were found to have average availability, capacity and utilization factors of 91 per cent, 84 per cent and 76 per cent respectively.
4. The load displacement project realization ranged from 75 per cent to 107 per cent, with a weighted average project realization rate of 91 per cent for Rebuilt Turbo Generator and 98 per cent for New Power Generation type projects. The overall program realization rate was 92 per cent.
5. All projects undergo annual verification of the generation energy using hourly interval data. Rebuilt Turbo Generator load displacement projects had verification of actual gross generation energy recorded by BC Hydro, whereas New Power Generation projects underwent annual measurement and verification activities, recording both gross and net generation energy. The reported generation energy is adjusted yearly based on this annual review for all New Power Generation type projects but not for Rebuilt Turbo Generator type projects.
6. The generation energy provided in the customer's annual CBL Statements was found to be the best available estimate for projects without annual measurement and verification. These generation energy records explain most of the variance between reported and evaluated gross generation energy for Rebuilt Turbo Generator type load displacement projects.
7. The peak-to-energy factor was found to be 8 per cent higher than the industrial rate class average because six of the eight projects generated more power during BC Hydro's system

winter peak as a result of higher availability factors in winter months. Generator shutdowns and annual maintenance periods, which decreased overall availability, were observed to typically occur in the spring and summer months. Two projects had peak-to-energy factor lower than the industrial rate class average because of higher process heat requirements in winter.

8. Parasitic energy is the difference between gross and net generation energy and was evaluated at 3 per cent for Rebuilt Turbo Generator projects and 6.5 per cent for New Power Generation projects. New Power Generation projects have more auxiliary energy requirements than incremental generation projects from Rebuilt Turbo Generators. The parasitic energy explains most of the difference between reported and evaluated net generation energy.
9. The average weighted persistence of load displacement projects was estimated to be 16 years and ranging from 10 years to 20 years. The BC Hydro Persistence Standard indicates 20 years persistence for New Power Generation type projects and 15 years persistence for Rebuilt Turbo Generator projects. Any changes to generation energy and persistence are captured in the annual M&V and engineering review process.
10. The evaluation found evidence of continuous improvement of the utilization factor of three New Power Generation load displacement projects through the annual review and the M&V process. Project underperformance was observed due to restriction in condensing capacity, fuel supply, and electrical metering issues that were identified and corrected during the first three years of operating the load displacement projects.

Recommendations

The following recommendations are for the BC Hydro Load Displacement initiative managers based on the findings of this evaluation.

1. Continue to conduct annual review and measurement and verification of all load displacement projects for reporting of actual net generation energy per fiscal year.
2. The program should use the generation energy from customer's annual CBL Statements as the best available estimate when annual measurement and verification results are not available. These apply to Rebuilt Turbo Generator type projects at large industrial customer sites with transmission service that are on the stepped rate (RS 1823B).
3. The program should apply a 3 per cent reduction to the gross generation energy for projects without an engineering estimate of parasitic energy, i.e., load displacement projects of Rebuilt Turbo Generator type.

4.5 Conclusions

BC Hydro's load displacement initiatives achieved 92 per cent of expected generation energy during fiscal years F2012 to F2018. The New Power Generation projects achieved 98 per cent due to continuous improvement of project performance, whereas the Rebuilt Turbo Generator projects achieved 91 per cent due to overestimated utilization factor and underestimated parasitic energy. The evaluated net generation energy of both types of load displacement projects was found to produce an equivalent reduction in site energy purchases.

5.0 Glossary

ANCOVA: is a general linear model which blends analysis of variance (**ANOVA**) and regression to test the main and interaction effects of categorical variables on a continuous dependant variable, controlling for the effects of selected other continuous variables, which co-vary with the dependant.

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 behaviour.

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.

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

Evaluated Savings: Savings estimates reported after the energy efficiency activities have been implemented and an impact evaluation has been completed.

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 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 M&V results.

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.

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

Realization Rate: The ratio of initial estimates of savings to savings adjusted for data errors and M&V 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 M&V 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.

Impact Evaluation of the Commercial New Construction (CNC) Program: F2012-F2016

January 23, 2020

Prepared by:

BC Hydro Conservation and Energy Management Evaluation

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Executive Summary

Introduction

This report presents an impact evaluation of the BC Hydro Commercial New Construction program for BC Hydro fiscal years F2012 to F2016 (April 2011 to March 2016). The CNC Program was targeted at developers and the building design community who play a role in building and expanding commercial buildings in BC Hydro's service territory. Market actors included developers, building owners, architects, engineers, energy modellers and consultants.

The program's key objective is to obtain electricity energy savings by supporting the design and implementation of cost effective energy conservation measures beyond applicable building code requirements. There are associated capacity savings (MW) with this program that are derived from the energy savings resulting from the program's energy-focused DSM activities, not a result of capacity-focused DSM. The CNC Program provides direct savings for BC Hydro by supporting the following:

- Energy Efficient Design: identify energy savings by promoting and funding the design of energy efficient buildings (i.e., more energy efficient than the minimum building code legislation requires);
- Energy Efficient Construction: acquire energy savings by promoting and funding the construction of energy efficient buildings and offer training and education on the efficient operation of new buildings; and
- Training and Recognition: enable transformation of the market by training a team of industry professionals to act as energy conservation "ambassadors" (i.e., advocates) on all new construction projects that they work on in the future. In addition, to publicly recognize energy efficient design teams and projects and create a market where consumers highly desire energy efficient buildings.

The program had 4 offerings:

1. Whole Building Design: targeted at buildings over 50,000 square feet;
    a. Energy Modelling/Computer simulation of the whole building energy use
2. System Design: targeted at improving the energy efficiency of selected building systems in buildings typically over 50,000 square feet;
    b. Energy use analysis of a specific system (e.g., lighting, refrigeration, HVAC)
3. Energy Efficient Lighting Design: targeted at buildings typically over 10,000 square feet; and
    c. Energy use analysis for lighting. Reduction of light power density requirement from building code through design and controls
4. Program Enabled.
    d. Projects in which the customer engaged with BC Hydro, undertook a funded Energy Study and through this engagement the building design/equipment was influenced leading to energy savings. These measures did not receive a program incentive due to not meeting BC Hydro cost effectiveness ratios or due to failing to comply with program incentive offer timing and process.

The Commercial New Construction program is winding down, with all remaining applications scheduled to be completed in F2022. BC Hydro will continue to support the transformation of the commercial new construction market through codes and standards activities that support the B.C. Energy Step Code.

Approach

The evaluation addressed five objectives each with related research questions, as presented in Table ES. 1.

Table ES.1. Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Assess the participant experience	• What is the level of participant awareness of the various CNC program components? • How do participants rate their program experience and overall satisfaction? • How influential is the CNC program on participant decisions around energy efficiency?
2. Assess practices and opinions related to market transformation	• What are the most common types of design studies being conducted in view of helping to make new construction projects perform better than code? (e.g., whole building energy modelling, a refrigeration system design study, and/or a lighting design study) • What are the most common measures being implemented to help make new construction projects perform better than code? • To what extent do market actors believe the commercial new construction market in the province has improved over the last 10-15 years? • How much electricity do market actors believe new construction projects are saving relative to the energy efficiency requirements in the B.C. Building Code?
3. Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements	• To what extent has the CNC program developed support for design and construction of more energy efficient buildings (beyond code requirements) among commercial new construction market actors (designers, builders, mechanical engineers, architects etc.)? • To what extent and through which activities is the CNC program influencing building design practices and the new construction market beyond incented projects?
4. Estimate gross energy and peak demand savings	• What are the gross and peak demand savings?
5. Estimate net energy and peak demand savings	• What are the net energy and peak demand savings for the overall CNC program? • What are the free ridership, participant spillover and non-participant spillover rates?

The data sources and analytical methods used to address the objectives are summarized in Table ES.2.

Table ES.2. Evaluation Objectives, Data and Methods

Evaluation Objective	Data	Methods
1. Assess the participant experience	• Participant Survey (n=57)	• Cross tabulations
2. Assess practices and opinions related to market transformation	• Market Actor Survey (n=13-30)	• Cross tabulations
3. Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements	• Market Actor Survey (n=13-30)	• Cross tabulations
4. Estimate gross energy and peak demand savings	• Program tracking data • Measurement and verification (n=12)	• IPMVP Option A, B and D • Ratio estimation • Peak demand savings based on peak-to-energy factor
5. Estimate net energy and peak demand savings	• Statistics Canada data on commercial new construction activity, F2012-F2016 • Participating building area (square metres) • Conservation Potential Review (CPR) Energy Use Intensity (EUI) inputs • Results from Objective 4 • Participant survey (n=51) • Market actor survey (n=13-30)	• Survey based free ridership and participant spillover algorithms • Market Actor Survey based non-participant spillover algorithm

Results

The results of the evaluation are presented by objective.

Results for Objective 1: Assess the participant experience

Among program participants, 79 percent reported being aware of the CNC offer by name. Of the individual program components, awareness, understanding and rating score was highest for the role that key account managers play as liaisons between CNC and participants.

Overall satisfaction was high for CNC at 80 percent, comprised of 41 percent stating they were very satisfied and 39 percent stating they were somewhat satisfied. When asked the likelihood of recommending the program to others, 95 percent indicated that they definitely (53%) or probably (42%) would, and 49 percent reported that they had in fact already done so.

A total of 80 percent of participants indicated that CNC was very (33%) or somewhat (47%) influential on the decision to implement the energy efficient measures at this site. Looking more broadly at conservation motivators, 60 percent of participants indicated that the CNC program was a 'major factor' in the organization's effort to manage electricity use over the past year. In terms of barriers to managing electricity use, lack of funds for energy efficient retrofits/projects was noted as a 'major barrier' by 33 percent of participants, followed by there being other operational priorities (29%) and lack of financial incentives for conservation programs and energy efficiency (26%).

Results for Objective 2: Assess practices and opinions related to market transformation

With regards to buildings that did not participate in the CNC program, but that market actors reported were performing better than the energy efficiency requirements of the B.C. Building Code, the most common type of design study conducted to help these buildings perform better than code was whole building design, with on average approximately two-thirds of respondents confirming that at least some floor area of their 'better than code, non-participating projects' had come through this study type. This was followed by lighting design studies, with about 44 percent of respondents, on average, confirming at least some floor area had come through this study type.

Again, with regards to buildings that did not participate in the CNC program but that were performing better than code, by far the most common measure being implemented to help make these buildings perform better than code was highly efficient lighting, with 83 percent of respondents reporting that the measure was at least sometimes implemented in their 'better than code, non-participating projects. This was followed by HVAC measures at 64 percent.

Market actors, including electrical engineers, mechanical engineers, energy modellers, architects and project managers, were asked how much they thought energy efficiency had improved in the entire commercial new construction market in B.C. over the past 10 to 15 years. All had thought that there had been some improvement over the past 10 to 15 years – although not necessarily beyond code – with the majority (55%) reporting a 20 percent improvement. Additionally, all thought that both their own buildings and those constructed by other firms were performing better than code specifically in regards to electricity savings. Savings were reported in the 1 percent to 30 percent range, with about half of respondents perceiving that their own buildings had 20 percent to 30 percent electricity savings relative to code, compared to only about one-third feeling the same way about buildings constructed by others.

Results for Objective 3: Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements

A total of 91 percent of respondents had experience with at least one of the energy efficiency resources or touchpoints provided by the program. The most common were *discussions about projects with BC Hydro staff* (70%) and *reviewing case studies/resource literature* (64%). This was followed by 60 percent who had *attended a program workshop or training session* and 40 percent who had re*viewed the Building Envelope Thermal Guide*. The least commonly used resource was the *Enhanced Thermal Performance Spreadsheet*, with only 21 percent of respondents indicating they had reviewed it.

Market actors were asked to consider all of their various touchpoints with the program and the influence that these had on their design decisions to have non-participating projects perform better than the building code. A total of 60 percent indicated that these program touchpoints were 'very' or 'somewhat' influential on their decisions to do so.

In order to understand program influence relative to other factors in the broader new construction context, market actors were asked to credit various factors for making non-program projects perform better than the B.C. Building Code, such that the factors summed to 100 percent. On average, BC Hydro 'drivers' were given a net of 24 percent of the credit for making projects perform better than code. It follows that non-BC Hydro drivers were given 76 percent of the credit for buildings performing better than code.

Another approach to assessing program influence was to query market actors on how much of the improvement in the energy use over time – although not necessarily beyond code – could be attributed to BC Hydro's Commercial New Construction program. About half (49%) felt it was in the 20 to 30 percent range, with the most common answer at 20 percent.

Results for Objective 4: Estimate gross energy and peak savings

The evaluated gross savings in fiscal year covered by the evaluation period are presented in Table ES.3. Evaluated gross electricity savings ranged from 9.2 GWh/yr to 24.2 GWh/yr from F2012 to F2016, with the most savings occurring in F2014 and the least occurring in F2012.

Table ES.3. Summary of Evaluated Gross and Net Energy and Peak Demand Savings

Year	Evaluated Gross Energy Savings (GWh/yr)	Evaluated Gross Peak Demand Savings (MW)	Calculated Net-to-Gross Ratio	Evaluated Net Energy Savings (GWh/yr)	Evaluated Net Peak Demand Savings (MW)
F2012	9.2	1.3	0.91	8.4	1.2
F2013	19.9	2.8	0.96	19.2	2.8
F2014	24.4	3.5	0.93	22.7	3.2
F2015	18.8	2.7	0.95	17.9	2.6
F2016	20.6	3.0	0.99	20.4	2.9
CNC (F12-F16)	**92.9**	**13.3**	**0.95**	**88.6**	**12.7**

Results for Objective 5: Estimate net energy and peak savings

The evaluated net savings in fiscal year covered by the evaluation period are presented in Table ES.4. Evaluated net electricity savings ranged from 8.4 GWh/yr to 22.7 GWh/yr from F2012 to F2016, with the most savings occurring in F2014 and the least occurring in F2012.

Table ES.4. Summary of Net Energy and Peak Demand Savings

Fiscal Year	Net Energy Savings (GWh/yr)		Net Peak Demand Savings (MW)	
	Reported	Evaluated	Reported	Evaluated
F2012	8.1	8.4	1.1	1.2
F2013	15.3	19.2	2.2	2.8
F2014	20.7	22.7	3.0	3.2
F2015	14.0	17.9	2.0	2.6
F2016	15.3	20.4	2.2	2.9
CNC (F12-F16)	**73.4**	**88.6**	**10.5**	**12.7**

The cumulative variance between the reported net energy savings and evaluated energy savings was 15.2 GWh/yr. The largest variance occurred in F2016 with a difference of 5.10 GWh between reported and evaluated savings.

Overall, the program achieved 121 percent of reported savings during fiscal years F2012 to F2016, showing the program performed better than reported. The variance between reported and evaluated net savings is primarily due to the impact of non-participant spillover which was estimated in the evaluation.

Findings and Recommendations

Findings

Participant Experience

1. Overall satisfaction was high for CNC at 80 percent, comprised of 41 percent stating they were very satisfied and 39 percent stating they were somewhat satisfied.

2. In terms of program experience, the highest scores related to aspects around service/communications from BC Hydro, as well as service provided by contractors. Mid-range scores typically related to aspects around the program offer (variety of products and level of incentives) and the overall application procedures. The lowest scores were for length of time to receive the incentive, length of time for the project/process to be completed and direct mail/email about the program (which was not relied on heavily by this program).

3. Participants reported that the program had been influential on their decision to implement the energy-efficient measures, with 33 percent indicating that it had been very influential and 47 percent indicating it had been somewhat influential.

Market Transformation

4. All market actors thought that there had been some improvement in the entire commercial new construction market in B.C. over the past 10 to 15 years – although not necessarily beyond code – with the majority reporting a 20 percent improvement in terms of energy use over time.

5. The most common types of design study conducted to help new construction projects perform better than code were whole building design and lighting design. The most common measures implemented to help projects perform better than code were lighting and HVAC.

Influence on Adoption of Energy Efficiency Measures Beyond Building Code Requirements

6. On average, BC Hydro 'drivers' were given a net of 24 percent of the credit for making projects perform better than code, with the largest credit given to previous learnings and experience with the CNC program. The remaining 76 percent of credit was given to non-BC Hydro drivers, with the largest given to general industry innovation/good practices and to clients directing the projects to be built as such.

Gross Electrical Energy Savings

7. The evaluated gross energy savings were 93 GWh/yr.

8. The program gross realization rate calculated using the inspected and verified results including cross effects was 1.06, indicating that the energy conservation measures largely performed better than expected. The realization rates by program offer were 1.17, 1.04, 0.89 and 0.89 for whole building design, system design, lighting design and program enabled projects, respectively.

9. Expected energy savings averaged 18 percent of site energy consumption across all participants during the five-year evaluation period.

Net Electrical Energy Savings

10. The evaluated net energy savings were 89 GWh/yr.
11. The net-to-gross ratio was 95 percent based on free ridership of 20 percent, participant spillover of 1 percent and non-participant spillover of 14 percent.
12. Evaluated net savings during the evaluation period from F2012 to F2016 averaged 121 percent of reported savings.

Recommendations

The following two recommendations are for future new construction initiatives:

1. Support and enabling activities for whole building energy modelling and integrated system approach to estimate a project's energy savings should continue and include the Building Envelope Thermal Bridging Guide and the Enhanced Thermal Performance Spreadsheet.
2. Future Market Actor surveys could be done more frequently so that respondents are better able to recall the projects they are being surveyed about.

Conclusions

BC Hydro's Commercial New Construction Program achieved high participant satisfaction. Evaluated net savings were 89 GWh/yr, which is 121 percent of reported savings. Evidence suggests that the program has supported the market in complying with and exceeding the energy efficiency requirements of the B.C. Building Code.

1.0 Introduction

Evaluation Scope

This impact evaluation presents the evaluated net electricity savings of the BC Hydro Commercial New Construction (CNC) program for fiscal years F2012 to F2016 (April 2011 to March 2016).

Due to the time it takes for construction, and occupancy of buildings, a fairly long delay was required before Measurement and Verification (M&V) of a representative sample of buildings that went through the CNC program could be completed. This is why the evaluation period goes back so far and stops at F2016. Additionally, this will mark the final evaluation of the CNC program as all active applications are scheduled to be completed in F2022 and no new applications are being accepted. Therefore, the remaining years of the program (F17-F22) will not be evaluated.

Organization of the Report

The organization of this report is as follows. Section 1 covers the evaluation scope, the organization of the report and the initiative description. Section 2 discusses the approach to the evaluation, including evaluation objectives, methodology review, data sources, and methods. Section 3 provides the results organized by evaluation objective. Section 4 provides findings and recommendations. Section 5 provides conclusions. Additional supporting material is contained in the appendices.

Initiative Description

The CNC Program was targeted at developers and the building design community who play a role in building and expanding commercial buildings in BC Hydro's service territory. Market actors included developers, building owners, architects, engineers, energy modellers and consultants. The key objectives of the CNC program were as follows:

1. Energy Efficient Design: Identify energy savings by promoting and funding the design of energy efficient buildings (i.e., more energy efficient than the building code legislation requires).

2. Energy Efficient Construction: Acquire energy savings by promoting the construction of energy efficient buildings and continued efficient operation.

3. Training and Recognition: Enable transformation of the market by training a team of industry professionals to act as energy conservation "ambassadors" (i.e., advocates) on all new construction projects that they work on in the future. In addition, publicly recognize energy efficient design teams and projects and create a market where consumers desire energy efficient buildings.

4. Advance Building Codes: Support the transformation of the new building market to higher sustained levels of energy efficiency and improved building code compliance. The program's activities help drive developer acceptance to a level where they are accepting of the next phase of more stringent building codes and standards introduced by government.

As noted in the fourth key objective above, the program was designed to support increases in the energy efficiency requirements in building codes. The term "code" or "building code" in this report refers specifically to the energy efficiency requirements of the B.C. Building Code or the Vancouver Building By-law. Although identified as part of the objective, any savings realized by meeting code requirements are not attributed to the program.

The program had 4 offerings:

1. Whole Building Design: Targeted at buildings over 50,000 square feet.
2. System Design: Targeted at improving the energy efficiency of selected buildings systems typically over 50,000 square feet.
3. Energy Efficient Lighting Design: Targeted at buildings typically over 10,000 square feet.
4. Program Enabled:
    - Projects in which the customer engaged with BC Hydro and undertook a funded Energy Study through which the building design/equipment was influenced, leading to energy savings. The savings for this offer were from customer-funded energy conservation measures. These measures are not incented due to not meeting BC Hydro cost effectiveness ratios or due to failing to comply with program incentive offer timing and process.

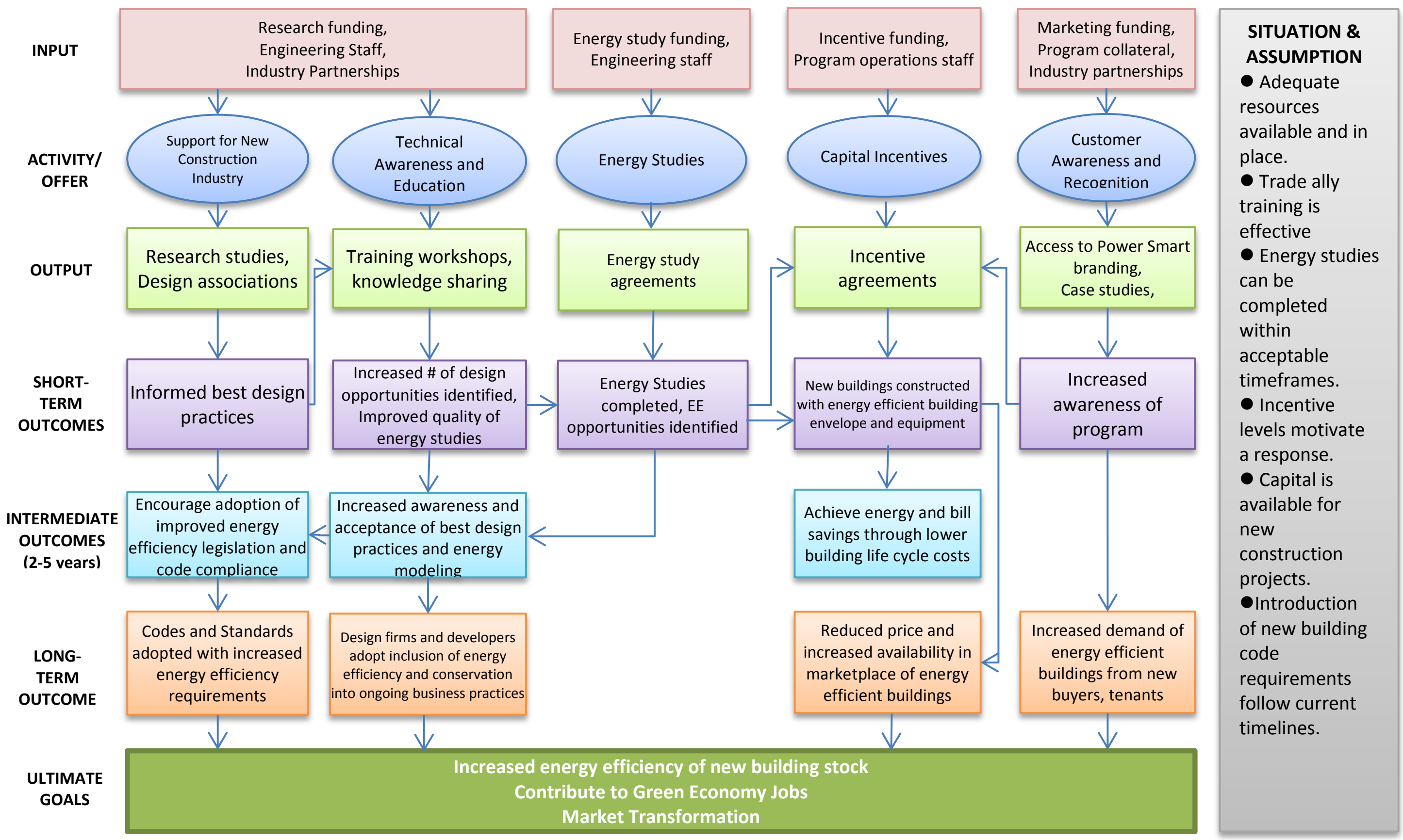
Table 1.1 Program Offers

	Whole Building Design ("Leaders')	System Design (Identified Too Late, Immature Mindshare)	Energy Efficient Lighting Design
Overview	Computer simulation of the whole building energy use	Energy use analysis of a specific system (e.g. lighting, refrigeration, HVAC)	Energy use analysis for lighting. Reduction of light power density requirement from building code though design and controls.
Target Market	• > 50,000 ft^2 ~> 50,000 kWh savings • Buildings with complicated systems • Engineered buildings • Market Leaders • Engaged developers in EE • Part 3 building code • Includes major renovations or major leasehold improvements	• >50,000 kWh savings • Buildings with complicated systems • Market Leaders & Followers • Engaged developers • Part 3 building code	• > 10,000 kWh savings • ~> 10,000 ft2
Building Types	• Office • Institutional • Multi unit residential building (MURB) • Commercial • Large retail	• Office • Institutional • MURB • Commercial • Large retail • Recreation • Supermarket	• Office • Institutional • MURB • Commercial • Large retail • Recreation • Supermarket
Applicable Components	• All electrical energy conservation measures, including building envelope	• All electrical conservation systems: o Lighting o HVAC o Refrigeration	• Lighting • Lighting controls
Incentive	• Fund Energy Study (100%) • Tiered Capital Incentive based on kWh saving	• Fixed Incentive based on kWh Saving • Select study funding (cap at $10k) on complex systems	• Fund lighting calculator (up to $1K) • Fixed Incentive based on kWh Saving

As noted above, the Commercial New Construction program is winding down, with all remaining applications scheduled to be completed in F2022. BC Hydro will continue to support the transformation of the commercial new construction market through codes and standards activities that support the B.C. Energy Step Code.

The program logic model depicts the main inputs, activities and outputs associated with program design and delivery as well as their connection to and the interconnections between the expected short, medium and longer-term outcomes. The logic model for CNC can be found below.

Figure 1.1. Logic Model



2.0 Approach

Evaluation Objectives

The evaluation addressed five objectives and their related research questions as presented in Table 2.1.

Table 2.1. Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Assess the participant experience	• What is the level of participant awareness of the various CNC program components? • How do participants rate their program experience and overall satisfaction? • How influential is the CNC program on participant decisions around energy efficiency?
2. Assess practices and opinions related to market transformation	• What are the most common types of design studies being conducted in view of helping to make new construction projects perform better than code? (e.g., whole building energy modelling, a refrigeration system design study, and/or a lighting design study) • What are the most common measures being implemented to help make new construction projects perform better than code? • To what extent do market actors believe the commercial new construction market in the province has improved over the last 10-15 years? • How much electricity do market actors believe new construction projects are saving relative to the energy efficiency requirements in the B.C. Building Code?
3. Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements	• To what extent has the CNC program developed support for design and construction of more energy efficient buildings (beyond code requirements) among commercial new construction market actors (designers, builders, mechanical engineers, architects etc.)? • To what extent and through which activities is the CNC program influencing building design practices and the new construction market beyond incented projects?
4. Estimate gross energy and peak demand savings	• What are the gross and peak demand savings?
5. Estimate net energy and peak demand savings	• What are the net energy and peak demand savings for the overall CNC program? • What are the free ridership, participant spillover and non-participant spillover rates?

Methodology Review

A methodology review covering evaluation protocols and standards, as well as completed evaluations was undertaken to assess common methods used for evaluations of commercial new construction programs. Evaluations were identified through a search of various industry associations and energy program organizations, such as the U.S. Department of Energy, the California Measurement Advisory Council (CALMAC), the U.S. Department of Energy's Uniform Methods Project (UMP), the International Energy Program Evaluation Conference (IEPEC), the American Council for an Energy Efficient Economy (ACEEE), and the Northwest Energy Efficiency Alliance (NEEA). Past BC Hydro evaluations were also reviewed. Recommended evaluation methods are summarized below, along with common methods used in other evaluations.

In general, the recommended approach to estimating evaluated gross energy savings for new construction is to conduct M&V of a sample of projects, and extrapolate findings to the population of all projects. M&V methods included calibrated whole building modelling as well as sub-metering of individual energy end uses and systems, guided by the International Performance Measurement and Verification Protocol (IPMVP). The U.S. Department of Energy's Uniform Methods Project includes several protocols for determining energy efficiency savings for a variety of commercial and industrial end-uses and equipment measures including a protocol for new construction[1].

A literature review of evaluations from BC Hydro and other jurisdictions was conducted to inform this evaluation. The purpose of the literature review was to understand the scope, and evaluation methods employed in recent evaluations of new commercial construction programs. Studies were identified for potential inclusion in the literature review through a search of energy efficiency association websites as well as an internet search. To be included in this literature review, the study had to meet the following criteria: (1) the scope and objectives of the study had to be clear and well defined; and (2) the methods used to evaluate net and gross energy savings had to be clearly identified and transparent.

All of the studies examined focussed on verifying installation of equipment receiving an incentive, estimating gross savings for a sample of projects using suitable M&V methods, and aggregating individual project savings to estimate total gross savings. Most studies estimated a net-to-gross ratio using information from participant and trade ally surveys, typically multiple questions with an algorithm used to aggregate responses. The methods used to estimate gross savings were generally consistent with the IPMVP. Comparison and control groups were not employed in any of the evaluations reviewed.

The Uniform Methods Project protocol for evaluating net savings requires that, at a minimum, a free ridership adjustment is applied to evaluated gross savings[2]. The protocol also indicates that gross savings can be adjusted for spillover (participant and non-participant), but this is discretionary. An acceptable method outlined in the protocol for estimating free ridership and spillover is to use survey responses of program participants regarding the decisions they would have made in the absence of the program and how much the program influenced their decision to undertake specific energy savings activities. Free ridership estimates for programs that involved projects with complex, lengthy, multi-party decision making are increasingly derived using multiple lines of evidence. These lines of evidence commonly include participant survey data supplemented by information from sources such as program files, vendor surveys, or case studies. Using multiple lines of evidence to estimate free ridership in these complex situations has been the approach taken in BC Hydro's recent evaluations of its large industrial and new plant design programs due to small sample sizes and the complexity of decision-making around projects. Less common in other impact evaluations was the inclusion of an adjustment for spillover savings for participants and, particularly, for non-participants. Similar to the estimation of free ridership, the most common approach to estimating spillover was to use surveys of decision makers. Spillover was estimated this way for BC Hydro's most recent impact evaluations of BC Hydro's commercial and industrial programs[3].

[1] Uniform Methods Project: Chapter 15: Commercial New Construction Evaluation Protocol (September 2017)

[2] Uniform Methods Project, Chapter 21: Estimating Net Savings - Common Practices (October 2017)

[3] BC Hydro (2019). Leaders in Energy Management – Commercial: F2013-F2017; BC Hydro (2018). *Power Smart Partner – Industrial Distribution: F2011 to F2016*. BC Hydro (2017). *Power Smart Partner – Industrial Transmission: F2012 to F2014*.

Methodology

The data sources and methods used to address each evaluation objective are summarized in Table 2.2.

Table 2.2. Evaluation Objectives, Data and Method

Evaluation Objectives	Data	Method
1. Assess the participant experience	• Participant Survey (n=57 respondents)	• Cross tabulations
2. Assess practices and opinions related to market transformation	• Market Actor Survey (n=13-30)	• Cross tabulations
3. Assess the influence of the program on the adoption of energy efficiency measures beyond building code requirements	• Market Actor Survey (n=13-30)	• Cross tabulations
4. Estimate gross energy and peak demand savings	• Program tracking data • M&V (n=12)	• IPMVP Options A, B and D • Probability Proportional to Size (PPS) ratio estimation • Peak demand savings based on peak-to-energy factor
5. Estimate net energy and peak demand savings	• Statistics Canada data on commercial new construction activity, F2012-F2016 • Participating building floor area (sq. metres) • CPR, EUI inputs • Results from Objective 4 • Participant survey (n=51 projects) • Market actor survey (n=13-30)	• Survey based free ridership and participant spillover algorithms • Market Actor Survey based non-participant spillover algorithm

Data and Methods for Objective 1: Assess Participant Experience

The main source for addressing Objective 1 was an online survey of program participants, conducted in multiple waves. The first wave of the participant survey was fielded in May 2013 (covering projects completed in F2012), followed by a second wave in July/August 2014 (covering projects completed in F2013 and F2014). After that, the participant survey was conducted every six months on an ongoing basis in May and November (covering projects completed within the past 6 months). Details on the survey method are included in Appendix C.1 and questionnaire is included in Appendix F.

A total of 57 surveys were completed by F2012-F2016 program participants, representing an overall response rate of 41 percent and covering 20 percent of all square footage that came through the program. Although the returned sample was generally representative of the population based on known population parameters, the data were statistically weighted to further align it with the known population (by square footage and industry sub-sector for cross tabulations and by project savings for free ridership). Note that of the 57 survey respondents, only 51 were able to fully answer the free rider section. These 51 projects represented 17 percent of total projects completed and 18 percent of energy savings reported by the program during the evaluation period. The survey sample and population sizes by program offer are summarized in Table 2.3 on the following page.

Table 2.3. Participant Sample Size and Population

	Eligible Population	Surveys Sent	Responses Received	Response Rate	Margin of Error at the 95% Confidence Level
CNC Participants	284 sites	140	57	41%	+/- 11.6%

Data and Methods for Objective 2: Assess Practices and Opinions Related to Market Transformation

Objective 2 was addressed through results of a Market Actors Survey. This survey was administered in March 2018, aiming to solicit the views of professionals in British Columbia's commercial new construction industry who had decision making roles regarding the extent that their past projects would be energy efficient.

If not a key decision maker, candidates for this research were also screened based on the requirement to have held positions whereby they regularly provided inputs, alternate options and/or their opinions on the extent that their past new construction projects – those that became occupied between 2012 and 2016 – would be energy efficient.

The survey was conducted online due to the fact that a self-administered approach afforded these professionals the flexibility to complete it at their leisure and the time to formulate and express well-considered responses to the number of comprehensive questions being asked of them.

Potential candidates for this research were sourced via two parallel and complementary methods – one direct and one indirect. First, survey invitations were directly emailed to approximately 300 industry professionals for which business contact information (i.e., email addresses) was ascertained from internal databases and publicly available lists. Second, an invitation to participate in this research was indirectly made by embedding the communications into various industry association e-newsletters and online bulletin boards.

Ultimately, the final sample was comprised of 30 such professionals, primarily electrical engineers, mechanical engineers, energy modellers, architects and project managers. An accompanying response rate and margin of error is not presented due to the nature of the methodology and the fact that the total population size of eligible professionals is not specifically known with any certainty.

See Appendix C for more details in regards to this survey and Appendix E for the survey instrument.

Data and Methods for Objective 3: Assess the Influence of the Program on the Adoption of Energy Efficiency Measures Beyond Building Code Requirements

Objective 3 was addressed with the Market Actors Survey discussed above. Specifically, the survey asked industry professionals about drivers for making projects perform better than the energy efficiency requirements in the B.C. Building Code and BC Hydro influence.

Data and Methods for Objective 4: Estimate Gross Energy and Peak Demand Savings

In order to address Objective 4 and understand the estimation of evaluated gross savings, it is useful to understand the steps in the BC Hydro project cycle through which energy savings were initially estimated, then reviewed and verified for the different program components. The approach to estimate the evaluated gross energy savings include the following four steps and highlights the three components of the gross realization rate:

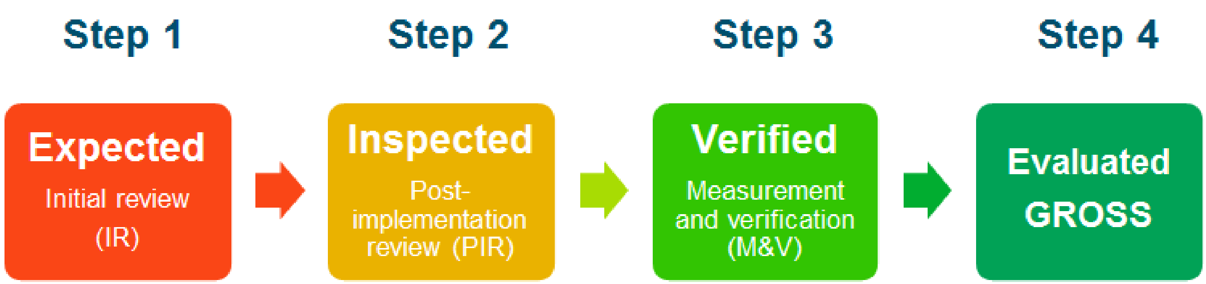
Step 1: Expected savings and initial engineering review.

Step 2: Inspected savings and component of realization rate for projects without post-implementation review.

Step 3: Verified savings and component of realization rate for projects without M&V.

Step 4: Evaluated savings and component of realization rate for cross effects where applicable.

Figure 2.1. Estimating Energy Savings Steps



In mathematical form, the gross evaluated savings were calculated by program offer according to the following equation.

Equation 1

$$Gross\ Evaluated\ Savings_j = Expected_i \times \left(\frac{Inspected}{Expected}\right)_j \times \left(\frac{Verified}{Inspected}\right)_j \times \left(1 - Cross\ Effects_j\right)$$

where $Expected_i$ is the expected savings for all projects (i) and the ratios were estimated from a sample of projects within each program offer (j)

Step 1: Expected Savings by Initial Review (IR)

All projects in the evaluation scope had an engineering review conducted by BC Hydro staff which was considered the expected energy savings for each measure in the project. In general, the initial engineering estimate of a project's energy savings was based on a technical application of engineering principles to forecast assumptions of hours of use and energy performance data. For the Whole Building Design and System Design offers, this estimate was documented in an energy study and resulted from whole building energy modelling or integrated system based energy calculation during design and construction. For the Lighting Design offer, the initial engineering estimate was based on a custom prescriptive approach and calculated by measure in the program lighting calculator tool using the applicable energy code as the baseline. For program enabled projects, the initial energy savings estimate was also based on an engineering estimate of a project's predicted energy savings before project implementation. Table 2.4 on the next page lists the count of projects, the count of measures and the expected savings by program offer.

Table 2.4. Expected Energy Savings by Program Offer

Program Offer	Approach	Count of Projects	Count of Measures	Expected Savings (GWh/yr)
Whole Building Design	Whole building energy modelling	95	665	53.4
Lighting Design	BC Hydro Lighting Calculator Tool	169	300	29.2
System Design	System based energy calculation	13	25	2.9
Program Enabled	Energy modelling or system calculation	7	35	1.8
Overall CNC F12-F16		**284**	**1,025**	**87.3**

Step 2: Inspected Savings by Post-implementation Review (PIR)

Energy savings estimates for most of the projects were refined through a post-implementation review (PIR). The purpose of the review is to confirm equipment installation and operation through various means such as examining customer-submitted project records and photos or physical site inspections. Not all projects in the Lighting Design offer were selected for post-implementation site inspections, especially if these projects were smaller in size and involved technologies with well-established engineering estimates.

Tag-on savings are energy savings that are generated above and beyond a project's original contract scope, for example when additional products are installed by the customer compared to what was outlined in the agreement. Tag-on savings do not impact incentives, but are recognized and reported by the program during post implementation review of lighting projects only. Tag-on energy savings were identified during post-implementation review on 11 projects for a total of 1,335 MWh per year.

Energy savings of projects without PIR were estimated based on the ratio of PIR over IR savings using ratio estimation method. The following table provides an overview of the coverage and method for estimation of these results.

Table 2.5. Coverage and Method of Post-implementation Review Savings by Program Offer

Program Offer	Coverage of Number of Projects with PIR	Coverage of Energy Savings with PIR	Method for estimation of (PIR/IR) ratio
Whole Building Design	100%	100%	Calculated
Lighting Design	89%	71%	Ratio estimation
System Design	100%	100%	Calculated
Program Enabled	100%	100%	Calculated

Step 3: Verified Savings by M&V

A subset of Whole Building Design and System Design projects was subject to M&V to validate the energy savings of the implemented measures. M&V was undertaken in accordance with the International Performance Measurement and Verification Protocol (IPMVP) for whole building design projects and inspired by IPMVP principles for system design projects. M&V involved energy modelling and simulation of variables that have a significant impact on energy consumption combined with post-implementation energy metering. To conduct this impact evaluation, a sample of twelve projects was selected for M&V. The sampling method used stratified sampling by savings magnitude and program offer for an overall target confidence of 80 percent and relative precision of 20 percent.

The fundamental equation for estimating energy savings is given by the following equation.

Equation 2: M&V Savings Estimation

kWh Savings = ($kWh_{baseline}$ – $kWh_{energy\ efficient}$) ± Routine Adjustments ± Non-Routine Adjustments

where:

$kWh_{baseline}$ is the estimated baseline energy consumption of the system as determined by the energy study and/or engineering review completed as a condition of program participation

$KWh_{energy\ efficient}$ is the M&V estimate of consumption of the installed energy efficient system. This estimate is based on data collected using power meters, current transformer meters, or hours of use loggers, as well as verification of equipment counts through site visit.

Routine Adjustments are for any energy-governing factors, expected to change routinely during the reporting period, such as weather or schedule of operation.

Non-Routine Adjustments are for those energy-governing factors which are not usually expected to change, such as: the facility size, the design and operation of installed equipment, the number of weekly production shifts, or the type of occupants. These static factors must be monitored for change throughout the reporting period.

The approach to M&V differed between projects that went through the program's system design and whole building design offers.

System Design

Three projects that had participated in the system design offer underwent M&V using principles of IPMVP Option A and D[4]. Each project consisted of one or more conservation measures in energy efficient refrigeration systems at a unique building site. The M&V approach involved continuous measurements on a sample of components of the refrigeration system for a duration of three months, followed by engineering analysis to estimate the electricity savings from the energy conservation measures.

Whole Building Design

Nine building parcels that had participated in the whole building design offer underwent M&V using Option D of the IPMVP. The Cadmus Group and RDH Building Engineering Ltd. (RDH) were retained by BC Hydro to undertake this work. Under this approach, an "as-built" whole building energy simulation model was

[4] A combination of the concept of measure isolation (Option A) and calibrated simulation (Option D) was considered an acceptable approach as the engineering principles of the measures and systems are well established and control for the interactive effects within the system boundary through computer simulation.

developed based on the actual construction, systems, and operation of the building. The model was then calibrated such that it aligned with metered energy consumption data for the building. Once an acceptable calibration was achieved, a baseline model was developed by removing the energy conservation measures (ECMs) that went beyond building code requirements from the calibrated as-built model. Savings were determined by subtracting energy consumption for the calibrated as-built model from the calibrated baseline model. This M&V methodology is broken down into the following steps.

1. Data Collection: Information on the building is collected, including the design, as-built, and operating conditions, as well as metered utility energy consumption data (electricity and thermal energy). A site visit is conducted to meet with the building manager and review operational conditions.

2. Whole Building Energy Modelling: An energy simulation model of the building is developed based on the as-built and as-operated conditions determined through the data collection task. The model is calibrated to align with utility-metered energy consumption data by adjusting inputs that are not known with a high degree of certainty, such as plug loads. Modelling uncertainty[5] was determined using ASHRAE Guideline 141 for calibrating to monthly utility bills. Once an acceptable calibration has been obtained, a baseline or reference model is developed by removing energy conservation measures from the calibrated model.

3. Analyze results. Energy savings were determined by comparing the calibrated model to the baseline model and provide whole facility savings only. Energy savings of individual measures cannot be extrapolated due to the interactive effects.

Option D M&V controls for the effect of parallel DSM initiatives by using the measure level savings as an input to the analysis. The measure level savings were developed based on the engineering analysis of measures implemented through the CNC program, and only include savings that go beyond building code requirements. Option D M&V will produce savings estimates that include electricity cross effects, to the extent that they exist.

M&V Sample Coverage

The final M&V sample was assessed to compare it to the population of projects without M&V. The overall program M&V coverage was 7 percent in terms of electric energy savings, and it was estimated at 5 percent in terms of affected floor area. In order to extrapolate the M&V results to the population of projects that did not undergo M&V, projects were stratified according to the magnitude of their savings. The sample was drawn using the probability proportional to size method and the M&V results analyzed using ratio estimation by savings size in order to obtain the most reliable program realization rate estimate[6]. Results of sampling, confidence and precision are discussed in section 3.6.

[5] The Coefficient of Variation of the Root Mean Square Error (CVRMSE) must be less than 15%, while the Normalized Mean Bias Error (NMBE) must be less than 5%.

[6] The target for sampling error and ratio estimation is a confidence level of 80% or better with a relative precision of 20% or better.

The seven program enabled projects were a mix of whole building design and system design projects that were not included in the M&V sampling and therefore not evaluated using ratio estimation.

Table 2.6. Coverage and Method of M&V Savings by Program Offer

Program Offer	Coverage of Number of Projects with M&V	Coverage of Energy Savings with M&V	Method for estimation of (MV/PIR) ratio
Whole Building Design	9%	11%	Ratio estimation
Lighting Design	0%	0%	Estimated from LEM-C F13-F17
System Design	23%	18%	Ratio estimation
Program Enabled	0%	0%	Not evaluated

Ratio Estimation

Ratio estimation was used to calculate evaluated gross savings for three components of the program offers: PIR of Lighting Design projects, M&V of Whole Building Design projects, and M&V of System Design projects. Ratio estimation is a statistical method of extrapolating findings from projects with estimated results to projects without estimated results. Project samples of the three program offers were used to provide data inputs for ratio estimation for the components of realization rate. An overview of the steps involved in ratio estimation is provided below. For additional details, see Chapter 13 of the California Evaluation Framework[7]. The steps involved in determining evaluated gross savings using stratified ratio estimation are described below.

First, the realization rate sample for each of the three program offers was stratified to improve the statistical validity of the resulting estimate of evaluated gross savings. Three strata were selected, based on project savings size. These are shown in Table 2.7.

Table 2.7. Stratification of Components of Realization Rate by Project Size and Program Offer

Strata	Lighting Design Inspected Savings	Whole Building Design Verified Savings	System Design Verified Savings
1	< 0.07 GWh/yr	< 0.2 GWh/yr	< 0.1 GWh/yr
2	0.07-0.70 GWh/yr	0.2-0.75 GWh/yr	0.1-0.2 GWh/yr
3	0.70-2.3 GWh/yr	0.75-4.0 GWh/yr	0.2-0.4 GWh/yr

Second, case weights were calculated for each stratum. Case weights, also known as probability weights, are used to reduce bias when working with sample data. Case weights represent the probability that a project was selected into the ratio estimation sample from the population of projects in the strata, as per Equation 3. Higher case weights indicate that relatively few projects were found in the ratio estimation sample. Weightings applied to the savings in each stratum improve the statistical significance of the resulting ratio estimation.

[7] TecMarket Works, et. al., 2004.

Equation 3

$$Weighting\ (w_i) = \frac{N}{n}$$

Where: (N) is the number of measures in the population
(n) is the number of measures in the realization rate sample

Weightings for the ratio estimation samples are shown below.

Table 2.8. Weighting by Strata and Ratio Estimation Sample

	Lighting Design Inspected Ratio (PIR/IR)			Whole Building Design Verified Ratio (M&V/PIR)			System Design Verified Ratio (M&V/PIR)		
Strata	Population Count, N	Sample Count, n	**Weighting (N/n)**	Population Count, N	Sample Count, n	**Weighting (N/n)**	Population Count, N	Sample Count, n	**Weighting (N/n)**
1	89	89	**1.0**	27	2	**13.5**	3	1	**3.0**
2	76	58	**1.3**	48	3	**16.0**	5	1	**5.0**
3	4	4	**1.0**	20	4	**5.0**	5	1	**5.0**

Third, the required ratios were calculated according to Equation 4.

Equation 4

$$Ratio\ Estimate\ (RE)_j = \frac{\sum_{i=1}^{n} w_i y_i}{\sum_{i=1}^{n} w_i x_i}$$

Where: The summation is over all projects from the ratio estimation sample for program offer (j)
w_i is the case weighting of the stratum for project (i), derived from Equation 1
y_i is the known PIR or M&V savings for project (i) in the realization rate sample
x_i is the known IR or PIR savings for project (i) in the ratio estimation sample

Fourth, each of the three ratio estimation results was tested for statistical validity. Equation 5 was used to estimate the standard error of the ratio estimate, Equation 6 was used to estimate the error bounds at the 90 percent confidence level, and Equation 7 was used to estimate the relative precision, also at the 90 percent confidence level. The definitions of the terms in Equation 5 are the same as for Equations 3 and 4.

Equation 5

$$Standard\ error\ of\ GRR, se(GRR)_j = \frac{1}{\sum_{i=1}^{n} w_i x_i}\sqrt{\sum_{i=1}^{n} w_i(w_i - 1)(y_i - bx_i)^2}$$

Equation 6

$$Error\ bounds, eb(GRR)_j = \pm 1.645 * se(GRR)$$

Equation 7

$$Relative\ precision_j = \frac{eb(GRR)}{GRR}$$

Step 4: Evaluated Savings and Gross Realization Rates

Finally, the gross realization rate was estimated for each of the four program offers using the three components of realization rate and calculated according to Equation 8.

Equation 8

$$Gross\ Realization\ Rate\ (GRR)_j = \left(\frac{PIR}{IR}\right)_j \times \left(\frac{MV}{PIR}\right)_j \times (1 - CE_j)$$

Where: *Gross realization rate* was calculated for each program offer (j) and
(PIR/IR) is the ratio of post-implementation review savings to the initial review savings;
(MV/PIR) is the ratio of M&V savings to the post-implementation review savings;
and *CE* is the factor for cross effects where applicable.

Cross Effects (CE)

Gross savings for Lighting Design projects were adjusted for cross effects in accordance with BC Hydro's Standard Procedure for Cross Effects[8]. BC Hydro's commercial programs apply cross-effects only to lighting end-uses. Cross effects are estimated by breaking down lighting savings by building type and computing a weighted average HVAC Interactive factor for each building type based on tabulated values of HVAC interactive factors for different HVAC system types, weighted according to the prevalence of each HVAC system type in the commercial sector. Cross effect assumptions were applied only to evaluated gross savings of the lighting design projects.

The following table provides the summary of the applicability and method for cross effects by program offer.

Table 2.9. Applicability and Method for Cross Effects by Program Offer

Program Offer	Applicability of Cross Effects (%-Lighting savings)	Method for estimation of Cross Effects (CE)
Whole Building Design	30%	Included in M&V
Lighting Design	100%	BC Hydro Standard: Cross Effects
System Design	0%	Included in M&V
Program Enabled	28%	Not evaluated

[8] BC Hydro Standard Procedure: Cross Effects, August 2013

The table below summarizes how the parameters of the gross realization rate were determined for each program offer (i.e., calculated directly or through ratio estimation, included in M&V, or estimated from other data sources).

Table 2.10. Components of Gross Realization Rate by Program Offer

Program Offer	Step 1 Expected Savings	Step 2 (PIR/IR)	Step 4 (M&V/PIR)	Step 4 (CE)
Whole Building Design	Program data	Calculated	Ratio Estimation	Included in M&V
Lighting Design	Program data	Ratio estimation	Assumed*	Estimated
System Design	Program data	Calculated	Ratio Estimation	Included in M&V
Program Enabled	Program data	Calculated	Not evaluated	Not evaluated

* Assumed from BC Hydro LEM-Commercial Impact Evaluation F2013-F2017

The last step was to calculate the evaluated gross energy savings of the program from the gross realization rate and expected savings for all projects in each of the four program offers according to the following equation.

Equation 9

$$Evaluated\ Gross\ Savings_j\ \left(\frac{GWh}{yr}\right) = \sum Expected\ Savings_i\ \left(\frac{GWh}{yr}\right) \times GRR_j$$

Where the summation is over all projects (i) in each program offer (j).

Gross Peak Demand Savings

Peak demand savings were estimated by applying an average peak-to-energy factor derived by CEM Strategic Planning from the commercial rate class load shape, as more refined data on peak savings was not available. For the purpose of this evaluation, the average peak-to-energy factor was 0.143 MW per GWh. This approach introduces uncertainty because it relies on the assumption that energy savings have the same annual shape as the associated load shape, but this may not be true for unique projects and sites.

Baselines

The baseline represents the energy that would have been used without implementation of the energy efficiency project. The baseline energy consumption of a new commercial building is, by necessity, theoretical. Baselines were determined through engineering analysis during the building design, using the building code and relevant codes and standards that were in place at the time of building design as input into the selected building energy modeling software to determine the baseline consumption.

Threats to Validity

Projects without M&V results were the main threat to the validity of evaluated gross savings. Evaluated gross savings for whole building design and system design projects without M&V results were estimated using a gross realization rate, as described above. This can create some uncertainty if the realization rate is not representative of the population. M&V results were only available for a small sample of projects. To mitigate this threat to validity, the gross realization rate was segregated in its three components and each component was tested through estimation of its relative precision.

There were no M&V results available for any Lighting Design projects in the program which introduces uncertainty in the component of gross realization rate for this program offer. To mitigate this threat to validity, the (M&V/PIR) results of similar lighting projects from the recent impact evaluation of the BC Hydro commercial program[9] were used.

Peak demand savings were estimated by applying a peak-to-energy factor derived from the commercial rate class load shape. This approach introduces uncertainty because it relies on the assumption that energy savings have the same annual shape as the associated load shape, but this may not be true for unique projects and sites.

Data and Methods for Objective 5: Estimate Net Energy and Peak Demand Savings

Gross savings do not account for factors external to the program that could impact energy savings and may include energy savings that are not attributable to the program. The evaluated net savings are attributable to the program and include adjustments for free-ridership of participants and spillover of participants and non-participants. Net electricity savings were determined through the following equation:

Equation 10

$$Evaluated\ Net\ Savings\ = Evaluated\ Gross\ Savings\ \times\ (1 - Free\ Rider\ Rate + Spillover\ Rate)$$

Free Ridership

Online surveys of program participants were employed to estimate the savings that were attributable to the CNC program using a self-report approach. As mentioned previously, of the 57 survey respondents, only 51 were able to fully answer the free rider section. These 51 projects represented 17 percent of total projects completed and 18 percent of energy savings reported by the program during the evaluation period. To ensure that survey respondents had the appropriate level of decision making authority for the purpose of this study, a number of questions were asked to determine key characteristics of the respondent and of their facility. In order to estimate free ridership, program participants were asked a series of questions about the counterfactual – what the organization would have done at the site in the absence of the program. First, participants were reminded of the energy conservation measures that were undertaken at the site with assistance from the program. Participants were then asked a series of sequential questions about what they would have implemented without enabling activities or incentives from the program. A decision tree was used to assign free rider scores based on responses to these questions (see Appendix C.3). Free ridership results were weighted based on evaluated gross savings and extrapolated to the project population.

Participant Spillover

In order to estimate participant spillover, survey respondents were once again reminded about the projects they had already completed with assistance from the program. They were then asked to indicate the number of end-uses or technologies that they had upgraded on their own and a series of questions about the program's influence on their decision to do so. A decision tree was used to assign spillover scores based on responses to these questions (see Appendix C.3). Responses were then converted to a metric that is comparable with the free rider score by applying typical energy savings associated with the upgraded end-use or technology, adjusting those savings by the influence of the program, and then comparing those savings to total program savings.

[9] BC Hydro (2019) Leaders in Energy Management - Commercial Program Evaluation

Non-Participant Spillover

Non-participant spillover pertaining to the entire five year evaluation period of interest was estimated via a calculation involving both empirical and survey-based inputs.

To begin, the total commercial new construction building stock in British Columbia – projects that first became occupied between 2012 and 2016 – that could have possibly been influenced by BC Hydro's program was ascertained from Statistics Canada permit data together with costing estimates from Hanscomb Quantity Surveyors. Specifically, this estimate of the total building stock is measured in floor area and was computed by aggregating the dollar values of new construction permits issued for the buildings that became occupied during this period, and dividing this total dollar value by Hanscomb's estimate of construction costs given as dollars per square meter.

As shown in row A of Table 2.11, this total floor area is comprised of all new construction projects during this period – including those that may have received program funding (i.e., participants).

Next, the total commercial new construction building stock during this period that did receive program funding was ascertained from program tracking data. This too was summarized in floor area and is shown in row B.

Through the five years of the evaluation, the commercial new construction building stock that did not receive program funding – and was, therefore, eligible for non-participant spillover savings – is shown in row C as the value of A minus the value of B.

Table 2.11 Non-Participant Spillover Methodology

A.	Commercial new construction building stock in BC that could have been influenced by the program F12-F16 (m^2)	A
B.	Commercial new construction building stock that did receive BC Hydro program funding F12-F16 (m^2)	B
C.	Commercial new construction building stock that did <u>not</u> receive BC Hydro program funding F12-F16 (m^2)	C = A – B
D.	Percent of commercial new construction building stock that exceeds code F12-F16 (%)	D
E.	For commercial new construction building stock that exceeds the B.C. Building Code, the average unit electricity savings relative to the code (kWh/m^2)	E
F.	Attribution of electricity savings to BC Hydro's Commercial New Construction Program (%)	F
G.	Non-Participant Spillover F12-F16 (GWh)	$G = \frac{C \times D \times E \times F}{1{,}000{,}000}$

The Market Actors Survey was then leveraged for three additional inputs. First, findings from the survey were used to estimate the percentage of commercial new construction floor area in this period that exceeded the B.C. Building Code (row D). Second, findings from the survey – together with end-use intensity data from BC Hydro's 2016 Conservation Potential Review (CPR) – were used to estimate average unit electricity savings for the floor area that exceed the code (row E). Third, findings from the survey were used to estimate the attribution of gross electricity savings from non-participants back to the Commercial New Construction Program (row F).

It follows that non-participant spillover (row G) was estimated as the product of the values in rows C, D, E and F, divided by 1,000,000 to yield gigawatt-hour savings (GWh).

See Appendix C.3 for more details about this estimation of non-participant spillover, particularly in regards to the calculation of the inputs D, E and F.

Threats to Validity

Threats to the validity of the survey-based methods to estimate free ridership, participant spillover and non-participant spillover in this study were tied to three types of potential bias: 1) response bias, 2) recall bias, and 3) non-response bias.

1. Response Bias

Response bias can occur when the structure of the survey, the presentation of information in the survey, the survey questions and/or the response options influence the responses of customers away from accurate or truthful responses. This potential source of bias was mitigated in the Participant Survey and the Market Actors Survey by administering what is believed to be well-structured, well-ordered, unambiguous and non-leading questions together with balanced response scales that covered the potential range of customer opinion.

One particular type of response bias is 'social desirability response bias' whereby respondents provide answers that they believe an interviewer may want to hear and/or answers that they believe are consistent with the preferred outcome of the study. For each of the two surveys, this potential source of bias was mitigated by utilizing self-administered online surveys rather than an interviewer led approach.

2. Recall Bias

Recall bias – in the most typical of scenarios – can occur when respondents' recollection and opinions of events and/or experiences from the past are 'clouded' by the passage of time giving way to potentially inaccurate responses.

For the Participant Survey, this potential source of bias could emerge if respondents do not remember the project in question and the accompanying approval process. However, it was managed first by administering the survey every six months through the evaluation period whereby customers that completed projects were queried about them no more than six months thereafter. Additionally, the survey presented respondents with detailed descriptions of their projects undertaken at their site. If respondents were not aware of the project, they were skipped around the section on free ridership, and were excluded from the free rider calculation.

As the Market Actors Survey was administered just once at the end of this evaluation period, the sample and findings were potentially prone to recall bias as respondents were asked about their projects that became occupied from 2012 through to 2016. This necessarily meant them trying to recollect design decisions that were made two to three years even before construction and subsequent occupation. This potential source of bias was mitigated by the intuitive layout and flow of the survey, presenting questions in a series of small, logical steps to solicit recollections and opinions.

Additionally, because the survey was self-administered, it afforded respondents the flexibility and time to retrieve and review planning files pertaining to their past commercial new construction projects. In fact, there is anecdotal proof that many respondents did just this.

3. Non-Response Bias

Non-response bias can occur when subjects comprising the final survey sample are significantly different in the key exploratory parameters of interest than eligible subjects in the same population who did not complete a survey. These responders may be different than non-responders on these exploratory parameters because their demographic, geographic, attitudinal or behavioural makeup is different. This can render the survey sample not wholly representative of the population.

For the Participant Survey, this potential source of bias may materialize if the survey respondents and their views are significantly different than all others, particularly if they are not qualified in the first place to be commenting on their organization's decision-making criteria. This potential source of bias was mitigated in two ways. First, it was managed by sending the survey to all available program participants and promoting high response rates through survey completion incentives and multiple reminders to complete the survey. Second, it was further managed by screening respondents by job title and decision-making authority. See Appendix C.1 for this information.

For the Market Actors Survey, non-response bias was plausible due in large part to the fact that the sample was comprised of 30 industry professionals of interest – a fraction of the likely hundreds of them working in British Columbia's commercial new construction marketplace. In fact, some of the inputs into the calculation of non-participant spillover were based on the responses of as few as 13 individuals. Their views in regards to the industry and their attribution of the advancement of energy efficiency back to BC Hydro may not be representative of all professionals who were eligible to complete the survey.

However, proving the existence or non-existence of non-response bias in a survey sample requires either 1) a follow-up survey sample of the non-responders or 2) an understanding of the true population distribution of the exploratory parameters of interest. Follow-up surveys with non-responders are very rarely conducted because they often incur additional costs, extend research timelines, and most often come with their own group of non-responders. Having an understanding of the true population distribution of the exploratory parameters before embarking on a survey is generally rare – the absence of this information is the very reason for conducting the survey in the first place.

Alternative Methodologies

An alternative approach explored in the estimation of gross realization rates for the CNC program was to use M&V results at the energy conservation measure level to estimate separate gross realization rates by end use. This approach was abandoned due to the cost of conducting the M&V at the measure level instead of the project level, concerns about the small number of measures with M&V results in each sample, and the difficulty in estimating the cross effects between end uses.

Analysis of load shapes and interval data of buildings together with benchmarking energy use indices for buildings was also considered but many of the buildings were multi or mixed-use and therefore difficult to compare by building type and space function.

3.0 Results

Participant Experience

Program Components. Among program participants, 79 percent reported being aware of the CNC offer by name. Of the individual program components, awareness was highest for the role that key account managers play as liaisons between CNC and participants at 74 percent. Awareness of the basics of the energy study component and the project incentive structure were equal at 63 percent each.

Table 3.1. Awareness of Program and Components

	CNC Participants (n=57)
Overall awareness of CNC offer	**79%**
Key Account Managers' role as liaison between CNC and participants (among those with a KAM; n=45)	74%
Energy study component of CNC	63%
Project incentive structure of CNC	63%

Among those aware of individual program components, the highest level of understanding was for the role that key account managers play as liaisons between the program and participants with 87 percent reporting an excellent or good understanding. Understanding of the energy study component was more moderate at 72 percent, followed by understanding of the project incentive structure at 66 percent.

Table 3.2. Understanding of Program Components (Excellent + Good)

	CNC Participants (n=57)
Key account mangers' role as liaison between CNC and participants (among those with a KAM; n=33)	87%
Energy study component of CNC	72%
Project incentive structure of CNC	66%

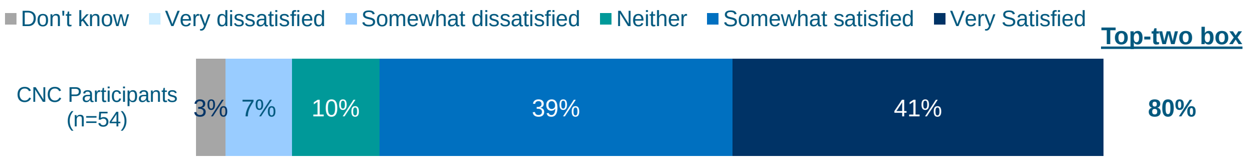
The rating of key account managers in relation to their support of participation in CNC was very high with 100 percent providing an excellent (60%) or good (40%) rating. The overall rating of the project incentive structure was also high with 83 percent providing favourable rating, but with only a small proportion providing an excellent rating (3%) and the balance (80%) providing a good rating. Although the energy study component had a lower combined excellent plus good rating of 72 percent, it had a higher proportion rating it as excellent (20%).

Table 3.3. Rating of Program Components (Excellent + Good)

	CNC Participants (n=57)
Key account managers in relation to their support of participation in CNC (among those with a KAM; n=33)	100%
Project incentive structure of CNC	83%
Energy study component of CNC	72%

Overall Satisfaction. Overall satisfaction was high for CNC at 80 percent, comprised of 41 percent stating they were very satisfied and 39 percent stating they were somewhat satisfied. Results were examined by year, but there were no clear trends over time. When asked the likelihood of recommending the program to others, 95 percent indicated that they definitely (53%) or probably (42%) would, and 49 percent reported that they had in fact already done so.

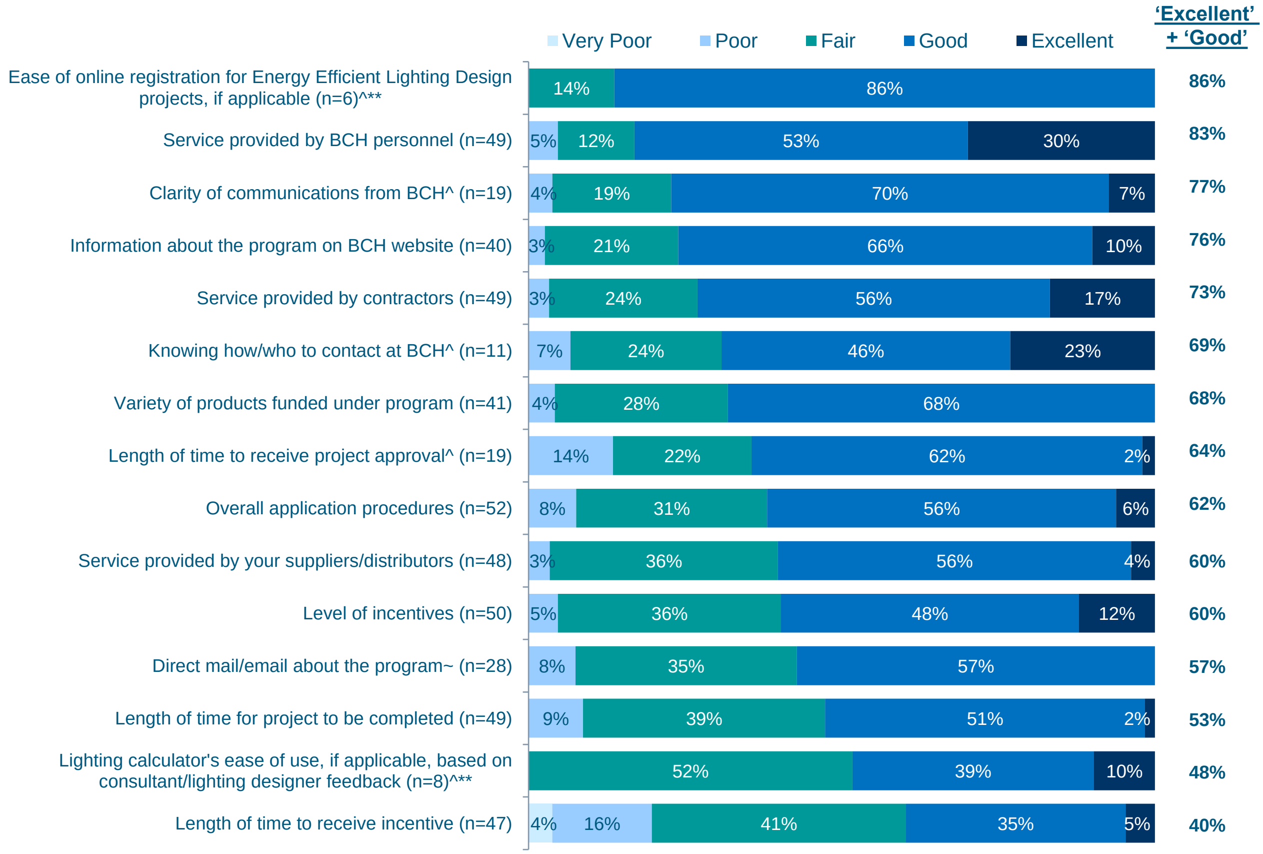
Figure 3.1. Overall Satisfaction



Program Experience. Program participants were asked to provide an overall rating from 'very poor' to 'excellent' on a five-point scale for various aspects of their experience with the program.

- **Service** – While service provided by BC Hydro personnel rated very favourably with 83 percent rating it as excellent or good, service provided by contractors and suppliers/distributors was lower at 73 percent and 60 percent, respectively. Service provided by BC Hydro had the highest excellent score of all individual aspects at 30 percent.
- **Customer Contact** – 'Clarity of communications from BC Hydro' also rated well with 77 percent rating it as excellent or good. Although 'knowing who to contact at BC Hydro' rated lower at 69 percent, it had a higher proportion rating it as excellent (23%).
- **Program Information** – Both 'information about the program on the website' and 'information about program via direct mail/email' had a large proportion of respondents answering 'don't know' to these questions (25% and 43%, respectively), presumably because they had not looked for program information on the website or did not recall receiving any direct mail/email about the program. Among those providing a rating, information on the website was rated favourably at 76 percent, while directly mail/email, which was not relied on heavily by the program, was rated lower at 57 percent.
- **Program Offer** –The 'variety of products funded under the program' and 'level of incentives offered' were rated moderately at 68 percent and 60, respectively.
- **Application Process** – The 'overall application procedures to receive funding' was also rated moderately with 62 percent rating it as either excellent or good.
- **Length of Time** – Aspects related to length of time were among the lowest rated of all aspects, with 'length of time to receive project approval' at 64 percent, 'length of time for project/process to be completed' at 53 percent, and 'length of time to receive incentive' receiving the lowest score of all aspects at 40 percent.
- **Lighting design** – Two new questions about lighting design projects were added to the survey in F2016. Although sample sizes for these questions are small and the results should be interpreted with caution, directionally, the results suggest that 'ease of online registration for Energy Efficient Lighting Design projects' was rated more favourably than the 'lighting calculator's ease of use' (based on feedback they had received from their consultant/lighting designer).

Figure 3.2. Ratings of Program Experience



Note: 'Don't know' responses are excluded and range from 3% to 43%. ^New questions added in F2015 and F2016. ~Wording updated to include 'email' in F2016. **Small sample size.

Influence of CNC on Energy Efficiency Decisions. The influence of the CNC program on participant decisions around energy efficiency can be gleaned from various questions in the participant survey. A direct question asking about program influence on the decision to implement the specific energy efficient measures funded by the program was used in the decision tree for calculating free ridership. For this question, a total of 80 percent of participants indicated that CNC was very (33%) or somewhat (47%) influential on the decision to implement the energy efficient measures at this site (n=51).

To understand changes in customer awareness of energy conservation measures and opportunities, participants were asked about their organization's prior experience with the energy-efficient measure or technology that was installed though the program. While 10 percent had a great deal of experience and 39 percent had a fair amount of experience, similar amounts had only a little (37%) or no experience at all (12%) with the energy-efficient measure (n=51).

Looking more broadly at conservation motivators, 60 percent of participants indicated that the CNC program was a 'major factor' in the organization's effort to manage electricity use over the past year (n=10)[10]. In terms of barriers to managing electricity use, lack of funds for energy efficient retrofits/projects was noted as a 'major barrier' by 33 percent of participants, followed by there being other operational priorities (29%) and lack of financial incentives for conservation programs and energy efficiency (26%) (n=22).

See Appendix D for additional findings from the survey research.

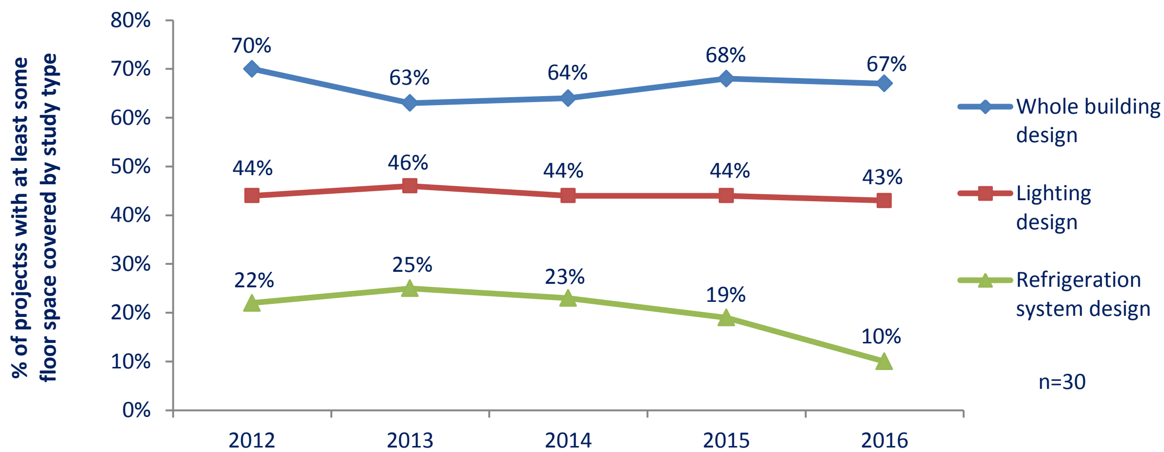
[10] The small sample size is due to a change in the response scale for this question during the evaluation period (from a 5-point influence scale to a 3-point major/minor scale) and due to the motivators/barriers question not being asked each wave due to survey length.

Practices and Opinions Related to Market Transformation

This section assesses the extent and the ways through which the new construction market is performing better than the B.C. Building Code.

With regards to buildings that did not participate in the CNC program, but that market actors reported were performing better than the energy efficiency requirements of the B.C. Building Code , the most common type of design study conducted to help these buildings perform better than code was whole building design, with on average approximately two-thirds of respondents confirming that at least some floor area of their 'better than code, non-participating projects' had come through this study type. This was followed by lighting design studies, with about 44 percent of respondents, on average, confirming at least some floor area had come through this study type. It comes expectedly that refrigeration system design studies were the least common given that not all construction projects would have had this end use.

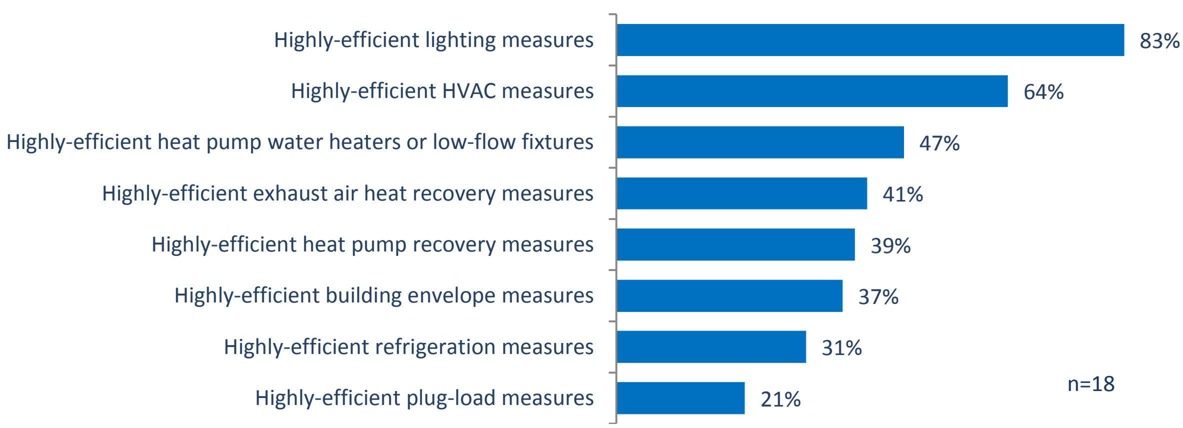
Figure 3.3. Most Common Types of Design Studies (percent of respondents with 'better than code, non-participating projects' that had at least some floor area receive the study type)



Note: because some respondents answered 'don't know' to these questions, results shown are for confirmed studies, and values thus could measure higher.

Again, with regards to buildings that did not participate in the CNC program but that were performing better than code, by far the most common measure being implemented to help make these buildings perform better than code was highly efficient lighting, with 83 percent of respondents reporting that the measure was at least sometimes implemented in their 'better than code, non-participating projects'. This was followed by HVAC measures at 64 percent; all remaining measures were below 50 percent.

Figure 3.4. Measures Implemented in 'Better than Code, Non-Participating Projects' (percent of respondents reporting that the measure was at least sometimes implement in their 'better than code', non-participating projects)



Market actors were asked how much they thought energy efficiency had improved in the entire commercial new construction market in B.C. over the past 10 to 15 years. All had thought that there had been some improvement – although not necessarily beyond code – with the majority (55%) reporting a 20 percent improvement in terms of energy use over time.

Table 3.4. Perceived Improvement in Energy Efficiency in Terms of Energy Use of Entire Commercial New Construction Market in B.C. Over Time (2012 – 2016 compared to 2005 – 2011)

	n=30
0% - no better	0%
1% - 9% better	5%
10% better	15%
20% better	55%
30% better	10%
40% better	10%
50% + better	4%
Don't know	3%

Market actors were also asked how much they thought projects completed by their own organization and by other organizations were performing relative to the energy efficiency requirements of the B.C. Building Code in terms of electricity savings. All thought that both their own buildings and those constructed by other firms were performing better than code, with organizations perceiving their own projects as performing better than those constructed by others. Savings were reported in the 1 percent to 30 percent range, with about half of respondents perceiving that their own buildings had 20 percent to 30 percent electricity savings relative to code, compared to only 36 percent feeling the same way about buildings constructed by others.

Table 3.5. Perceived Electricity Savings of Commercial New Construction Projects Relative to the Energy Efficiency Requirements in the B.C. Building Code (2012 to 2016)

n=23	Own Projects		All Other Projects in B.C.	
0% electricity savings (the projects would be performing to the energy efficiency requirements in the B.C. Building Code)	0%		0%	
1% - 9% electricity savings	18%		26%	
10% electricity savings	13%		13%	
20% electricity savings	35%	**48%**	27%	**36%**
30% electricity savings	13%		9%	
40% electricity savings	0%		0%	
50% + electricity savings	0%		0%	
Don't know	21%		24%	

Influence of the Program on the Adoption of Energy Efficiency Measures Beyond Building Code Requirements

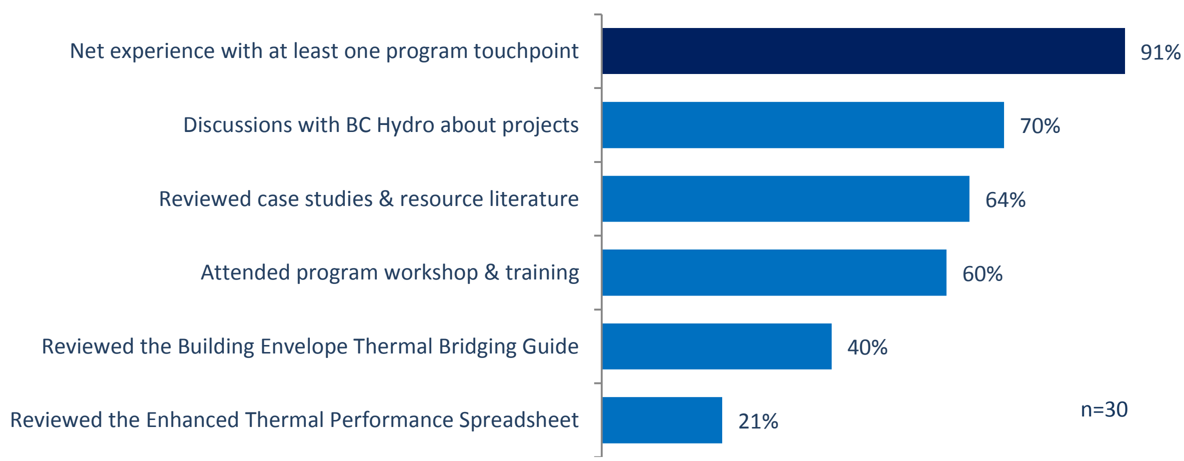
This section assesses the extent to which the CNC program has influenced building design practices and the new construction market beyond incented projects.

The CNC program developed tools to support the industry design and construct more energy efficient buildings (beyond code requirements), including:

- Workshops and training – sometimes in partnership with industry associations – in regards to new building construction;
- Case studies and resource literature in regards to new building construction posted on BC Hydro's website;
- The Building Envelope Thermal Bridging Guide[11] which BC Hydro sponsored and contributed to, and which details how the commercial new construction market can effectively account for the impact of thermal bridging as part of meeting the challenges of reducing energy use in buildings;
- The Enhanced Thermal Performance Spreadsheet[12], which BC Hydro provided technical support and funding for and which is included in BC Hydro's energy modelling guidelines; and
- Discussions with BC Hydro staff about projects aside from the interactions at workshops and other formal events.

A total of 91 percent of respondents had experience with at least one of the energy efficiency resources or touchpoints provided by the program. The most common were *discussions about projects with BC Hydro staff* (70%) and *reviewing case studies/resource literature* (64%). This was followed by 60 percent who had *attended a program workshop or training session* and 40 percent who had re*viewed the Building Envelope Thermal Guide*. The least commonly used resource was the *Enhanced Thermal Performance Spreadsheet*, with only 21 percent of respondents indicating they had reviewed it.

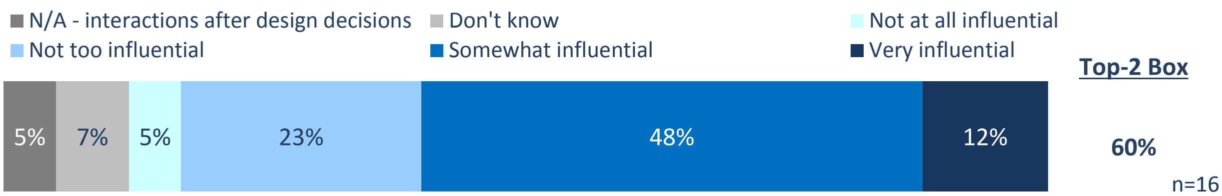
Figure 3.5. Experience with Program Resources (multiple response question)



[11] https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/builders-developers/building-envelope-thermal-bridging-guide-1.1.pdf
[12] https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/builders-developers/betbg-enhanced-spreadsheet.xlsm

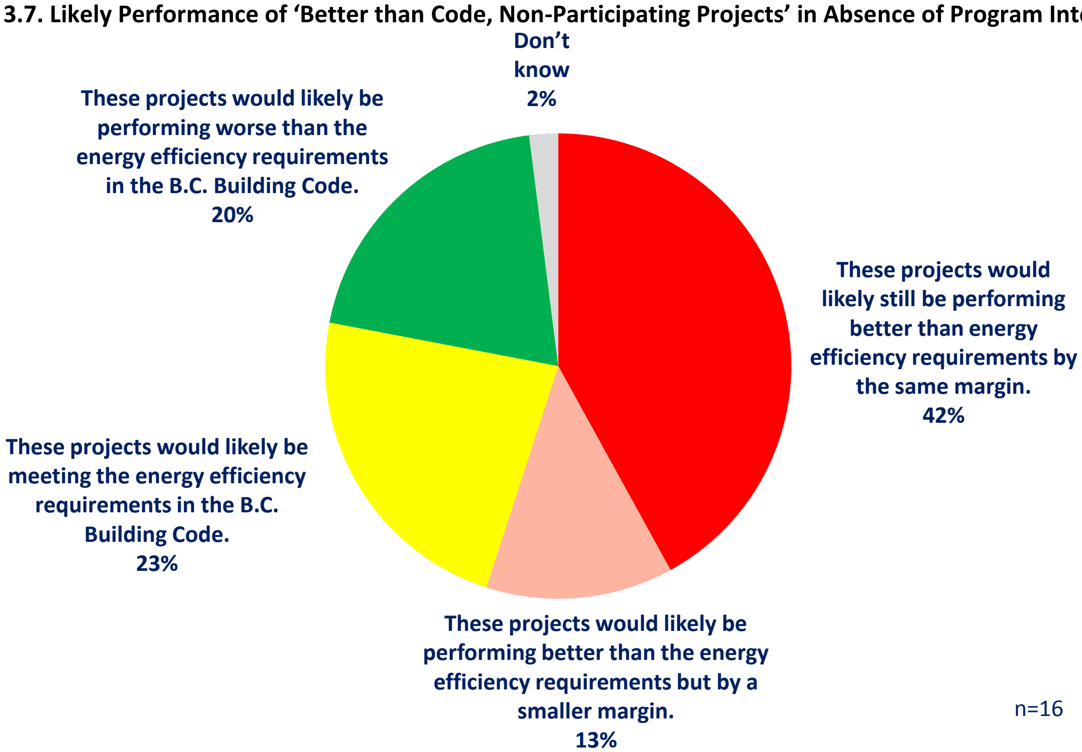
Market actors were asked to consider all of their various touchpoints with the program and the influence they had on their design decisions to have non-participating projects perform better than the building code. A total of 60 percent indicated that these program touchpoints were 'very' or 'somewhat' influential on their decisions to do so, while 28 percent indicated that the program had been 'not too influential' or 'not at all influential'. A further 7 percent did not know, while the remaining 5 percent indicated that the interaction(s) had occurred after the design decisions were made for these projects.

Figure 3.6. Influence of BC Hydro Program Interactions on Decisions to have Non-Participating Projects Perform Better than Requirements in the B.C. Building Code



Market actors were asked to think about influence from another perspective – the likely energy efficiency of their 'better than code, non-participating projects' had they not (nor any of their colleagues) had any interactions with BC Hydro's CNC program and its resources and touchpoints. While 42 percent of respondents indicated that these projects would likely still be performing better than building code energy efficiency requirements and by the same margin, a total of 56 percent indicated that these projects would likely be performing with lower energy efficiency had they not experienced these program touchpoints. This was comprised of 13 percent that felt their projects would still be performing better than the energy efficiency requirements in the B.C. Building Code but by a smaller margin, 23 percent that felt that their projects would have just met the requirements, and 20 percent that felt that their projects would likely be performing worse than the requirements. This is generally consistent with the 60 percent of respondents indicating the program had been somewhat or very influential in Figure 3.6 above.

Figure 3.7. Likely Performance of 'Better than Code, Non-Participating Projects' in Absence of Program Interactions



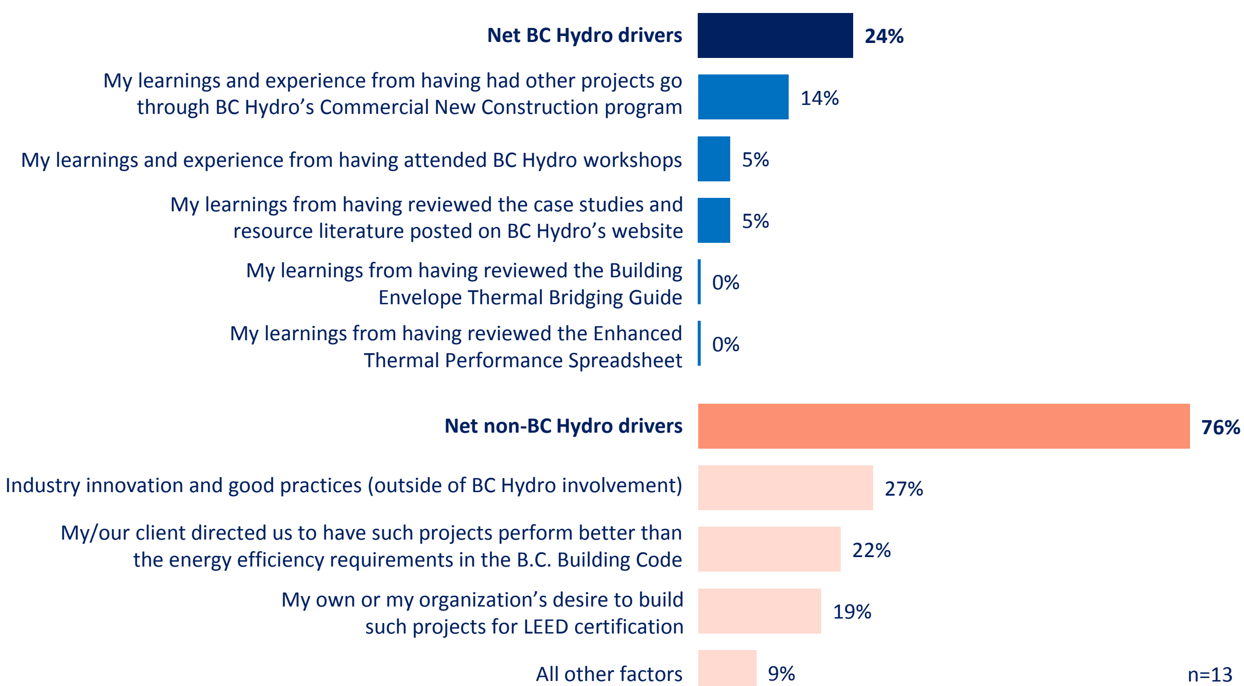
In order to understand program influence relative to other factors in the broader new construction context, market actors were asked to credit various factors for making non-program projects perform better than the B.C. Building Code, such that the factors summed to 100 percent.

Note that after excluding industry professionals who did not report any ‘better than code, non-participating projects’ during the evaluation period, as well as several more who were unable to provide estimates, a total of 13 respondents in the sample weighed in on this question.

On average, BC Hydro ‘drivers’ were given a net of 24 percent of the credit for making projects perform better than code. Specifically, previous learnings and experience with the CNC program was given the highest credit at 14 percent, followed by learnings from workshops at 5 percent and learnings from case studies/resources on the website, also at 5 percent. None explicitly gave credit to the Building Envelope Thermal Bridging Guide or to the Enhanced Thermal Performance Spreadsheet despite some respondents reporting having reviewed these resources; however, this may be due to these resources becoming available late in the evaluation period.

It follows that non-BC Hydro drivers were given 76 percent of the credit for buildings performing better than code, with the highest credit given to general industry innovation and good practices (27%) and clients directing the projects to be built as such (22%). There is a possibility that some of these non-BC Hydro factors were – to some extent – influenced by market effects ultimately tied to the Commercial New Construction Program. Should this in fact be the case, the estimate of attribution back to the program could be a conservative one as could be the overall estimate of spillover savings.

Figure 3.8. Drivers for Making Non-Participating Projects Perform Better than the Requirements in the B.C. Building Code



Another approach to assessing program influence was to query market actors on how much of the improvement in the energy use of the entire commercial new construction market in the B.C. (participant and non-participant buildings) over time could be attributed to BC Hydro's Commercial New Construction program. About half (49%) felt it was in the 20 to 30 percent range, with the most common answer at 20 percent. These results are generally consistent with findings from Figure 3.7 above on drivers where 24 percent of credit was given to BC Hydro for savings beyond code.

Table 3.6. Attribution of Savings of the Entire B.C. Commercial New Construction Market to BC Hydro's Commercial New Construction Program – For All Buildings Occupied in 2012-2016 Compared to Those Occupied in 2005 to 2011

	n=25
0% of the improved energy use in the province is attributable to BC Hydro's program	0%
1% - 9%	18%
10%	10%
20%	41%
30%	8%
40%	3%
50% + of the improved energy use in the province is attributable to BC Hydro's program	3%
Don't know	18%

Gross Electrical Energy and Peak Demand Savings

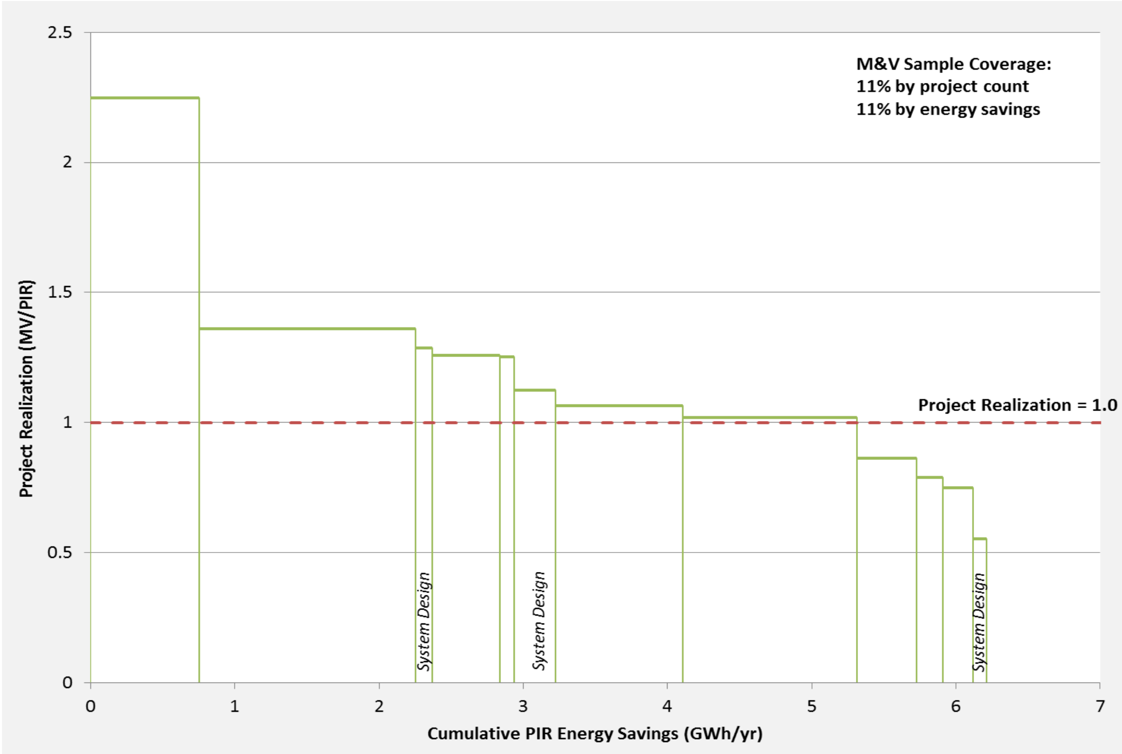
Gross electricity savings are the change in energy consumption that results directly from the program related actions taken by participants in CNC. As detailed in Section 2.3, the evaluated gross energy savings were determined through four steps (and three components of realization rate) for each of the four program offers. The four steps described were expected, inspected, verified and evaluated savings. The general approach for each step and program offer was to use a sample of projects and extrapolate to the remaining projects in the population.

Overall CNC projects involved lighting with 52 percent of the expected savings, HVAC with 37 percent, and the remaining savings distributed among building envelope improvements (5%), hot water and low-flow fixtures (2%), and refrigeration (4%) measures. The twelve projects with M&V results covered whole building design and system design projects with inclusion of interactive effects but without insight into individual measure performance by end use. Therefore, gross realization rates were evaluated by program offer.

The figure below shows the distribution of the twelve projects with M&V. Nine projects were from the Whole Building Design offer and three projects were from the System Design program offer. First, the project realizations were sorted in descending order to graphically illustrate their range and distribution. Each column in the graphs represents a single project, with the height of the column representing the project realization and the width of the column representing the project's inspected energy savings. A project realization of 1.0 indicates that the verified savings were equal to the inspected savings. The results are graphically divided into those with measure realizations above 1.0 (over performing) and below 1.0 (under performing).

The whole building design project with the highest realization rate was found to consume twice the electricity as the original model because of increased internal loads and extended hours of operation. This presented a greater opportunity for the efficient as-built HVAC systems to realize energy savings over the baseline.

Figure 3.9. M&V Results by Project Realization and Savings Size



Evaluated gross savings were analyzed to understand the breakdown by program offer between the components of realization rate. The table below summarizes the results of the components of realization rate and the overall gross realization rate by program offer. This analysis revealed that the component of realization rate for the inspected savings was between 0.89 and 0.99, whereas the component of realization rate for the verified savings was between 0.98 and 1.18. Cross effects were assumed to be embedded in the M&V results for whole building design and system design projects. An additional adjustment for cross effects was necessary for the lighting design offer and estimated at 5 percent cross effect based on the BC Hydro Standard for Cross Effects and found similar to a recent LEM-C evaluation. Of the four program offers, the whole building design offer achieved the highest gross realization rate (1.17), while the program enabled offer and the lighting design offer had the lowest realization rate (0.89).

Table 3.7. Components of Gross Realization Rate by Program Offer

Program Offer	Step 1 Expected Savings (GWh/yr)	Step 2 Factor Inspected (PIR/IR) [A]	Step 3 Factor Verified (MV/PIR) [B]	Step 4 Factor Cross Effects (CE) [C]	Gross Realization Rate [A]x[B]x[C]	Step 4 Evaluated Gross Savings (GWh/yr)
Whole Building Design	**53.4**	0.991 Calculated	1.181 Ratio Estimation	Included in M&V	**1.17**	**62.4**
Lighting Design	**29.2**	0.948 Ratio estimation	0.984 Assumed*	1-0.05 Estimated	**0.89**	**25.9**
System Design	**2.9**	0.948 Calculated	1.096 Ratio Estimation	Included in M&V	**1.04**	**3.0**
Program Enabled	**1.8**	0.887 Calculated	Not evaluated	Not evaluated	**0.89**	**1.6**
Overall CNC (F12-F16)	**87.3**	**0.973**	**1.111**	**0.014**	**1.06**	**92.9**

* Assumed from BC Hydro LEM-Commercial Impact Evaluation F2013-F2017

The following table provides the expected and evaluated gross energy and peak demand savings by fiscal year. Electricity savings are presented as incremental savings achieved within each fiscal year and expressed as an annual rate of savings (also known as run rate savings).

Table 3.8. Expected and Evaluated Gross Energy and Demand Savings All Participants (F2012-F2016)

Period	Number of Projects	Number of Measures	Expected Gross Energy Savings (GWh/yr)	Calculated Realization Rate	Evaluated Gross Energy Savings (GWh/yr)	Evaluated Gross Peak Demand Savings (MW)
F2012	47	134	9.2	1.00	9.2	1.3
F2013	60	226	18.3	1.08	19.9	2.8
F2014	58	186	23.8	1.03	24.4	3.5
F2015	67	272	17.7	1.06	18.8	2.7
F2016	52	207	18.3	1.13	20.6	3.0
CNC (F12-F16)	**284**	**1,025**	**87.3**	**1.06**	**92.9**	**13.3**

As noted above, the overall gross realization rate of the program was 1.06. This realization rate estimate is statistically valid across all projects over the five years evaluated. In order to report evaluated savings by year, as required for business purposes, annual realization rates were also calculated. These annual estimates reflect information on the types of projects reported each year, and their evaluated performance. The annual estimates do not have the statistical validity of the overall estimate, and should be treated as informative rather than conclusive. The use of annual realization rate estimates introduces some uncertainty to the annual evaluated gross savings result. An alternative approach would have been to apply the overall realization rate of 1.06 to each year evaluated. However, this approach was not taken because it would mask the year-over-year variations in participation by program offer.

Net Electrical Energy and Peak Demand Savings

Net electricity savings are the change in energy consumption attributable to the program. Net savings exclude free riders and include spillover.

Free ridership provides an estimate of the proportion of savings that were reported by the CNC program but are not attributable to it. Free ridership in this context may also be referred to as natural conservation due to market forces beyond the influence of BC Hydro.

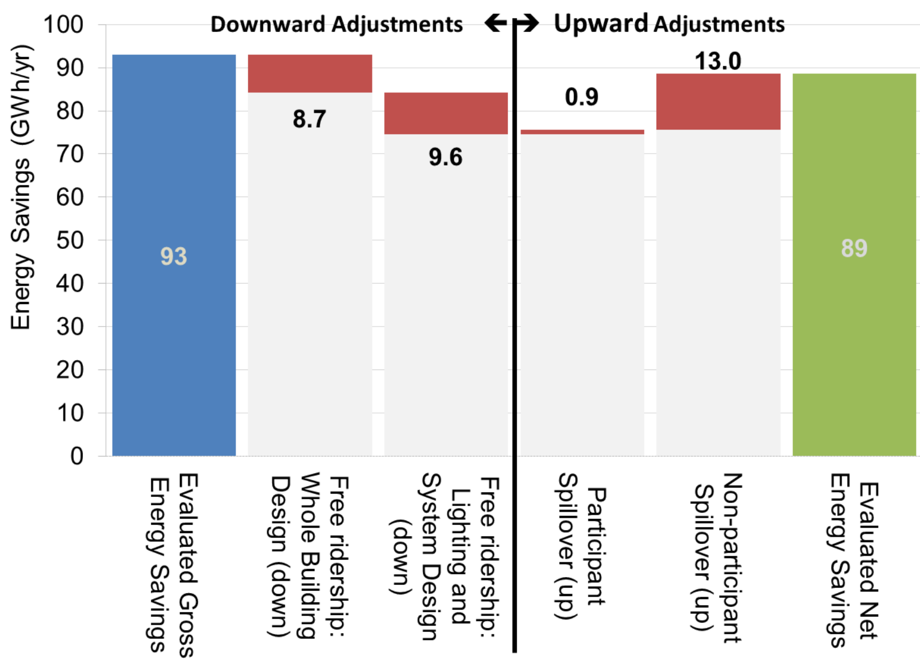
The overall level of free ridership is estimated at 20 percent for the program. Free ridership was estimated at 14 percent for whole building design and 32 percent for lighting and system design projects. Participant spillover was estimated at 1 percent and non-participant spillover was estimated at 14 percent, for a total of 15 percent. Together they result in a net-to-gross ratio of 95 percent.

Table 3.9. Free Ridership, Spillover, and Net-to-Gross Ratio

	CNC
Evaluated Gross Energy Savings (GWh/yr)	93 GWh/yr
Free Ridership (FR)	20%
Spillover (SO)	15%
Participant Spillover	*1%*
Non-Participant Spillover	*14%*
Net-to-Gross Ratio (1 – FR + SO)	**95%**
Evaluated Net Energy Savings (GWh/yr)	89 GWh/yr

The figure below illustrates both the overall effect of downward and upward adjustments to the evaluated gross energy savings from free ridership, and spillover.

Figure 3.10 Net-to-Gross Adjustments to Evaluated Gross Energy Savings



Evaluated net energy savings in each fiscal year were calculated using the evaluated gross energy savings of each project multiplied by the net-to-gross ratio of its program offer. Electricity savings are presented as incremental savings achieved within each fiscal year and expressed as an annual rate of savings. Peak demand savings were calculated using the same peak-to-energy factor as for gross demand savings. The yearly net-to-gross ratio varied slightly due to changes in the mix of projects by program offer and their respective level of energy savings. These results are summarized in the following table.

Table 3.10. Evaluated Gross and Net Energy and Peak Demand Savings

Year	Evaluated Gross Energy Savings (GWh/yr)	Evaluated Gross Peak Demand Savings (MW)	Calculated Net-to-Gross Ratio	Evaluated Net Energy Savings (GWh/yr)	Evaluated Net Peak Demand Savings (MW)
F2012	9.2	1.3	0.91	8.4	1.2
F2013	19.9	2.8	0.96	19.2	2.8
F2014	24.4	3.5	0.93	22.7	3.2
F2015	18.8	2.7	0.95	17.9	2.6
F2016	20.6	3.0	0.99	20.4	2.9
CNC (F12-F16)	**92.9**	**13.3**	**0.95**	**88.6**	**12.7**

Reported and evaluated net energy and peak demand savings for CNC are shown below. Reported savings included the results of post-implementation review and tag-on savings, where available, and were adjusted by a forecast net-to-gross ratio of 0.85. Evaluated net energy savings provide an estimate of evaluated savings that are attributable to CNC. Electricity savings are presented as incremental savings achieved within each fiscal year and expressed as an annual rate of savings (also known as run rate savings). Overall, the program achieved 121 percent of reported savings during fiscal years F2012 to F2016, showing the program performed better than reported. The variance between reported and evaluated net savings is primarily due to the impact of non-participant spillover which was estimated in the evaluation.

Table.3.11. Summary of Net Energy and Peak Demand Savings

Fiscal Year	Net Energy Savings (GWh/yr)		Net Peak Demand Savings (MW)	
	Reported	Evaluated	Reported	Evaluated
F2012	8.1	8.4	1.1	1.2
F2013	15.3	19.2	2.2	2.8
F2014	20.7	22.7	3.0	3.2
F2015	14.0	17.9	2.0	2.6
F2016	15.3	20.4	2.2	2.9
CNC (F12-F16)	**73.4**	**88.6**	**10.5**	**12.7**

Confidence and Precision

Relative precision indicates how much random error exists in an estimate derived through sampling, with lower values aligning with better precision. In impact evaluations of DSM programs and initiatives, BC Hydro targets relative precision of 20 percent or better at a confidence level of 80 percent or better.[13] For small samples, the sample to population size is weighted. If the minimum levels are not achieved, the results are considered to be inconclusive.

In the case of realization rates, relative precision provides a measure of how well the realization rate sample represents the population by savings size. As shown below, the relative precision of the three components of realization rates by program offer is 4 to 15 percent at a 90 percent confidence level, which exceeds BC Hydro's minimum target.

[13] Standard for Impact Evaluation, BC Hydro Power Smart, Conservation and Energy Management , February 2016.

Table 3.12. Confidence and Relative Precision of Gross Realization Rates

Statistical Parameter	Result for Inspected Savings in Lighting Design	Result for Verified Savings in Whole Building Design	Result for Verified Savings in System Design
Gross Realization Rate	0.95	1.18	1.10
Standard Error	0.022	0.011	0.070
Error Bound	0.036	0.182	0.116
Error Ratio	0.282	0.282	0.111
Confidence Level	90%	90%	90%
Relative Precision	**0.038**	**0.154**	**0.106**

See Table 2.3 in the methodology section for the margin of error for participant survey results.

Limitations

Limitations of the work are presented below.

1. The participant survey results for F2012 to F2014 have the potential for recall bias because the surveys were administered up to two years after the decisions that the survey queried. The magnitude and direction of any recall bias is unknown. Since F2015, the participant survey has been conducted every 6 months, mitigating the possibility for recall bias.
2. M&V coverage of whole building design and system design offers was representative by project savings size, and exceeded the target confidence and precision levels. However, the M&V coverage for lighting design projects was zero. The realization rate was assumed to be similar to the one found in the most recent evaluation of lighting projects in the BC Hydro commercial retrofit program, which introduced an unknown level of uncertainty to the evaluated gross savings.
3. Some components of the gross realization rate such as the estimation of M&V and cross effects of program enabled projects were not evaluated and add uncertainty to the results. However, the limited number of program enabled projects and the small relative magnitude of associated energy savings, compared to other program offers, limits the impact on the overall evaluated program results and did not justify further refinement of the energy savings evaluation for this program offer.
4. Demand savings could not be estimated with available data sources because project demand savings are often not reported in the program tracking data. The use of an average peak-to-energy factor based on the commercial rate class load shape for new construction sites adds uncertainty to the estimates of peak demand savings, because it relies on the assumption that the program’s energy savings have the same shape as the associated load shape.
5. Due to the high cost of M&V and the lack of willing participants allowing their buildings for additional data collection and to be modelled, the evaluation lacked a representative number of M&V results which introduces uncertainty in the component of gross realization rate that it may not be representative of the population.

4.0 Findings and Recommendations

Findings and recommendations are presented below.

Findings

Participant Experience

1. Overall satisfaction was high for CNC at 80 percent, comprised of 41 percent stating they were very satisfied and 39 percent stating they were somewhat satisfied.

2. In terms of program experience, the highest scores related to aspects around service/communications from BC Hydro, as well as service provided by contractors. Mid-range scores typically related to aspects around the program offer (variety of products and level of incentives) and the overall application procedures. The lowest scores were for length of time to receive the incentive, length of time for the project to be completed and direct mail about the program.

3. Participants reported that the program had been influential on their decision to implement the energy-efficient measures, with 33 percent indicating that it had been very influential and 47 percent indicating it had been somewhat influential.

Market Transformation

4. The most common types of design study conducted to help new construction projects perform better than code were whole building design and lighting design. The most common measures implemented to help projects perform better than code were lighting and HVAC.

5. All market actors thought that there had been some improvement in the entire commercial new construction market in B.C. over the past 10 to 15 years – although not necessarily beyond code – with the majority reporting a 20 percent improvement.

Influence on Adoption of Energy Efficiency Measures Beyond Building Code Requirements

6. On average, BC Hydro ‘drivers’ were given a net of 24 percent of the credit for making projects perform better than code, with the largest credit given to previous learnings and experience with the CNC program. The remaining 76 percent of credit was given to non-BC Hydro drivers, with the largest given to general industry innovation/good practices and to clients directing the projects to be built as such.

Gross Electrical Energy Savings

7. The evaluated gross energy savings were 93 GWh/yr.

8. The program gross realization rate calculated using the inspected and verified results including cross effects was 1.06, indicating that the energy conservation measures largely performed better than expected. The realization rates by program offer were 1.17, 1.04, 0.89 and 0.89 for whole building design, system design, lighting design and program enabled projects, respectively.

9. Expected energy savings averaged 18 percent of site energy consumption across all participants during the five-year evaluation period.

Net Electrical Energy Savings

10. The evaluated net energy savings were 89 GWh/yr.

11. The net-to-gross ratio was 95 percent based on free ridership of 20 percent, participant spillover of 1 percent and non-participant spillover of 14 percent.

12. Evaluated net savings during the evaluation period from F2012 to F2016 averaged 121 percent of reported savings.

Recommendations

The following two recommendations are for future new construction initiatives:

1. Support and enabling activities for whole building energy modelling and integrated system approach to estimate a project's energy savings should continue and include the Building Envelope Thermal Bridging Guide and the Enhanced Thermal Performance Spreadsheet.

2. Future Market Actor surveys could be done more frequently so that respondents are better able to recall the projects they are being surveyed about.

5.0 Conclusions

BC Hydro's Commercial New Construction Program achieved high participant satisfaction. Evaluated net savings were 89 GWh/yr, which is 121 percent of reported savings. Evidence suggests that the program has supported the market in complying with and exceeding the energy efficiency requirements of the B.C. Building Code.

Evaluation Oversight Committee Sign-Off

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

The Evaluation of the [Report name here including fiscal] 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.

Anthea Jubb

for Serina Grahn, Finance manager, Business Services
Evaluation Oversight Committee Chair

January 23, 2020
Date

References

Abbreviations and 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 (e.g., building code), 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):	"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". (*Clean Energy Act, s. 1*)
Expected Savings:	Estimate of gross energy savings based on the initial engineering estimates. These estimates represent the unverified savings.
Evaluated Savings:	Savings estimates reported after the energy efficiency activities have been implemented and an impact evaluation has been completed.
Free ridership:	Energy use of a program participant or ratepayer under a conservation rate who would have implemented the program conservation measure or practice in the absence of the program or rate.
Gigawatt Hour (GWh):	One billion watt-hours; one million kilowatt-hours.
Gross Savings:	The change in energy consumption and/or demand that results directly from program-related action taken by the participants in the demand side management program irrespective of why they participated.
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 over time.
Natural Conservation:	Natural conservation refers to those efficiency improvements that would occur in the absence of any DSM activity. This may be due to equipment efficiencies, behaviors, changes to codes and standards or simply reactions to general rate increases.
Net savings:	The change in energy consumption and/or demand that is attributable to the utility demand side management program. The change in consumption or demand may include the effects of free riders and spillover.

Net-to-Gross Ratio:	The combination of free rider and spillover estimates which are then applied to the gross savings to provide an estimate of attributable net savings for the program. Reflects program influence, does not reflect project performance in terms of energy savings estimated or measured.
Peak-to-Energy Factor:	Relates to BC Hydro's system peak demand in MW, to annual energy consumption, in GWh based on the load shape of a given sector.
Realization Rate:	The ratio of initial estimates of savings to savings adjusted for data errors and M&V results. Realization rate 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.
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

The purpose of this appendix is to summarize key numerical results from the CNC program evaluation for the period of F2012 to F2016. The following table present the savings summary.

Table A.1. Summary of Net Energy and Peak Demand Savings

	Net Energy Savings (GWh/yr)		Net Peak Demand Savings (MW)	
Fiscal Year	**Reported**	**Evaluated**	**Reported**	**Evaluated**
F2012	8.1	8.4	1.1	1.2
F2013	15.3	19.2	2.2	2.8
F2014	20.7	22.7	3.0	3.2
F2015	14.0	17.9	2.0	2.6
F2016	15.3	20.4	2.2	2.9
CNC (F12-F16)	**73.4**	**88.6**	**10.5**	**12.7**

Table A.2. Key Results of the CNC Program Evaluation F2012-F2016

Estimate	**Result**
Realization rate (evaluated gross as % of expected savings)	106%
Cross effects (calculated as % of expected savings of Lighting Design offer) To the extent they occurred, cross effects are included in evaluated gross savings for Whole Building Design and System Design program offers.	5%
Net-to-gross ratio (calculated as % of evaluated gross; excluding cross effects)	95%
Free ridership (calculated as % of evaluated gross)	20%
Participant spillover (calculated as % of evaluated gross)	1%
Non-participant spillover (calculated as % of evaluated gross)	14%
Rebound (% of evaluated gross)	Not required[1]
Peak-to-Energy Factor (MW/GWh)	0.143 MW/GWh
Weighted average persistence of program savings	15 years
Variance Factor (evaluated net as % of reported savings)	121%

[1] BC Hydro Standard for Rebound Effects (2011)

Appendix B Advisor Memos on Evaluation Report

January 24, 2020

To: BC Hydro
333 Dunsmuir St.
Vancouver, B.C.
V6B 5R3

From: Pierre Baillargeon
Evaluation Advisor
Vice President Econoler
160 Saint-Paul St., Suite 200
Quebec City, QC GIK 3W1

Re: Evaluation of the Commercial New Construction (CNC) Program: F2012-F2016

Dear Madam or Sir:

This advisory memo summarizes the opinions of the evaluation advisor on the evaluation work performed by the BC Hydro evaluation team for the abovementioned program. It takes into consideration the comments and answers from and exchanges with the evaluation team, which were incorporated into the final version of the evaluation report.

Overall appreciation of the report:

- Excellent quality in general. The report is easy to read and flows well. It clearly demonstrates the important impact of the initiative on the market, as well as the high participant satisfaction and high realization rate achieved.
- The advisor commends the evaluation team for the openness and transparency during the whole review process. Exchanges with the BC Hydro team were excellent. They provided clear and precise answers to all questions and additional information whenever necessary.

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?
   - The quality of the research design is excellent and appropriate for a new construction program.
     - The program and how it operates to transform the market is well described;
     - The logic model clearly summarizes the program components, outputs, outcomes (short, intermediate and long-term objectives);
     - The evaluation objectives and research questions are clear.
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?

- The advisor notes the significant effort that went into determining the savings of nine sites using Option D (calibrated simulation) of the International Performance Monitoring and Verification Protocol (IPMVP). While the sample is relatively small, this approach is complex and time consuming, which justify limiting the number of sites with calibrated simulation.
- The projects without full measurement and verification (M&V) went through an initial review of the expected savings; then a significant share of participants went through an additional post-implementation review. This is an appropriate approach for this type of program.
- The advisor expressed some concern about the small number of market actors that were interviewed to determine non-participant spillover. However, the report clearly states the limitation associated with this low number of respondents. Moreover, the advisor recognizes that market actor interviews to determine market trends and non-participant probable courses of action are always a difficult endeavour.

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?
    - The analytical method was good and appropriate for the type of evaluation conducted. The portion of participants evaluated through M&V are in line with international best practices for program evaluation. The lighting component of the program relies on initial and post-installation reviews and is acceptable since lighting is a less complex measure to evaluate.
    - The spillover calculations have some uncertainty due to the low number of respondents and a relatively complex questionnaire. The threat to validity and these limitations are well identified and discussed in the report.
4. How does the methodology compare to common industry practice for evaluations of similar initiatives?
    - The methodologies are in line with best evaluation practices. The report properly covers the review of literature for similar programs and identifies and applies recommendations from the Uniform Methods Project (UMP).
5. What are your suggestions for future evaluations of this DSM initiative?
    - The advisor is in agreement with the main recommendations for future evaluations included in the report by the BC evaluation team.
6. Do you have any other comments that you would like to make?
    - No, this evaluation effort is well done.

January 28, 2020

To: BC Hydro
333 Dunsmuir St.
Vancouver, B.C.
V6B 5R3

From: Rafael Friedmann
Evaluation Advisor
Oakland, California

Re: Evaluation of the Commercial New Construction (CNC) Program: F2012-F2016

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?
    - The effort is appropriate to the research goals. Good description of both goals and CNC program. Good integration of a variety of information, both primary and secondary, to obtain a good understanding of changes in this varied customer segment and impact of BC Hydro's comprehensive mix of CNC offerings.

2. What is the 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?
    - Data is drawn from a comprehensive and appropriate mix of program tracking data, M&V of specific projects, secondary data, and surveys of participants and market actors. Limited number of survey responses at times could affect the validity of results depending on how representative these are of the broader population. Data for M&V of specific projects very good. Data used for free ridership and spillover/market effects limited and more uncertain.

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 evaluated results?
    - Market actor surveys provide insights on market changes and impacts to building codes. Methods for estimating gross savings draw from specific projects M&V based on IPMVP and UMP. Free ridership and Spillover (participant and non-participant) use surveys similar to those used in other BC Hydro evaluations and by other jurisdictions. All these methods are sound as long as respondents are a good representation of the broader population.

4. How does the methodology compare to common industry practice for evaluations of similar initiatives?
    - Methods used align well with those used elsewhere to address the evaluation questions. BC Hydro's efforts to estimate non-participant spillover go beyond usual practice and provide a better understanding of the CNC offerings impact.

5. What are your suggestions for future evaluations of this DSM initiative?
    - The CNC program is being phased out by 2022 and no more evaluations are being considered. Lessons from this evaluation that provide useful insights to consider in other similar evaluations include: 1) Study more why non-participants are not engaging with the program; 2) Consider doing

some sensitivity analyses on savings estimates; 3) Conduct ongoing market actor and participant satisfaction surveys soon after participation; 4) Examine more deeply spillover (participant & non-participant) to improve our understanding of how to foster it and also reduce the uncertainty in its savings estimates.

6. Do you have any other comments that you would like to make?
   - Well written, easy to follow report for a quite complex mix of program offerings to a varied customer base, over a long time period. Appreciate the added language in the final report on threats to validity and uncertainty in the results.

Appendix C Approach Details

C.1. Additional Details on the Participant Survey

Surveys were used as the main source of information for evaluation objective 1 (customer experience) and as a key input for objective 5 (net savings). An online survey of program participants and non-participants was employed, with the following main steps listed below.

An online methodology was selected for this survey for a number of reasons: 1) email addresses were available for the full participant population; 2) the online format better allowed for presenting detailed information on projects completed under the program (e.g., service address, types of upgrades completed, etc.) compared to most other methodologies; 3) the length and complexity of the survey was better suited to a format where the respondent could take the time to make well-considered responses and/or obtain information from others involved in the project; and 4) an online methodology was more cost-effective to collect large sample sizes as compared to telephone surveys.

- Draft survey instruments were prepared, reviewed with program stakeholders and revised to include additional questions of interest.
- The participant sample was developed to include all available CNC program participants. The sample excluded any contacts who had been surveyed within the past six months for any other BC Hydro survey (as per BC Hydro policy on customer contacts). The invitation email included text that asked respondents to forward the survey link to an individual who, in that person's opinion, may have more knowledge about their organization's participation in the program.
- The surveys were programmed in an online format and tested for ease of use and proper functionality.
- The participant surveys were fielded in:
  - May 2013 (for projects completed in F2012)
  - July/August 2014 (for projects completed in F2013 to F2014)
  - November 2014 (for projects completed in the first half of F2015)
  - May 2015 (for projects completed in the second half of F2015)
  - November 2015 (for projects completed in the first half of F2016)
  - May 2016 (for projects completed in the second half of F2016)
- Participants received an honorarium of a $50 gift card for completion of their survey. Multiple reminders were sent to increase the response rate.
- Data were cleaned and cross tabulations were prepared for the evaluation period.

To ensure that survey respondents had the appropriate level of decision making authority for the purpose of this study, a number of questions were asked to determine key characteristics of the respondent and of their facility. The tables below provide customer responses about their title/position within the company as well as decision making responsibilities.

Table C.1. Position/Title of Respondent

Position or Title	CNC Participants (n=57)
Project Manager	34%
Developer	16%
General manager	9%
Business owner or co-owner	8%
Energy Manager – hired as part of BC Hydro's PSP/Energy Manager Program	7%
Executive	6%
Energy Manager - unspecified if BCH funded (response option from prior to 2013)	6%
Site or property manager/supervisor	4%
Energy Manager – NOT hired as part of BC Hydro's PSP/Energy Manager Program	3%
Accountant/Bookkeeper	1%
Finance manager	1%
Other	6%
Total	100%

Table C.2. Primary or Joint Decision Maker (% yes)

Responsible for decisions related to...	CNC Participants (n=57)
Energy management	59%
Investments in equipment costing less than $100,000	58%
Investments in equipment costing $100,000+	51%
Capital investments in retrofitting existing sites/facilities or building new sites/facilities	37%
The operation and maintenance of sites/facilities	36%
The maintenance of equipment	31%

C.2. Additional Details on the Market Actors Survey

For many of the same reasons given in regards to the participant survey, the Market Actors Survey was conducted online. In the same way, the Market Actors Survey was designed by Evaluation staff, and reviewed and revised based on stakeholder feedback. Subsequent to that, the survey was programmed in the online format and tested in a first round by internal staff for its desired functionality, and tested in a second round by five external industry contacts to ensure the questions were meaningful, well-understood and unambiguous.

As already explained earlier in this report, industry professionals for this survey were targeted and sourced via two methods. In the first method, survey invitations were directly emailed to approximately 300 industry professionals for which business contact information (i.e., email addresses) was known. In the second method, an invitation to participate in this research was indirectly made by embedding communications into various industry association e-newsletters and online bulletin boards. These associations included:

- International Building Performance Simulation Association;
- Illuminating Engineering Society of BC;
- ASHRAE BC: American Society of Heating, Refrigerating and Air conditioning Engineers; and
- Architectural Institute of British Columbia.

A total of 30 eligible professionals completed the survey. In doing so, they considered and responded to lines of questions about energy efficiency design and decision making in British Columbia's commercial new construction industry in its broadest context, and also in regards to their own projects in a much narrower context. In this regard, they were funneled through an iteration of questions and grids that converged to be specifically about any of their projects that were designed to perform better than the B.C. Building Code, but did not come through BC Hydro's program. As illustrated in the survey document, this approach was conducted for each of the five years – concurrently – 2012 through to 2016. Note that the sample size decreased to 13-15 through some of these questions due to the fact that not all 30 respondents had 'better than code, non-participating projects' in these particular years.

Based on the input of experts who advised on this evaluation, the data was statistically weighted by the role of the industry professional, reflecting the fact that certain professions – their design roles and decisions – have a greater influence than others in the extent that a project is to be energy efficient. Specifically, three groups of respondents – electrical engineers, mechanical engineers, and energy modelers – were each assigned a 30 percent weighting in their opinions on any given question. All other respondents with other occupational roles in the design and decision process were collectively assigned the 10 percent balance of weight.

Table C.3 below details the role of the industry professionals in the survey sample before statistical weighting.

Table C.3. Role of Industry Professional

	Industry Professionals (n=30)
I was often a key decision maker regarding the extent that projects would be energy efficient	40%
I typically was not a key decision maker, but did provide inputs, alternate options and/or my opinions into the decision making process	60%
I typically had little or no role in the decision making process	0%

Percents are unweighted data.

Table C.4 below details the occupational title or role of the industry professionals in the survey sample before statistical weighting.

Table C.4. Position/Title of Industry Professional

	Industry Professionals (n=30)
Mechanical engineer	53%
Electrical engineer	17%
Energy modeller	17%
Project management	17%
Architect	13%
Real estate	7%
Specifications writer	7%
Project developer/development	3%
Other	20%

Percents are unweighted data.
Other is comprised of the following: Building Code / Fire Engineers; Energy Advisor; Facility Management; Mechanical Designer; Set energy performance standards; Turnkey system provider.

C.3: Additional Details on the Free Rider and Spillover Analysis

Free Ridership

The algorithm used to assign free rider scores for the decision maker survey is shown in the free rider decision tree (see below). For each organization, a free rider score was assigned according to the organization's answers to the survey questions shown in the decision tree. Free rider scores vary between 0.0 and 1.0; where a score of 1.0 represents a full free rider, a score of 0.0 represents a full non-free rider, and a score between 0.0 and 1.0 represents a partial free rider. An example of a full free rider would be an incentive project where the organization indicated that it would have completed the project on its own, at the same efficiency level and scale, even without the assistance of the program, and it was not at all influenced by the program, nor required program assistance to have met any financial criteria. An example of a partial free rider would be an incentive project where an organization indicated that it would have completed it on its own but at a lower efficiency level. An example of a full non-free rider would be a project that would not have been completed at all without the assistance of the CNC program. Spillover was estimated using a similar approach.

There were seven self-report parameters used to inform the free rider algorithm. The rationale for the various pathways and deductions that are shown within the free rider decision tree are described below.

a. Action the organization would have taken if the program had not existed (Steps 1 to 5)

- If the organization indicated that it DID NOT KNOW whether it would have completed the project in absence of the program (Step 2), the final free rider score depended on the organization's answer to the 'influence' question (Step 3). The answers to the influence question range from 0.0 to 1.0 with increments of 0.25, and 'don't know' scoring 0.5. These scores help differentiate between responses and permit the assignment of free rider scores (e.g., 'very influential' was assigned a lower free rider score than a 'somewhat influential' response; 0.0 versus 0.25, respectively).
- If the organization indicated that it WOULD NOT HAVE completed the energy efficiency project in absence of the program, it was assigned a final free rider score of 0.0 (Step 4). Organizations were not queried further because 'not completing a project' represented the path of least resistance from a planning perspective. No attempt was made to further 'test' their intentions, nor were they asked about program influence (an assumption was made that they would have answered that the program had been 'very influential').
- If the organization indicated it WOULD have implemented the energy efficient measures, it was assigned an initial free rider score of 1.0 (Step 5). Deductions to this score were then applied to reflect prior plans, efficiency and scale of the project had they completed it on their own (Steps 6 to 13). The algorithm 'chips away' their stated intention and their initial free rider score of 1.0 by considering their responses to these additional questions.

b. Prior plans to install energy efficient measures/technologies before becoming aware of the program (Steps 6 to 8)

- If the organization WOULD have implemented the energy efficient measures and had plans to do so BEFORE becoming aware of the program, no deductions were made to the free rider score in this step (Step 7). This group was not asked the influence question as their plans had been made before any interaction with the program. As such, it was assumed the program would have been 'not at all influential' on their basic plans to carry out some sort of upgrades.
- If the organization WOULD have implemented the energy efficient measure, but had made plans only AFTER the idea was first suggested by a BC Hydro-funded energy consultant, a BC Hydro-funded

Energy Manager or a BC Hydro representative (Step 8), the organization was then asked how influential the program was on the decision to implement the measure.

c. Influence of the program on the decision to install energy efficient measures/technologies (Step 9)

- For those organizations that made plans AFTER suggestion from BC Hydro, influence was taken into account to reflect the possibility of a causal relationship between 2nd or 3rd party 'suggestion' and the decision to implement the energy efficient measures. The rationale for utilizing the 'influence' question at this stage of the algorithm was that a suggestion could take many different forms, ranging anywhere from a simple verbal suggestion during a meeting, to an energy study. Based on professional judgment, points were deducted from the free rider score to reflect the fact that we were no longer 100% sure that the organization would have installed the measure in absence of the program:0.5 for VERY INFLUENTIAL, 0.35 for SOMEWHAT INFLUENTIAL, 0.15 for NOT TOO INFLUENTIAL, 0 for NOT AT ALL INFLUENTIAL and 0.25 for don't know responses The assumption was that the program was at least partially influential on the organization's decision to do so.

d. Financial criteria around site investment (Step 10)

- For incentive projects, if an organization indicated that its energy efficiency project would NOT have met their organization's financial criteria for site investments without assistance from the program, then the free rider score was reduced by an additional 0.5. Although for-profit businesses rely heavily on the financial bottom line, a project can still proceed even if it does not meet an organization's financial criteria due to other non-financial factors such as anticipated change of regulations, safety, market prices, etc. This suggests that a project can still be a partial free rider even if it requires an incentive payment from the program to meet the organization's financial criteria. If the organization believed their financial criteria would have been met, the free rider score was not adjusted. If the organization did not know, the free rider score was reduced by 0.25.

e. Energy efficiency level of new measures/technologies in absence of the program (Step 11)

- If an organization indicated that the energy efficiency of the project would have been AS EFFICIENT or MORE EFFICIENT in absence of the program, no points were deducted.
- A deduction of 1.0 was made if the organization would have completed a LESS ENERGY EFFICIENT project in absence of the program. For CNC, baselines are determined through BC Hydro Conservation & Energy Management Engineering review. In cases where several different options are available to the customer that range in efficiency, Engineering calculates gross energy savings using a baseline of what the customer would have likely done without the influence of the program. In other words, only savings that go beyond common market practice (natural conservation) are claimed by the program. Therefore, a participant who reports that they would have done something less efficient in the absence of the program is a 0 percent free rider on this specific aspect of free ridership (i.e., a 1.0 deduction).
- A deduction of 0.5 was made if the organization DID NOT KNOW what level of energy efficiency the project would have had. This value was used to maintain the average deduction between those organizations which would have implemented a measure with the same or higher efficiency and those organizations which would have implemented a measure with less efficiency.

g. Percent of the project that would have been completed in absence of the program (Step 12)

- A final adjustment to the free rider score was made based on the percentage of the project that would have been completed if no assistance had been provided through the program, e.g., if 40 percent of the project would have been completed in absence of the program, the free rider score was multiplied by 0.4. 'Don't know' response did not receive any adjustments, i.e., they were multiplied by 1.

h. Timing

- Note that while timing of the project was explored in the survey, it was excluded from the algorithm due to the nature of CNC projects. Due to the high cost and long lifespan of the types of projects CNC pertains to, if a particular energy efficient technology is not installed as part of the initial construction, it is unlikely that it would be brought in to replace a less efficient technology in the short to medium term. It would not be financially feasible to replace a recently installed technology with a more energy efficient one – it is either included as part of initial construction or not replaced again until the long term.

- After applying all of the adjustments, an individual free rider score was calculated for each site that responded to the survey. These scores were then weighted by savings and averaged to calculate a grand mean free rider score.

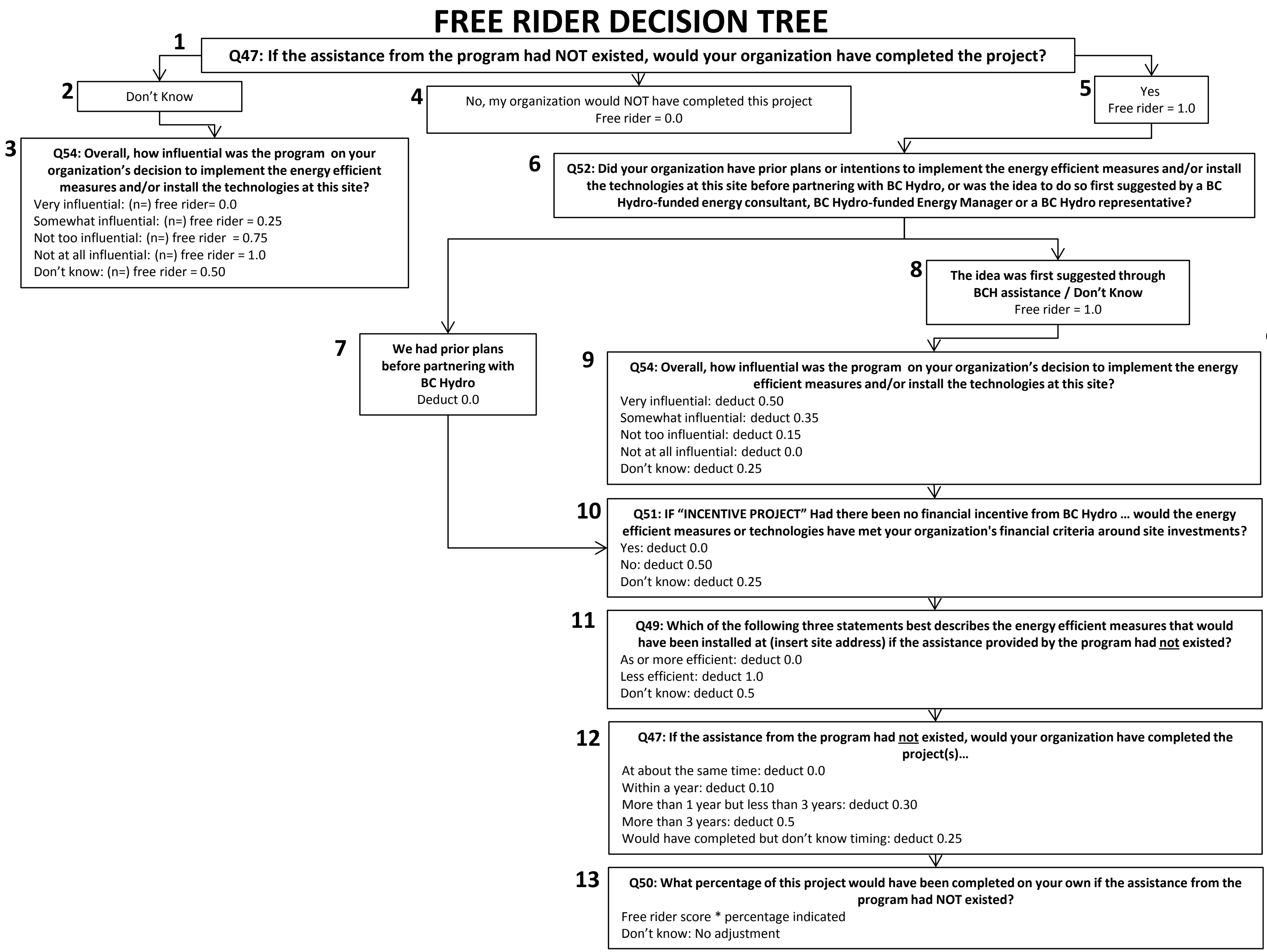


Figure C.1. Free Rider Decision Tree

Participant Spillover

The participant spillover decision tree logic is presented as Figure C.2. The rationale for the various pathways and additions on the spillover decision tree are described below. All organizations were initially assigned a spillover score of 0.0. Spillover points were then *added* – thereby crediting the program with additional savings – depending on responses a series of questions.

a. Additional energy efficient projects completed without assistance from CNC (Steps 1-4)

- Organizations that DID NOT KNOW whether any new energy efficiency projects were undertaken at a specified site were given a final spillover score of 0.0. This is because the program cannot claim additional savings for something that may or may not have been completed (Step 2).
- Organizations that indicated that NO additional energy efficiency projects had been undertaken were given a final spillover score of 0.0. A score of 0.0 indicated that no additional savings could be claimed by the program for this site and they were excluded from further analysis (Step 3).
- Organizations that indicated that additional energy efficiency projects HAD BEEN IMPLEMENTED without assistance from the program were asked to select the ones they installed from a list of common end-uses and technologies (e.g., lighting, cooling systems, heating systems, water heating, etc.). From this point forward, each end-use or technology that was upgraded was analyzed separately in order to assign a spillover score at a retrofit level.

b. Funding from other organizations (Steps 5 to 7)

- Projects that received assistance from a program offered by another organization were assigned a final spillover score of 0.0 (Step 6). While it was possible that the CNC program could have influenced these particular projects, these projects were removed from further analysis as it was not possible to reliably separate the level of influence from the different overlapping programs. This removal resulted in a more conservative spillover estimate.
- If no other funding was received, no credits were added, but the organization continued with additional questions.

c. Action the organization would have taken if the program had not existed (Steps 8 to 11)

- Energy-efficient retrofits or upgrades made without the assistance of another organization were then grouped using the ‘timing’ question. Those projects that would have NOT been completed at all if the organization had not participated in the program were giving a final spillover score of 1.0, fully crediting the program for the spillover savings associated with these projects.
- Those projects that would have gone ahead regardless of program participation continued with questioning regarding prior plans, influence, timing, efficiency and scale of the project. If the organization was unsure about whether the project would have been completed in absence of the program, it was also asked these additional questions – a more conservative approach – rather than being assigned any spillover additions at this point.

d. Prior plans and influence of the program on the decision to install additional energy efficient measures/ technologies (Steps 12 to 15)

- If an organization first had plans to implement the measure PRIOR to its participation in the program, it was not asked the influence question (Step 12). It was assumed that the influence would have been ‘not at all’ since their plans were in place before any interaction with the program.

- If the organization first made plans AFTER its participation in the program, it was asked how influential the program was on its decision to complete these additional projects. The spillover score at this step ranges from 0.0 to 1.0.

e. Timing of installing the additional energy efficiency measures/technologies in absence of the program (Step 16)

- If an organization would have completed the project AT THE SAME TIME or WITHIN A YEAR of when it was actually done, no credits were added to the spillover score. Also, no credits were added if the organization would have completed the project, but was unsure about the timing.
- For those organizations that would have completed the project, a credit of 0.1 was added for MORE THAN ONE YEAR BUT LESS THAN 3 YEARS and 0.3 was added for MORE THAN 3 YEARS. The higher credits for the projects originally planned further in the future reflects bringing those projects – and the associated savings – forward in time by a greater number of years. Similar to the free rider influence question, the credits are heuristics that help differentiate between responses and permit the assignment of spillover scores.

f. Energy efficiency level of the additional measures/technologies in absence of the program (Step 17)

- If the project would have been LESS ENERGY EFFICIENT had the organization not participated in the program, a credit of 0.5 was added to the spillover score.
- However, if the project would have been AS EFFICIENT or MORE EFFICIENT, no credits were added since the program interaction did not result in any additional savings beyond the organization's original plans. No credits were added for 'don't know' responses.

g. Amount or number of additional energy efficient measures/technologies that would have been completed in absence of the program (Step 18)

- If the organization originally intended to implement FEWER energy efficient measures prior to participating in/becoming aware of the program, the program was credited with the additional savings associated with the increased scale of the project through an addition of 0.25 points.
- If the SAME or MORE measures were originally planned, no credits were added to the spillover score.

In order to convert the spillover score into the same metric as the free rider score, a typical savings estimate was applied to each individual end-use that was upgraded, and then those savings were adjusted by the organization's final spillover score for that particular end-use. The adjusted spillover savings for each individual end-use for each organization were summed and then used to calculate an average spillover savings per site (including those sites that reported no spillover activity). This average was then used to extrapolate spillover savings to the entire participant population. Finally, the total spillover savings were expressed as a percentage of the total evaluated gross program savings.

SPILLOVER DECISION TREE

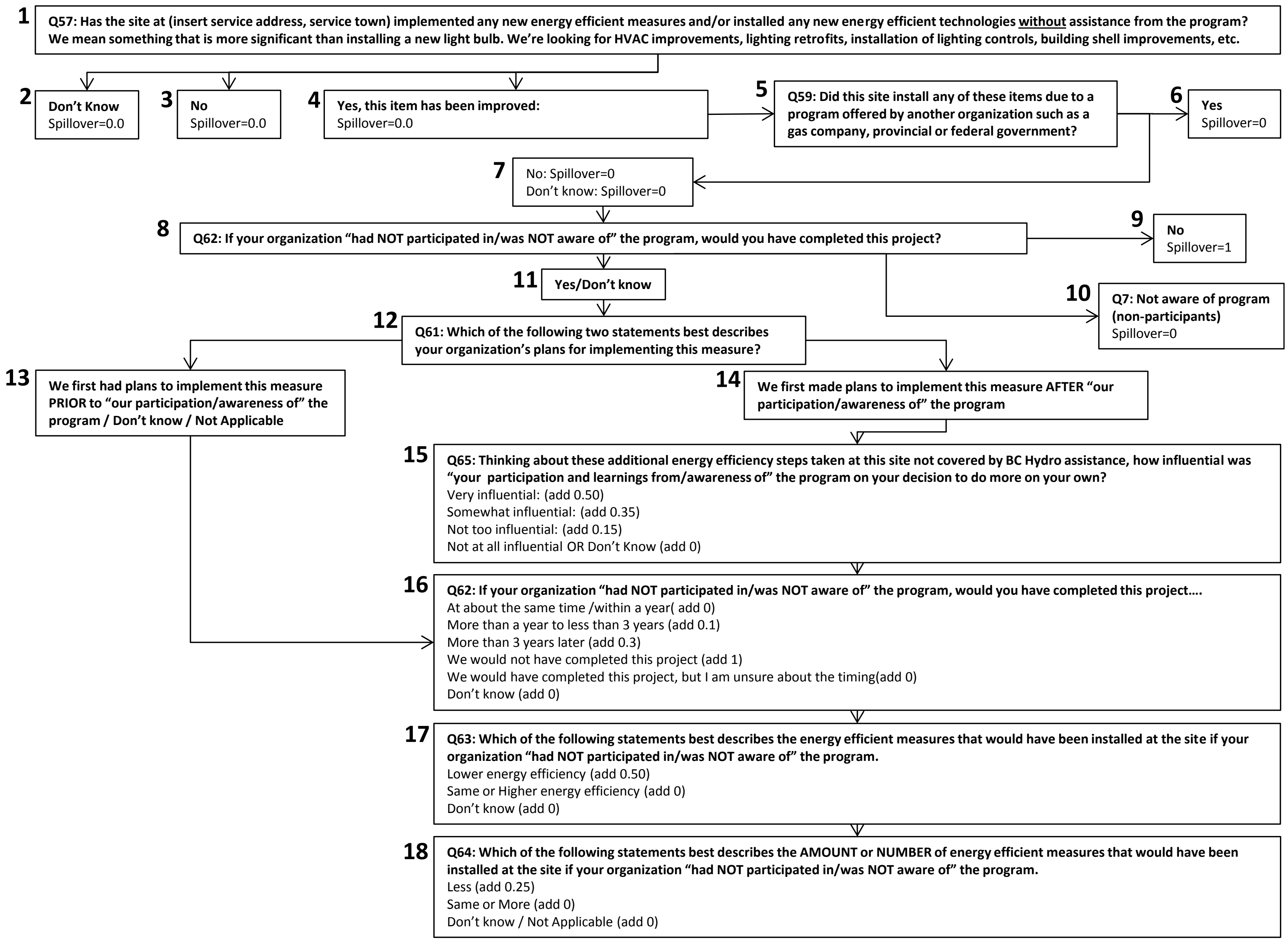


Figure C.2. Participant Spillover Decision Tree

Non-Participant Spillover

As already outlined in Section 2 and presented again in Table C.5 below, non-participant spillover pertaining to the entire five year evaluation period of interest was estimated via a calculation involving five inputs. The calculations of inputs D, E and F are further explained below.

Table C.5

A.	Commercial new construction building stock in B.C. that could have been influenced by the program F12-F16 (m^2)	A
B.	Commercial new construction building stock that did receive BC Hydro program funding F12-F16 (m^2)	B
C.	Commercial new construction building stock that did not receive BC Hydro program funding F12-F16 (m^2)	C = A – B
D.	Percent of commercial new construction building stock that exceeds code F12-F16 (%)	D
E.	For commercial new construction building stock that exceeds the B.C. Building Code, the average unit electricity savings relative to the code (kWh/m^2)	E
F.	Attribution of electricity savings to BC Hydro's Commercial New Construction Program (%)	F
G.	Non-Participant Spillover F12-F16 (GWh)	$G = \frac{C \times D \times E \times F}{1,000,000}$

Details of Input D: Percent of commercial new construction building stock that exceeds code

Findings from the Market Actors Survey were used to estimate the percent of commercial new construction floor area during the evaluation period that exceeded the B.C. Building Code (row D).

As this estimate was applied to the commercial new construction projects that did not receive program funding in the pursuit of non-participant spillover, it was ultimately based on survey respondents' non-participating projects. However, this estimate of the percent of commercial new construction floor area that exceeded code could only be distilled after respondents were taken through questions about all of their projects – some of which were in fact participating projects. As explained further below, such estimates that were later determined to include participating projects were excluded from further calculations.

Lines of questions in the survey solicited – for each of the five years 2012 through to 2016 – a respondent's total amount of commercial new construction floor area that they worked on and, through further calculation, the total amount of floor area that was designed and built to perform better than the energy efficiency requirement in the B.C. Building Code. The questions pertaining to each year were presented concurrently in a grid format.

For each year, a respondent then disaggregated their 'better than code' floor area – if there was any – into the amount that received program funding and the amount did not receive BC Hydro program funding[14].

[14] An alternate approach would have been to first ask survey respondents to estimate the total amount of their commercial new construction floor area that did not receive program funding, then to estimate the amount of that non-participating floor area that was designed and built to perform better than the B.C. Building Code. However, it was believed that this sequence of questioning and deduction would be less intuitive for most respondents.

For each year in which a respondent did not have any projects at all that received program funding, the percent of their commercial new construction floor area that exceeded the energy efficiency requirement in the B.C. Building Code was calculated as the total amount of their floor area in that year that exceeded the code divided by the total amount of floor area that they had worked on. Conversely, for any year in which a respondent did have at least some of their 'better than code' projects receive program funding, the estimate of the percent 'better than code' – intended to be applied strictly to non-participating projects for that year – was subsequently discarded. This was because for any given year, a respondent's 'better than code' floor area that did not receive program funding could not be disentangled from their 'better than code' floor area that did receive funding.

For each year, an average percent of commercial new construction floor area that exceeded code was then calculated as the average percent among all eligible respondents – weighted by the total built floor area that any one respondent had worked on.

Covering the entire five years of this evaluation period, the grand average of the percent of commercial new construction floor area that exceeded code was then calculated as the average percent from each individual year – weighted by the combined total built floor area for all respondents in each year.

Details of Input E: Average unit electricity savings for new construction building stock that exceeds code

Findings from the survey – together with end-use intensity data from BC Hydro's 2016 Conservation Potential Review (CPR) – were used to estimate average unit electricity savings for the floor area that exceed the B.C. Building Code (row E) over the five year evaluation period.

Survey respondents who reported having had commercial new construction projects over the five years that were designed to perform better than the B.C. Building Code and that did not receive BC Hydro program funding were asked a series of questions about their 'better than code, non-participating' projects.

These respondents were first asked to indicate which one(s) of eight different energy-efficient measures they at least sometimes designed or recommended to be implemented in their 'better than code, non-participating' projects.

Next, for each measure that was at least sometimes implemented, respondents were then asked to 1) estimate the percentage of their 'better than code, non-participating' floor area over the five years that either incorporated or benefitted from the measure, and 2) estimate the percent electricity savings from the measure as compared to a conventional measure that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code.

This information was then integrated with end-use intensity data from BC Hydro's 2016 Conservation Potential Review (CPR) to yield an estimate of the average unit electricity savings (kWh/m^2) – relative to the building code – for these 'better than code, non-participating' projects.

Details of Input F: Attribution of savings to BC Hydro's Commercial New Construction Program

Findings from the survey were used to estimate the attribution of gross electricity savings from 'better than code, non-participating' commercial new construction projects over the five year evaluation period back to the Commercial New Construction Program (row F).

Survey respondents were asked to reflect upon their new construction projects in B.C. – those that became occupied from 2012 to 2016 – that are performing better than the energy efficiency requirements in the B.C. Building Code and that did not receive BC Hydro program funding.

In doing so, they were asked to assess each of nine different factors in terms of the factors' influence on making these particular projects perform 'better than code'. As detailed on the following page, five of these factors were tied to BC Hydro's Commercial New Construction Program, its complementary offerings and the industry resources for which it played an integral role in developing. Four of the factors were categorized as non-BC Hydro factors.

Specifically, respondents were asked to record the percent share they would credit each of the nine factors for making their 'non-participating' projects perform 'better than code' such that the percent shares summed to 100 percent. Note that for any given respondent, a BC Hydro factor was not shown – via the survey's programming logic – if the respondent previously indicated having had no experience with the factor. In this scenario, the factor was effectively rendered a 0 percent share.

- BC Hydro Factors
  - My learnings and experience from having had other projects go through BC Hydro's Commercial New Construction program;
  - My learnings and experience from having attended BC Hydro workshops;
  - My learnings from having reviewed the case studies and resource literature posted on BC Hydro's website;
  - My learnings from having reviewed the Building Envelope Thermal Bridging Guide; and
  - My learnings from having reviewed the Enhanced Thermal Performance Spreadsheet.
- Non-BC Hydro Factors
  - Industry innovation and good practices (outside of BC Hydro involvement);
  - My own or my organization's desire to build such projects for LEED certification;
  - My/our client directed us to have such projects perform better than the energy efficiency requirements in the B.C. Building Code; and
  - All other factors.

For each respondent, the percent shares they credited to the five BC Hydro factors were added up to a net BC Hydro total – essentially, their attribution of their 'better than code, non-participating' projects during the evaluation period back to the Commercial New Construction Program. The grand average – the final point estimate of attribution (row F) – was then calculated as the equally weighted average among all eligible respondents.

Notably, this line of questioning around attribution was administered near the very end of the survey after respondents were taken through very comprehensive and algorithmic sets of questions about their commercial new construction projects that became occupied during the period of interest. It is believed that the sequencing and build-up of these prior questions set respondents up in a favourable position and mindset to make reliable, informed and unbiased assessments of the factors.

Appendix D Results Details

D.1 Additional Detail for Expected Energy Savings

The number of measures and expected energy savings by program offer and by industry sub-sector and end uses are given in the graphs below.

Figure D.1. Project and Savings Distribution by Program Offer

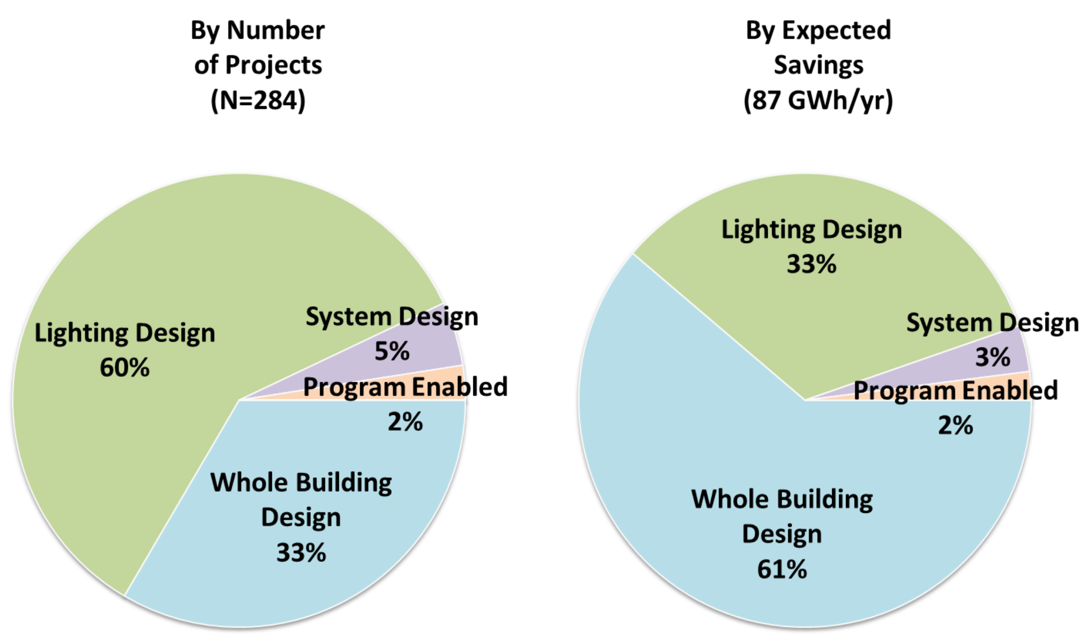


Figure D.2. Savings Distribution by Program Offers and Fiscal Year

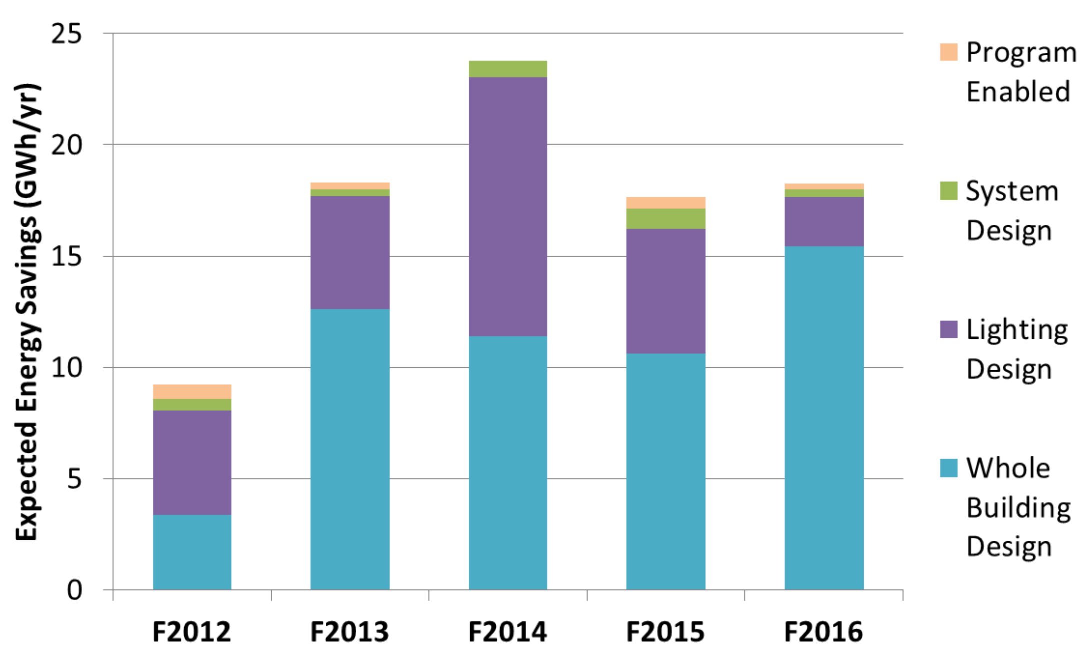


Figure D.3. Project and Savings Distribution by Sector

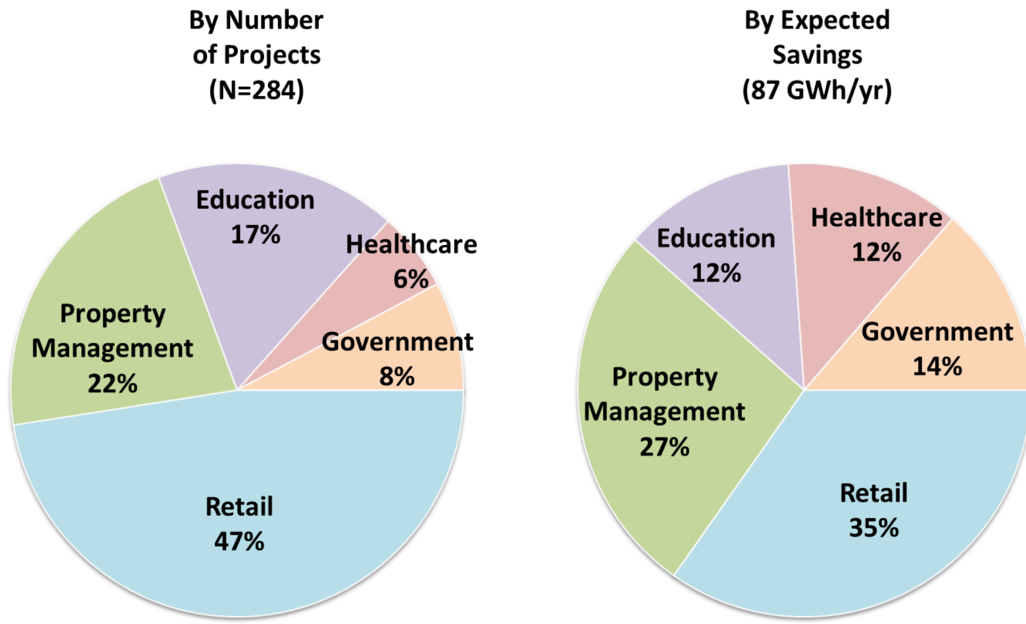


Figure D.4. Savings Distribution by Industry Sub-sector and Fiscal Year

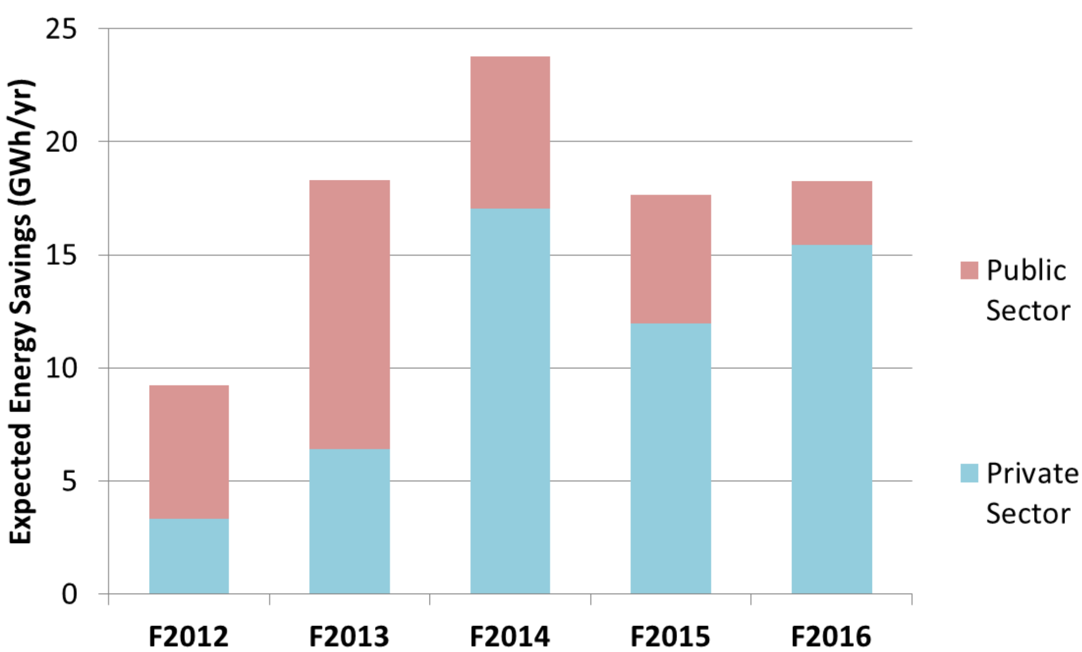
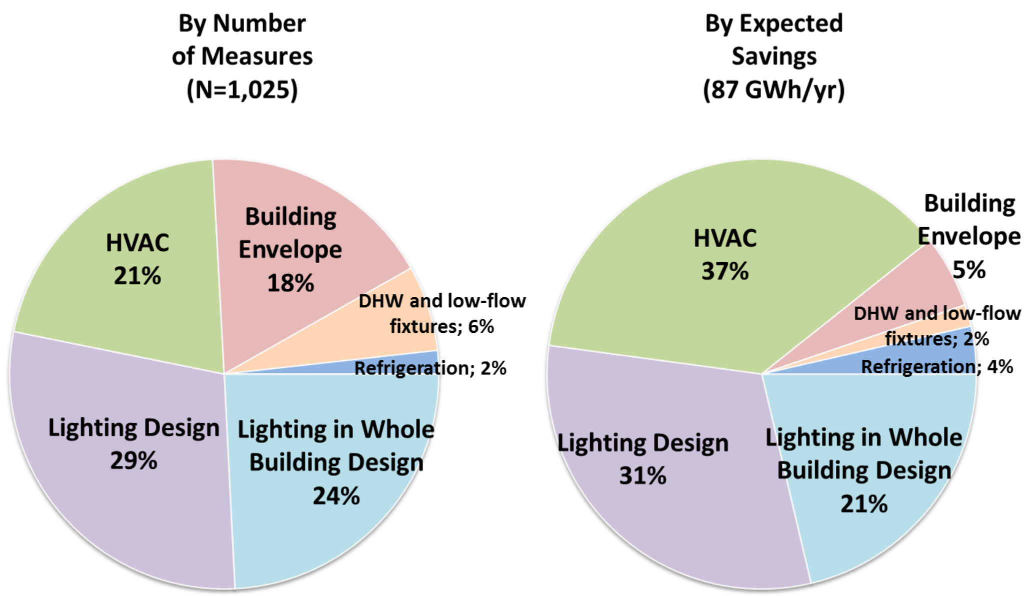
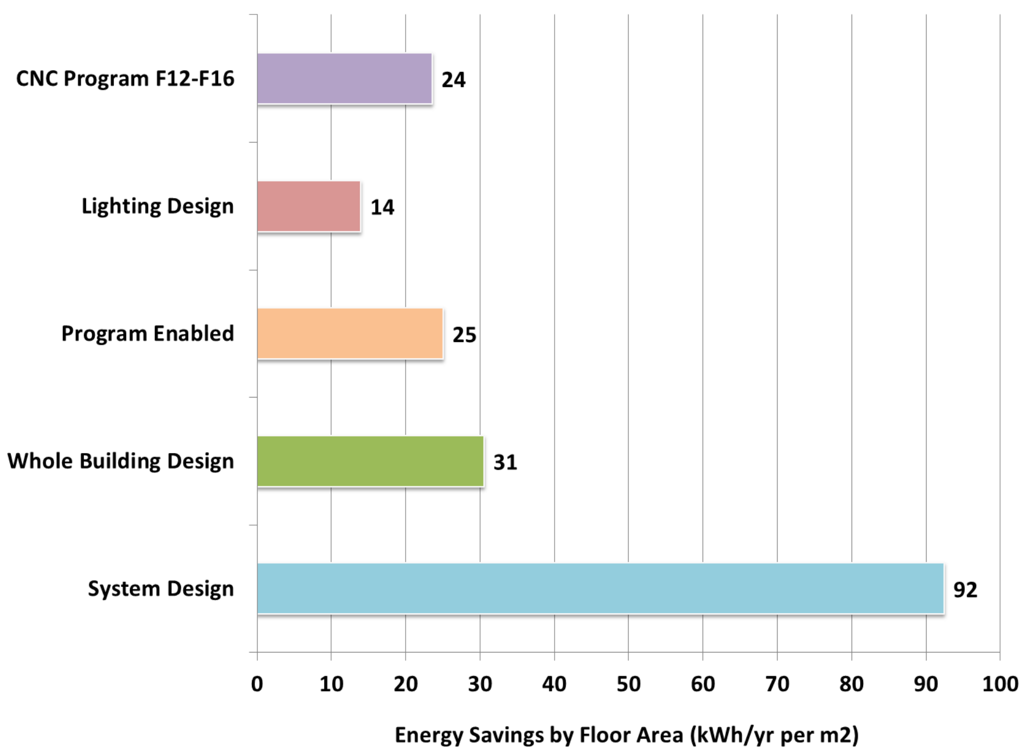


Figure D.5. Measures and Savings Distribution by End Use



The figure below illustrates the unit energy savings by affected floor area and program offer for the CNC program from F2012 through F2016. The figure shows the increasing unit energy savings from Lighting Design to Whole Building Design to System Design. Overall, the CNC program achieved building energy intensity savings of 24 kWh per year per square meter which is approximately 18 percent of the building's electricity consumption.

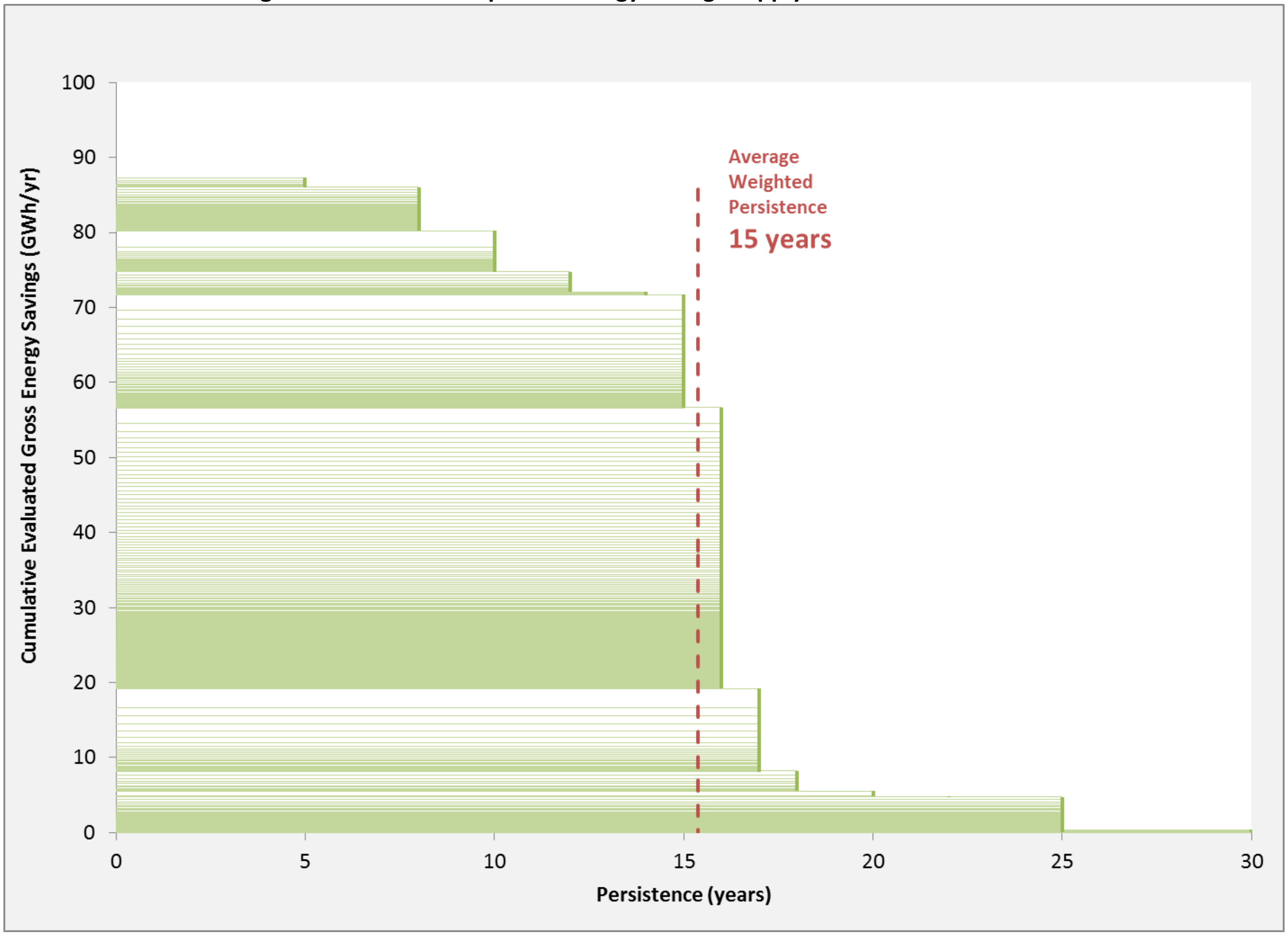
Figure D.6. Energy Savings by Affected Floor Area and Program Offer



D.3 Additional Results for Persistence

The persistence of measures was not evaluated but persistence values were assigned during the technical review of measures in accordance to the BC Hydro Persistence Standard[15]. The graph below illustrates the magnitude of expected energy savings of measures in order of increasing persistence. At the top of the chart are projects of lowest persistence (5 years) and at the bottom projects of highest persistence (30 years). In general, measures with 5 to 8 year persistence are lighting control measures; measures with 8 to 16-year persistence are hard-wired equipment and system measures; and measures with over 16 year persistence are typically upgrades to building envelope, or redesign of air distribution ductwork or water piping networks. The row height indicates the magnitude of savings. The weighted average persistence of energy savings from CNC in the F2012 – F2016 period was calculated to be 15.4 years as indicated by the dotted red vertical line.

Figure D.7. Measure Expected Energy Savings Supply and Persistence Curve



[15] BC Hydro DSM Standard: Effective Measure Life and Persistence – Revision 10, June 2016.

D.1 Additional Results from the Participant Survey

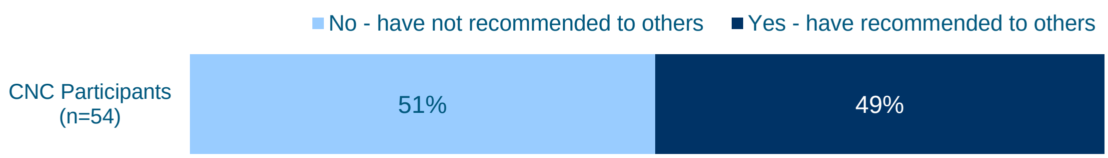
This section presents additional results from the participant survey.

Likelihood of Recommending the Program

Below are the full distributions of the likelihood of recommending the program to others and having already done so.

Figure D.8. Likelihood of Recommending the Program to Others

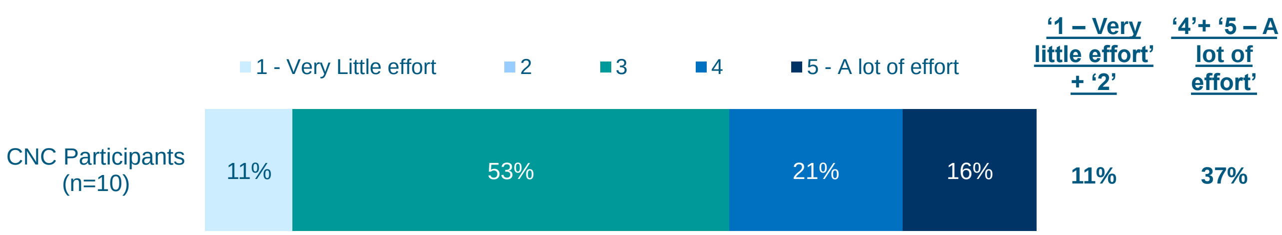
Figure D.9. Have Recommended the Program to Others



Level of Effort

Participants reported that they had put in moderate levels of effort to participate in CNC, with the bulk of respondents (53%) reporting a level of 3 on a 5-point scale. A further 37 percent reported having to put in a higher level of effort – a level of 4 or 5 on a 5-point scale. Very few (11%) reported having to put in very little effort in order to participate in the program – a score of 1 on the 5-point scale. Note that the sample size for this question is small because it was added to the survey in F2016.

Figure D.10. Level of Effort to Complete Participation in the Program



Suggestions for Improvement

Participants were asked to provide comments or suggestions about the program. In total, 25 percent of those who responded provided comments. Comments related to the process being too slow, the process being too complicated and communication issues emerged as main themes.

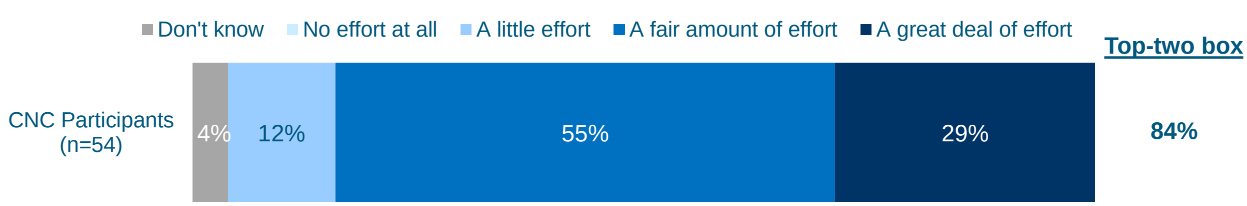
Table D.1. Comments/Suggestions for Improvement

	CNC Participants (n=15)
Process too slow / approvals take too long / speed up process	26%
Process/forms too complicated / create simpler process	24%
Communication issues / better communication with BCH/KAMs	14%
Website issues (hard to navigate, needs better info/tools)	8%
Increase variety of eligible products	4%
Increase incentive amounts	4%
Provide more information / training / seminars about program	3%
Want site visit/energy audit/in-person meeting	3%
Other program related	9%
Other non-program related	4%

Conservation Efforts and Momentum

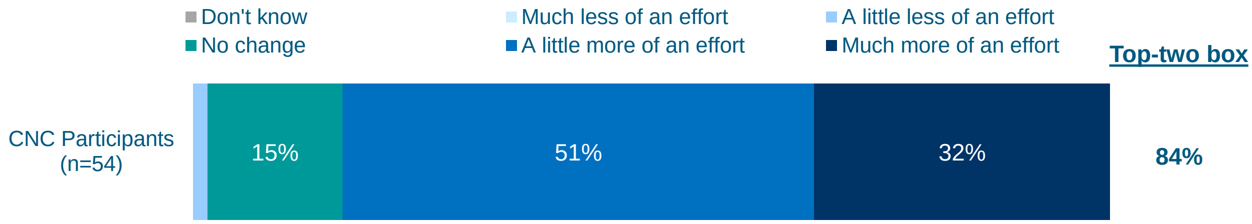
In total, 84 percent of CNC participants reported making either ‘a great deal of effort’ (29%) or ‘a fair amount of effort’ (55%) to conserve electricity over the past year. Only a small percentage reported making ‘a little effort’ (12%) and none reported making ‘no effort at all’.

Figure D.11. Efforts to Conserve



Compared to efforts a year ago, 84 percent of participants reported increased levels of conservation effort, with 32 percent indicating that they had made ‘much more of an effort’ and 51 percent indicating that they had made ‘a little more of an effort’. A further 15 percent indicated that there was ‘no change’, while only 2 percent indicated making less of an effort.

Figure D.12. Conservation Momentum



Energy Management Motivators

Participants were asked to rate various motivators to manage their use of electricity over the past year. 'Key account managers' and the 'CNC program' emerged as major factors. Other top motivators included 'reducing electricity use to make operating costs as low as possible' and an 'energy manager'. Note that the sample sizes for this question are small for two reasons: 1) the scale for this question was changed starting in F2013 (from an influence scale to a major/minor scale) and results from F2012 have thus been excluded and 2) due to the overall length of the survey, this bank of questions is not asked every survey wave.

Table D.2. Motivators to Manage Use of Electricity Over the Past Year

	Major Factor (n=10)
Key Account Manager (among those with a KAM; n=5)	65%
CNC program	60%
Reducing electricity use to make operating costs as low as possible	44%
Energy Manager	44%
Reducing electricity use to benefit the environment – it's just the right thing to do	37%
The incentive to conserve electricity that is built into BC Hydro's rate structure	37%
Overall level of electricity prices	34%
Increased funds within your company for energy-efficient retrofits	32%
Focus on cost cutting measures due to any economic downturn	23%
Federal, Provincial, or Local government initiatives	9%
Employees	9%
Contractors, vendors or customers	9%

Percentages shown are for 'major factor based on a 3-point labelled scale: major factor, minor factor, and not a factor. 'Don't know' responses are included in the calculation of percentages. Scale changed in F2013; responses from F2012 have been excluded.

Energy Management Barriers

Participants were also asked about barriers to manage electricity over the past year. The factors that emerged as the largest barriers were 'lack of funds for energy efficiency retrofits/projects', that there are 'other operational priorities' and 'lack of financial incentives for conservation programs and energy efficiency'.

Table D.3. Barriers to Manage Use of Electricity Over the Past Year

	Major Factor (n=22)
Lack of funds for energy efficient retrofits/projects	33%
There are other operational priorities	29%
Lack of financial incentives for conservation programs and energy efficiency	26%
Interruption to business operations	14%
Lack of staffing/staffing requirements	11%
Can't control employees' behaviour in regards to energy efficiency practice	7%
Takes too much time	3%
Current usage is already near its lowest possible level	3%
Lack of knowledge of where the opportunities for savings might be	0%
All equipment is functioning efficiently as possible	0%
Currently leasing the property and no property changes are permitted	0%

Percentages shown are for 'major barrier' based on a 3-point labelled scale: major barrier, minor barrier, and no barrier.
'Don't know' responses are included in the calculation of percentages.

Program Participation

While the questions below were used primarily as inputs to the free rider algorithm, looking at them individually can provide additional insights into the decision making process for implementing energy efficient upgrades, as well as provide insights on the role that each plays in the free ridership score. Recall, however, that free ridership is calculated using a decision tree with the individual questions receiving scoring based on the response options selected. Note also that the overall free rider score was weighted based on savings. Further details about the free rider algorithm and the scoring for each element are discussed in Appendix C.2.

Project Completion and Timing

As part of the timing question, organizations stated whether or not the energy efficiency project would have gone ahead without assistance from the CNC program. All participants indicated that that the project would have gone ahead in some form even in the absence of the program, comprised both of those who were able to provide an estimate of the timing and those who were unsure of timing. The vast majority would have completed the project at the same time (76%), while the next largest proportion was unsure about timing (16%).

Note that while timing of the project was explored in the survey, it was excluded from the algorithm due to the nature of CNC projects. Due to the high cost and long lifespan of the types of projects CNC pertains to, if a particular energy efficient technology is not installed as part of the initial construction, it is unlikely that it would be brought in to replace a less efficient technology in the short to medium term. It would not be financially feasible to replace a recently installed technology with a more energy efficient one – it is either included as part of initial construction or not replaced again until the long term.

Table D.4. Project Completion and Timing

We would have completed the project…	CNC Participants (n=51)
...at about the same time as actually done so	76%
...within a year of when actually done so	4%
...more than a year but less than 3 years later	0%
...more than 3 years later	0%
My organization would have completed this project, but I am unsure about the timing	16%
My organization would NOT have completed this project	0%
Don't know	4%
Total	100%

Prior Plans

A total of 41 percent of CNC participants reported that the idea to implement the energy efficiency measures was first suggested through BC Hydro assistance, such as a BC Hydro-funded energy consultant, BC Hydro-funded Energy Manager or a BC Hydro representative. A total of 43 percent of participants had the idea to implement the measure prior to suggestion by BC Hydro, while the remaining 16 percent were unsure about prior plans.

Table D.5. Prior Plans

	CNC Participants (n=51)
Yes, the idea was first suggested through BC Hydro assistance	41%
No, the ideas was NOT first suggested through BC Hydro assistance	43%
Don't know	16%
Total	100%

Among those who would have completed the project even if assistance from CNC had not existed.

Energy Efficiency

Participants were asked what level of energy efficiency they would have implemented in absence of the program. A total of 45% would have done so with a lower energy efficiency than actually implemented, while 41% would have installed the same efficiency as actually done so.

Table D.6. Energy Efficiency

We would have completed the measure with…	CNC Participants (n=51)
…a LOWER ENERGY EFFICIENCY than actually installed	45%
…the SAME ENERGY EFFICIENCY as actually installed	41%
…a HIGHER ENERGY EFFICIENCY than actually installed	2%
Not applicable	2%
Don't know	10%
Total	100%

Among those who would have completed the project even if assistance from CNC had not existed.

Financial Criteria

A total of 45 percent of participants indicated that the project would have met their organization's financial criteria around site investments, even without assistance from the program. A similar proportion indicated that it would not have met their financial criteria (43%), while the remainder were either unsure or felt that the financial criteria was not applicable to the project. Lighting design projects were more likely to have met an organization's financial criteria than whole building design projects (56% versus 40%). Note that although for-profit businesses rely heavily on the financial bottom line, projects often still proceed even if they do not meet an organization's financial criteria due to other factors (e.g., anticipated change of regulations, market prices, etc.).

Table D.7. Financial Criteria

	CNC Participants (n=51)
Yes, it would have met our financial criteria	45%
No, it would NOT have met our financial criteria	43%
Not applicable	4%
Don't know	8%
Total	100%

Among those who would have completed the project even if assistance from CNC had not existed.

Scale of Project

About one-quarter of participants who believed they would have completed the project on their own even without assistance from the program would have completed it at the same scale or higher. A further 40 percent would have completed between 50% and 99% of the project on their own, while only 8 percent would have completed less than half of it.

Table D.8. Scale of Project

	CNC Participants (n=51)
0%	0%
1% to 24%	2%
25% to 49%	6%
50% to 74%	12%
75% to 99%	28%
100% or greater	28%
Not applicable	4%
Don't know	20%
Total	100%

Among those who would have completed the project even if assistance from CNC had not existed.

Program Influence

Participants were asked how influential the program was on their organization's decision to implement the measures. In total, 80 percent of participants reported that the program was 'very influential' or 'somewhat influential' on their decision to do so. A further 12 percent indicated that the program had been 'not too influential' while 4 percent indicated that it had been 'not at all influential'.

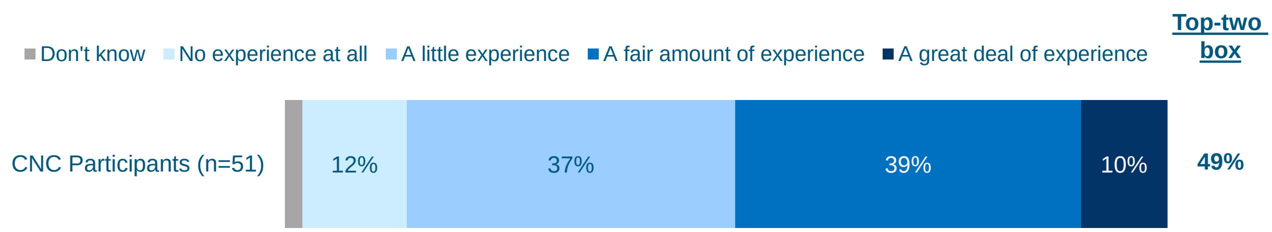
Figure D.13. Program Influence

Among those who would have completed the project even if assistance from CNC had not existed.

Prior Experience with Measure/Technology Installed

Prior experience with the measures or technologies installed was fairly evenly distributed, with about half of participants having at least at least a fair amount of experience and half having little to no experience. Note that this question was not used in the free rider algorithm.

Figure D.14. Prior Experience with Measures/Technologies Installed



Appendix E Market Actor Survey – Questionnaire

Commercial New Construction – Market Actor Survey

Welcome to BC Hydro's Commercial New Construction Survey.

As the commercial new construction industry in British Columbia continues in its drive to build and operate higher performing and more energy efficient buildings, it is important to understand 'where it is currently at' in this regard.

While BC Hydro has very deep insights into the building projects that have come through its own Commercial New Construction Program, it has fewer and less reliable insights in regards to the many more projects that have not come through its program.

To this end, BC Hydro is embarking on a study to estimate the extent that new construction projects in the province are energy efficient. We are particularly interested in understanding the buildings or major additions that became occupied from 2012 to 2016 for which you may have had a decision making role regarding the extent that the projects would be energy efficient.

Again, our interest in this study is about the commercial new construction projects in the province that have not received direct BC Hydro funding or support.

The survey will likely take 30 minutes to work through, but we have tried to make your participation as easy as possible by allowing you to log on/off of the survey to complete it at your leisure. The next screen page will show you how.

For privacy reasons, do not self-identify (unless for the purposes of entering the contest) or identify other specific individuals in your written comments. Any comments including self-identification or identification of third parties will be discarded.

Thank you for your participation, your opinions are extremely important to us.

Cohesium Research, an independent research company based in B.C., is assisting us to conduct this survey. Your responses will be held in strict confidence by BC Hydro's Evaluation department and will be compiled with those of other customers for the research and planning purposes as identified above.

If you have any further questions about how to complete your survey, please contact please contact Connie Cheng, Project Manager, Cohesium Research at conniecheng@cohesiumresearch.com. If you have questions about why BC Hydro is conducting this research, please contact Marc Pedersen, Senior Evaluation Specialist at marc.pedersen@bchydro.com.

The personal information gathered through this study, including your opinions, demographic information, and name (if you choose to provide it at the end of the survey for participation in the prize draw) is being collected in furtherance of BC Hydro's electricity conservation mandate under the Clean Energy Act.

About You and Your Work

1. To begin the survey, can you please confirm that at least some of your work over the past 5-10 years has been in regards to the commercial new construction market in British Columbia?

By this we mean work that informs new construction or building additions in the commercial (e.g., offices and retail stores), institutional (e.g., schools & universities, hospitals), and multi-unit residential sectors.

☐[1] Yes

☐[0] No ⇒ SKIP TO Q70

☐[99] Don't know ⇒ SKIP TO Q70

2. Consider the commercial new construction projects you worked on that became occupied between 2012 and 2016.

Which one of the following statements best describes your involvement in the decisions regarding the extent that the projects would be energy efficient?

- **Decisions for such projects very likely occurred some three to five years prior to when they became occupied.**
- **Decisions regarding a project's energy efficiency may pertain to the building's envelope, its heating, cooling and ventilation systems, service water heating, its lighting system and its plug-load system.**

☐[1] I was often a key decision maker in the extent that projects would be energy efficient

☐[2] I typically was not a key decision maker, but did provide inputs, alternate options and/or my opinions into the decision making process

☐[3] I typically had little or no role in the decision making process ⇒ SKIP TO Q70

☐[99] Don't know ⇒ SKIP TO Q70

3. Consider the commercial (Part 3) new construction projects in B.C. for which you had any sort of decision making role regarding the extent that the projects would be energy efficient and only those that became occupied between 2012 and 2016. What segments of the market were the projects a part of?

- **Decisions for such projects very likely occurred some three to five years prior to when they became occupied.**
- **New construction projects include buildings and/or major additions in the commercial, institutional and the multi-unit residential sectors.**

Select all that apply.

☐[1] Hospitals and other health care facilities

☐[2] Grocery stores

☐[3] Mixed-use buildings

☐[4] Multi-unit residential buildings

☐[5] Non-food retail stores

☐[6] Office buildings

☐[7] Restaurants/Fast food

☐[8] Schools

☐[9] Universities

☐[98] Other (please specify): ______________________________

☐[99] Don't know ⇒ SKIP TO Q70

4. What was your specific role regarding the extent that that the new construction projects in B.C. – those that became occupied between 2012 and 2016 – would be energy efficient?

- **Decisions in such projects very likely occurred some three to five years prior to when they became occupied.**
- **New construction projects include buildings and/or major additions in the commercial, institutional and the multi-unit residential sectors.**

Select all that apply.

☐[1] Architect

☐[2] Electrical engineer

☐[3] Energy modeller

☐[4] Mechanical engineer

☐[5] Project developer/development

☐[6] Project financing

☐[7] Project management

☐[8] Quantity surveyor

☐[9] Real estate

☐[10] Specifications writer

☐[98] Other (please specify): ____________________________

☐[99] Don't know

5. How many years have you had any decision making roles regarding the extent that new construction projects would be energy efficient?

☐[1] Less than 2 years

☐[2] 2 years to less than 5 years

☐[3] 5 years to less than 10 years

☐[4] 10 years to less than 25 years

☐[5] 25 years or more

☐[99] Don't know

6. Intentionally left empty

7. **Intentionally left empty**

8. **Intentionally left empty**

9. **Intentionally left empty**

BC Hydro's Commercial New Construction Program

10. **Previously known as BC Hydro's High Performance Buildings program until 2009, the Commercial New Construction program assists in the design and construction of new high performance and energy efficient institutional, commercial, and multi-unit residential buildings in B.C.**

    The program encourages developers and their design teams to adopt energy-efficient design early in the design process, and provides them with a range of tools and potential financial incentives.

    Which of the following statements best reflects your awareness and experience with BC Hydro's Commercial New Construction program?

    ☐[2] I have worked on projects that have come through BC Hydro's Commercial New Construction program and/or the High Performance Buildings program

    ☐[1] I was previously aware of the program, but I don't believe that I have ever worked on any projects that came through it

    ☐[0] I was not previously aware of the program

CONTINUE WITH Q11 IF Q10=2; ELSE SKIP TO Q12

11. **Please consider once again the new construction projects in B.C. – that eventually became occupied in 2012 to 2016 – for which you had any sort of decision making role regarding the extent that a project would be energy efficient.**

    Did <u>any</u> of those projects come through BC Hydro's Commercial New Construction program?

    ☐[1] Yes

    ☐[0] No

    ☐[99] Don't know

12. BC Hydro has offered workshops and training in the past – sometimes in partnership with the APEGBC, IES, AIBC and IBPA – in regards to new building construction.

Have you ever attended one of these workshops or training opportunities?

☐[1] Yes

☐[0] No

☐[99] Don't know

13. BC Hydro's Commercial New Construction program has case studies and resource literature in regards to new building construction posted on its website.

Have you ever reviewed these case studies and resource literature?

☐[1] Yes

☐[0] No

☐[99] Don't know

- **Building Envelope Thermal Bridging Guide**
- **Accounting for Thermal Bridging at Interface Details**
- **New Construction Energy Modelling Guideline**
- **New Construction Lighting Calculator**
- **Recommended lamp and ballast wattages**
- **City of Vancouver Energy Modelling Guidelines**
- **GeoExchange BC Professional Guidelines**

14. Aside from the interactions you may have had with BC Hydro staff at workshops and other formal events, have you ever had other discussions with them about your projects in B.C.?

☐[1] Yes

☐[0] No

☐[99] Don't know

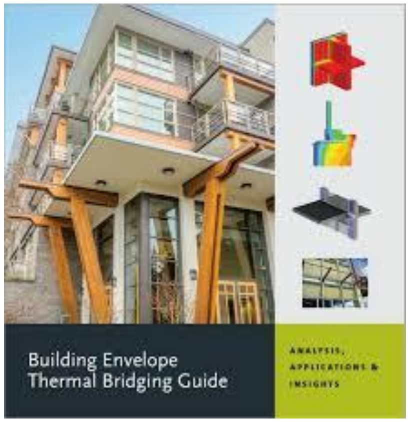
15. BC Hydro was a prime sponsor and contributor of the Building Envelope Thermal Bridging Guide which details how the commercial new construction market can effectively account for the impact of thermal bridging as part of meeting the challenges of reducing energy use in buildings.

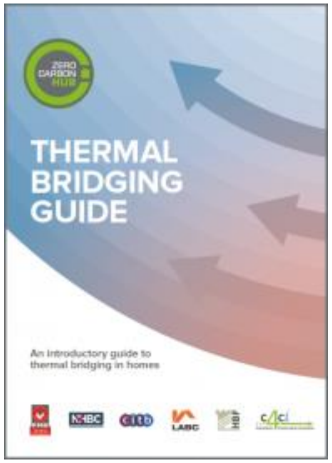
Have you ever reviewed the Building Envelope Thermal Bridging Guide?

☐[1] Yes

☐[0] No

☐[99] Don't know





16. BC Hydro provided technical support and funding in developing the Enhanced Thermal Performance Spreadsheet which is included in BC Hydro's energy modelling guidelines.

Have you ever reviewed the Enhanced Thermal Performance Spreadsheet?

☐[1] Yes

☐[0] No

☐[99] Don't know

17. Intentionally left empty

The New Construction Projects You Have Worked On

18. The diagram below illustrates the flow of questions that will be asked of you in the subsequent sections.

1. Total floor area of the projects in B.C. – that became occupied in 2012 through 2016 – you had a decision making role regarding the extent that a project would be energy efficient.

⇩

2. The total floor area of your projects (from 1 above) that is performing better than the energy efficiency requirements in the B.C. Building Code

⇩

3. For your projects that are performing better than the energy efficiency requirements in the B.C. Building Code (from 2 above), the floor area that did and did not come through the program

⇩

4. Building types associated with the 'better than code, non-participating' floor area (from 3 above)

⇩

5. Measures implemented and estimated electricity savings for the 'better than code, non-participating' floor area (from 3 and 4 above)

⇩

6. Influence of factors on your decisions

19.

The remaining portions of this survey are about the new building and major addition construction projects you worked on that became occupied between 2012 and 2016.

20. For each of the five years presented in the table below, please estimate how many new construction projects in B.C. – that eventually became occupied in 2012 to 2016 – for which you had any sort of decision making role regarding the extent that a project would be energy efficient.

Of course, your involvement in such projects very likely occurred some three to five years prior to when they became occupied.

- **New construction projects include buildings and/or major additions in the commercial, institutional and the multi-unit residential sectors.**
- **Your best estimate or recollection is all that is requested.**

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Number of projects you had a decision making role regarding the extent that a project would be energy efficient?	_________ ☐[0] None ☐[99] Don't know	_________ ☐[0] None ☐[99] Don't know	_________ ☐[0] None ☐[99] Don't know	_________ ☐[0] None ☐[99] Don't know	_________ ☐[0] None ☐[99] Don't know

ALLOWABLE RANGE OF TEXT FIELD 1-98

IF NONE FOR ALL YEARS 2012-2016, THEN SKIP TO Q71

21. Related to the previous question, we would like to understand the total floor area of the new construction projects in B.C. – that eventually became occupied in 2012 to 2016 – for which you had any sort of decision making role regarding the extent that a project would be energy efficient.

Please estimate the total floor area (square feet) associated with those projects.

- **Your involvement in such projects very likely occurred some three to five years prior to when they became occupied.**
- **New construction projects include buildings and/or major additions in the commercial, institutional and the multi-unit residential sectors.**
- **You may enter an estimate in the field, or choose from the ranges provided.**
- **Your best estimate or recollection is all that is requested.**

SHOW GRID YEARS FOR ONLY WHERE PROJECTS IN Q20 =>1 (DON'T KNOWS INCLUDED)

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Number of new construction projects:	[INSERT # OF PROJECTS FROM Q20]	[INSERT # OF PROJECTS FROM Q20]	[INSERT # OF PROJECTS FROM Q20]	[INSERT # OF PROJECTS FROM Q20]	[INSERT # OF PROJECTS FROM Q20]
Total floor area (square feet) of the projects you had a decision making role regarding the extent that a project would be energy efficient?	_________ ft^2 ☐[1] < 50,000 ft^2 ☐[2] 50,000 - 99,999 ☐[3] 100,000 - 249,999 ☐[4] 250,000 - 499,999 ☐[5] 500,000 - 999,999 ☐[6] 1,000,000 ft^2 + ☐[99] Don't know	_________ ft^2 ☐[1] < 50,000 ft^2 ☐[2] 50,000 - 99,999 ☐[3] 100,000 - 249,999 ☐[4] 250,000 - 499,999 ☐[5] 500,000 - 999,999 ☐[6] 1,000,000 ft^2 + ☐[99] Don't know	_________ ft^2 ☐[1] < 50,000 ft^2 ☐[2] 50,000 - 99,999 ☐[3] 100,000 - 249,999 ☐[4] 250,000 - 499,999 ☐[5] 500,000 - 999,999 ☐[6] 1,000,000 ft^2 + ☐[99] Don't know	_________ ft^2 ☐[1] < 50,000 ft^2 ☐[2] 50,000 - 99,999 ☐[3] 100,000 - 249,999 ☐[4] 250,000 - 499,999 ☐[5] 500,000 - 999,999 ☐[6] 1,000,000 ft^2 + ☐[99] Don't know	_________ ft^2 ☐[1] < 50,000 ft^2 ☐[2] 50,000 - 99,999 ☐[3] 100,000 - 249,999 ☐[4] 250,000 - 499,999 ☐[5] 500,000 - 999,999 ☐[6] 1,000,000 ft^2 + ☐[99] Don't know

IF DON'T KNOW IN EACH GRID YEAR SHOWN, THEN SKIP TO Q63

22. As shown below, you previously estimated the total floor area of the new construction projects in B.C. – that eventually became occupied in 2012 to 2016 – for which you had any sort of decision making role regarding the extent that a project would be energy efficient.

What percent of the total floor area of those projects would you estimate is performing better – including just slightly better – than the energy efficiency requirements in the B.C. Building Code (ASHRAE 90.1 / NECB 2011)?

- **Your best estimate or recollection is all that is requested.**

SHOW GRID YEARS FOR ONLY WHERE Q21 VALUES =1-6 OR RESPONSE IN TEXT FIELD

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Total floor area of your projects that you had a decision making role regarding the extent that a project would be energy efficient	[INSERT RESPONSE FROM Q21] ft^2	[INSERT RESPONSE FROM Q21] ft^2	[INSERT RESPONSE FROM Q21] ft^2	[INSERT RESPONSE FROM Q21] ft^2	[INSERT RESPONSE FROM Q21] ft^2
Percentage of floor area of your projects that is performing better than the energy efficiency requirements in the B.C. Building Code?	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know

IF Q22=0 FOR ALL YEARS, THEN SKIP TO Q63; ASK Q23 IF Q11=1; ELSE SKIP TO Q25

23. For the new construction projects in B.C. that you had a decision making role, you previously estimated the percent of total floor area that is performing better than the energy requirements in the B.C. Building Code. The absolute floor area – for applicable years 2012 to 2016 – is shown in the table below.

What percent of the floor area of these 'better than code' projects would you estimate as having come through BC Hydro's Commercial New Construction program?

- **Your best estimate or recollection is all that is requested.**

SHOW GRID YEARS FOR ONLY WHERE Q22 VALUES =1-99

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Total floor area of your projects that is performing better than the energy efficiency requirements in the B.C. Building Code:	[CALCULATE ft² FROM RESPONSE IN Q22]; IF Q22 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE ft² FROM RESPONSE IN Q22]; IF Q22 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE ft² FROM RESPONSE IN Q22]; IF Q22 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE ft² FROM RESPONSE IN Q22]; IF Q22 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE ft² FROM RESPONSE IN Q22]; IF Q22 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'
For your projects that are performing better than the energy efficiency requirements in the B.C. Building Code, the percent of floor area that came through the program?	☐0 0% of the floor area (none of it came through the program) ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area (all of it came through the program) ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area (none of it came through the program) ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area (all of it came through the program) ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area (none of it came through the program) ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area (all of it came through the program) ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area (none of it came through the program) ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area (all of it came through the program) ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area (none of it came through the program) ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area (all of it came through the program) ☐98 At least some, but don't know how much ☐99 Don't know

24. In the previous question, you estimated the percent of floor area of your 'better than code' projects that came through BC Hydro's Commercial New Construction program. Your responses are shown in the first row of the table below.

Through subtraction, the percents of floor area of your 'better than code' projects that you believe did not come through the program are shown, and through further multiplication by your earlier responses, the total floor area of your 'better than code, non-participating' projects.

This total floor area of your 'better than code, non-participating' projects will be carried forward and shown in subsequent tables.

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
a. Your estimate of the percent of your 'better than code' floor area that came through the program:	INSERT RESPONSE FROM Q23	INSERT RESPONSE FROM Q23	INSERT RESPONSE FROM Q23	INSERT RESPONSE FROM Q23	INSERT RESPONSE FROM Q23
b. Through subtraction, the percent of your 'better than code' floor area that did not come through the program:	CALCULATE AS 100% MINUS VALUE OF Q23 RESPONSE; or show code 98 or 99 response of Q23	CALCULATE AS 100% MINUS VALUE OF Q23 RESPONSE; or show code 98 or 99 response of Q23	CALCULATE AS 100% MINUS VALUE OF Q23 RESPONSE; or show code 98 or 99 response of Q23	CALCULATE AS 100% MINUS VALUE OF Q23 RESPONSE; or show code 98 or 99 response of Q23	CALCULATE AS 100% MINUS VALUE OF Q23 RESPONSE; or show code 98 or 99 response of Q23
c. Through multiplication, the floor area of your 'better than code, non-participating' projects:	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'

IF Q24c=0 FOR EACH YEAR SHOWN, THEN SKIP TO Q63;

OTHER RESPONDENTS COMING THROUGH THIS TABLE SKIP TO Q29 MESSAGE PAGE

25.

SHOW THIS TEXT IF (Q11=0, 99): **You previously indicated that you had worked on projects that came through BC Hydro's Commercial New Construction program, but none were projects that became occupied from 2012 to 2016.**

SHOW THIS TEXT IF (Q10=1): **You previously indicated that you have never worked on a project that came through BC Hydro's Commercial New Construction program.**

SHOW THIS TEXT IF (Q10=0): **You previously indicated that you were not previously aware of BC Hydro's Commercial New Construction program.**

For this reason you were deliberately skipped around – not asked – a question about how much of your 'better than code' projects from 2012 to 2016 came through the program. Your earlier responses suggest that none of it did.

Therefore, some of the forthcoming questions are populated with this in mind.

26. Intentionally left empty

27. Intentionally left empty

28. Intentionally left empty

Your 'Better than Code, Non-Participating' Projects

29.

This section is about the construction projects in B.C. you worked on that became occupied between 2012 and 2016 that are performing better than the energy efficiency requirements in the B.C. Building Code and did not come through BC Hydro's Commercial New Construction program.

30. **For your new construction projects that are performing better than the energy efficiency requirements in the B.C. Building Code,** SHOW THIS TEXT IF [(Q11=0, 99) OR Q10=0, 1)]: **you indicated or believed that none of them came through BC Hydro's Commercial New Construction program.** SHOW THIS TEXT IF Q11=1: **you previously estimated the percent of the floor area that did not come through BC Hydro's Commercial New Construction program. The absolute floor area – for each year 2012 to 2016 – is shown in the table below.**

SHOW ALL: **We are interested in learning where in the province these projects were built. For each year in the table below, please apportion the floor space of these 'better than code, non-participating' projects by the four regions of the province.**

- **For example, for the 'better than code, non-participating' floor space in 20XX, one may estimate that 80% of it was in the Lower Mainland, 10% on Vancouver Island, 5% in the Southern Interior and 5% in the North.**

IF Q11=1: SHOW EACH GRID YEAR FOR ONLY WHERE Q23 VALUES = 0-9, 98, 99

IF [(Q11=0, 99) OR Q10=0, 1)]: SHOW GRID YEARS FOR ONLY WHERE Q22 VALUES =1-99

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Floor area of your 'better than code, non-participating' projects:	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'
Lower Mainland	_____ %	_____ %	_____ %	_____ %	_____ %
Vancouver Island	_____ %	_____ %	_____ %	_____ %	_____ %
Southern Interior	_____ %	_____ %	_____ %	_____ %	_____ %
North	_____ %	_____ %	_____ %	_____ %	_____ %
Your total	**SHOW RUNNING**	**SHOW RUNNING**	**SHOW RUNNING**	**SHOW RUNNING**	**SHOW RUNNING**
Target Total	**100%**	**100%**	**100%**	**100%**	**100%**
Don't know	☐ 99 Don't know	☐ 99 Don't know	☐ 99 Don't know	☐ 99 Don't know	☐ 99 Don't know

31. For these 'better than code, non-participating projects, we would like to learn what portion of them received 1) whole building energy modelling, 2) a refrigeration system design study, and/or 3) a lighting design study.

For each year in the table below, first estimate the percent of the floor area of those 'better than code, non-participating' projects that received whole building energy modelling.

Note: do not include any separate lighting studies in this grid; do not include any separate refrigeration system design studies.

IF Q11=1: SHOW EACH GRID YEAR FOR ONLY WHERE Q23 VALUES = 0-9, 98, 99

IF [(Q11=0, 99) OR Q10=0, 1)]: SHOW GRID YEARS FOR ONLY WHERE Q22 VALUES =1-99

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Floor area of your 'better than code, non-participating' projects:	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'
For your projects that are performing better than the energy efficiency requirements in the B.C. Building Code and did not come through the program, the percent of the floor area that received whole building energy modelling?	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know

32. And what percent of the floor area of those 'better than code, non-participating' projects received a refrigeration system design study?

IF Q11=1: SHOW EACH GRID YEAR FOR ONLY WHERE Q23 VALUES = 0-9, 98, 99

IF [(Q11=0, 99) OR Q10=0, 1)]: SHOW GRID YEARS FOR ONLY WHERE Q22 VALUES =1-99

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Floor area of your 'better than code, non-participating' projects:	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'
For your projects that are performing better than the energy efficiency requirements in the B.C. Building Code and did not come through the program, the percent of the floor area that received a refrigeration system design study?	☐0 0% of the floor area ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area ☐98 At least some, but don't know how much ☐99 Don't know	☐0 0% of the floor area ☐1 10% ☐2 20% ☐3 30% ☐4 40% ☐5 50% ☐6 60% ☐7 70% ☐8 80% ☐9 90% ☐10 100% of the floor area ☐98 At least some, but don't know how much ☐99 Don't know

33. And what percent of the floor area of those 'better than code, non-participating' projects received a lighting design study?

IF Q11=1: SHOW EACH GRID YEAR FOR ONLY WHERE Q23 VALUES =0-9, 98, 99

IF [(Q11=0, 99) OR Q10=0, 1)]: SHOW GRID YEARS FOR ONLY WHERE Q22 VALUES =1-99

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
Floor area of your 'better than code, non-participating' projects:	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'
For your projects that are performing better than the energy efficiency requirements in the B.C. Building Code and did not come through the program, the percent of the floor area that received a lighting design study?	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know	☐[0] 0% of the floor area ☐[1] 10% ☐[2] 20% ☐[3] 30% ☐[4] 40% ☐[5] 50% ☐[6] 60% ☐[7] 70% ☐[8] 80% ☐[9] 90% ☐[10] 100% of the floor area ☐[98] At least some, but don't know how much ☐[99] Don't know

34. We are interested in learning about the types of buildings associated with the projects that are performing better than the energy efficiency requirements in the B.C. Building Code and that did not come through BC Hydro's Commercial New Construction program.

Please apportion the floor space of these 'better than code, non-participating' projects by the building types you had said – in the beginning of the survey – that you had worked on.

- **For example, for the 'better than code, non-participating' floor space in 20XX, one may estimate that 80% of it is tied to hospital projects, 20% to mixed use buildings and 20% to office buildings.**

IF Q11=1: SHOW EACH GRID YEAR FOR ONLY WHERE Q23 VALUES =0-9, 98, 99

IF [(Q11=0, 99) OR Q10=0, 1)]: SHOW GRID YEARS FOR ONLY WHERE Q22 VALUES =1-99

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013… show other years in next columns
Floor area of your 'better than code, non-participating' projects	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'	[CALCULATE AS FLOOR AREA SHOWN IN Q23 x VALUE OF Q24b] ft^2 IF Q22 AND/OR Q23 VALUE=99 (DON'T KNOW) THEN WRITE 'You had said Don't know to this'
Hospitals and other health care facilities [SHOW THIS ONLY IFQ3=1]	_____ %	_____ %
Grocery stores [SHOW THIS ONLY IF Q3=2]	_____ %	_____ %
Mixed-use buildings [SHOW THIS ONLY IF Q3=3]	_____ %	_____ %
Multi-unit residential buildings [SHOW THIS ONLY IF Q3=4]	_____ %	_____ %
Non-food retail stores [SHOW THIS ONLY IF Q3=5]	_____ %	_____ %
Office buildings [SHOW THIS ONLY IF Q=6]	_____ %	_____ %
Restaurants/Fast food [SHOW THIS ONLY IF Q3=7]	_____ %	_____ %
Schools [SHOW THIS ONLY IF Q3=8]	_____ %	_____ %
Universities [SHOW THIS ONLY IF Q3=9]	_____ %	_____ %
Other commercial building types	_____ %	_____ %
Your total	SHOW RUNNING	SHOW RUNNING
Target Total	**100%**	**100%**
Don't know	☐[99] Don't know	☐[99] Don't know

35. For the construction projects you worked on that are performing better than the energy efficiency requirements in the B.C. Building Code and that did not come through BC Hydro's Commercial New Construction program, how much better than the code in terms of electricity savings would you estimate these particular projects are performing?

IF Q11=1: SHOW EACH GRID YEAR FOR ONLY WHERE Q23 VALUES =0-9, 98, 99

IF [(Q11=0, 99) OR Q10=0, 1)]: SHOW GRID YEARS FOR ONLY WHERE Q22 VALUES =1-99

	Projects that became occupied in 2012 ⇓	Projects that became occupied in 2013 ⇓	Projects that became occupied in 2014 ⇓	Projects that became occupied in 2015 ⇓	Projects that became occupied in 2016 ⇓
For your project that are performing better than the energy efficiency requirements in the B.C. Building Code and did not come through the program, the percent better than the code they are performing?	☐1 1% - 5% better ☐2 6% - 9% better ☐3 10% better ☐4 20% better ☐5 30% better ☐6 40% better ☐7 50% + better ☐99 Don't know	☐1 1% - 5% better ☐2 6% - 9% better ☐3 10% better ☐4 20% better ☐5 30% better ☐6 40% better ☐7 50% + better ☐99 Don't know	☐1 1% - 5% better ☐2 6% - 9% better ☐3 10% better ☐4 20% better ☐5 30% better ☐6 40% better ☐7 50% + better ☐99 Don't know	☐1 1% - 5% better ☐2 6% - 9% better ☐3 10% better ☐4 20% better ☐5 30% better ☐6 40% better ☐7 50% + better ☐99 Don't know	☐1 1% - 5% better ☐2 6% - 9% better ☐3 10% better ☐4 20% better ☐5 30% better ☐6 40% better ☐7 50% + better ☐99 Don't know

36. Intentionally left empty

37. Intentionally left empty

38. Intentionally left empty

Measures Implemented in 'Your Better than Code, Non-Participating' Projects

39.

The next set of questions is about the measures specific to your construction projects in B.C. that were completed and became occupied between 2012 and 2016, and that are performing better than the energy efficiency requirements in the B.C. Building Code but did not come through BC Hydro's Commercial New Construction program.

40. We would like to learn about the electricity conservation measures that helped your new construction projects in B.C. perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about the different types of measures for which you personally had a decision making role, what measures did you at least sometimes design or recommend to be implemented in the 'better than code, non-participating' projects?

- **Broadly consider the different types of projects that became occupied between 2012 and 2016.**

Select all that apply.

☐[1] Highly-efficient heat pump recovery measures (water to water and air to water heat pumps)

☐[2] Highly-efficient heat pump water heaters or low-flow fixtures

☐[3] Highly-efficient building envelope measures (roof/wall Insulation, high efficiency glazing)

☐[4] Highly-efficient lighting measures (includes controls and/or reduction of lighting power density)

☐[5] Highly-efficient HVAC measures

☐[6] Highly-efficient exhaust air heat recovery measures

☐[7] Highly-efficient plug-load measures

☐[8] Highly-efficient refrigeration measures

☐[99] Don't know ⇒ SKIP TO Q60

ASK Q41 IF Q40=1 (HEAT PUMP RECOVERY MEASURES); ELSE SKIP TO RULE FOR Q44

41. You previously indicated that some of your projects in B.C. that did <u>not</u> come through BC Hydro's Commercial New Construction program incorporated <u>highly-efficient heat pump recovery measures</u> that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, <u>non</u>-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the <u>highly-efficient heat pump recovery measures</u>?

- ☐[0] 0% (none of the floor area) ⇒ SKIP TO RULE FOR Q44
- ☐[2] 10%
- ☐[2] 20%
- ☐[3] 30%
- ☐[4] 40%
- ☐[5] 50%
- ☐[6] 60%
- ☐[7] 70%
- ☐[8] 80%
- ☐[9] 90%
- ☐[10] 100% (all of the floor area)
- ☐[97] At least some floor area, but don't know how much
- ☐[99] Don't know ⇒ SKIP TO RULE FOR Q44

42. For those projects that incorporated <u>highly-efficient heat pump recovery measures</u>, what heating equipment would you likely have chosen if the heat pumps were not an option?

Select all that apply.

- ☐[1] Natural gas boiler/packaged rooftop unit
- ☐[2] Electric resistance heat
- ☐[3] Hybrid heating source
- ☐[98] Other (please specify): ____________________________
- ☐[99] Don't know

43. For these 'better than code, non-participating' projects that incorporated highly-efficient heat pump recovery measures, what is your estimate of the electricity savings from these measures as compared to conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

And what is your estimate of the gas savings?

Electricity Savings ⇓	Gas Savings ⇓
☐[1] 1% - 5% electricity savings	☐[1] 1% - 5% gas savings
☐[2] 6% - 9% electricity savings	☐[2] 6% - 9% gas savings
☐[3] 10% electricity savings	☐[3] 10% gas savings
☐[4] 20% electricity savings	☐[4] 20% gas savings
☐[5] 30% electricity savings	☐[5] 30% gas savings
☐[6] 40% electricity savings	☐[6] 40% gas savings
☐[7] 50% + electricity savings	☐[7] 50% + gas savings
☐[99] Don't know	☐[99] Don't know

ASK Q44 IF Q40=2 (HEAT PUMP DOMESTIC HOT WATER HEATING MEASURES); ELSE SKIP TO RULE FOR Q46

44. You previously indicated that some of your projects in B.C. that did not come through BC Hydro's Commercial New Construction program incorporated highly-efficient heat pump water heater or low-flow fixture measures that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, non-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the highly-efficient heat pump water heater or low-flow fixture measures?

☐[0] 0% (none of the floor area) ⇒ SKIP TO RULE FOR Q46
☐[1] 1% - 9%
☐[2] 10%
☐[3] 20%
☐[4] 30%

- ☐[5] 40%
- ☐[6] 50%
- ☐[7] 60%
- ☐[8] 70%
- ☐[9] 80%
- ☐[10] 90%
- ☐[11] 100% (all of the floor area)
- ☐[98] At least some floor area, but don't know how much
- ☐[99] Don't know ⇒ SKIP TO RULE FOR Q46

45. For these 'better than code, <u>non</u>-participating' projects that incorporated <u>highly-efficient heat pump domestic hot water heating measures</u>, what is your estimate of the <u>electricity savings</u> from these measures as compared to the conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

- ☐[1] 1% - 5% electricity savings
- ☐[2] 6% - 9% electricity savings
- ☐[3] 10% electricity savings
- ☐[4] 20% electricity savings
- ☐[5] 30% electricity savings
- ☐[6] 40% electricity savings
- ☐[7] 50% + electricity savings
- ☐[99] Don't know

ASK Q46 IF Q40=3 (BUILDING ENVELOPE MEASURES); ELSE SKIP TO RULE FOR Q48

46. You previously indicated that some of your projects in B.C. that did <u>not</u> come through BC Hydro's Commercial New Construction program incorporated <u>highly-efficient building envelope measures</u> that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, <u>non</u>-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the <u>highly-efficient building envelope measures</u>?

- ☐[0] 0% (none of the floor area) ⇒ SKIP TO RULE FOR Q48
- ☐[1] 1% - 9%
- ☐[2] 10%

- ☐[3] 20%
- ☐[4] 30%
- ☐[5] 40%
- ☐[6] 50%
- ☐[7] 60%
- ☐[8] 70%
- ☐[9] 80%
- ☐[10] 90%
- ☐[11] 100% (all of the floor area)
- ☐[98] At least some floor area, but don't know how much
- ☐[99] Don't know ⇒ SKIP TO RULE FOR Q48

47. For these 'better than code, non-participating' projects that incorporated the highly-efficient building envelope measures, what is your estimate of the electricity savings from these measures compared to the conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

And what is your estimate of the gas savings?

Electricity Savings ⇓	Gas Savings ⇓
☐[1] 1% - 5% electricity savings	☐[1] 1% - 5% gas savings
☐[2] 6% - 9% electricity savings	☐[2] 6% - 9% gas savings
☐[3] 10% electricity savings	☐[3] 10% gas savings
☐[4] 20% electricity savings	☐[4] 20% gas savings
☐[5] 30% electricity savings	☐[5] 30% gas savings
☐[6] 40% electricity savings	☐[6] 40% gas savings
☐[7] 50% + electricity savings	☐[7] 50% + gas savings
☐[99] Don't know	☐[99] Don't know

ASK Q48 IF Q40=4 (LIGHTING MEASURES); ELSE SKIP TO RULE FOR Q50

48. You previously indicated that some of your projects in B.C. that did not come through BC Hydro's Commercial New Construction program incorporated highly-efficient lighting measures that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, non-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the highly-efficient lighting measures?

- ☐[0] 0% (none of the floor area) ⇒ SKIP TO RULE FOR Q50
- ☐[1] 1% - 9%
- ☐[2] 10%
- ☐[3] 20%
- ☐[4] 30%
- ☐[5] 40%
- ☐[6] 50%
- ☐[7] 60%
- ☐[8] 70%
- ☐[9] 80%
- ☐[10] 90%
- ☐[11] 100% (all of the floor area)
- ☐[98] At least some floor area, but don't know how much
- ☐[99] Don't know ⇒ SKIP TO RULE FOR Q50

49. For these 'better than code, non-participating' projects that incorporated the highly-efficient lighting measures, what is your estimate of the electricity savings from these measures compared to the conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

- ☐[1] 1% - 5% electricity savings
- ☐[2] 6% - 9% electricity savings
- ☐[3] 10% electricity savings
- ☐[4] 20% electricity savings
- ☐[5] 30% electricity savings
- ☐[6] 40% electricity savings

☐[7] 50% + electricity savings
☐[99] Don't know

ASK Q50 IF Q40=5 (HVAC MEASURES); ELSE SKIP TO RULE FOR Q52

50. You previously indicated that some of your projects in B.C. that did not come through BC Hydro's Commercial New Construction program incorporated highly-efficient HVAC measures that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, non-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the highly-efficient HVAC measures?

☐[0] 0% (none of the floor area) ⇒ SKIP TO RULE FOR Q52
☐[1] 1% - 9%
☐[2] 10%
☐[3] 20%
☐[4] 30%
☐[5] 40%
☐[6] 50%
☐[7] 60%
☐[8] 70%
☐[9] 80%
☐[10] 90%
☐[11] 100% (all of the floor area)
☐[98] At least some floor area, but don't know how much
☐[99] Don't know ⇒ SKIP TO RULE FOR Q52

51. For these 'better than code, non-participating' projects that incorporated the highly-efficient HVAC measures, what is your estimate of the electricity savings from these measures compared to the conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

And what is your estimate of the gas savings?

Electricity Savings ⇓	Gas Savings ⇓
☐[1] 1% - 5% electricity savings	☐[1] 1% - 5% gas savings
☐[2] 6% - 9% electricity savings	☐[2] 6% - 9% gas savings
☐[3] 10% electricity savings	☐[3] 10% gas savings
☐[4] 20% electricity savings	☐[4] 20% gas savings
☐[5] 30% electricity savings	☐[5] 30% gas savings
☐[6] 40% electricity savings	☐[6] 40% gas savings
☐[7] 50% + electricity savings	☐[7] 50% + gas savings
☐[99] Don't know	☐[99] Don't know

ASK Q52 IF Q0=6 (EXHAUST AIR HEAT RECOVERY MEASURES); ELSE SKIP TO RULE FOR Q54

52. You previously indicated that some of your projects in B.C. that did <u>not</u> come through BC Hydro's Commercial New Construction program incorporated <u>highly-efficient exhaust air heat recovery measures</u> that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, <u>non</u>-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the <u>highly-efficient exhaust air heat pump recovery measures</u>?

☐[0] 0% (none of the floor area) ⇒ SKIP TO RULE FOR Q54
☐[1] 1% - 9%
☐[2] 10%
☐[3] 20%
☐[4] 30%
☐[5] 40%
☐[6] 50%
☐[7] 60%
☐[8] 70%
☐[9] 80%
☐[10] 90%

☐[11] 100% (all of the floor area)
☐[98] At least some floor area, but don't know how much
☐[99] Don't know ⇒ SKIP TO RULE FOR Q54

53. For these 'better than code, non-participating' projects that incorporated the highly-efficient exhaust air heat recovery measures, what is your estimate of the electricity savings from these measures compared to the conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

And what is your estimate of the gas savings?

Electricity Savings ⇓	Gas Savings ⇓
☐[1] 1% - 5% electricity savings	☐[1] 1% - 5% gas savings
☐[2] 6% - 9% electricity savings	☐[2] 6% - 9% gas savings
☐[3] 10% electricity savings	☐[3] 10% gas savings
☐[4] 20% electricity savings	☐[4] 20% gas savings
☐[5] 30% electricity savings	☐[5] 30% gas savings
☐[6] 40% electricity savings	☐[6] 40% gas savings
☐[7] 50% + electricity savings	☐[7] 50% + gas savings
☐[99] Don't know	☐[99] Don't know

ASK Q54 IF Q40=7 (PLUG LOAD MEASURES); ELSE SKIP TO RULE FOR Q56

54. You previously indicated that some of your projects in B.C. that did not come through BC Hydro's Commercial New Construction program incorporated highly-efficient plug-load measures that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, non-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the highly-efficient plug-load measures?

- ☐[0] 0% (none of the floor area) ⇒ SKIP TO RULE FOR Q56
- ☐[1] 10%
- ☐[2] 20%
- ☐[3] 30%
- ☐[4] 40%
- ☐[5] 50%
- ☐[6] 60%
- ☐[7] 70%
- ☐[8] 80%
- ☐[9] 90%
- ☐[10] 100% (all of the floor area)
- ☐[97] At least some floor area, but don't know how much
- ☐[99] Don't know ⇒ SKIP TO RULE FOR Q56?

55. For these 'better than code, non-participating' projects that incorporated the highly-efficient plug-load measures, what is your estimate of the electricity savings from these measures compared to the conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

- ☐[1] 1% - 5% electricity savings
- ☐[2] 6% - 9% electricity savings
- ☐[3] 10% electricity savings
- ☐[4] 20% electricity savings
- ☐[5] 30% electricity savings
- ☐[6] 40% electricity savings
- ☐[7] 50% + electricity savings
- ☐[99] Don't know

ASK Q56 IF Q40=8 (REFRIGERATION MEASURES); ELSE SKIP TO Q60

56. You previously indicated that some of your projects in B.C. that did not come through BC Hydro's Commercial New Construction program incorporated highly-efficient refrigeration measures that helped the projects perform better than the energy efficiency requirements in the B.C. Building Code.

Thinking about all of these 'better than code, non-participating' projects collectively – those that became occupied between 2012 and 2016 – what percentage of their floor area incorporated the highly-efficient refrigeration measures?

☐[0] 0% (none of the floor area) ⇒ SKIP TO Q60
☐[1] 1% - 9%
☐[2] 10%
☐[3] 20%
☐[4] 30%
☐[5] 40%
☐[6] 50%
☐[7] 60%
☐[8] 70%
☐[9] 80%
☐[10] 90%
☐[11] 100% (all of the floor area)
☐[98] At least some floor area, but don't know how much
☐[99] Don't know ⇒ SKIP TO Q60

57. For these 'better than code, non-participating' projects that incorporated the highly-efficient refrigeration measures, what is your estimate of the electricity savings from these measures compared to the conventional measures that could have been implemented to just meet – not exceed – the energy efficiency requirements in the B.C. Building Code?

☐[1] 1% - 5% electricity savings
☐[2] 6% - 9% electricity savings
☐[3] 10% electricity savings
☐[4] 20% electricity savings
☐[5] 30% electricity savings
☐[6] 40% electricity savings
☐[7] 50% + electricity savings
☐[99] Don't know

58. Intentionally left empty

59. Intentionally left empty

Drivers of Your 'Better than Code, Non-Participating' Projects

ASK Q60 IF [(Q10=2, 1) AND/OR (Q12=1) AND/OR (Q13=1)]; ELSE SKIP TO Q63

60. Consider your new construction projects in B.C. – that became occupied from 2012 to 2016 – that are performing better than the energy efficiency requirements in the B.C. Building Code and that did not come through BC Hydro's Commercial New Construction program.

What 'drivers' do you credit for making these particular projects perform even better than the energy efficiency requirements in the B.C. Building Code?

Please record the percent shares you would credit each 'driver' such that they total 100 percent.

	Projects that became occupied from 2012 - 2016 ⇓
BC Hydro Drivers	
My learnings and experience from having had other projects go through BC Hydro's Commercial New Construction program (previously, the High Performance Buildings program) [SHOW ONLY IFQ10=2]	__________
My learnings and experience from having attended BC Hydro workshops [SHOW ONLY IF Q12=1]	__________
My learnings from having reviewed the case studies and resource literature posted on BC Hydro's website [SHOW ONLY IF Q13=1]	__________
My learnings from having reviewed the Building Envelope Thermal Bridging Guide [SHOW ONLY IF Q15=1]	__________
My learnings from having reviewed the Enhanced Thermal Performance Spreadsheet [SHOW ONLY IF Q16=1]	__________
Non-BC Hydro Drivers	
Industry innovation and good practices (outside of BC Hydro involvement)	__________
My own or my organization's desire to build such projects for LEED certification	__________
My/our client directed us to have such projects perform better than the energy efficiency requirements in the B.C. Building Code	__________
All other factors	__________
Your Total (SHOW RUNNING TOTAL)	XX%
Target Total	100%

61. Consider your new construction projects in B.C. – that became occupied from 2012 to 2016 – that are performing better than the energy efficiency requirements in the B.C. Building Code and that did not come through BC Hydro's Commercial New Construction program.

Which one of the following statements best describes what the energy efficiency of those non-participating projects would have been had you NOT – nor any of your colleagues…

SHOW AS BULLETS:

SHOW IF A PAST PARTICIPANT [Q10=2]: **had any prior experience with the Commercial New Construction program**

SHOW IF ATTENDED A WORKSHOP [Q12=1]: **ever attended any of BC Hydro's workshops on commercial new construction**

SHOW IF REVIEWED CASE STUDIES [Q13=1]: **ever reviewed any case studies or resource literature on BC Hydro's website**

SHOW IF REVIEWED THERMAL BRIDGING GUIDE [Q15=1]: **ever reviewed the Building Envelope Thermal Bridging Guide**

SHOW IF REVIEWED ENERGY MODELLING GUIDELINES [Q16=1]: **ever reviewed the Enhanced Thermal Performance Spreadsheet**

☐[1] These projects would likely still be performing better than the energy efficiency requirements in the B.C. Building Code by the same margin.

☐[2] These projects would likely be performing better than the energy efficiency requirements in the B.C. Building Code, but by a smaller margin.

☐[3] These projects would likely be meeting the energy efficiency requirements in the B.C. Building Code.

☐[4] These projects would likely be performing worse than the energy efficiency requirements in the B.C. Building Code.

☐[99] Don't know

☐[97] Not applicable – the interaction(s) occurred after the design decisions were made for these projects.

62. Consider each of the following experiences and 'touchpoints' you have had with BC Hydro in regards to commercial new construction:

SHOW AS BULLETS:

SHOW IF A PAST PARTICIPANT [Q10=2]: **your learnings and experience from having worked on 'participating projects' that came through the Commercial New Construction program**

SHOW IF ATTENDED A WORKSHOP [Q12=1]: **your learnings and experience from having attended BC Hydro's workshops on commercial new construction**

SHOW IF REVIEWED CASE STUDIES [Q13=1]: **your learnings and experience from having reviewed case studies or resource literature on BC Hydro's website**

SHOW IF REVIEWED THERMAL BRIDGING GUIDE [Q15=1]: **your learnings and experience from having reviewed the Building Envelope Thermal Bridging Guide**

SHOW IF REVIEWED ENERGY MODELLING GUIDELINES [Q16=1]: **your learnings and experience from having reviewed the Enhanced Thermal Performance Spreadsheet**

Overall, how influential were these experiences and 'touchpoints' on your decisions to have '<u>non</u>-participating projects' that became occupied from 2012 to 2016 – those that did <u>not</u> come through the program – designed to perform better than the energy efficiency requirements in the B.C. Building Code?

☐[1] Very influential

☐[2] Somewhat influential

☐[3] Not too influential

☐[4] Not at all influential

☐[99] Don't know

☐[97] Not applicable – the interaction(s) occurred after the design decisions were made for these projects.

Industry Evolution

63. Compared to buildings that became occupied say 2005 - 2011, to what extent do you believe the entire commercial new construction market in the province has improved in terms of the energy use of the projects that became occupied in 2012 - 2016?

- ☐[0] 0% - no better ⇒ SKIP TO Q65
- ☐[1] 1% - 9% better
- ☐[2] 10% better
- ☐[3] 20% better
- ☐[4] 30% better
- ☐[5] 40% better
- ☐[6] 50% + better ⇒ SKIP TO Q65

64. Thinking about your response to the previous question, how much of the improvement in the commercial new construction energy use in the province – for projects that became occupied in 2012 - 2016 as compared to those that became occupied in 2005 - 2011 – would you attribute to BC Hydro's Commercial New Construction program (previously, the High Performance Buildings program)?

- ☐[0] 0% of the improved energy use is attributable to BC Hydro's program
- ☐[1] 1% - 9%
- ☐[2] 10%
- ☐[3] 20%
- ☐[4] 30%
- ☐[5] 40%
- ☐[6] 50% + of the improved energy use is attributable to BC Hydro's program
- ☐[99] Don't know

65. Think about all of the commercial new construction projects in B.C. from 2012 to 2016 for which you had any sort of decision making role regarding the extent that the projects would be energy efficient – regardless of whether or not they came through BC Hydro's Commercial New Construction program.

How much electricity would you say those projects are saving relative to the energy efficiency requirements in the B.C. Building Code?

☐[0] 0% electricity savings (the projects would be performing to the energy efficiency requirements in the B.C. Building Code)
☐[1] 1% - 9% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[2] 10% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[3] 20% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[4] 30% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[5] 40% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[6] 50% + electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[99] Don't know

66. What's your impression of all other commercial new construction projects in the province from 2012 to 2016? (those you were <u>not</u> involved in)

How much electricity would you say those projects are saving relative to the energy efficiency requirements in the B.C. Building Code?

☐[0] 0% electricity savings (the projects would be performing to the energy efficiency requirements in the B.C. Building Code)
☐[1] 1% - 9% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[2] 10% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[3] 20% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[4] 30% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[5] 40% electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[6] 50% + electricity savings better than the energy efficiency requirements in the B.C. Building Code
☐[99] Don't know

Your Confidence in Your Responses

67. It is very much appreciated that because most of the questions in this survey pertain to your commercial new construction projects that became occupied several years ago, it may have been difficult to remember the projects – in their collectivity – and to have provided various estimates about them.

Overall, how much confidence would you say you have in the accuracy of the various estimates you gave in this survey?

- ☐0 0% confidence
- ☐1 10%
- ☐2 20%
- ☐3 30%
- ☐4 40%
- ☐5 50%
- ☐6 60%
- ☐7 70%
- ☐8 80%
- ☐9 90%
- ☐10 100% confidence ⇒ SKIP TO Q69
- ☐99 Don't know

68. Which of the following areas of the survey would you say you are generally confident about in your estimates?

Which of the areas would you say you are not confident about in your estimates?

	Confident	Not Confident	Don't know
The type of buildings that became occupied from 2012 to 2016 for which you played a design decision role.	☐[1]	☐[0]	☐[99]
Your estimates of the floor area of your project in B.C. that became occupied from 2012 to 2016.	☐[1]	☐[0]	☐[99]
Your estimates of the percent of floor area of your projects that are performing better than the energy efficiency requirements in the B.C. Building Code.	☐[1]	☐[0]	☐[99]
Your estimates of the percent of floor area of your 'better than code' projects that came through BC Hydro's Commercial New Construction Program. [SHOW ONLY IF Q11=1]	☐[1]	☐[0]	☐[99]
The various electricity conservation measures you designed or recommended in your 'highly performing, non-participating' projects.	☐[1]	☐[0]	☐[99]
The percent of floor area of your 'highly performing, non-participating' projects that incorporated these conservation measures.	☐[1]	☐[0]	☐[99]
Your estimates of the electricity savings from each of these conservation measures.	☐[1]	☐[0]	☐[99]
Your credit(s) to BC Hydro on their influence on the commercial new construction industry in B.C.	☐[1]	☐[0]	☐[99]

Your Project Names

69. A large number and wide variety of professionals within the commercial new construction industry have been invited to participate in this survey. In an effort to further understand the sample composition of completed surveys, it would be beneficial to learn the names of the 3 largest projects in B.C. that you worked on – those that became occupied from 2012 to 2016.

- **Only list those new construction projects in B.C. – that became occupied from 2012 to 2016 – that are performing better than the energy efficiency requirements in the B.C. Building Code and that did not come through BC Hydro's Commercial New Construction program.**
- **To ensure clarity, also indicate each project's building types (e.g. hospital, grocery store, office building, etc.)**
- **In BC Hydro's reporting, none of your earlier responses in this survey will be linked to the names of the projects that you list below.**

	Project Name ⇓	Project building type ⇓
Project 1		
Project 2		
Project 3		

Thank You

SHOW Q70 ONLY IF [(Q1=0, 99) OR (Q2=3, 99) OR (Q3=99)]; ELSE SKIP TO Q71

70. Thank you for your willingness to complete this survey, however, based on your responses, you aren't in this study's target population of interest. Please advance to the next page to enter your name into the prize draw

Incentive Prize Draw

71. Please provide your name and contact information below if you wish to be entered into the draw for one of four $250 gift cards to a home improvement retailer of your choice. You can view the official rules and regulations here.

	Name:	Telephone:	Email Address:
☐[1] Yes ⇒	____________________	____________	________________________
☐[0] No thanks			

Appendix F Participant Survey – Questionnaire

Commercial New Construction Survey (Wave 5 – May 2016)

INTRODUCTION TEXT

Thank you for taking the time to complete this survey.

Commercial New Construction Program (umbrella program name)

Participants: Survey IDs 500,000 – 528,999

Our records indicate that your organization's site located at (insert service address, service town) **participated in BC Hydro's** (insert umbrella program name as per survey ID) **between (DATEflag=1 "October 2015 and March 2016"; DATEflag=2, "April and October 2015"). We are interested in your organization's experience with the program and would appreciate your feedback. If you feel that this survey should be completed by another individual at your organization, please forward the original email invitation to that person. In recognition of your time and effort to complete this survey you will receive a $50 gift certificate upon completing and submitting the survey.**

In consideration of privacy issues, do not self-identify (unless for the purposes of receiving the gift card) or identify other specific individuals in your written comments. Any comments including self-identification or identification of third parties will be discarded.

About You

1. Which of the following best describes your position/title within the organization? Check one only.

☐[1] Operations or maintenance manager
☐[2] Operations or maintenance technician/engineer
☐[3] Plant manager
☐[4] Business owner or co-owner
☐[5] Executive
☐[6] Site or property manager/supervisor
☐[7] General manager
☐[8] Energy Manger – hired as part of BC Hydro's Energy Manager program
☐[9] Energy Manager – NOT hired as part of BC Hydro's Energy Manager program
☐[10] Finance manager
☐[11] Purchasing manager
☐[12] Accountant/Bookkeeper
☐[13] Developer
☐[14] Project Manager
☐[16] Strata council member
☐[15] Other: please specify __________________

2. For each of the following, please indicate whether you are primarily or jointly responsible for decision making in relation to this particular site, whether someone else at the site is responsible, or whether the decision making is made by a person or team away from the site such as at a corporate office.

		Yes, I am the primary or joint decision maker	No, someone else at this site is the decision maker	No, someone else away from this site is the decision maker	Don't know
a.	Decisions related to investments in equipment costing less than $100,000	☐1	☐2	☐3	☐999
b.	Decisions related to investments in equipment costing $100,000 or more	☐1	☐2	☐3	☐999
c.	Decisions related to energy management	☐1	☐2	☐3	☐999
d.	Decisions related to the maintenance of equipment	☐1	☐2	☐3	☐999
e.	Decisions related to capital investments in retrofitting existing sites/facilities or building new sites/facilities	☐1	☐2	☐3	☐999
f.	Decisions related to the operation and maintenance of sites/facilities	☐1	☐2	☐3	☐999

About this Site

3. Which of the following best describes the ownership of this organization?

- ☐[1] Government or public sector (e.g., schools, hospitals, universities, etc.)
- ☐[2] Non-governmental organization (e.g,, non-profit, strata council, etc.)
- ☐[3] For profit (e.g., publically owned, privately owned, franchise, chain, etc.)
- ☐[4] Other: please specify ________________
- ☐[999] Don't know/Not sure

4. Please check the one box corresponding to your organization's primary business activity at this particular site. Check one only.

- ☐[2] Apartment building or strata property
- ☐[3] Arts/entertainment/film
- ☐[4] Automotive
- ☐[5] Banking/finance/insurance
- ☐[6] Business or personal services
- ☐[7] Camps/recreation/sports/amusement
- ☐[8] College
- ☐[9] Communications/media
- ☐[10] Construction/home & building contractors
- ☐[11] Development/real estate/commercial property management
- ☐[12] Food & beverage production or storage
- ☐[13] Forest products or wood processing
- ☐[14] Government – Local/Provincial/Federal
- ☐[15] Hospital (including care facilities)
- ☐[16] Hospitality/lodging/tourism
- ☐[26] Mixed-use building (e.g., mixed commercial/residential units, etc.)
- ☐[28] Retail – non-food
- ☐[29] Retail – food stores
- ☐[30] Restaurants and food service
- ☐[31] Religious organization
- ☐[32] School (public or private)
- ☐[33] Social services
- ☐[35] Transportation
- ☐[36] University
- ☐[38] Warehousing
- ☐[39] Wholesale and Distribution
- ☐[40] Other: please specify______________

Awareness of BC Hydro's CNC Program

7b. [For CNC, ask Q29 and Q30 first, then skip back to Q7b] Where did you hear about this program? Select all that apply. [do not randomize]

☐[1] Advertising
☐[2] Direct Mail
☐[3] Email
☐[4] Power of Business Newsletter
☐[5] Current Newsletter
☐[6] Media news story
☐[7] BC Hydro website
☐[8] Other website
☐[9] Facebook or Twitter
☐[10] BC Hydro Key Account Manager
☐[11] BC Hydro Engineering
☐[12] BC Hydro Alliance of Energy Professionals member (formerly Power Smart Alliance)
☐[13] Industry colleagues
☐[14] Work colleagues
☐[15] Friends and family
☐[16] Other, please specify: (*please do not identify individuals by name, title or organization)*
☐[999] Don't know

7c. Please complete the following sentence, 'My business was interested in BC Hydro's (insert umbrella program as per survey ID) because we wanted to …' Select all that apply. [randomize1 to 6]

☐[1] "Green" the business
☐[2] Decrease operating costs
☐[3] Receive incentives
☐[4] Implement energy efficiency technology at the business
☐[5] Improve the lighting at the business
☐[6] Improve the comfort at the business
☐[7] Other reason, please specify: (*please do not identify individuals by name, title or organization)*
☐[999] Don't know

Commercial New Construction Program

29. In the last two years, has your organization completed a major renovation or expansion to an existing facility or built a new facility either at this location or at another location? Check all that apply.

- ☐[1] Yes, we have renovated or expanded an existing facility and/or built a new facility either at this location or at another location in the last two years
- ☐[2] We are currently in the process of renovating or expanding an existing facility and/or building a new facility at this location or at another location
- ☐[3] No
- ☐[999] Don't know

30. BC Hydro's Commercial New Construction Program provides funding and design expertise to eligible customers who are building new facilities, doing a major renovation or expanding existing ones. The program starts with a fully-funded comprehensive energy study which determines a site's energy baseline followed by a range of design options and financial incentives to implement the energy conservation measures and improve its efficiency.

`Prior to this survey, had you heard of BC Hydro's Commercial New Construction Program?

- ☐[1] Yes ⇒ SURVEY IDS 500,000-528,999 SKIP BACK TO Q7b AND Q7c; THEN RETURN TO Q31
- ☐[2] No ⇒ SKIP TO Q40
- ☐[999] Don't know SKIP TO Q40

31. The Commercial New Construction Program pays up to 100% of an energy study which can help customers understand their design options for a new or expanded facility/site and how energy-efficient designs will help them save energy and money over a theoretical baseline.

Prior to receiving this survey, were you aware of the basics of the Energy Study component of the Commercial New Construction Program?

- ☐[1] Yes ⇒ CONTINUE TO Q32
- ☐[2] No ⇒ SKIP TO Q34
- ☐[999] Don't know ⇒ SKIP TO Q34

32. Prior to receiving this survey, how would you rate your understanding of the Energy Study component of the Commercial New Construction Program?

- ☐[1] Excellent
- ☐[2] Good
- ☐[3] Fair
- ☐[4] Poor
- ☐[5] Very Poor
- ☐[999] Don't know

33. Overall, how would you rate the Energy Study component of the Commercial New Construction Program?

- ☐[1] Excellent
- ☐[2] Good
- ☐[3] Fair
- ☐[4] Poor
- ☐[5] Very Poor
- ☐[999] Don't know

34. The Commercial New Construction Program provides financial incentives that reduce the incremental costs (i.e., those costs that exceed the costs for standard, inefficient design options) of energy efficiency measures, or bundle of measures, related to building new facilities or renovating existing ones, up to a maximum of $500,000.

Prior to receiving this survey, were you aware of the basics of the Project Incentive structure of the Commercial New Construction Program?

- ☐[1] Yes ⇒ CONTINUE TO Q35
- ☐[2] No ⇒ SKIP TO Q40
- ☐[999] Don't know ⇒ SKIP TO Q40

35. Prior to receiving this survey, how would you rate your understanding of the Project Incentive structure of the Commercial New Construction Program?

- ☐[1] Excellent
- ☐[2] Good
- ☐[3] Fair
- ☐[4] Poor
- ☐[5] Very Poor
- ☐[999] Don't know

36. Overall, how would you rate the Project Incentive structure of the Commercial New Construction Program?

- ☐[1] Excellent
- ☐[2] Good
- ☐[3] Fair
- ☐[4] Poor
- ☐[5] Very Poor
- ☐[999] Don't know ⇒ ALL SKIP TO Q40

Program Components: Key Account Manager

40. (Only ask if KAMflag=1; otherwise skip to Q44) A Key Account Manager is an organization's point-person inside BC Hydro who is responsible for managing various aspects of the customer relationship. This may include aspects relating to rates, outages, etc., but also those aspects relating to energy efficiency and conservation.

Prior to receiving this survey, were you aware of Key Account Managers?

☐[1] Yes ⇒ CONTINUE TO Q41
☐[2] No ⇒ SKIP TO Q44
☐[999] Don't know ⇒ SKIP TO Q44

41. Prior to receiving this survey, were you aware that the Key Account Manager acts as a liaison between BC Hydro's (insert umbrella program as per survey ID) and its participants?

☐[1] Yes ⇒ CONTINUE TO Q42
☐[2] No ⇒ SKIP TO Q44
☐[999] Don't know ⇒ SKIP TO Q44

42. Prior to receiving this survey, how would you rate your understanding of the role of the Key Account Manager in relation to BC Hydro's (insert umbrella program as per survey ID)?

☐[1] Excellent
☐[2] Good
☐[3] Fair
☐[4] Poor
☐[5] Very Poor
☐[999] Don't know

43. Overall, how would you rate your organization's Key Account Manager in relation to their support of your participation in BC Hydro's (insert umbrella program as per survey ID)?

☐1 Excellent
☐2 Good
☐3 Fair
☐4 Poor
☐5 Very Poor
☐999 Don't know
☐998 Not applicable – I have had no experience with a Key Account Manager in regards to the program

Program Component: BC Hydro Alliance of Energy Professionals (ALL SURVEY IDs)

The BC Hydro Alliance of Energy Professionals (formerly Power Smart Alliance) is a network of independent contractors and engineers that can help you select, install and maintain your site's energy related equipment.

44. Were you aware of the BC Hydro Alliance of Energy Professionals (formerly Power Smart Alliance) before this survey?

☐1 Yes ⇒ CONTINUE TO Q45
☐2 No ⇒ SKIP TO RULE FOR Q45b
☐999 Don't know => SKIP TO RULE FOR Q45b

45. Has a BC Hydro Alliance of Energy Professionals partner contacted your organization regarding BC Hydro's (insert program as per survey ID)?

☐1 Yes
☐2 No
☐999 Don't know

Your Site's Participation in BC Hydro's (insert umbrella program as per survey ID)

46. (FOR FIRST PROJECT THAT RESPONDENT IS SEEING) **As first mentioned at the beginning of this survey, BC Hydro records indicate that energy-efficient measures were implemented and/or technologies were installed at** (insert service address; service town) **through your organization's participation in BC Hydro's (insert umbrella program as per survey ID). Below is a project completed with the assistance of the program between** (DATEflag=1, "October 2015 and March 2016"; DATEflag=2, "April and September 2015").

(FOR ANY ADDITONAL PROJECTS) **Here is another project completed with the assistance of BC Hydro's** (insert umbrella program as per survey ID) **at** (insert service address; service town) **between** (DATEflag=1, "October 2015 and March 2016"; DATEflag=2, "April and September 2015").

Were you generally aware of the project listed below?

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

☐[1] Yes, I was generally aware of this project
☐[2] No, I was not aware of this project
☐[999] Don't know

⇒NB: Question repeated for each project completed at the site level up to a maximum of 3 projects (e.g., if 3 separate projects completed at the site level, then questions Q47 to Q54 get repeated as Q47-2 to Q54-2 and Q47-3 to Q54-3 with the descriptions of each project shown)

⇒IF "DON'T KNOW" OR "NO" FOR ALL, THEN SKIP TO Q57. OTHERWISE IF "NO" TO A PROJECT, SKIP TO FOLLOWING PROJECT IF MORE THAN 1 PROJECT.

⇒IF "YES" FOR ANY PROJECT SHOWN THEN CONTINUE THROUGH Q47 TO Q54.

47. For the project listed below…

(ONLY INCLUDE THOSE PROJECTS THAT HAVE BEEN SELECTED 'YES' IN Q46 ABOVE)

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

…if the assistance from BC Hydro's (insert umbrella program name as per survey ID) had not existed, would your organization have completed the project…

☐1 …at about the same time as actually done so
☐2 …within a year of when actually done so
☐3 …more than a year but less than 3 years later
☐4 …more than 3 years later
☐5 My organization would have completed this project, but I am unsure about the timing
☐6 My organization would NOT have completed this project (⇒ CONTINUE TO Q48)
☐999 Don't know

⇒ ANSWERS 1-5 AND 99 SKIP TO Q49.

⇒ Q48 IS ASKED FOR A PROJECT ONLY IF THE CORRESPONDING Q47 IS 6 "MY ORGANIZATION WOULD NOT HAVE COMPLETED THIS PROJECT"

48. Why would your organization NOT have completed this project? (In consideration of privacy issues, please do not reference any individuals' names.) (OPEN END)

☐0 No comments

SKIP TO Q54

49. For the project listed below… (ONLY INCLUDE THOSE PROJECTS THAT HAVE BEEN SELECTED 'YES' IN Q46 ABOVE)

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

…which of the following three statements best describes the energy efficiency of the measure that would have been installed at (insert service address, service town) if the assistance provided by BC Hydro's (insert umbrella program name as per survey ID) had not existed?

☐[1] We would have completed this measure with a LOWER ENERGY EFFICIENCY than actually installed
☐[2] We would have completed this measure with the SAME ENERGY EFFICIENCY as actually installed
☐[3] We would have completed this measure with a HIGHER ENERGY EFFICIENCY than actually installed
☐[999] Don't know
☐[998] Not applicable

50. For the project listed below… (ONLY INCLUDE THOSE PROJECTS THAT HAVE BEEN SELECTED 'YES' IN Q46 ABOVE)

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

…what percentage of this project would your organization have completed on its own if the assistance from BC Hydro's (insert umbrella program name as per survey ID) had not existed?

When considering your answer, please keep in mind all the equipment, all the technologies, and/or all of the sites included in this project.

You may either enter a percentage in the field provided, or choose from the list provided:

OR:

☐[1] 0% ☐[2] 1% to 24% ☐[3] 25% to 49% ☐[4] 50% to 74% ☐[5] 75% to 99%
☐[6] 100% or greater ☐[999] Don't know
☐[988] Not applicable

51. For the project listed below… (ONLY INCLUDE THOSE PROJECTS THAT HAVE BEEN SELECTED 'YES' IN Q46 ABOVE)

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

…had there been no financial incentive from BC Hydro (i.e., money paid directly from BC Hydro to your organization – which does not include money for energy audits, studies or Energy Managers – would the energy-efficient measure have met your organization's financial criteria around site investments?

☐[1] Yes, it would have met our financial criteria
☐[2] No, it would NOT have met our financial criteria
☐[999] Don't know
☐[998] Not Applicable

52. For the project listed below… (ONLY INCLUDE THOSE PROJECTS THAT HAVE BEEN SELECTED 'YES' IN Q46 ABOVE)

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

…was the idea to implement the energy efficiency measure first suggested through BC Hydro assistance, such as a BC Hydro-funded energy consultant, BC Hydro-funded Energy Manager or a BC Hydro representative?

☐[1] Yes, the idea was first suggested through BC Hydro assistance.
☐[2] No, the idea was NOT first suggested through BC Hydro assistance
☐[999] Don't know

53. For the project listed below… (ONLY INCLUDE THOSE PROJECTS THAT HAVE BEEN SELECTED 'YES' IN Q46 ABOVE)

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

…how much experience did your organization have with this type of energy-efficient measure that was implemented and/or technology that was installed, previous to your site's participation in BC Hydro's (insert umbrella program as per survey ID)?

☐1 A great deal of experience
☐2 A fair amount of experience
☐3 A little experience
☐4 No experience at all
☐999 Don't know

54. For the project listed below… (ONLY INCLUDE THOSE PROJECTS THAT HAVE BEEN SELECTED 'YES' IN Q46 ABOVE)

Type of Assistance:	(insert assistance name)
Brief Project Description:	(insert brief project description)
Incentive amount paid by CNC	(insert incentive amount)

…overall, how influential was BC Hydro's (insert umbrella program as per survey ID) on your organization's decision to implement the energy-efficient measure listed above at this site?

☐1 Very influential
☐2 Somewhat influential
☐3 Not too influential
☐4 Not at all influential
☐999 Don't know

Additional Site Investments in Energy Efficiency (ALL SURVEY IDs)

57. Since participating in BC Hydro's (insert umbrella program as per survey ID) for the projects listed below," and no further back than April 2015, has the site at (insert service address, service town) implemented any new energy-efficient measures and/or installed any new energy-efficient technologies without assistance from BC Hydro, or have plans in place to do so within the next two years? We mean something that is more significant than installing a new light bulb. We're looking for HVAC improvements, lighting retrofits, installation of lighting controls, building shell improvements, etc.

- ☐[1] Yes, additional energy efficiency measures have been made and /or will be made at this site without the assistance from BC Hydro ⇒ CONTINUE TO Q58
- ☐[2] No additional significant energy efficiency measures have been made at this site ⇒ SKIP TO Q68
- ☐[999] Don't know / not sure ⇒ SKIP TO Q68

(IF "TYPE OF ASSISTANCE" AND "BRIEF PROJECT DESCRIPTION" ARE POPULATED IN Q46, THEN SHOW FOLLOWING TEXT AND TABLE)

AS A REMINDER …

Please exclude the following projects which your organization completed with BC Hydro's (insert umbrella program as per survey ID)

Type of Assistance	Brief Project Details
(insert assistance name)	(insert brief project description)
(insert assistance name)	(insert brief project description)
(insert assistance name)	(insert brief project description)

58. Which of the following areas or components (if any) of your site located at (insert service address, service town) have been improved or do you have plans to improve within the next 2 years without assistance from BC Hydro? We mean something that is more significant than installing a new light bulb. We're looking for HVAC improvements, lighting retrofits, installation of lighting controls, building envelope improvements, for a new or expanded site/facility, etc. Check all that apply.

			Have been improved	Have plans to improve within the next 2 years
a.	New lighting systems, components, or controls	→	☐[1]	☐[1]
b.	New cooling systems, components or controls	→	☐[2]	☐[2]
c.	New heating systems, components or controls	→	☐[3]	☐[3]
d.	New technologies for process cooling	→	☐[4]	☐[4]
e.	New motors or pumps	→	☐[5]	☐[5]
f.	New motor drive systems	→	☐[6]	☐[6]
g.	New technologies for compressed air	→	☐[7]	☐[7]
h.	New technologies for material conveyors	→	☐[8]	☐[8]
i.	New compressed air systems	→	☐[9]	☐[9]
j.	New technologies for fans	→	☐[10]	☐[10]
k.	New refrigeration systems, components or controls	→	☐[11]	☐[11]
l.	New technologies for energy management control/software	→	☐[12]	☐[12]
m.	New technologies for water heating	→	☐[13]	☐[13]
n.	New technologies for computers, IT and office equipment	→	☐[14]	☐[14]
o.	Building envelope measures/improvements	→	☐[15]	☐[15]
p.	Other: please specify___________________________	→	☐[16]	☐[16]
q.	None of the above ⇒ SKIP TO Q68	→	☐[17]	☐[17]

⇒ IF "YES" FOR ANY OF 'A' TO 'O' THEN CONTINUE TO Q59

59. For each item that you have improved or will improve, did or will this site install any of these items due to a program offered by another organization such as a gas company, provincial or federal government? (INSERT ONLY THOSE ITEMS SLECTED FROM Q58).

		Yes	No	Don't know
a. New lighting systems, components, or controls	→	☐1	☐2	☐999
b. New cooling systems, components or controls	→	☐1	☐2	☐999
c. New heating systems, components or controls	→	☐1	☐2	☐999
d. New technologies for process cooling	→	☐1	☐2	☐999
e. New motors or pumps	→	☐1	☐2	☐999
f. New motor drive systems	→	☐1	☐2	☐999
g. New technologies for compressed air	→	☐1	☐2	☐999
h. New technologies for material conveyors	→	☐1	☐2	☐999
i. New compressed air systems	→	☐1	☐2	☐999
j. New technologies for fans	→	☐1	☐2	☐999
k. New refrigeration systems, components or controls	→	☐1	☐2	☐999
l. New technologies for energy management control/software	→	☐1	☐2	☐999
m. New technologies for water heating	→	☐1	☐2	☐999
n. New technologies for computers, IT and office equipment	→	☐1	☐2	☐999
o. Building envelope measures/improvements	→	☐1	☐2	☐999
p. Other (INSERT DESCRIPTION FROM 58, selection 'p')	→	☐1	☐2	☐999

⇒ IF 'YES' FOR ALL THEN SKIP TOQ68; IF 'NO' OR 'DON'T KNOW' FOR AT LEAST 1 ITEM THEN CONTINUE TO Q60 (ONLY INCLUDE THOSE ITEMS THAT WERE ANSWERED 'NO' OR 'DON'T KNOW').

60. What percentage of this equipment at this site has been (or will be) affected by this installation? (INSERT ONLY THOSE ITEMS THAT HAVE BEEN CHECKED 'NO' OR 'DON'T KNOW' FROM Q59) For example, if you had a building that was 10 stories tall and a lighting retrofit was completed on 4 floors, you would say 40% of the lighting equipment was affected. Another example is if your site has 4 buildings with heating systems and 1 of the buildings was upgraded, you would say 25% of the heating equipment was affected.

			Percentage of this equipment affected	Don't know
a.	New lighting systems, components, or controls	→	____%	☐999
b.	New cooling systems, components or controls	→	____%	☐999
c.	New heating systems, components or controls	→	____%	☐999
d.	New technologies for process cooling	→	____%	☐999
e.	New motors or pumps	→	____%	☐999
f.	New motor drive systems	→	____%	☐999
g.	New technologies for compressed air	→	____%	☐999
h.	New technologies for material conveyors	→	____%	☐999
i.	New compressed air systems	→	____%	☐999
j.	New technologies for fans	→	____%	☐999
k.	New refrigeration systems, components or controls	→	____%	☐999
l.	New technologies for energy management control/software	→	____%	☐999
m.	New technologies for water heating	→	____%	☐999
n.	New technologies for computers, IT and office equipment	→	____%	☐999
o.	Building envelope measures/improvements	→	____%	☐999
p.	Other (INSERT DESCRIPTION FROM Q58, selection 'p')	→	____%	☐999

61. Did your organization first have the idea to install this measure before participating in BC Hydro's (insert umbrella program as per survey ID)? (INSERT ONLY THOSE ITEMS THAT HAVE BEEN CHECKED 'NO' OR 'DON'T KNOW' FROM Q59)

		Yes, we first had the idea to implement this measure PRIOR to our participation in the conservation program(s)	No, we didn't have the idea to implement this measure until AFTER our participation in the conservation program(s)	Not Applicable	Don't know
a. New lighting systems, components, or controls	→	☐1	☐2	☐998	☐999
b. New cooling systems, components or controls	→	☐1	☐2	☐998	☐999
c. New heating systems, components or controls	→	☐1	☐2	☐998	☐999
d. New technologies for process cooling	→	☐1	☐2	☐998	☐999
e. New motors or pumps	→	☐1	☐2	☐998	☐999
f. New motor drive systems	→	☐1	☐2	☐998	☐999
g. New technologies for compressed air	→	☐1	☐2	☐998	☐999
h. New technologies for material conveyors	→	☐1	☐2	☐998	☐999
i. New compressed air systems	→	☐1	☐2	☐998	☐999
j. New technologies for fans	→	☐1	☐2	☐998	☐999
k. New refrigeration systems, components or controls	→	☐1	☐2	☐998	☐999
l. New technologies for energy management control/software	→	☐1	☐2	☐998	☐999
m. New technologies for water heating	→	☐1	☐2	☐998	☐999
n. New technologies for computers, IT and office equipment	→	☐1	☐2	☐998	☐999
o. Building envelope measures/improvements	→	☐1	☐2	☐998	☐999
p. Other (INSERT DESCRIPTION FROM Q58, selection 'p')	→	☐1	☐2	☐998	☐999

62. If your organization had NOT participated in BC Hydro's (insert umbrella program as per survey ID), would your organization have completed (or made plans to complete) the following project(s)…(INSERT ONLY THOSE ITEMS THAT HAVE BEEN CHECKED 'NO' OR 'DON'T KNOW' FROM Q59)

		…at about the same time as actually done so	…within a year of when actually done so	…more than a year to less than 3 years later	…more than 3 years later	We would have completed this project, but I am unsure about the timing	We would NOT have completed this project	Don't know
a. New lighting systems, components, or controls	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
b. New cooling systems, components or controls	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
c. New heating systems, components or controls	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
d. New technologies for process cooling	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
e. New motors or pumps	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
f. New motor drive systems	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
g. New technologies for compressed air	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
h. New technologies for material conveyors	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
i. New compressed air systems	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
j. New technologies for fans	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
k. New refrigeration systems, components or controls	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
l. New technologies for energy management control/software	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
m. New technologies for water heating	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
n. New technologies for computers, IT and office equipment	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
o. Building envelope measures/improvements	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999
p. Other (INSERT DESCRIPTION FROM Q58, selection 'p')	→	☐1	☐2	☐3	☐4	☐5	☐6	☐999

⇒ IF 'WE WOULD NOT HAVE COMPLETED THIS PROJECT" FOR ALL SKIP TO Q65; OTHERWISE CONTINUE TO Q63

63. Which of the following three statements best describes the energy efficiency of the measures that would have been installed at (insert service address, service town) if your organization had NOT participated in BC Hydro's (insert umbrella program as per survey ID). (INSERT ONLY THOSE ITEMS THAT HAVE BEEN CHECKED 1-5 OR 'DON'T KNOW' FROM Q62)

		We would have completed this measure with a LOWER ENERGY EFFICIENCY than actually installed	We would have completed this measure with the SAME ENERGY EFFICIENCY as actually installed	We would have completed this measure with a HIGHER ENERGY EFFICIENCY than actually installed	Not Applicable	Don't know
a. New lighting systems, components, or controls	→	☐1	☐2	☐3	☐998	☐999
b. New cooling systems, components or controls	→	☐1	☐2	☐3	☐998	☐999
c. New heating systems, components or controls	→	☐1	☐2	☐3	☐998	☐999
d. New technologies for process cooling	→	☐1	☐2	☐3	☐998	☐999
e. New motors or pumps	→	☐1	☐2	☐3	☐998	☐999
f. New motor drive systems	→	☐1	☐2	☐3	☐998	☐999
g. New technologies for compressed air	→	☐1	☐2	☐3	☐998	☐999
h. New technologies for material conveyors	→	☐1	☐2	☐3	☐998	☐999
i. New compressed air systems	→	☐1	☐2	☐3	☐998	☐999
j. New technologies for fans	→	☐1	☐2	☐3	☐998	☐999
k. New refrigeration systems, components or controls	→	☐1	☐2	☐3	☐998	☐999
l. New technologies for energy management control/software	→	☐1	☐2	☐3	☐998	☐999
m. New technologies for water heating	→	☐1	☐2	☐3	☐998	☐999
n. New technologies for computers, IT and office equipment	→	☐1	☐2	☐3	☐998	☐999
o. Building envelope measures/improvements	→	☐1	☐2	☐3	☐998	☐999
p. Other (INSERT DESCRIPTION FROM Q58, selection 'p')	→	☐1	☐2	☐3	☐998	☐999

64. Which of the following three statements best describes the AMOUNT or NUMBER of energy-efficient measures that would have been installed at (insert service address, service town) if your organization had NOT participated in BC Hydro's (insert umbrella program as per survey ID)? (INSERT ONLY THOSE ITEMS THAT HAVE BEEN CHECKED 1-5 OR 'DON'T KNOW' FROM Q62)

		We would have installed or completed a LESSER amount	We would have installed or completed the SAME amount	We would have installed or completed a GREATER amount	Not Applicable	Don't know
a. New lighting systems, components, or controls	→	☐1	☐2	☐3	☐998	☐999
b. New cooling systems, components or controls	→	☐1	☐2	☐3	☐998	☐999
c. New heating systems, components or controls	→	☐1	☐2	☐3	☐998	☐999
d. New technologies for process cooling	→	☐1	☐2	☐3	☐998	☐999
e. New motors or pumps	→	☐1	☐2	☐3	☐998	☐999
f. New motor drive systems	→	☐1	☐2	☐3	☐998	☐999
g. New technologies for compressed air	→	☐1	☐2	☐3	☐998	☐999
h. New technologies for material conveyors	→	☐1	☐2	☐3	☐998	☐999
i. New compressed air systems	→	☐1	☐2	☐3	☐998	☐999
j. New technologies for fans	→	☐1	☐2	☐3	☐998	☐999
k. New refrigeration systems, components or controls	→	☐1	☐2	☐3	☐998	☐999
l. New technologies for energy management control/software	→	☐1	☐2	☐3	☐998	☐999
m. New technologies for water heating	→	☐1	☐2	☐3	☐998	☐999
n. New technologies for computers, IT and office equipment	→	☐1	☐2	☐3	☐998	☐999
o. Building envelope measures/improvements	→	☐1	☐2	☐3	☐998	☐999
p. Other (INSERT DESCRIPTION FROM Q58, selection 'p')	→	☐1	☐2	☐3	☐998	☐999

65. Thinking about these additional energy efficiency steps taken (or planned) at this site not covered by BC Hydro assistance, how influential was your participation and learnings from BC Hydro's (insert umbrella program as per survey ID) on your organization's decision to do more on your own? (INSERT ONLY THOSE ITEMS THAT HAVE BEEN CHECKED 'NO' OR 'DON'T KNOW' FROM Q59 → note this brings back the full list of "NO" from Q59)

		Very influential	Somewhat influential	Not too influential	Not at all influential	Don't know
a. New lighting systems, components, or controls	→	☐1	☐2	☐3	☐4	☐999
b. New cooling systems, components or controls	→	☐1	☐2	☐3	☐4	☐999
c. New heating systems, components or controls	→	☐1	☐2	☐3	☐4	☐999
d. New technologies for process cooling	→	☐1	☐2	☐3	☐4	☐999
e. New motors or pumps	→	☐1	☐2	☐3	☐4	☐999
f. New motor drive systems	→	☐1	☐2	☐3	☐4	☐999
g. New technologies for compressed air	→	☐1	☐2	☐3	☐4	☐999
h. New technologies for material conveyors	→	☐1	☐2	☐3	☐4	☐999
i. New compressed air systems	→	☐1	☐2	☐3	☐4	☐999
j. New technologies for fans	→	☐1	☐2	☐3	☐4	☐999
k. New refrigeration systems, components or controls	→	☐1	☐2	☐3	☐4	☐999
l. New technologies for energy management control/software	→	☐1	☐2	☐3	☐4	☐999
m. New technologies for water heating	→	☐1	☐2	☐3	☐4	☐999
n. New technologies for computers, IT and office equipment	→	☐1	☐2	☐3	☐4	☐999
o. Building envelope measures/improvements	→	☐1	☐2	☐3	☐4	☐999
p. Other (INSERT DESCRIPTION FROM Q58, selection 'p')	→	☐1	☐2	☐3	☐4	☐999

66. Thinking about these additional energy efficiency steps taken (or planed) at this site not covered by BC Hydro assistance, would you estimate that these annual electricity savings are greater than or less than the annual electricity savings directly made by participating in the BC Hydro program, or are they about equal?

- ☐[1] Annual non-program savings are greater than BC Hydro program savings ⇒ CONTINUE TO Q67
- ☐[2] Annual non-program savings are less than BC Hydro program savings ⇒ CONTINUE TO Q67
- ☐[3] About equal ⇒ SKIP TO Q68
- ☐[999] Don't know ⇒ SKIP TO Q68

67. Approximately how much (IF ANSWER Q66=1 THEN "greater"; IF ANSWER Q66 =2 THEN "less") are these annual non-program savings than the annual BC Hydro program savings? (If ANSWER Q66 =2 also include "e.g., if non-program savings were about a quarter the size of your total program savings, you would write in 25%.")

Please specify: _______% (If ANSWER Q66=1 "**greater than total program savings**"; ANSWER Q66 =2, "**of total program savings**"

- ☐[999] Don't know

Program Participation: Experience

68. We would like to ask your opinion of several features of BC Hydro's (insert umbrella program as per survey ID). From Excellent to Very Poor, how would you rate the following aspects of the program? (only items A to I and M are randomized, and then the questions about length (J, K and L) be rearranged into the order L, K, J and shown at the bottom of the table

		Excellent	Good	Fair	Poor	Very poor	Don't know/ do not recall	Not applicable
a.	Direct mail information about BC Hydro's (insert umbrella program as per survey ID)	☐1	☐2	☐3	☐4	☐5	☐999	☐998
b.	Information about BC Hydro's (insert umbrella program as per survey ID on the website	☐1	☐2	☐3	☐4	☐5	☐999	☐998
c.	Service provided by BC Hydro personnel	☐1	☐2	☐3	☐4	☐5	☐999	☐998
d.	Service provided by your product supplier(s)/distributor(s)	☐1	☐2	☐3	☐4	☐5	☐999	☐998
e.	Service provided by your contractor(s)/consultant(s) **(for 500,000-528,999 add "**/designer(s)**")**	☐1	☐2	☐3	☐4	☐5	☐999	☐998
f.	Level of incentives offered	☐1	☐2	☐3	☐4	☐5	☐999	☐998
g.	The variety of products funded under the program	☐1	☐2	☐3	☐4	☐5	☐999	☐998
i.	Overall application procedures to receive funding	☐1	☐2	☐3	☐4	☐5	☐999	☐998
m.	Clarity of communications from BC Hydro about your project	☐1	☐2	☐3	☐4	☐5	☐999	☐998
l.	Length of time to receive project approval	☐1	☐2	☐3	☐4	☐5	☐999	☐998
k.	Length of time for the project to be completed	☐1	☐2	☐3	☐4	☐5	☐999	☐998
j.	Length of time to receive the incentive	☐1	☐2	☐3	☐4	☐5	☐999	☐998

68b. Here are some additional aspects of the program. Please rate them from Excellent to Very Poor. [do not randomize]

		Excellent	Good	Fair	Poor	Very poor	Don't know/ do not recall	Not applicable
s.	Knowing how and who to contact at BC Hydro for any project and process questions on the program	☐1	☐2	☐3	☐4	☐5	☐999	☐998
t.	Ease of the online Company Registration for Energy Efficient Lighting Design (EELD) projects	☐1	☐2	☐3	☐4	☐5	☐999	☐998
u.	Consultant/Lighting Designer feedback on the Lighting Calculator's ease of use *(if applicable)*	☐1	☐2	☐3	☐4	☐5	☐999	☐998

68c. On a scale of 1 to 5, with 1 being very little effort and 5 being a lot of effort, please indicate the total effort that was required by your organization to complete your participation in the program?

1 – Very little effort	2	3	4	5 – A lot of effort	Don't know
○	○	○	○	○	○999

69. Overall, how satisfied are you with your experience with BC Hydro's (insert umbrella program as per survey ID)?

- ☐1 Very satisfied
- ☐2 Somewhat satisfied
- ☐3 Neither satisfied or dissatisfied
- ☐4 Somewhat dissatisfied
- ☐5 Very dissatisfied
- ☐999 Don't Know

69b. Thinking about things a little differently, on a scale of 1 to 10, where 1 is not at all satisfied and 10 is extremely satisfied, overall how satisfied are you with BC Hydro's (insert umbrella program as per survey ID)?

1 – Not at all satisfied	2	3	4	5	6	7	8	9	10 – Extremely Satisfied	Don't know
○	○	○	○	○	○	○	○	○	○	○[999]

Follow-Up

70. Based on your experience with BC Hydro's (insert umbrella program as per survey ID), would you recommend the program to organizations similar to your own?

- ☐[1] Definitely would recommend
- ☐[2] Probably would recommend
- ☐[3] Might or might not recommend
- ☐[4] Probably would not recommend
- ☐[5] Definitely would not recommend
- ☐[999] Don't Know

71. Have you recommended BC Hydro's (insert umbrella program as per survey ID) to anyone else?

- ☐[1] Yes
- ☐[2] No

72. We would like to know if there are ways to improve BC Hydro's (insert umbrella program as per survey ID). Do you have any suggestions on how the program could be improved? (In consideration of privacy issues, please do not reference any individuals' names.) (OPEN END)

Specify: ____________________

- ☐[0] No comments

Electricity Management

75. Over the past year, how much of an effort would you say your organization has made to conserve electricity?

- ☐[1] A great deal of effort
- ☐[2] A fair amount of effort
- ☐[3] A little effort
- ☐[4] No effort at all ⇒ ASK Q76, BUT THEN SKIP TO Q78
- ☐[999] Don't know

76. Compared to one year ago, would you say your organization is making more of an effort to conserve electricity, less of an effort, or has there been no change?

- ☐[1] Much more of an effort
- ☐[2] A little more of an effort
- ☐[3] No change
- ☐[4] A little less of an effort
- ☐[5] Much less of an effort
- ☐[999] Don't know

⇒IF Q75=4, THEN SKIP TO Q78, OTHERWISE CONTINUE TO Q77

Energy Management: Motivation

77. In this section, we would like to learn about what motivated your organization to make an effort to manage its use of electricity over the past year.

For each item in the table below, please indicate how much of a factor it has had on your organization's effort to manage its use of electricity over the past year. (RANDOMIZE)

		Major factor	Minor factor	Not a factor	Don't know / Not applicable
a.	Overall level of electricity prices	☐1	☐2	☐3	☐999
b.	The incentive to conserve electricity that is built into BC Hydro's rate structure	☐1	☐2	☐3	☐999
c.	BC Hydro's (INSERT UMBRELLA PROGRAM AS PER SURVEY ID)	☐1	☐2	☐3	☐999
d.	BC Hydro Key Account Manager (Only ask if KAMflag=1)	☐1	☐2	☐3	☐999
e.	Contractors, vendors or customers (e.g., supply chain/marketplace demands)	☐1	☐2	☐3	☐999
f.	Employees	☐1	☐2	☐3	☐999
g.	Energy Manager	☐1	☐2	☐3	☐999
h.	Reducing electricity use to make operating costs as low as possible	☐1	☐2	☐3	☐999
i.	Focus on cost cutting measures due to any economic downturn	☐1	☐2	☐3	☐999
j.	Federal, Provincial, or Local government initiatives	☐1	☐2	☐3	☐999
k.	Increased funds within your company for energy-efficient retrofits	☐1	☐2	☐3	☐999
l.	Reducing electricity use to benefit the environment – it's just the right thing to do	☐1	☐2	☐3	☐999
m.	Other influences: please specify ________________	☐1	☐2	☐3	☐999
n.	Other influences: please specify ________________	☐1	☐2	☐3	☐999

Electricity Management: Barriers

78. In this section, we would like to learn about the barriers your organization may have faced in any effort to manage its use of electricity over the past year. For each item in the table below, please indicate how much of a barrier it has been on your organization's effort to manage its use of electricity over the past year. (RANDOMIZE)

	Major barrier	Minor barrier	No barrier	Don't Know / Not Applicable
a. Lack of funds available for energy-efficient retrofits	☐1	☐2	☐3	☐999
b. Lack of staffing/staffing requirements	☐1	☐2	☐3	☐999
c. Lack of knowledge of where the opportunities for savings might be	☐1	☐2	☐3	☐999
d. Lack of financial incentives for conservation programs and energy efficiency	☐1	☐2	☐3	☐999
e. Can't control employees' behaviour in regards to energy efficiency practice	☐1	☐2	☐3	☐999
f. There are other operational priorities	☐1	☐2	☐3	☐999
g. Takes too much time	☐1	☐2	☐3	☐999
h. Current usage is already near its lowest possible level	☐1	☐2	☐3	☐999
i. Currently leasing the property and no property changes are permitted	☐1	☐2	☐3	☐999
j. All equipment is functioning as efficiently as possible	☐1	☐2	☐3	☐999
m. Interruption to business operations	☐1	☐2	☐3	☐999
k. If applicable: Other barrier (1): specify__________________	☐1	☐2	☐3	☐999
l. If applicable: Other barrier (2): specify__________________	☐1	☐2	☐3	☐999

Comments in Regards to BC Hydro's (insert umbrella program as per survey ID)

79. Do you have any final comments or suggestions in regards to this survey, BC Hydro or its energy conservation programs? (In consideration of privacy issues, please do not reference any individuals' names.) (OPEN-END)

☐[0] No comments

Final Words

80. Are you the original recipient of the survey invitation or was it forwarded along to you by a colleague?

- ☐[1] Original recipient
- ☐[2] The survey was forwarded to me
- ☐[999] Don't know/not sure

81. The key objective of this survey is to collect the necessary information to inform our program evaluation, including how an account's consumption of electricity may vary with the various electrical end-uses associated with it.

To facilitate this, it is important to analyze an account's consumption of electricity for a period dating back to 2010 as a long 'time series' of consumption helps us to better control for year-to-year changes in the weather, the economy, etc.

Rather than asking you to estimate how much electricity this account has consumed over the past couple of years, BC Hydro would like to access this information from your organization's account history and link it to the responses you have given in this survey. We will NOT review any of your organization's bill payment information.

May we please have your organization's permission for BC Hydro to do this?

- ☐[1] Yes
- ☐[2] No

83. If you wish to receive a $50 gift certificate to a home improvement retailer upon completing and submitting the survey, please choose from 1 of 4 retailers and indicate your name, address, city, postal code and phone number below. The information provided below will be stored separately from your survey responses.

Name:
Business Name:
Business Address:
City:
Postal Code:
Business Telephone:

Retailer :

☐1 Canadian Tire
☐2 Home Hardware
☐3 Rona
☐4 Home Depot

☐0 No thanks

Final page after submitting:

Thank you for taking the time to complete this survey. Your responses have been received and secured

POWER SMART PARTNERS –

LOAD DISPLACEMENT INITIATIVES

IMPACT EVALUATION:

F2012-F2018

Final Report

March 31, 2020

Prepared by:

BC Hydro Conservation and Energy Management Evaluation

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Executive Summary

Introduction

This report presents the results of an impact evaluation covering eight load displacement projects implemented during the period from F2012 to F2016. Since the program has ended and no new projects were implemented in F2017 and F2018 and operational data was available for all the projects, the evaluation period covers F2012 to F2018.[1] The projects were funded through the Power Smart Partners-Transmission (PSP-T) Integrated Power Offer (IPO) or Load Displacement (LD) program offers and were not included in the scope of any previous impact evaluations.

Load displacement projects are customer-based generation projects that self-supply part of the customer's site electrical load. For these projects, industrial, commercial and institutional customers received BC Hydro funding and program support to generate their own electricity for self-supply and offset their electricity purchases from BC Hydro. All customer-based generation projects over 50 kW were reviewed through the Integrated Customer Solutions (ICS) process. The load displacement project enabling activities were specifically designed to operate under the ICS framework and remove technical and financial barriers specific to self-generation projects. Load displacement projects were treated as having reduced customer energy purchases similar to energy conservation project initiatives for industrial transmission customers.

Approach

The evaluation objectives and research questions are summarized in the following table.

Table ES.1 Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Estimate gross electricity generation and peak demand impacts.	What were the evaluated gross electricity generation and demand impacts realized by load displacement projects aggregated by fiscal year and, to the extent possible, disaggregated by relevant factors*?
2. Estimate net electricity generation and peak demand impacts.	What were the relative magnitude of parasitic loads[2] and their energy use as related to the load displacement projects?
	What were the evaluated net electricity generation and demand impacts realized by load displacement projects aggregated by fiscal year and, to the extent possible, disaggregated by relevant factors?
	To what extent did parallel energy procurement initiatives[3] impact the net electricity generation of the load displacement projects?

* Relevant factors may include technology type, primary energy source, seasonal operating mode and operating strategy with other on-site process heat requirements that impact the net electricity generation.

[1] The Load Displacement initiative was no longer available after F2017.

[2] Parasitic load is the electrical energy that is required for the operation of the load displacement project.

[3] Other energy procurement initiatives include electricity purchase agreements, contracted generation baseline loads, and tariff treatments.

The objectives, data sources and methods used for this evaluation are shown in Table ES.2.

Table ES.1. Evaluation Objectives, Data and Method

Evaluation Objectives	Data	Method
1. Estimate gross electricity generation and peak demand impacts.	• Project files • Self-generation eMetering • Customer process requirements • Billing records and Customer Baseline Load (CBL) Statements[4]	• Annual M&V results and evaluation review • Self-generation load shapes, capacity factors and peak-to-energy factors • Engineering calculations
2. Estimate net electricity generation and peak demand impacts.	• Load displacement feasibility studies • Reported savings • Project files	• Engineering estimates of parasitic loads • Annual M&V results and evaluation review

Electricity self-generation impacts were evaluated over the period from F2012 to F2018 based on hourly interval data through annual measurement and verification or annual reconciliation of the site's total generation energy.

Objective 1: Evaluated Gross Electricity Generation and Peak Demand Impacts

Evaluated gross electricity generation is the energy generated due to the program and estimated from the annual M&V results and billing records by fiscal year. Four of the eight projects underwent an annual measurement and verification process for the estimation of gross and net electricity generation. These four projects with M&V are load displacement projects where a new generator was installed. They are grouped in this evaluation under 'New Power Generation' and M&V results were used as the basis of the gross generation energy for evaluation review. The other four load displacement projects were due to refurbishment and upgrading of an existing steam turbine which resulted in incremental generation to already existing generation. These are grouped in this evaluation under 'Rebuilt Turbo Generator'. The annual gross incremental generation energy from the rebuilt units was verified by BC Hydro Contract Management based on revenue metering data for each fiscal year and provided in the customer's billing records. For these projects, the customer's billing records were used as the basis of the gross generation energy for evaluation review.

The gross peak demand impact by the load displacement projects was estimated using the peak-to-energy factor of the total self-generation system at each site. These were evaluated based on hourly interval data during steady-state operations in winter by dividing the average generation power during peak periods by the load displacement project's annual generation energy.

Objective 2: Net Generation Energy and Peak Demand Impacts

The net generation energy is the difference between the energy delivered by the generator and the parasitic energy requirements. The evaluated parasitic energy was estimated based on recent actual performance as the most likely indicator of future performance of the load displacement project.

The parasitic energy estimate for the four New Power Generation projects with M&V was verified by the M&V group using engineering calculations and spot measurements when available. No M&V results were available for the four Rebuilt Turbo Generator projects and a deemed estimate of the incremental parasitic energy was applied based on the default assumption of 3% of incremental gross generation energy[5] of the load displacement project.

[4] CBL Statements are issued annually by BC Hydro for each customer on stepped rate schedule (RS1823B) that includes any adjustment made to a customer's energy bill for the purpose of Customer Baseline Load (CBL) administration.

[5] U.S. Department of Energy (2017). *Uniform Methods Project, Chapter 23: Combined Heat and Power Evaluation Protocol.*

The evaluated net generation peak demand impact of the program was estimated using the same peak-to-energy factors determined for Objective 1, applied to the project-based M&V estimates for parasitic energy and metered load shapes of the generation energy. This assumed that the load shape of the parasitic energy is the same as the load shape of the generation energy.

It was not an objective of this evaluation to attribute changes in generation energy to the load displacement initiatives, which would take into consideration free ridership and spillover. In this evaluation, the term 'net generation impact' refers to the gross generation energy less parasitic energy and does not imply attribution to any intervening initiative. These load displacement projects were assumed to have no free ridership and non-existent spillover, for a net-to-gross ratio of one, for two reasons. First, all self-generation projects had to apply to BC Hydro for generator inter-connection and go through the integrated customer solutions process for review and evaluation. All of the eight load displacement projects in this evaluation were then directed to the load displacement capital incentive offer by BC Hydro and each project had its own business case developed with BC Hydro executive approval of the incentive amount. Hence no free ridership of the capital incentive was anticipated. Second, all generation energy is metered and customers were required to service their self-generation contracts in a prescribed order which was verified by BC Hydro for billing purposes. Hence no spillover of any unreported generation energy was deemed possible.

Results

Objective 1

Table ES.3 shows the number of load displacement projects implemented by fiscal year, as well as the cumulative rated capacity, the evaluated gross generation energy, and the evaluated gross peak demand impact. Results are given as cumulative due to the variation of project results with annual review through measurement and verification.

The peak-to-energy factor was evaluated for each project from hourly interval data based on the average power generated between December and February. Peak-to-energy factors are usually determined using winter weekday evening loads, to correspond with the BC Hydro system peak, but the variations of generated power between winter days of the week (weekday versus weekend) and winter hours of the day (evenings versus other hours of the day) were found to be negligible. The average evaluated peak-to-energy factor was found to be 0.126 MW per GWh, almost 8 percent higher than the industrial transmission rate class average of 0.117 MW per GWh which is typically applied to energy conservation measures. This higher peak-to-energy factor resulted in a higher estimate of peak demand impact for load displacement projects.

A number of other factors were examined to assess the performance of load displacement projects in terms of system availability and capacity utilization. Detailed results discussed in the report indicate that all load displacement projects had excess capacity to potentially increase generation power and energy.

Table ES.3 Evaluated Cumulative Gross Generation Energy and Peak Demand Impact

Fiscal Year	Number of new Projects	Load Displacement Project Type	Cumulative Rated Capacity (MW)	Cumulative Evaluated Gross Generation Energy (GWh/yr)	Cumulative Evaluated Gross Peak Demand Impact (MW)
F2012	2	2x Rebuilt Turbo Generator	26	167	21
F2013	1	1x New Power Generation	28	181	23
F2014	0	-	28	181	23
F2015	2	1x Rebuilt Turbo Generator 1x New Power Generation	31	204	25
F2016	3	1x Rebuilt Turbo Generator 2x New Power Generation	41	263	33
F2017	0	-	41	263	33
F2018	0	-	41	263	33

Objective 2

Table ES.4 summarizes key results by project type and shows the evaluated net generation energy after adjustment for parasitic energy.

Table ES.4. Net Generation Results by Project Type

	Group 1 Rebuilt Turbo Generator	Group 2 New Power Generation
Number of Projects	4	4
Rated Capacity (MW)	32.1	8.9
Evaluated Gross Generation Energy (GWh/yr)	204	59
Evaluated Net Generation Energy (GWh/yr)	198	55
Parasitic Energy Factor	3%	6.5%
Peak-to-Energy Factor (MW/GWh)	0.129	0.117
Realization Rate[6]	91%	98%
Load displacement to facility energy ratio[7]	18%	14%
LD energy to total self-generation energy ratio[8]	25%	100%

[6] Realization rate is the ratio of evaluated net energy generation to the expected generation energy, which is the contracted generation energy of the incentive agreement.

[7] The load displacement to facility energy ratio indicates the proportion of site energy consumption that was displaced by the load displacement project on an annual basis.

[8] The load displacement to total self-generation ratio indicates the proportion of total self-generation energy at the site that was contributed by the load displacement project on an annual basis.

Table ES.5 shows a summary of reported and evaluated net generation energy and peak demand by fiscal year. Year over year reporting of load displacement generation energy improved as the operation of the systems reached steady-state. However, there was a time lag because measurement and verification results or billing reconciliation for a given reporting year only became available after fiscal year-end and were then used as the best available estimate for the next year. Considering this time lag in reporting of variations in performance between fiscal years, the evaluated net generation energy was estimated on average to have achieved 96 percent of the reported generation energy. The variance is primarily due to inconsistency in reporting of Rebuilt Turbo Generator projects, using their expected generation energy instead of the actual generation energy, and the lack of accounting of parasitic energy in reported savings for these projects. If the reported generation energy were adjusted for actual generation energy and estimated parasitic energy, the overall variance between reported and evaluated net generation energy of all eight load displacement projects would be reduced to less than one percent.

Table ES.5. Summary of Net Generation Energy and Peak Demand Impact

Fiscal Year	Net Generation Energy (GWh/yr)		Net Peak Demand Impact (MW)	
	Reported	Evaluated	Reported	Evaluated
F2012	254	162	30	20
F2013	254	176	30	22
F2014	195	176	23	22
F2015	215	196	25	25
F2016	271	253	32	32
F2017	260	253	30	32
F2018	262	253	31	32

Findings and Recommendations

Findings

1. Eight load displacement projects were evaluated for a total of 263 GWh per year in gross generation energy and 253 GWh per year in net generation energy. This resulted in 33 MW of gross peak demand impact and 32 MW of net peak demand impact.
2. Seven of the eight load displacement projects ranged from 1 MW to 5 MW in size and one exceeded 25 MW in rated capacity. Seven of the load displacement projects were considered combined heat and power and used biomass and bioenergy as the primary energy source.
3. The four Rebuilt Turbo Generator projects were found to have average availability, capacity and utilization factors of 94 percent, 78 percent and 72 percent respectively. The other four projects were of the New Power Generation type and were found to have average availability, capacity and utilization factors of 91 percent, 84 percent and 76 percent respectively.
4. The load displacement project realization ranged from 75 percent to 107 percent, with a weighted average project realization rate of 91 percent for Rebuilt Turbo Generator and 98 percent for New Power Generation type projects. The overall program realization rate was 92 percent.
5. All projects undergo annual verification of the generation energy using hourly interval data. Rebuilt Turbo Generator load displacement projects had verification of actual gross generation energy recorded by BC Hydro Contract Management, whereas New Power Generation projects underwent

annual measurement and verification activities, recording both gross and net generation energy. The reported generation energy is adjusted yearly based on this annual review for all New Power Generation type projects but not for Rebuilt Turbo Generator type projects.

6. The generation energy provided in the customer's annual CBL Statements was found to be the best available estimate for projects without annual measurement and verification. These generation energy records explain most of the variance between reported and evaluated gross generation energy for Rebuilt Turbo Generator type load displacement projects.
7. The peak-to-energy factor was found to be 8 percent higher than the industrial rate class average because six of the eight projects generated more power during BC Hydro's system winter peak as a result of higher availability factors in winter months. Generator shutdowns and annual maintenance periods, which decreased overall availability, were observed to typically occur in the spring and summer months. Two projects had peak-to-energy factor lower than the industrial rate class average because of higher process heat requirements in winter.
8. Parasitic energy is the difference between gross and net generation energy and was evaluated at 3 percent for Rebuilt Turbo Generator projects and 6.5 percent for New Power Generation projects. New Power Generation projects have more auxiliary energy requirements than incremental generation projects from Rebuilt Turbo Generators. The parasitic energy explains most of the difference between reported and evaluated net generation energy.
9. The average weighted persistence of load displacement projects was estimated to be 16 years and ranging from 10 years to 20 years. The BC Hydro Persistence Standard indicates 20 years persistence for New Power Generation type projects and 15 years persistence for Rebuilt Turbo Generator projects. Any changes to generation energy and persistence are captured in the annual M&V and engineering review process.
10. The evaluation found evidence of continuous improvement of the utilization factor of three New Power Generation load displacement projects through the annual review and the M&V process. Project underperformance was observed due to restriction in condensing capacity, fuel supply, and electrical metering issues that were identified and corrected during the first three years of operating the load displacement projects.

Recommendations

The following recommendations are for the BC Hydro Load Displacement initiative managers based on the findings of this evaluation.

1. Continue to conduct annual review and measurement and verification of all load displacement projects for reporting of actual net generation energy per fiscal year.
2. The program should use the generation energy from customer's annual CBL Statements as the best available estimate when annual measurement and verification results are not available. These apply to Rebuilt Turbo Generator type projects at large industrial customer sites with transmission service that are on the stepped rate (RS1823B).
3. The program should apply a 3% reduction to the gross generation energy for projects without an engineering estimate of parasitic energy, i.e., load displacement projects of Rebuilt Turbo Generator type.

Conclusions

BC Hydro's load displacement initiatives achieved 92 percent of expected generation energy during fiscal years F2012 to F2018. The New Power Generation projects achieved 98 percent due to continuous improvement of project performance, whereas the Rebuilt Turbo Generator projects achieved 91 percent due to overestimated utilization factor and underestimated parasitic energy. The evaluated net generation energy of both types of load displacement projects was found to produce an equivalent reduction in site energy purchases.

1.0 Introduction

1.1 Evaluation Scope

This report presents the results of an impact evaluation covering eight (8) load displacement projects implemented during the period from F2012 to F2016. Since the program has ended and no new projects were implemented in F2017 and F2018 and operational data was available for all the projects, the evaluation period covers F2012 to F2018. The projects were funded through the Power Smart Partners-Transmission Integrated Power Offer (IPO) or Load Displacement (LD) program offers. These load displacement projects were not included in the scope of any impact evaluations of the BC Hydro Power Smart Partners – Transmission (PSP-T) and Leaders in Energy Management – Transmission (LEM-T) programs.

1.2 Organization of the Report

The report is organized as follows. Section 1 covers the evaluation scope, the organization of the report and the initiative description. Section 2 discusses the approach to the evaluation, including evaluation objectives, methodology review, data sources, and methods. Section 3 provides the results organized by evaluation objective. Section 4 provides findings and recommendations. Section 5 provides conclusions. Additional supporting material is included in the appendices.

1.3 Initiative Description

Load displacement projects are customer-based generation projects that self-supply part of the customer's site electrical load. For these projects, industrial, commercial and institutional customers received BC Hydro funding and program support to generate their own electricity for self-supply and offset their electricity purchases from BC Hydro. All customer-based generation projects over 50 kW were reviewed through the Integrated Customer Solutions (ICS) process. The load displacement project enabling activities were specifically designed to operate under the ICS framework and remove technical and financial barriers specific to self-generation projects. Incentives for load displacement activities were modelled as having reduced customer energy purchases similar to energy conservation project initiatives for industrial transmission customers.

Parallel energy procurement initiatives for customer-based self-generation may include Contracted Generator Baseline (GBL) with an Energy Purchase Agreement (EPA), and the non-contracted GBL to offset energy purchases under the TSR rate structure.

BC Hydro's program records, generator interval data, as well as billing data of the customer's total self-generation energy by BC Hydro Contract Management were annually verified to ensure that there is only single attribution of any customer self-generation energy and no double counting among parallel self-generation initiatives.

Parallel demand side management (DSM) initiatives include previous and current BC Hydro DSM programs, such as LEM-T (formerly known as PSP-T) and LEM-D (formerly known as PSP-D), that allow incremental self-generation projects in their respective program portfolio. These types of self-generation projects were typically incremental generation of less than 1 MW in size and were included in the impact evaluation of their respective DSM program. None of the eight load displacement projects in this evaluation occurred in parallel with incremental self-generation projects through other DSM programs.

2.0 Approach

2.1 Evaluation Objectives

The evaluation objectives and research questions are summarized in the following table.

Table 2.1. Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Estimate gross electricity generation and peak demand impacts.	What were the evaluated gross electricity generation and demand impacts realized by load displacement projects aggregated by fiscal year and, to the extent possible, disaggregated by relevant factors*?
2. Estimate net electricity generation and peak demand impacts.	What were the relative magnitude of parasitic loads and their energy use as related to the load displacement projects? What were the evaluated net electricity generation and demand impacts realized by load displacement projects aggregated by fiscal year and, to the extent possible, disaggregated by relevant factors[1]? To what extent did parallel energy procurement initiatives impact the net electricity generation of the load displacement projects?

* Relevant factors may include technology type, primary energy source, seasonal operating mode and operating strategy with other on-site process heat requirements that impact the net electricity generation.

In this evaluation and in accordance with industry standard practice for evaluating combined heat and power projects[9], gross electricity generation is defined as the total electricity produced by the generator. Net electricity generation is defined as the gross electricity generated minus parasitic energy, which represents the net impact of the load displacement project to the customer. Parasitic energy is the electrical energy required to operate the load displacement project. The parasitic energy requirements are necessary auxiliary loads such as external generator excitation power, material handling, heating and cooling, lubrication equipment, and other electrical needs required to operate the load displacement project..

2.2 Methodology Review

The main focus of most evaluations is to determine the energy savings impacts of the installed measure. The evaluation of load displacement projects is basically similar to estimating the net electricity impacts from the self-generation system at the customer side of the meter. The Uniform Methods Project (UMP) has developed the basic scope, terminology and methodology for evaluation of combined heat and power systems that are used to meet on-site energy needs. It focuses on systems that are generally sized at less than five megawatts (MW) in rated electrical generating capacity and ensures consistency with other UMP protocols.

While a number of utilities provide incentives for load displacement projects under their custom commercial and industrial program offerings, there are only a few program administrators in North America that offer programs specifically focused on load displacement. These include California's Self Generation Incentive Program, New York State Energy Research and Development Authority's Distributed Generation Combined Heat and Power program, and Manitoba Hydro's Bioenergy Optimization Program.

In most evaluations, results were reported overall but also by technology type and primary energy source. The impact evaluations relied on metering a sample of projects and applying those results to non-metered systems

[9] U.S. Department of Energy (2017). *Uniform Methods Project, Chapter 23: Combined Heat and Power Evaluation Protocol.*

for estimation of gross or net generation. Both California and New York used tele-metering (or web-based metering) to perform systematic and continuous hourly monitoring of system outputs for certain distributed generation systems. These data sources were supplemented by short-term on-site metering and billing reviews, where necessary. The short-term on-site metering typically followed the International Performance Measurement and Verification Protocol (IPMVP®) Option B procedure (retrofit-isolation, all parameter measurement).[10]

2.3 Methodology

In this evaluation, electricity self-generation impacts were evaluated over the period from F2012 to F2018 based on hourly interval data and annual measurement and verification reports when available. The objectives, data sources and methods used for this evaluation are summarized in the table below, and described in more detail following the table.

Table 2.2. Evaluation Objectives, Data and Method

Evaluation Objectives	Data	Method
1. Estimate gross electricity generation and peak demand impacts.	• Project files • Self-generation eMetering • Customer process requirements • Billing records and Customer Baseline Load (CBL) Statements	• Annual M&V results and evaluation review • Self-generation load shapes, capacity factors and peak-to-energy factors • Engineering calculations
2. Estimate net electricity generation and peak demand impacts.	• Load displacement feasibility studies • Reported savings • Project files	• Engineering estimates of parasitic loads • Annual M&V results and evaluation review

Objective 1: Evaluated Gross Electricity Generation and Peak Demand Impacts

Evaluated gross electricity generation is the energy generated due to the program and estimated from the annual M&V results and billing records by fiscal year. Four of the eight projects underwent an annual measurement and verification process for the estimation of gross and net electricity generation. These four projects with M&V are load displacement projects where a new generator was installed, and they are grouped in this evaluation under 'New Power Generation'. The other four load displacement projects at transmission customer sites were due to refurbishment and upgrading of an existing steam turbine with capacity or efficiency improvements which resulted in incremental generation to already existing generation. These are grouped in this evaluation under 'Rebuilt Turbo Generator'. The annual gross incremental generation energy from the rebuilt units was verified by BC Hydro Contract Management for each fiscal year and provided in the customer's billing records, such as the Customer Baseline Load (CBL) Statement, for each fiscal year. Measurement and verification of load displacement projects for Rebuilt Turbo Generators could not be conducted due to interactive effects and rate specific billing formula applied for attribution of the customer's total self-generation energy across parallel initiatives under the terms and conditions of the self-generation agreements. Therefore, the customer's annual CBL Statements were used in the absence of M&V results as the basis of the gross generation energy for evaluation review.

[10] Efficiency Valuation Organization (October, 2016). *Core Concepts. International Performance Measurement and Verification Protocol.*

Baselines were determined on a project by project basis. Load displacement projects can occur at customer locations where self-generation is being implemented with new generators or where incremental generating capacity was added to an existing generating system. In all cases the generation energy was determined annually based on post-implementation measurements only.

Incremental generation from Rebuilt Turbo Generator projects involving optimization of existing self-generation, i.e., turbine upgrades, may have required additional billing adjustments during annual reconciliation because customers with a contracted GBL must service their generation contracts in a prescribed order.

Additional generation energy adjustments can be required during Authorized Plant Outages (APO) or when there were significant changes to the properties and composition of fuel supply and process load requirements. Bioenergy sources can experience much greater deviation from design conditions, which can substantially impact the energy generated through the load displacement program. In these cases, the project's long-term generation energy impact was reviewed and any shortfalls in generation energy were settled financially on an annual basis.

The following table shows the characteristics of the various projects, disaggregated by relevant factors including project type, technology type, primary energy source, seasonal operating mode, and operating strategy with other on-site process heat requirements that impact the net electricity generation.

Table 2.3. Distribution of Projects by Relevant Factors

Type of LD Project	Rebuilt Turbo Generator	New Power Generation	New Power Generation	New Power Generation
Number of Projects	4	2	1	1
Customer Rate Class	Transmission	Transmission	Transmission	Transmission
Industry Sector	Pulp Mills	Wood Products	District Energy	Municipal Water
Primary Energy Source	biomass	biomass	renewable natural gas[11]	clean water flow
Technology Type	steam turbine generator	organic rankine cycle	internal combustion engine	pelton wheel
Combined Heat and Power (CHP)	with heat for process steam	with heat for product drying	with heat for space and water	No CHP
Generation Energy (Data Source)	gross (CBL Statements)	gross and net (M&V Reports)	gross and net (M&V Reports)	gross and net (M&V Reports)
Parasitic Energy	Deemed estimate	Engineering estimate	Engineering estimate	Engineering estimate
Seasonality	Fairly constant power generation	Less power generation in winter	Fairly constant power generation	Highly seasonal power generation

The first step was to collect the project data from the program tracking system and the TSR administrative records for each project and each fiscal year. This included data from the initial engineering review, which provided the expected generation energy based on the incentive agreement of the load displacement projects.

[11] Renewable natural gas is derived from biogas, which is produced from decomposing organic waste from landfills, agricultural waste and wastewater from treatment facilities. In this application it is produced in a different location than the load displacement project.

Records of post implementation review and M&V reported values of energy generated by fiscal year were also collected. For Rebuilt Turbo Generator projects with incremental self-generation, the project related annual generation energy on the customer's CBL Statements was identified as the best available estimate of the project's gross energy generated in each fiscal year. The load displacement energy provided on the CBL Statements was verified by BC Hydro Contract Management under the terms and conditions of all contractual agreements. The Evaluation team did not have access to the contracts nor the details on the attribution of the total actual generation energy.

Due to the variability of historic generation output and verified annual reporting requirements of all load displacement projects, the evaluation estimated the average generation energy and relevant factors for the project's remaining period of persistence (labelled as evaluation review) to provide an estimate of the expected performance of these projects.

The gross peak demand impact by the load displacement projects was estimated using the peak-to-energy factor of the total self-generation system at each site. These were evaluated based on hourly interval data during steady-state operations in winter. The peak-to-energy factor is calculated by dividing the average generation power during BC Hydro's system peak demand (winter weekday evenings) by the load displacement project's annual generation energy, as in the following equation:

Equation 1

$$Peak\text{-}to\text{-}Energy\ Factor\ \left(\frac{MW}{GWh}\right) = \frac{Average\ Winter\ Evening\ Gross\ Generation\ Power\ (MW)}{Annual\ Gross\ Generation\ Energy\ (GWh\ per\ year)}$$

Three additional factors were also calculated from hourly interval data to characterise and compare the system performance of each load displacement project: the capacity factor, the availability factor, and the utilization factor. These are described in more details below.

The capacity factor for a New Power Generation system is the actual average running power output of the system divided by the rated installed capacity of the system, as shown in Equation 2. For consistency and comparison, the capacity factor of the Rebuilt Turbo Generator projects with incremental generation capacity, was estimated to be equal to the capacity factor of the total generating system. Because some projects experienced performance issues during initial commissioning, the evaluated capacity factor was estimated based on recent actual performance as the most likely indicator of future performance of the load displacement project.

Equation 2

$$Capacity\ Factor\ (CF) = \frac{Actual\ average\ gross\ power\ generated}{Rated\ installed\ capacity\ of\ generation\ system}$$

The availability factor is the percentage of time the system was actually operating for each fiscal year as given by the equation below. Again, the evaluated availability factor was estimated based on recent actual performance as the most likely indicator of future performance of the load displacement project.

Equation 3

$$Availability\ Factor\ (AF) = \frac{Actual\ hours\ the\ system\ is\ running\ in\ a\ year}{8760\ hours\ per\ year}$$

The utilization factor is the extent to which the load displacement system is actually used. This performance driver depends on the percentage of time the system was operating as well as on the degree to which the system operated at rated capacity when running and was calculated as the product of the capacity factor and the availability of the system as given by equation 4. Similarly, the evaluated utilization factor was estimated to represent the project's most likely indicator of future performance.

Equation 4

$$Utilization\ Factor\ (UF) = CF\ x\ AF = \frac{Actual\ annual\ gross\ energy\ generated\ (kWh/yr)}{Rated\ system\ capacity\ (kW)\ x\ 8760\ (hours/year)}$$

The four factors were estimated individually for each of the projects, and the results were also aggregated to compare the two types of load displacement projects.

Objective 2: Net Generation Energy and Peak Demand Impacts

The net generation energy is the difference between the energy delivered by the generator and the parasitic energy requirements, as calculated using the following equation. The evaluated parasitic energy was estimated based on recent actual performance as the most likely indicator of future performance of the load displacement project.

Equation 5

$$Net\ Generation\ Energy = Gross\ Generation\ Energy - Parasitic\ Energy$$

The parasitic energy estimate for the four New Power Generation projects with M&V was verified by the M&V group using engineering calculations and spot measurements when available. No M&V results were available for the four Rebuilt Turbo Generator projects and a deemed estimate of the incremental parasitic energy was applied based on the default assumption of 3% of incremental gross generation energy[12] of the load displacement project using equation 6.

Equation 6

$$Parasitic\ energy\ of\ incremental\ generation = Gross\ Generation\ Energy\ \times 3\%$$

The evaluated net generation peak demand impacts of the program were estimated using the same peak-to-energy factors determined for Objective 1, applied to the project-based M&V estimates for parasitic energy and metered load shapes of the generation energy. This assumed that the load shape of the parasitic energy is the same as the load shape of the generation energy.

Since the expected generation energy or initial engineering estimates were based on net generation energy, each project's realization is calculated as the ratio of net generation energy to the expected generation energy. The projects were aggregated by type and the realization rate was calculated for the two types of projects. As before, the evaluated project realization was estimated as the most likely indicator of future performance of the load displacement project.

Equation 7

$$Project\ Realization\ Rate = \frac{Evaluated\ Net\ Generation\ Energy}{Expected\ Generation\ Energy}$$

[12] U.S. Department of Energy (2017). *Uniform Methods Project, Chapter 23: Combined Heat and Power Evaluation Protocol.*

Another relevant factor estimated primarily for project comparison and program overview was the ratio of the load displacement generation energy compared to the facility's energy use. The facility energy use was estimated from the annual energy purchases from BC Hydro plus the total self-generation energy at the site.

Equation 8

$$Load\ Displacement\ to\ Facility\ Energy\ Ratio = \frac{Evaluated\ Net\ Generation\ Energy\ (kWh/yr)}{Facility\ Energy\ Use\ (kWh/yr)}$$

$$= \frac{Evaluated\ Net\ Generation\ Energy\ (kWh/yr)}{Energy\ Purchases\ (kWh/yr) + Site\ Generation\ Energy (kWh/yr)}$$

Also the ratio of the project's load displacement generation energy to the total self-generation energy at the site was determined using the following equation:

Equation 9

$$Load\ Displacement\ to\ Total\ Self\text{-}generation\ Energy\ Ratio = \frac{Evaluated\ Gross\ Generation\ Energy}{Total\ Self\text{-}generation\ Energy}$$

It was not an objective of this evaluation to attribute changes in generation energy to the load displacement initiatives, which would take into consideration free ridership and spillover. In this evaluation, the term 'net generation impact' refers to the gross generation energy less parasitic energy and does not imply attribution to any intervening initiative.

These load displacement projects are assumed to have had no free ridership and non-existent spillover, for a net-to-gross ratio of one, for two reasons: First, all self-generation projects had to apply to BC Hydro for generator inter-connection and go through the integrated customer solutions process for review and evaluation. All of the eight load displacement projects in this evaluation were then directed to the load displacement capital incentive offer by BC Hydro and each project had its own business case developed with BC Hydro executive approval of the incentive amount. Hence no free ridership of the capital incentive was anticipated. Second, all generation energy is metered and customers were required to service their self-generation contracts in a prescribed order which was verified by BC Hydro for billing purposes. Hence no spillover of any unreported generation energy was deemed possible.

2.4 Alternative Methodologies

The evaluation scope was limited to estimating the gross and net electricity generation energy and peak demand impact, and because the electricity impact of all projects was assessed based on metered interval data that was verified and reconciled with billing data and tariff treatment. Therefore, no alternative methodology was considered for this evaluation.

Alternative evaluation approaches and methodologies are available and differ in levels of rigor applied in estimating the full impacts of CHP projects. Besides net electricity impacts, other associated CHP performance parameters considered for evaluation may include:

1. Net fuel impact
2. Net electrical efficiency
3. Useful heat recovery rate
4. Overall fuel conversion efficiency
5. Electrical energy offset
6. Fuel offset

Although less frequently considered in CHP evaluations are other issues like degradation in availability and performance due to aging during the project's lifetime, normalization of performance to weather, process loads for CHP systems that serve process loads, relationship between the cost of fuel and electricity, heating and cooling loads served, and overall grid effects. Free ridership and spillover do not typically occur in CHP projects greater than 1 MW, because CHP projects are complex and require detailed engineering estimates and effort in obtaining permits, commissioning, and supporting maintenance and operation. These related performance factors were not used in this evaluation because only eight projects were completed in the evaluation period and the fact that the load displacement initiative was no longer available to customers since F2017.

3.0 Results

3.1 Gross Generation Energy and Peak Demand Impacts

Gross generation energy is the energy generated by customers as a result of participation in the load displacement initiative. As detailed in Section 2.3, gross generation energy was determined from M&V results for the four New Power Generation projects, and from CBL Statements and tariff treatment for the four Rebuilt Turbo Generator projects.

Evaluated results below are given as the best available estimate of overall project performance, considering the annual review and verification of the actual reported energy generated for each load displacement project.

Table 3.1. Gross Generation Results by Project Type

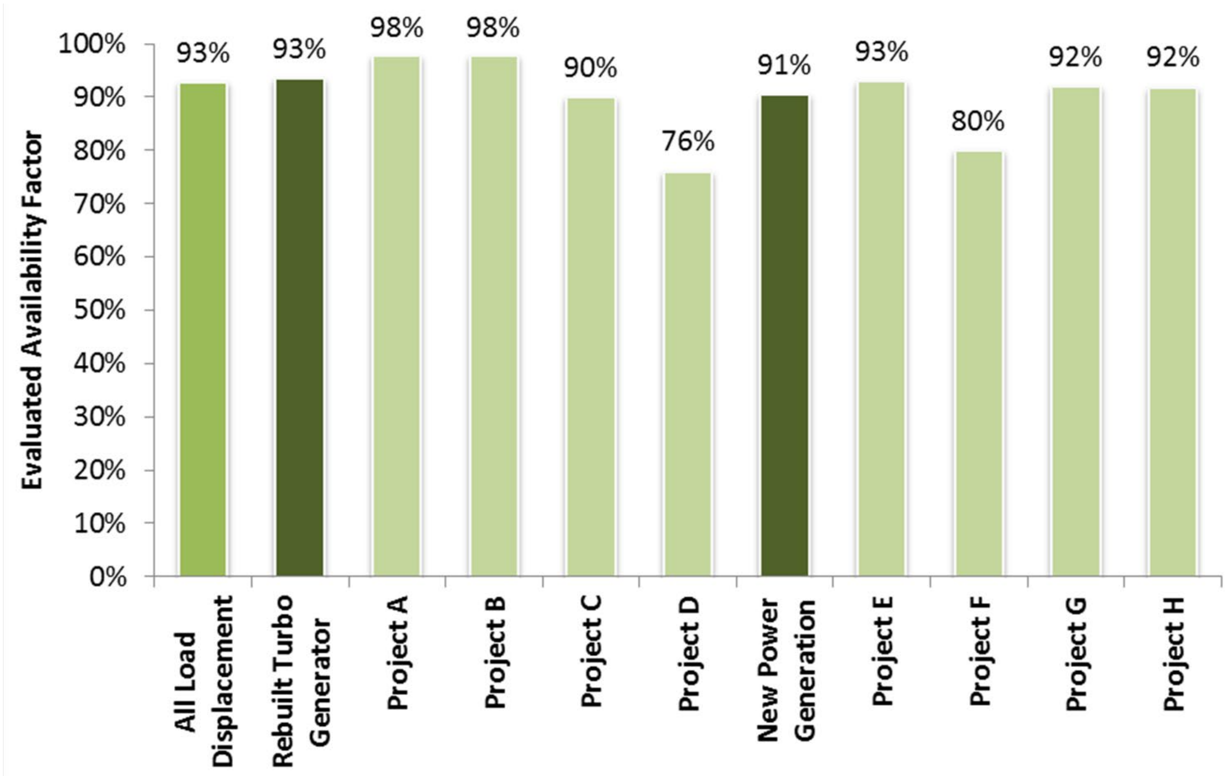
	Group 1 Rebuilt Turbo Generator	Group 2 New Power Generation
Number of Projects	4	4
Rated Capacity (MW)	32.1	8.9
Expected Generation Energy (GWh/yr)	218	56
Evaluated Gross Generation Energy (GWh/yr)	204	59
Availability Factor	93%	91%
Capacity Factor	77%	84%
Utilization Factor	72%	76%
Peak-to-Energy Factor (MW/GWh)	0.129	0.117

The following section describes the evaluated results of the relevant factors by project and project type. Additional details of relevant factors by project type and fiscal year are provided in Appendices C and D.

Availability Factor

The availability factor represents the percentage of time a project is operating within a given fiscal year and generating electricity, and was calculated from hourly interval data. Figure 3.1 shows the evaluated availability factor by project and in aggregate by project type.

Figure 3.1. Availability Factor by Project and Project Type



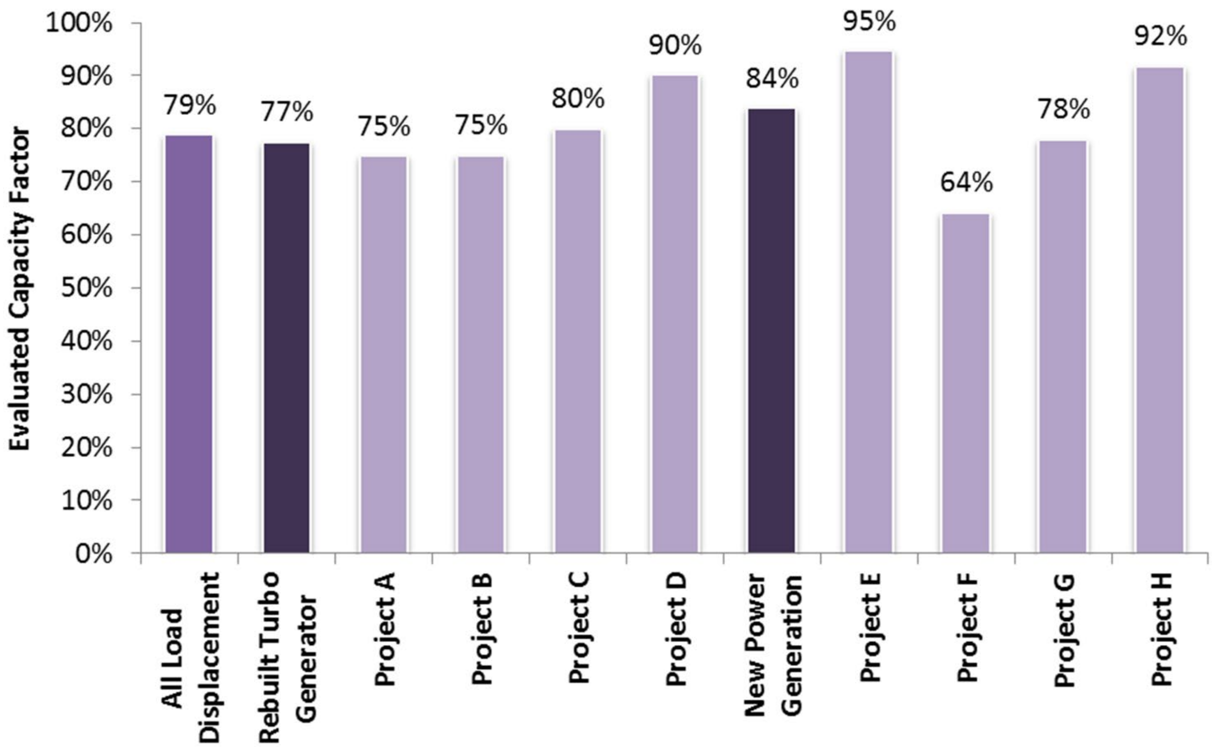
In general, the availability factor by individual projects ranged from 76 percent to 98 percent and Rebuilt Turbo Generator projects had a weighted average of 93 percent, slightly higher than New Power Generation projects which had a weighted average availability factor of 91 percent. These availability factors are as expected of these types of load displacement projects[13], especially with biomass as the primary energy source.

Capacity Factor

The capacity factor relates the average loading of the generator to its rated capacity and was calculated from hourly interval data. The capacity factor of Rebuilt Turbo Generator projects was estimated based on the average generated power and the rated capacity of the total generation system. The results are shown in Figure 3.2 for individual projects and in aggregate by project type. The capacity factor ranged from 64 percent to 95 percent, indicating that all load displacement projects had excess capacity to potentially increase generation power and energy.

[13] Catalog of CHP Technologies, U.S. Environmental Protection Agency Combined Heat and Power Partnership, September 2017.

Figure 3.2. Capacity Factor by Project and Project Type

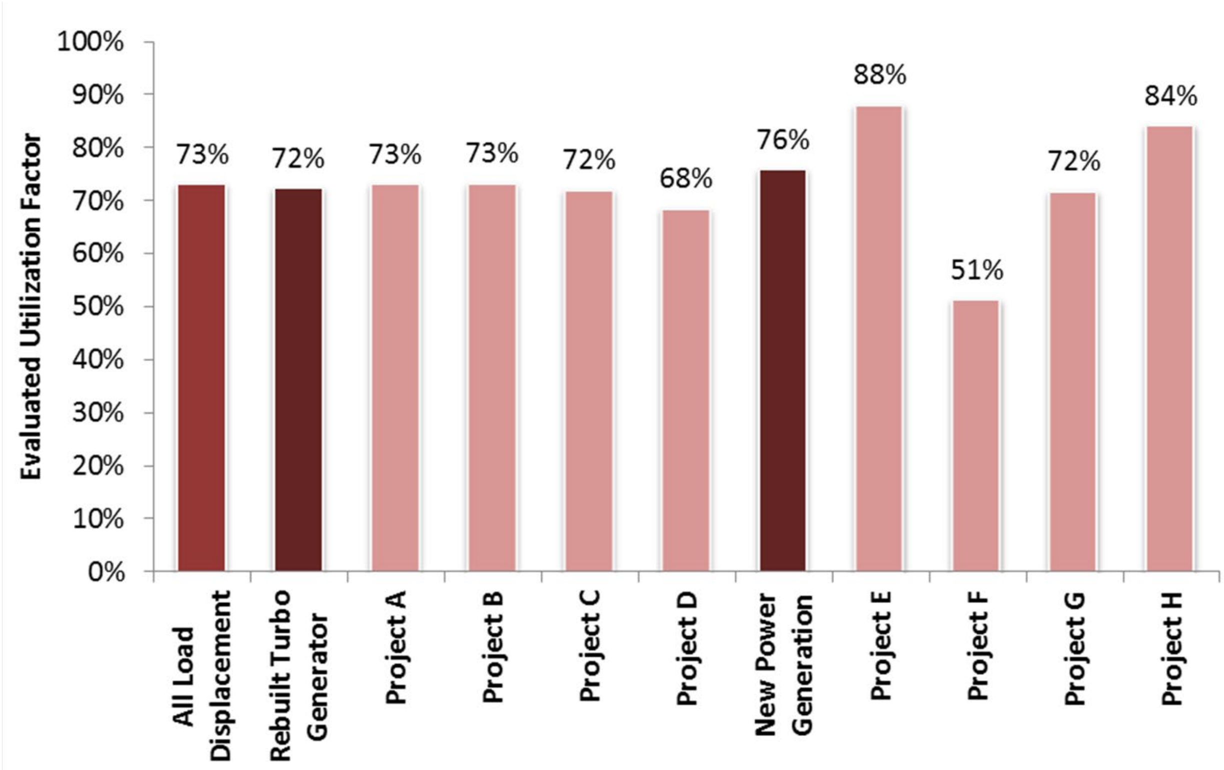


The capacity factor was found to increase over time (see Appendix D) for New Power Generation projects, reaching a weighted average of 84 percent. Likewise for the Rebuilt Turbo Generator projects, the capacity factor was found to average around 77 percent for all years of past operation. The reasons for lower capacity factors were not evaluated but can be due to variations in process heat requirements at mills and to variability in the fuel supply and quality that is common with biomass-based generation.

Utilization Factor

The utilization factor is the overall utilization of the load displacement project and is calculated as the product of the availability factor and the capacity factor. It is shown in Figure 3.3 and individual projects were found to range from 51 percent to 88 percent. On average, New Power Generation projects achieved a utilization factor of 76 percent and Rebuilt Turbo Generator projects 72 percent, for a weighted average utilization factor of 73 percent for all load displacement projects.

Figure 3.3. Utilization Factor by Project and Project Type

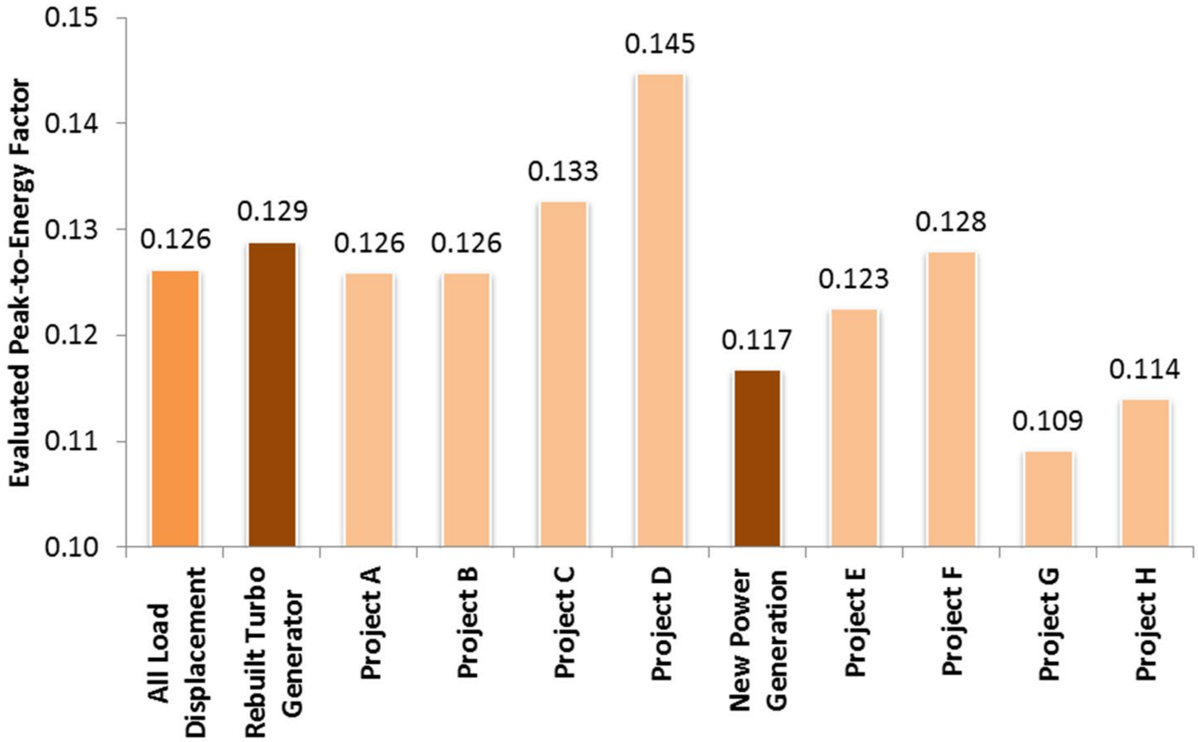


Peak-to-Energy Factor

The peak-to-energy factor was evaluated for each project from hourly interval data based on the average power generated between December and February and is shown in Figure 3.4. Peak-to-energy factors are usually determined using winter weekday evening loads, to correspond with the BC Hydro system peak, but the variations of generated power between winter days of the week (weekday versus weekend) and winter hours of the day (evenings versus other hours of the day) were negligible.

The evaluated peak-to-energy factor was found to be 0.126 MW per GWh, almost 8 percent higher than the industrial transmission rate class average of 0.117 MW per GWh which is typically applied to energy conservation measures. This higher peak-to-energy factor results in a higher estimate of peak demand impact from load displacement projects.

Figure 3.4 Peak-to-Energy Factor by Project and Project Type



Six of the eight projects had an evaluated peak-to-energy factor higher than the industrial rate class average of 0.117 MW per GWh used in the reported savings. Overall, this result indicates that the average power generated in winter is greater than the average power generated during the year. On the other hand, the two projects with lower evaluated peak-to-energy factor had a seasonal winter impact with lower generating power in winter, likely due to higher winter process heat requirements at the facility.

The average peak-to-energy factor for New Power Generation projects was found to be 0.117 MW per GWh, which is close to a flat load. In contrast, the Rebuilt Turbo Generator projects had, on average, a higher peak-to-energy factor of 0.129 MW per GWh.

The number of load displacement projects implemented by fiscal year, as well as the cumulative rated capacity, the evaluated gross generation energy, and the evaluated gross peak demand impact are summarized in the table below. Results are given as cumulative due to the variation of project results with annual review through measurement and verification.

Table 3.2 Evaluated Gross Generation Energy and Peak Demand Impact

Fiscal Year	Number of New Projects	Load Displacement Project Type	Cumulative Rated Capacity (MW)	Cumulative Evaluated Gross Generation Energy (GWh/yr)	Cumulative Evaluated Gross Peak Demand Impact (MW)
F2012	2	2x Rebuilt Turbo Generator	26	167	21
F2013	1	1x New Power Generation	28	181	23
F2014	0	-	28	181	23
F2015	2	1x Rebuilt Turbo Generator 1x New Power Generation	31	204	25
F2016	3	1x Rebuilt Turbo Generator 2x New Power Generation	41	263	33
F2017	0	-	41	263	33
F2018	0	-	41	263	33

The evaluated gross generation energy of the eight load displacement projects, with 41 MW of cumulative generating capacity, 93% availability factor, and 79% capacity factor, displaced gross energy purchases of 263 GWh per year and reduced BC Hydro's system peak demand by 33 MW.

3.2 Net Generation Energy and Peak Demand Impacts

The evaluated net generation energy is the net energy impact from the load displacement program and includes the adjustment for parasitic energy. Since these projects have annual reporting requirements, the generation energy and relevant factors given in the table below are aggregated by project type.

Table 3.3 Net Generation Results by Project Type

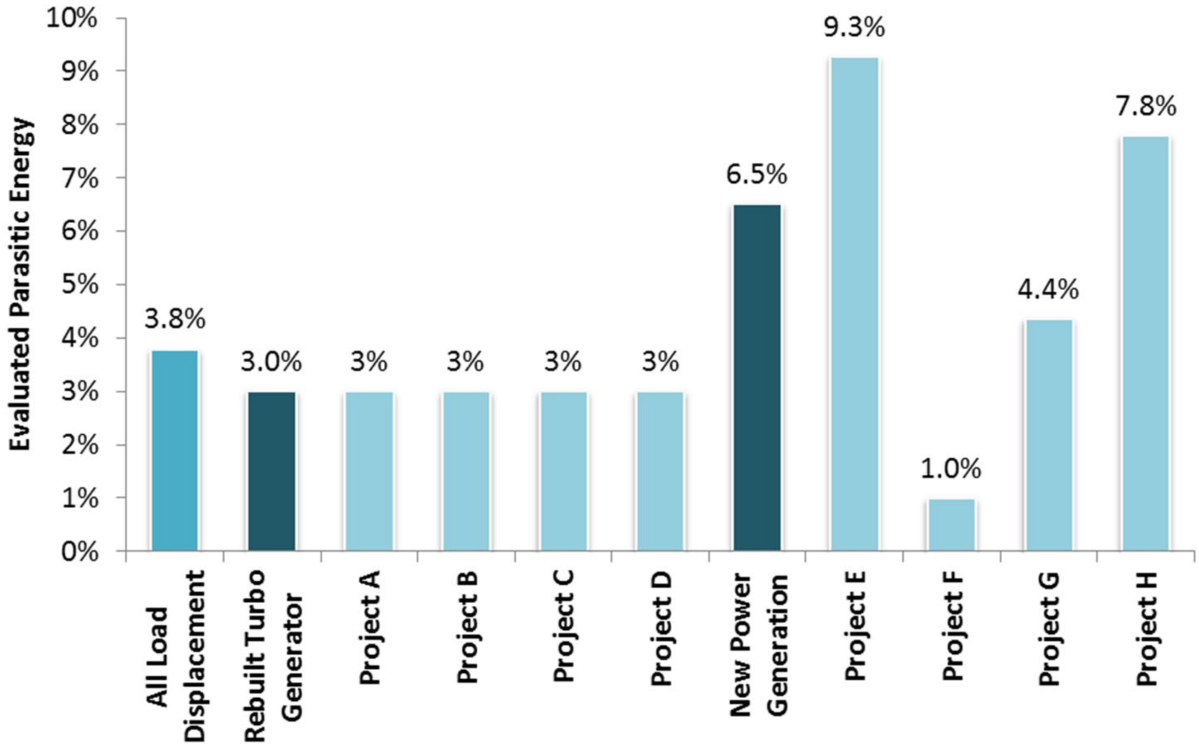
	Group 1 Rebuilt Turbo Generator	Group 2 New Power Generation
Number of Projects	4	4
Rated Capacity (MW)	32.1	8.9
Evaluated Gross Generation Energy (GWh/yr)	204	59
Evaluated Net Generation Energy (GWh/yr)	198	55
Parasitic Energy Factor	3%	6.5%
Peak-to-Energy Factor (MW/GWh)	0.129	0.117
Realization Rate	91%	98%
Load displacement to facility energy ratio*	18%	14%
LD energy to total self-generation energy ratio*	25%	100%

* The results for these two ratios are discussed in Section 3.3

Parasitic Energy Factor

The average weighted parasitic energy was found to be 3.8 percent and is shown by project type in Figure 3.5. The parasitic energy of New Power Generation projects had an engineering estimate with annual review during M&V ranging from 1 percent to over 9 percent of generation energy. However, the parasitic energy factor was not applied to Rebuilt Turbo Generator projects. The evaluation found that the default assumption of 3 percent of gross generation energy was appropriate for Rebuilt Turbo Generator projects.

Figure 3.5 Parasitic Energy Factor by Project and Project Type



Peak-to-Energy Factor

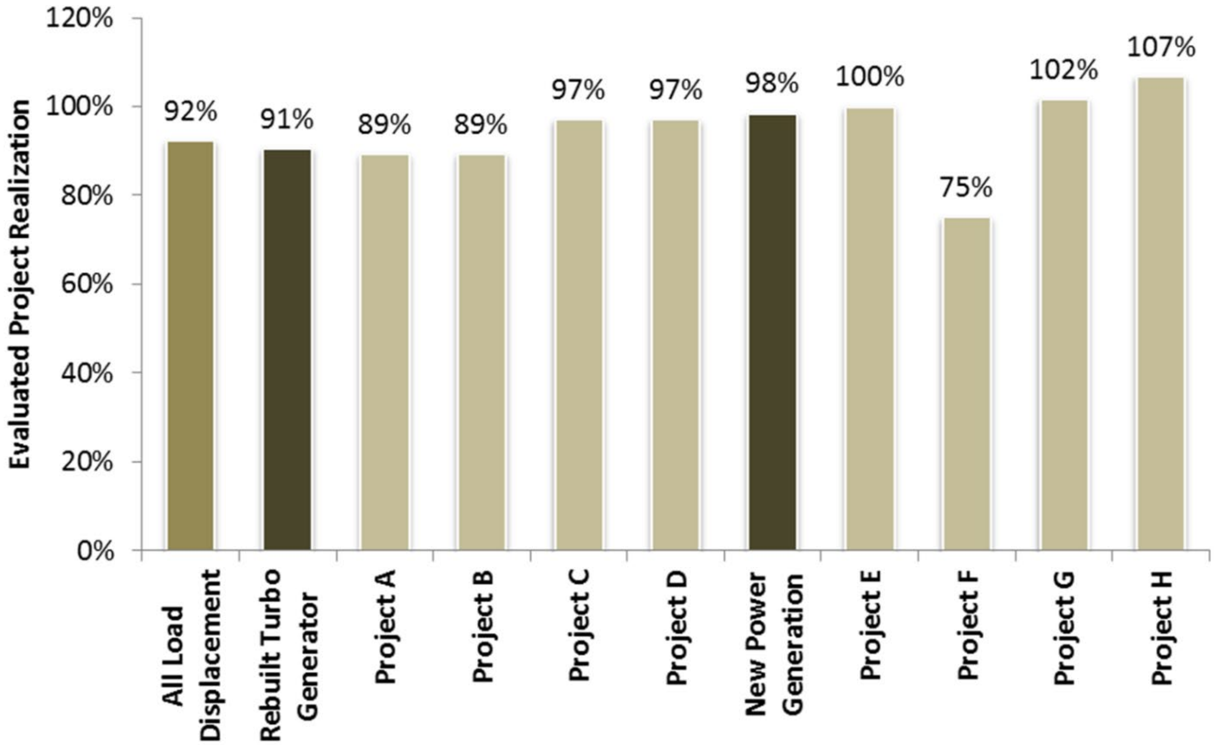
The peak-to-energy factor for net generation energy was assumed to be the same as estimated for gross generation energy which was estimated in Objective 1 for a weighted average of all eight load displacement projects of 0.126 MW per GWh. This assumed that generation energy and parasitic energy have the same load shape.

The peak demand impact of the load displacement projects was significant in magnitude and coincided with the BC Hydro system peak, and yet it was found that these projects potentially have additional capacity to ramp up electricity output. This potential capacity could be utilized as a capacity-focused DSM or demand response resource in the future. The evaluation estimated a theoretical potential to increase the peak-to-energy factor to 0.2 MW per GWh, for an additional 18 MW of peak demand impact for all CHP systems with a load displacement project. The ability to ramp up these combined heat and power systems during peak demand periods is dependent on a number of factors that may require further investigation, including the ability to control the generation rapidly and the ability of the host site to use the captured heat needed to increase the integration of these distributed energy resources onto the grid.

Project Realization

The project realization is the ratio of evaluated net energy generation to the expected generation energy, which is the contracted generation energy of the incentive agreement. Project realization is shown by project and aggregated by project type in the following figure.

Figure 3.6 Project Realization by Project and Project Type



Typical project realization was found to be 92 percent which means load displacement projects produced less than their expected generation energy. This is primarily due to the parasitic energy factor of Rebuilt Turbo Generator projects and the lower than expected aggregate utilization factor. New Power Generation projects also did not achieve their expected generation energy because of one project with lower than expected utilization factor.

The generation energy resulting from these projects is reported each fiscal year and adjusted using the most recent estimate as the best available estimate of net generation energy. In summary, the load displacement initiative included eight projects between F2012 and F2018 and achieved 96 percent of the reported generation energy and 101 percent of the reported peak demand impact. The results by fiscal year are given in the following table.

Table.3.4. Summary of Net Generation Energy and Peak Demand Impact

Fiscal Year	Net Generation Energy (GWh/yr)		Net Peak Demand Impact (MW)	
	Reported	Evaluated	Reported	Evaluated
F2012	254	162	30	20
F2013	254	176	30	22
F2014	195	176	23	22
F2015	215	196	25	25
F2016	271	253	32	32
F2017	260	253	30	32
F2018	262	253	31	32

Year over year reporting of load displacement generation energy improved as the operation of the self-generating systems reached closer to steady-state operation. However, there was a time lag because M&V results for a given reporting year only became available after fiscal year-end and were then used as the best available estimate for the next year. Considering this time lag in reporting variations in performance between fiscal years, the evaluated net generation energy was estimated, on average, to have achieved 96 percent of the reported generation energy. The variance is primarily due to inconsistency in the reporting of Rebuilt Turbo Generator projects, using their expected generation energy instead of the actual generation energy, and the lack of accounting of parasitic energy in reported savings for these projects. If the reported generation energy were adjusted for actual generation energy and estimated parasitic energy, the overall variance between reported and evaluated net generation energy of all eight load displacement projects would be reduced to less than one percent.

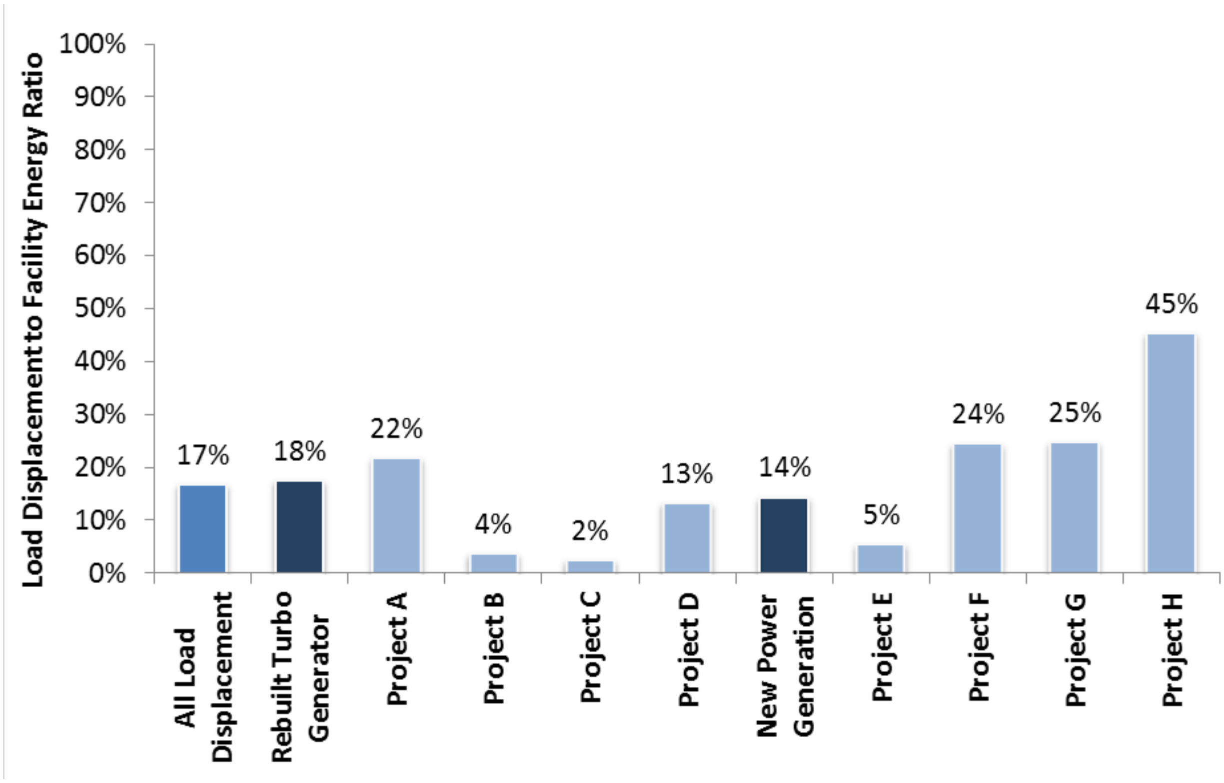
3.3 Results for Other Relevant Factors

The evaluation included other relevant factors as performance metrics for design and development of future load displacement projects. These include the load displacement to facility energy ratio and the load displacement to total self-generation energy ratio. The findings are described below.

Load Displacement to Facility Energy Ratio

The load displacement to facility energy ratio indicates the proportion of annual site energy consumption that was displaced by the load displacement project. The results are shown in the graph below for the eight projects and in aggregate by project type. This ratio ranged from 2 percent to almost 22 percent for Rebuilt Turbo Generator projects, and 5 percent to 45 percent for New Power Generation projects. The weighted average for all load displacement projects was 17 percent.

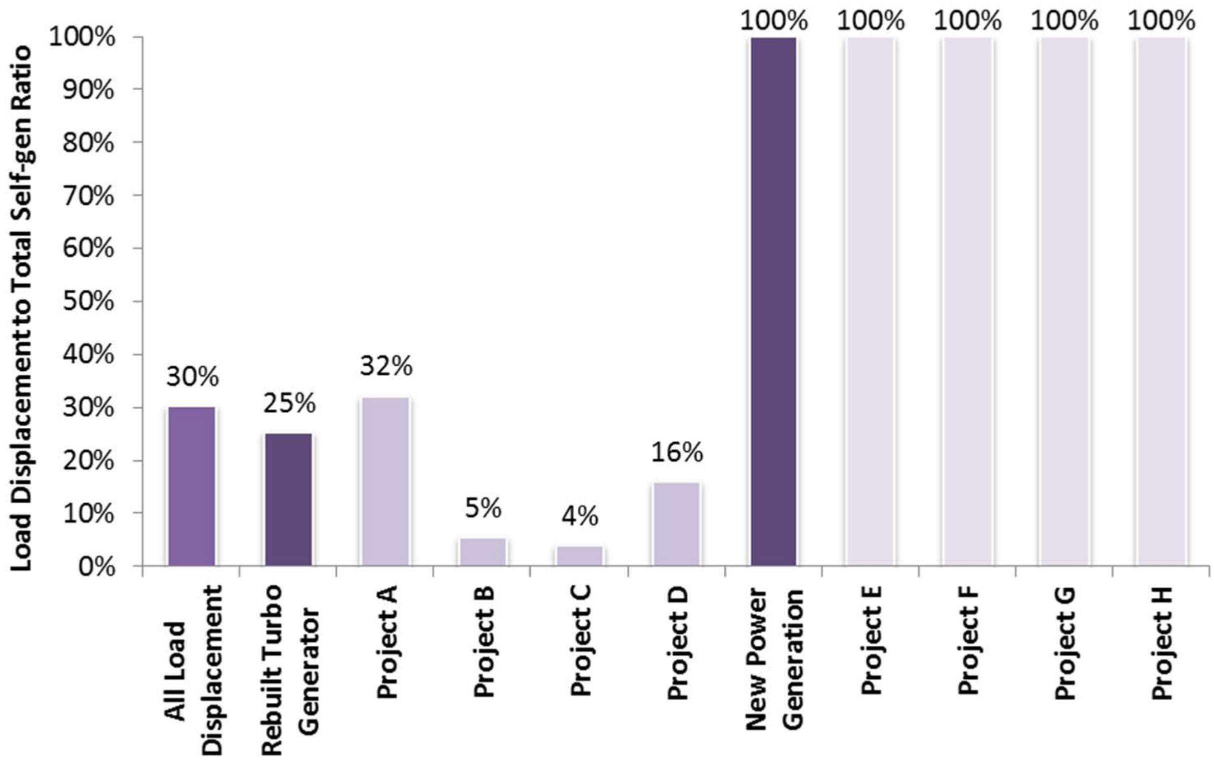
Figure 3.7 Load Displacement to Facility Energy Ratio by Project and Project Type



Load Displacement to Total Self-generation Energy Ratio

Load displacement projects of Rebuilt Turbo Generator type were found to have contributed approximately 25 percent to the total annual self-generation energy. All New Power Generation projects were at sites without previous self-generation and hence resulted in a 100% increase in self-generation at that site. This is illustrated in Figure 3.8.

Figure 3.8 Load Displacement to Total Self-generation Energy by Project and Project Type



Persistence

The average weighted persistence of the eight load displacement projects was found to be 16 years based on the BC Hydro Persistence Standard[14]. The BC Hydro Persistence Standard prescribes persistence and effective measure life of 20 years for New Power Generation and 15 years for Rebuilt Turbo Generator projects, although it includes provisions for adjusting these values based on annual review of generation energy and the terms of load displacement contracts. The evaluation found that project persistence for 3 projects (two Rebuilt Turbo Generator and one New Power Generation project) was adjusted to match the terms of the contract for the project.

3.4 Limitations

The following limitations were recognized in this evaluation.

1. Projects are complex, large, and unique, making it difficult to compare performance between projects. Although each project undergoes custom energy studies and extensive engineering reviews before implementation, the actual project operation and performance can vary over the project persistence, such that the evaluated project performance over the entire persistence period is difficult to predict based on past performance alone. However, this risk is substantially reduced over time and eventually eliminated due to the annual M&V and engineering review process.

[14]BC Hydro DSM Standard: Effective Measure Life and Persistence – Revision 10, June 2016

2. Confidence and precision of the performance characteristics were not statistically tested for their significance because all eight projects were included in the evaluation and no extrapolation was required.

3. Parasitic energy was mostly based on engineering estimates with spot measurements when available. No measurements of parasitic energy of incremental Rebuilt Turbo Generator projects were considered feasible, so that a default assumption of industry standard practice was used. However, this assumed that the parasitic load and energy is directly proportional to the variation in generation energy.

4. Other performance characteristics typical of combined heat and power projects, as well as variability in plant production, may impact the program performance but were not evaluated as there was no program need or requirement.

5. Customer satisfaction and experience was not evaluated because the program has ended and no future load displacement program is under consideration at this time.

4.0 Findings and Recommendations

Findings and recommendations are presented below.

4.1 Findings

1. Eight load displacement projects were evaluated for a total of 263 GWh per year in gross generation energy and 253 GWh per year in net generation energy. This resulted in 33 MW of gross peak demand impact and 32 MW of net peak demand impact.
2. Seven of the eight load displacement projects ranged from 1 MW to 5 MW in size and one exceeded 25 MW in rated capacity. Seven of the load displacement projects were considered CHP and used biomass and bioenergy as the primary energy source.
3. The four Rebuilt Turbo Generator projects were found to have average availability, capacity and utilization factors of 94 percent, 78 percent and 72 percent respectively. The other four projects were of the New Power Generation type and were found to have average availability, capacity and utilization factors of 91 percent, 84 percent and 76 percent respectively.
4. The load displacement project realization ranged from 75 percent to 107 percent, with a weighted average project realization rate of 91 percent for Rebuilt Turbo Generator and 98 percent for New Power Generation type projects. The overall program realization rate was 92 percent.
5. All projects undergo annual verification of the generation energy. Rebuilt Turbo Generator load displacement projects had verification of actual gross generation energy recorded by BC Hydro Contract Management, whereas New Power Generation type projects underwent annual measurement and verification activities, recording both gross and net generation energy recorded. The reported generation energy is adjusted yearly based on this annual review for all New Power Generation type projects but not for Rebuilt Turbo Generator type projects.
6. The generation energy provided in the customer's annual CBL Statements was found to be the best available estimate for projects without annual measurement and verification. These generation energy records explain most of the variance between reported and evaluated gross generation energy for Rebuilt Turbo Generator type load displacement projects.
7. The peak-to-energy factor was found to be 8 percent higher than the industrial rate class average because six of the eight projects generated more power during BC Hydro's system winter peak because of higher availability factors in winter months. Generator shutdowns and annual maintenance periods which decreased overall availability were observed to be typically in the spring and summer months. Two projects had peak-to-energy factor lower than the industrial rate class average because of higher process heat requirements in winter.
8. Parasitic energy is the difference between gross and net generation energy and was evaluated at 3 percent for Rebuilt Turbo Generator projects and 6.5 percent for New Power Generation projects. New Power Generation projects have more auxiliary energy requirements than incremental generation projects from Rebuilt Turbo Generators. The parasitic energy explains most of the difference between reported and evaluated net generation energy.
9. The average weighted persistence of load displacement projects was estimated to be 16 years and ranging from 10 years to 20 years. The BC Hydro Persistence Standard indicates 20 years persistence for New Power Generation type projects and 15 years persistence for Rebuilt Turbo Generator

projects. Any changes to generation energy and persistence are captured in the annual M&V and engineering review process.

10. The evaluation found evidence of continuous improvement of the utilization factor of three New Power Generation load displacement projects through the annual review and M&V process. Project underperformance was observed due to restriction in condensing capacity, fuel supply, and electrical metering issues that were identified and corrected during the first three years of operating the load displacement projects.

4.2 Recommendations

The following recommendations are for the BC Hydro Load Displacement initiative managers based on the findings of this evaluation.

1. Continue to conduct annual review and measurement and verification of all load displacement projects for reporting of actual net generation energy per fiscal year.

2. The program should use the generation energy from customer’s annual CBL Statements as the best available estimate when annual measurement and verification results are not available. These apply to Rebuilt Turbo Generator type projects at large industrial customer sites with transmission service and are on the stepped rate (RS1823B).

3. The program should apply a 3% reduction to the gross generation energy for projects without an engineering estimate of parasitic energy, i.e., load displacement projects of Rebuilt Turbo Generator type.

5.0 Conclusions

BC Hydro's load displacement initiatives achieved 92 percent of expected generation energy during fiscal years F2012 to F2018. The New Power Generation projects achieved 98 percent due to continuous improvement of project performance, whereas the Rebuilt Turbo Generator projects achieved 91 percent due to underestimated utilization factor and parasitic energy. The evaluated net generation energy of both types of load displacement projects was found to produce an equivalent reduction in site energy purchases.

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 *Power Smart Partners - Load Displacement Initiatives Impact Evaluation: F2012-F2018* 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.

__________________________________ April 8, 2020

Serina Grahn, Finance Manager, Business Services — Date

Evaluation Oversight Committee Chair

References

California Public Utilities Commission (2014). 2012 *Self-Generation Incentive Program Impact Evaluation and Program Outlook.*

California Public Utilities Commission (2011). *CPUC Self-Generation Incentive Program Tenth-Year Impact Evaluation Final Report*

California Public Utilities Commission (2010). *Self-Generation Incentive Program Combined Heat and Power Performance Investigation.*

Efficiency Valuation Organization (October, 2016). *Core Concepts. International Performance Measurement and Verification Protocol.*

New York State Energy Research and Development Authority (2010). *Distributed Generation-Combined Heat and Power DRAFT Evaluation, Measurement and Verification Plan.*

National Renewable Energy Laboratory (NREL), The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures*, Chapter 23: Combined Heat and Power, 2016. NREL/ SR-7A40-67307*.

U.S. Environmental Protection Agency Combined Heat and Power Partnership (2017). *Catalog of CHP Technologies*.

Abbreviations and Glossary

Customer Baseline Load (CBL): an energy quantity, established in accordance with principles described in the Transmission Service Rate (Tariff Supplement 74) that is intended to be representative of a customer's normal historic annual electricity consumption. An annual CBL Statement is issued by BC Hydro for each customer on stepped rate schedule (RS1823B) that includes all adjustments to a customer's energy bill for the purpose of CBL administration.

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".

Electricity Purchase Agreement (EPA): An agreement between BC Hydro and the customer establishing the terms and conditions under which BC Hydro purchases self-generation output produced at the customer's Contracted Generating Unit.

Expected Generation Energy: Estimate of generation energy that is net of parasitic energy and based on the initial engineering estimates. These estimates represent the unverified net electricity impacts of the load displacement project.

Generator Baseline (GBL): The customer's annual, seasonal, monthly or hourly contractual commitment for self-supply from a Contracted Generating Unit that must be satisfied to obtain financial payments.

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

Gross Generation Energy: The electrical energy produced by the load displacement project, not all of which is usable to offset the customer's energy purchases.

Load Displacement Agreement (LDA): An agreement between BC Hydro and a customer establishing the terms and conditions under which BC Hydro provides the customer with a financial incentive to make self-generation output for self-supply from a Contracted Generating Unit.

Load Displacement Project: Projects for industrial, commercial and institutional customers that received BC Hydro funding and program support to generate their own electricity for self-supply and offset electricity purchases from BC Hydro.

Net Generation Energy: The generation energy for actual use by the customer. It is estimated by the gross generation energy minus the parasitic energy.

New Power Generation: Type of load displacement project that includes a New Power Generating system of various technologies (internal combustion engine, organic Rankine cycle, combined cycle, boiler steam turbo-generator, combined heat and power, fuel cell, solar).

Parasitic Energy: The electrical energy that is required for the operation of the load displacement project. This is due to a variety of equipment associated with service of the load displacement project, for example, pumps and fans for moving fluids or gases, but not including generator losses.

Peak demand impact: The reduction in demand (MW) that occurs during BC Hydro's system peak hours (from 5 pm-7 pm, Monday through Friday, December through February) as a result of the load displacement project.

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

Realization Rate: The ratio of net generation energy adjusted during measurement and verification and evaluation review to the expect generation energy.

Rebuilt Turbo Generator: Type of load displacement project when the turbine casing, turbine blades, turbine shaft, generator windings, etc., are refurbished to improve generation performance, condition and life of the used turbo generator. Usually a lower persistence is given to a Rebuilt Turbo Generator compared to a new turbo generator type projects.

Renewable Natural Gas: Renewable natural gas is derived from biogas, which is produced from decomposing organic waste from landfills, agricultural waste and wastewater from treatment facilities.

Reported Savings: Estimate of net generation energy being recorded in the program tracking database for a given fiscal year. Reported generation energy is based on best information available from technical review of the initial engineering estimate, post-implementation review of documentation and/or inspection, measurement and verification results, or other information sources such as CBL Statements.

Appendix A Results Summary

The purpose of this appendix is to summarize key numerical results from the Load Displacement Initiatives impact evaluation for the period of F2012 to F2018. The following table present the savings summary.

Table A.1. Energy and Demand Savings

	Reported	Evaluated Gross	Evaluated Net
Generation energy (GWh/yr)	271	263	253
Peak demand impact (MW)	32	34	32

The following table presents the key results and findings.

Table A.2. Key Results of Load Displacement Projects for F2012-F2018

Key parameter and relevant factors	Group1: Rebuilt Turbo Generator	Group 2: New Power Generation
Number of projects	4	4
Rated Capacity (MW)	32	9
Expected Generation Energy (GWh/yr)	218	56
Reported Generation Energy (GWh/yr)	218	52
Evaluated Gross Generation Energy (GWh/yr)	204	59
Evaluated Net Generation Energy (GWh/yr)	198	55
Evaluated Net Peak Demand Impact (MW)	25.5	6.5
Parasitic Energy Factor	3%	6.5%
Realization Rate	91%	98%
Peak-to-Energy Factor	0.129	0.117
Availability Factor	93%	91%
Capacity Factor	77%	84%
Utilization Factor	72%	76%
Load Displacement to Facility Energy Ratio	18%	14%
Load Displacement to Total Self-generation Energy Ratio	25%	100%
Free ridership (not evaluated; deemed zero for large LD projects)	0; not evaluated	0; not evaluated
Spillover (not evaluated; deemed zero for large LD projects)	0; not evaluated	0; not evaluated
Average Weighted Persistence (years)	16	19
Variance Factor (evaluated net as % of reported generation energy)	91%	106%
Variance Energy (GWh/yr)	-21	+3
Reason for variance: 1. Average adjustment for actual generation from CBL Statements (GWh/yr) 2. Average adjustment for parasitic energy (GWh/yr)	 -15 GWh/yr -6 GWh/yr	

Appendix B Advisor Memos on Evaluation Report

Advisory Memo on Evaluation Report

March 27, 2020

To: BC Hydro
333 Dunsmuir St.
Vancouver, B.C.
V6B 5R3

From: Pierre Baillargeon
Evaluation Advisor
Vice President Econoler
160 Saint-Paul St., Suite 200
Quebec City, QC GIK 3W1

Re: Load Displacement Program Evaluation

Dear Madam or Sir,

This advisory memo summarizes the opinions of the evaluation advisor on the evaluation work performed by the BC Hydro evaluation team for the abovementioned program. It takes into consideration the initial comments and answers from the evaluation team, which were incorporated into the final version of the evaluation report when appropriate.

Overall appreciation of the report:

- Very good report, with clear and comprehensive explanations of the evaluation steps. The results highlight the key points demonstrating the achievement of the initiative.
- The advisor commends the evaluation team for the openness and transparency during the whole review process. Exchanges with the BC Hydro team were excellent. They provided clear and precise answers to all questions and additional information whenever necessary.

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?
   - The quality of the research design is excellent, the evaluation objectives and research questions are clear and the report answers those questions.

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?

- The program evaluation is based on high-quality data. Mainly emetering, customer billing and customer baseline load (CBL).

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?
    - The analytical method was good and appropriate for the type of evaluation conducted. The new construction component relied on well-known M&V approaches.
    - All equations used for the peak-to-energy factor, capacity factor, availability factor, utilization factor, etc., follow sound engineering principles.
    - The evaluation of a peak-to-energy factor for each site individually provides a better estimate of overall peak effects.
    - The assumption used to estimate parasitic loads (as proportional to generation) was appropriate, considering the small effect of those loads.

4. How does the methodology **compare to common industry practice** for evaluations of similar initiatives?
    - Combining the M&V and billing analysis approaches is generally consistent with best practices to establish load displacement program impacts.

5. What are your **suggestions for future evaluations** of this DSM initiative?
    - The only recommendation is to explore the untapped potential for LD from the implemented projects, which was estimated at approximately 18 MW.

6. Do you have any other comments that you would like to make?
    - No, this evaluation report is very good. Well done.

Advisor Memo on Evaluation Report

March 25, 2020

To: BC Hydro

From: Rafael Friedmann
EOC Evaluation Advisor
Oakland, California

Re: Load Displacement Program Evaluation

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?
    - The research design was appropriate for the task at hand.

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?
    - Data is adequate and based on a variety of sources, particularly billing and project M&V.

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?
    - Methods are straightforward and aligned with the results sought.
    - One project had major commissioning issues that delayed "steady-state" operations and thus, its impact results
    - Persistence based on BCH standards. These are based on engineering estimates; not evaluated due to the long life (16 or more years).

4. How does the methodology compare to common industry practice for evaluations of similar initiatives?
    - Unaware of similar research elsewhere as this is a unique program to my knowledge.

5. What are your suggestions for future evaluations of this DSM initiative?
    - Understand the program is discontinued. If it were to be started again, suggest that more research be done to explore further the apparently significant, untapped opportunities for further Load Displacement
    - Consider tracking persistence if deemed important given the size of some of these projects

6. Do you have any other comments that you would like to make?
    - Well written and comprehensive report

Appendix C Project Details

The following series of figures show the distribution of generation energy of the load displacement projects by project type, technology type, primary energy source, and combined heat and power applications.

Figure C.1. Distribution of Generation Energy by Project Type

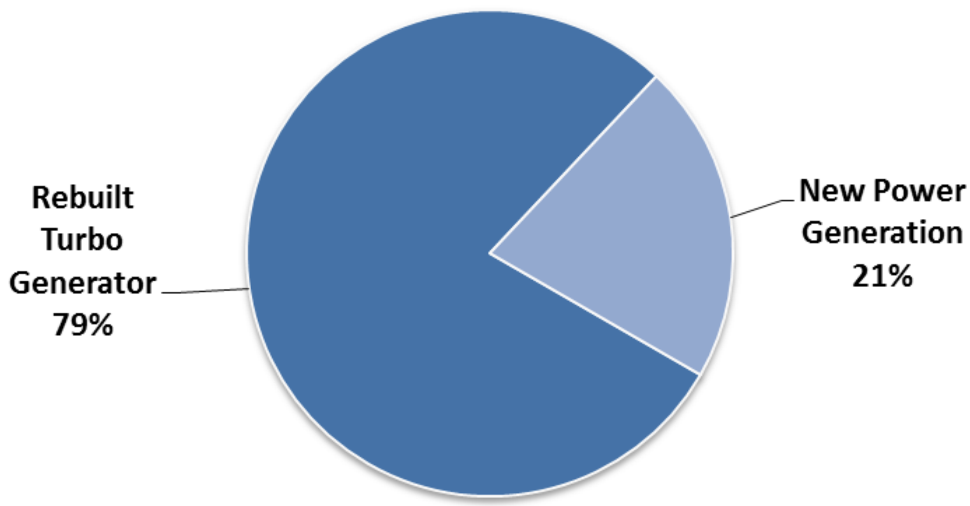


Figure C.2. Distribution of Generation Energy by Primary Energy Source

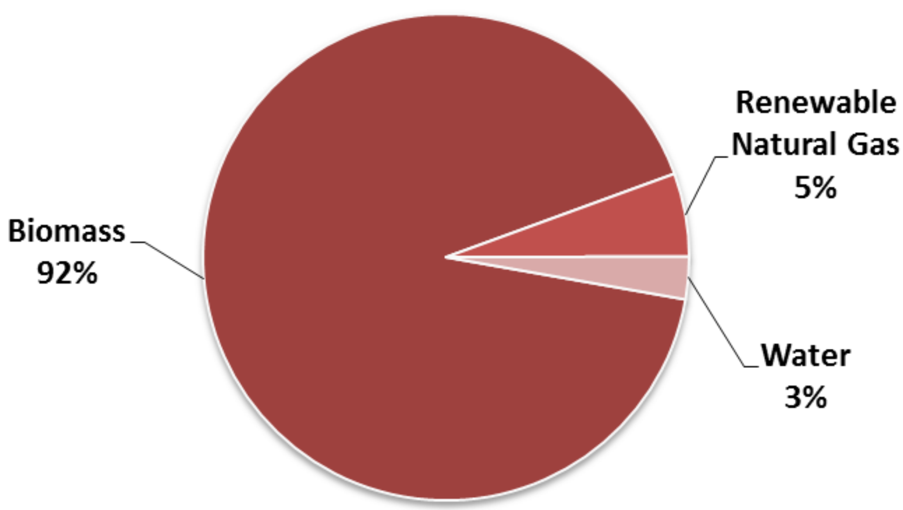


Figure C.3. Distribution of Generation Energy by Technology Type

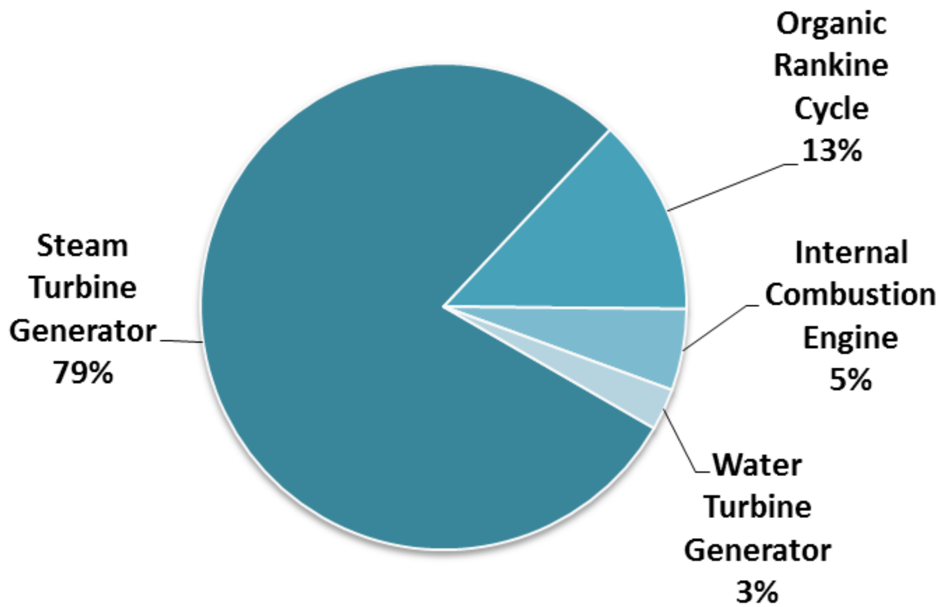
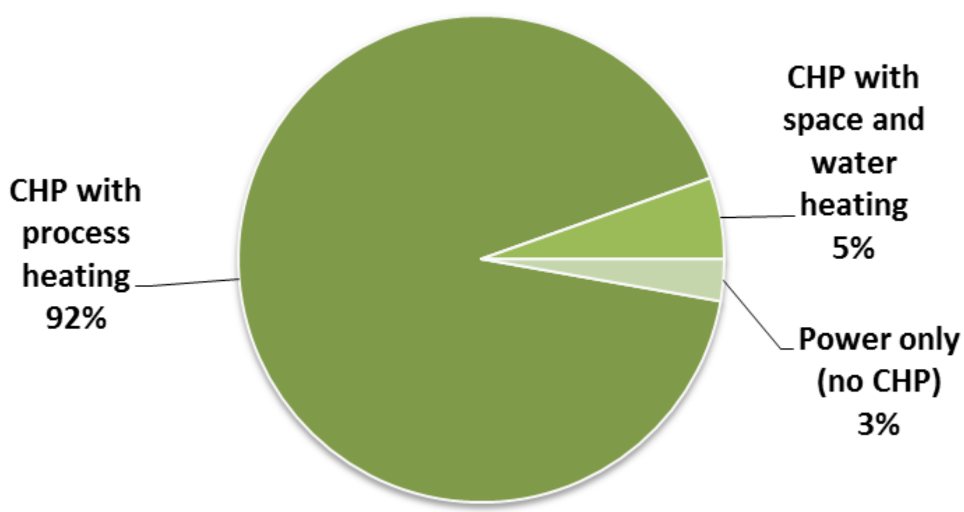


Figure C.4. Distribution of Generation Energy by Combined Heat and Power (CHP) Application



Appendix D Result Details

The following figures illustrate the distribution of relevant factors of the load displacement projects by fiscal year from F2012 through F2018. Since the last load displacement projects in this evaluation period were installed in F2016, the results for F2017 and F2018 are trending the continuing operation and performance of all load displacement projects.

Figure D.1. Availability Factor by Project, Project Type and Fiscal Year

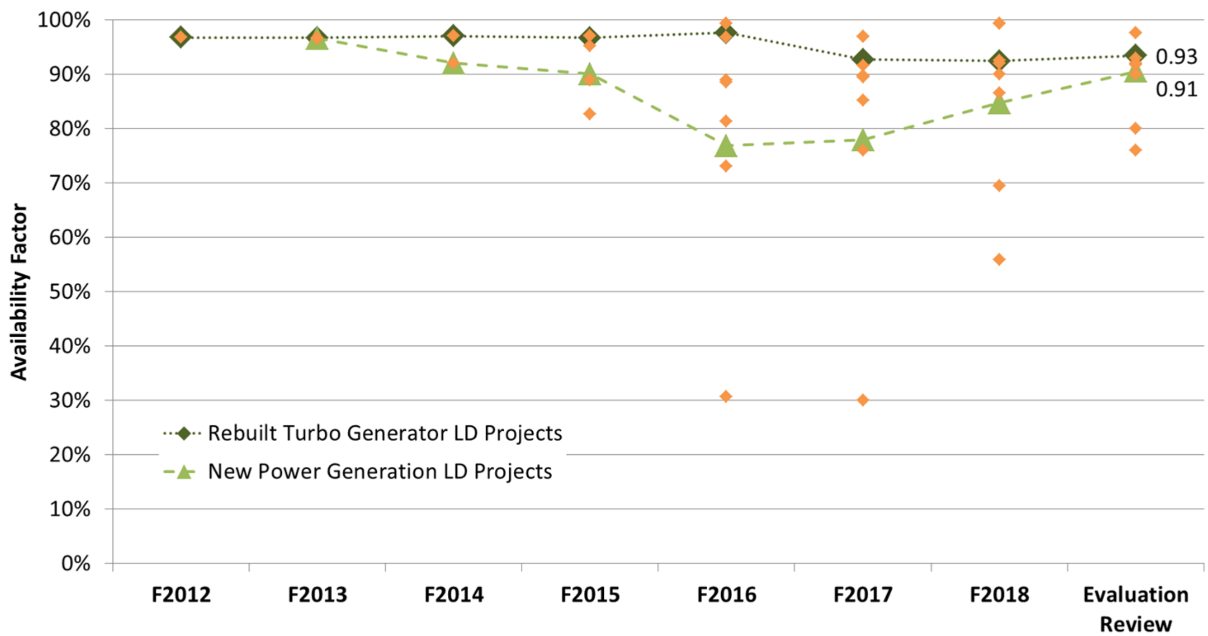


Figure D.2. Capacity Factor by Project, Project Type and Fiscal Year

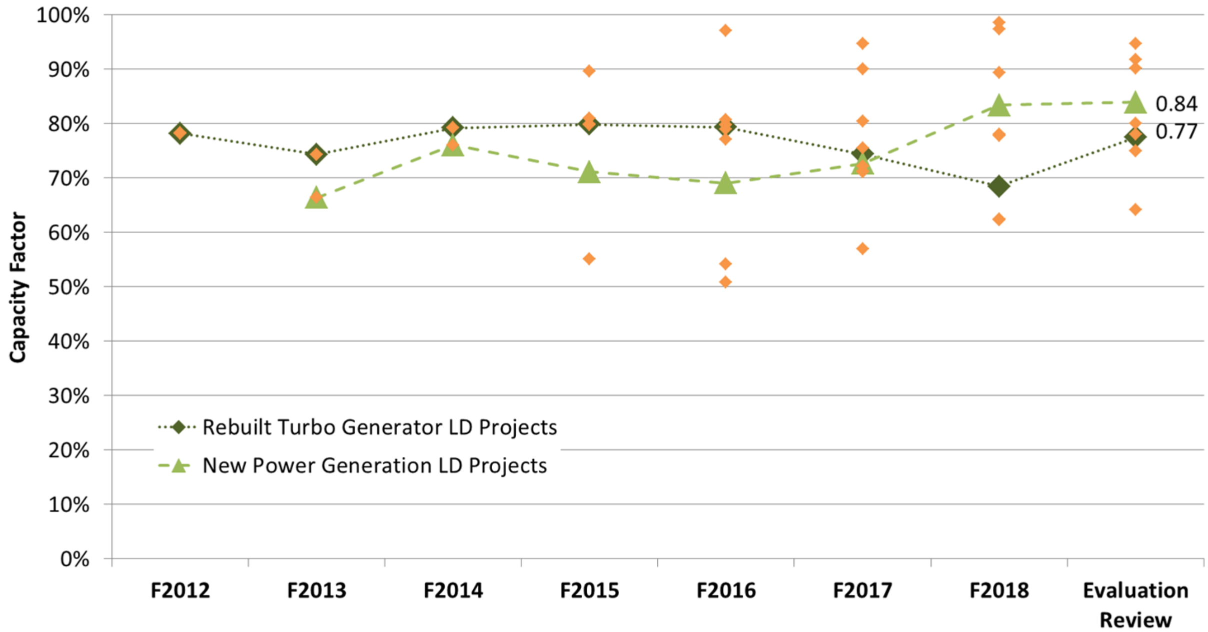


Figure E.3. Utilization Factor by Project, Project Type and Fiscal Year

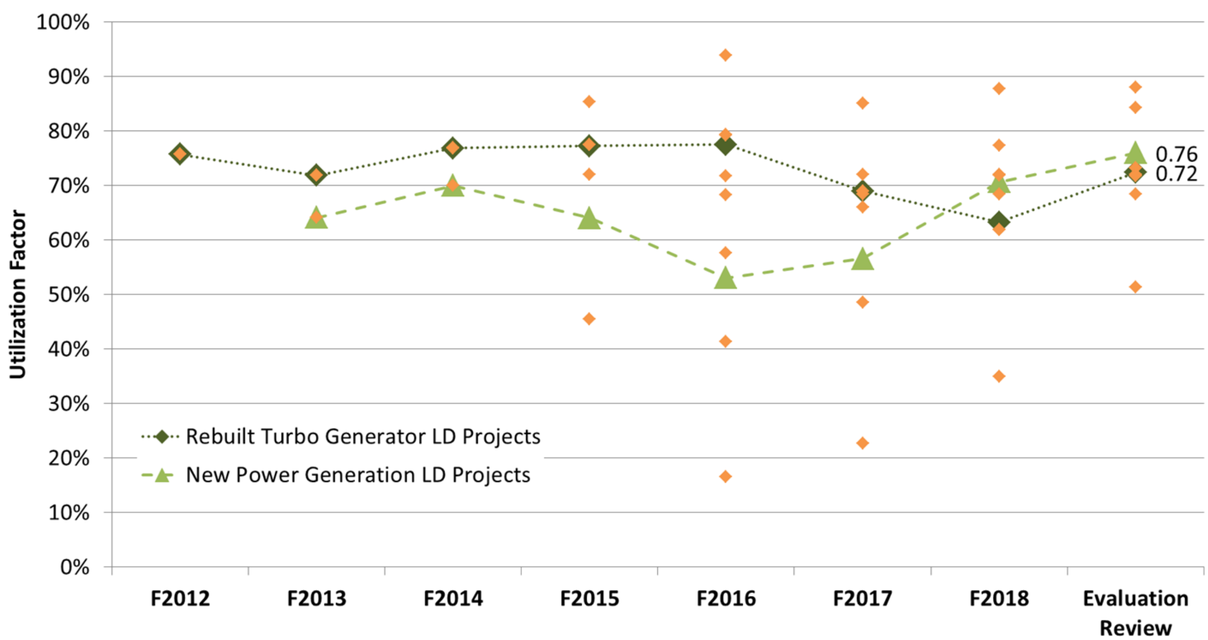


Figure D.4. Parasitic Energy Factor by Project, Project Type and Fiscal Year

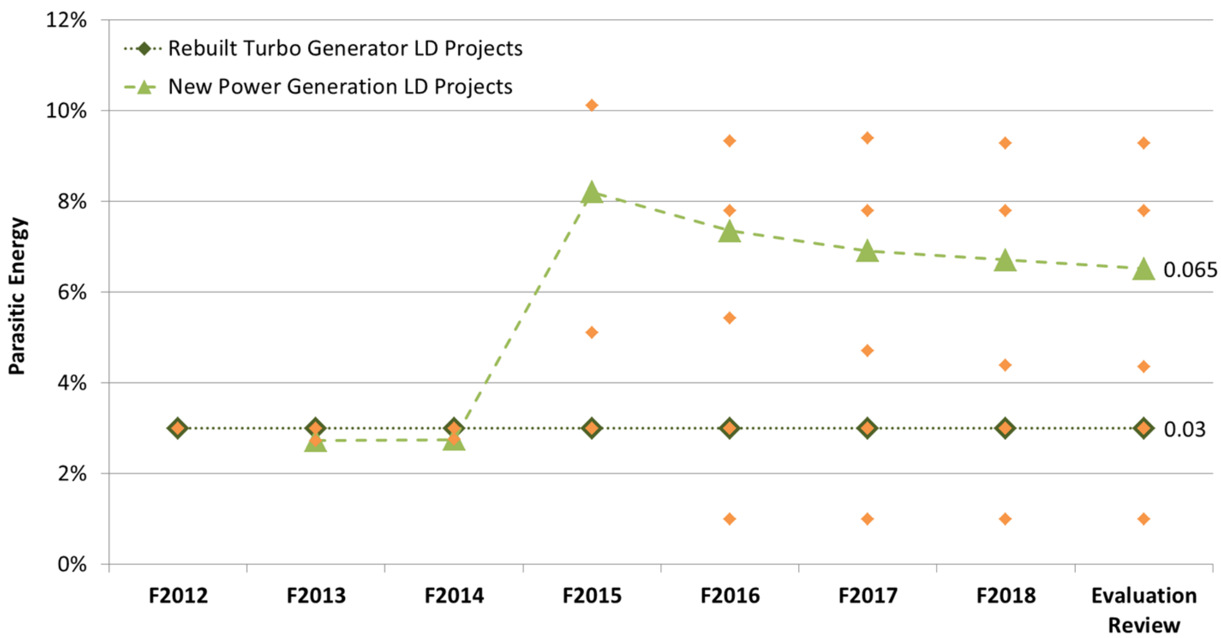


Figure D.5. Project Realization by Project, Project Type and Fiscal Year