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January 14, 2020

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
Commission Decision: Order No. G-96-04, October 29, 2004,
Directive 66 (page 197)**

BC Hydro writes to submit its F2019 Demand Side Management Milestone Evaluation Summary Report (**the Report**), dated December 2019 in compliance with Directive 66 (page 197) of the BCUC Decision on BC Hydro's 2004/05 to 2005/06 Revenue Requirements Application, dated October 29, 2004. Directive 66 directs BC Hydro to file the executive summaries of its milestone evaluation reports and full final evaluation reports for all its Power Smart programs.

The Report summarizes the impact evaluations completed during F2019 for the following:

1. B.C. Building Code - Commercial Sector: September 2009 – December 2014;
2. Leaders in Energy Management – Commercial Program: F2013-F2017; and
3. Television Market Evaluation: F2015-F2018.

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

Yours sincerely,

(for) Fred James
Chief Regulatory Officer

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Enclosure (1)

Demand Side Management Milestone Evaluation

Summary Report F2019

December 2019

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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 2019 (**F2019**). 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:

- B.C. Building Code - Commercial Sector: September 2009 – December 2014
- Leaders in Energy Management – Commercial Program: F2013-F2017
- Television Market Evaluation: F2015-F2018

2.0 B.C. Building Code - Commercial Sector: September 2009 – December 2014

2.1 Introduction

This report presents the evaluated gross electricity savings associated with the new provincial building code and the Vancouver Building By-law (**VBBL**) requirements for energy efficiency in commercial buildings adopted in September 2008. The scope of this evaluation includes all new[1] commercial and institutional Part 3 buildings,[2] including multi-unit residential buildings (**MURBs**). Gross energy savings associated with the commercial building code were estimated for the period September 1, 2009 to December 31, 2014 (hereinafter, the evaluation period is referred to as F2010 to F2015).

The BC Building Code is a provincial building regulation that applies to the construction of new residential, commercial, institutional and industrial buildings, as well as alterations and additions to existing buildings. The BC Building Code sets forth the minimum standards and rules by which the construction industry must abide.[3] Prior to September 2008, the BC Building Code did not have energy efficiency requirements for new buildings constructed in the province. In September 2008, the province revised the BC Building Code and adopted ASHRAE 90.1-2004 as the minimum acceptable standard for energy efficiency in commercial buildings. Near the end of 2008, the City of Vancouver adopted a by-law whereby the ASHRAE 90.1-2007 standard had to be met.

BC Hydro provides technical assistance and resources to support the research behind implementing and updating building codes for energy in the province. Support activities include participating in technical code committees; working with government stakeholders in order to help negotiate the advancement in the energy requirements of the building code; and developing strategies and testing new approaches to support and advance future building code updates. BC Hydro also designs and implements initiatives to ready the market for energy efficiency regulations. To support the implementation of the BC Building Code in the commercial sector, BC Hydro implemented the Commercial New Construction (**CNC**) program, which provided funding and training to support the advancement of energy efficiency design and offset the cost of more expensive technologies and design.

This study does not attempt to evaluate the influence of BC Hydro's work on building codes on energy efficiency. Instead, the goal is to estimate electricity savings in BC Hydro's service territory due to a reduction in electricity usage by new commercial building stock since the adoption of the ASHRAE 90.1-2004 standard by the BC Building Code (ASHRAE 90.1-2007 by the VBBL) in September 2008. Therefore, this evaluation will estimate only the gross savings. This is the first evaluation of the energy efficiency component of the commercial building code.

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1 Savings from additions or alterations to existing buildings were not included due to limited data.

2 Part 3 buildings refer to buildings over three stories in height or with a floor area of over 600 square meters. Examples include shopping malls, office buildings, apartment buildings, schools and restaurants.

3 BC Office of Housing and Construction Standards, June 2015. *Understanding B.C.'s Building Regulatory System*.

2.2 Approach

The evaluation objectives and research questions are shown below in Table 1, followed by the data sources and methods (Table 2).

Table 1 Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Characterize the new commercial building stock constructed after the building code requirements were changed in 2008	• What types of commercial buildings were constructed after the introduction of the 2008 provincial building code and Vancouver Building Bylaw (VBBL)? • How many square feet of commercial floor space by building type were constructed during each year of the evaluation period? • What was the regional breakdown of new commercial construction stock in the province for the evaluation period?
2. Estimate electricity usage intensity (EUI) savings	• What was the average annual electricity consumption per square foot by building type pre-code (2005-2008) and post-code (2009-2014)? • What were the gross energy savings per square foot by building type for each year of the evaluation period?
3. Estimate gross energy and peak demand savings	• What were the gross electricity savings by building type and year? • What were the total gross electricity savings by year? • What were the gross peak demand savings by building type and year?

The data sources and analytical methods used to address the objectives are summarized in Table 2, followed by a description for each objective.

Table 2 Evaluation Objectives, Data and Methods

Evaluation Objectives	Data	Method
1. Characterize the new commercial building stock constructed after the building code requirements were changed in 2008	Statistics Canada Building Permits Survey (2005-2015) BC Assessment data (2005-2016) BC Hydro account information	Cross tabulations Trends
2. Estimate EUI savings	BC Hydro billing data (F2014-F2018) Commercial New Construction program data Continuous Optimization program data Canada Green Building Council LEED building lists Weather data	Engineering algorithm Weather normalization modelling Billing data analysis
3. Estimate gross energy and peak demand savings	Results for Objectives 1 & 2 Statistics Canada Building Permits Survey (2009-2015) BC Hydro commercial rate class load shape (Peak Demand Ratio)	Engineering algorithm

Objective 1 used data from three different sources to develop and characterize commercial building stock in the BC Hydro service area. The total number of buildings was obtained from the Statistics Canada Building Permits Survey and information about building characteristics was taken from BC Assessment data and BC Hydro account information. Square footage was estimated using permit cost data collected in the Statistics Canada survey and the Hanscomb 2013 *Yardsticks for Costing*. The analysis of characteristics and trends in the commercial building stock was completed by summarizing trends in constructed buildings over time and generating cross tabulations by building type and region.

Objective 2 required estimation of pre- and post-code EUI for each building type to obtain the EUI savings, a key metric in the calculation of gross savings for commercial stock.

Calculating building EUI required using information from different sources:

- BC Assessment (**BCA**) data were used to identify the building type, year of construction and square footage at the building level;
- BC Hydro billing data were used in the calculation of annual electricity consumption at the building level. The following steps were undertaken to estimate the building normalized annual consumption:
  - removal of participants in other BC Hydro DSM program and LEED-certified buildings;
  - adjustments for construction time, occupancy and fluctuations in business operations based on individual building consumption patterns; and
  - normalizing for variations in weather.
- Information from the BC Hydro and BCA data sources was cross-referenced to compile the data necessary to calculate the normalized annual consumption per square foot (i.e., the building EUI).

In addition, calculating the EUI savings involved several steps:

- Develop the samples of buildings to represent the pre-code period and the post-code period using BCA data.
- Analyze the EUI distributions of the pre- and post-code samples for each building type and determine the median EUI[4] for each sample distribution.
- Calculate the difference between the pre- and post-code median EUIs for each building type.

Objective 3 was addressed by multiplying the EUI energy savings for each building type calculated in Objective 2 by the total square footage by building type for each year from F2010 to F2015, and summing up the results. As noted above, electricity savings are gross estimates, and do not include adjustments for attribution to the supports provided by BC Hydro.

2.3 Results

The results of the evaluation are presented by objective.

Objective 1: Characterize the new commercial building stock

The majority of commercial new construction occurred in the Lower Mainland and on Vancouver Island. During the post-code period, the Lower Mainland accounted for 69 per cent of total new buildings and Vancouver Island accounted for 17 per cent. Taken together these two regions account for a total of 86 per cent of the new commercial buildings in the province and 83 per cent of the total square footage.

Multi-Unit Residential Buildings (**MURBs**) represented the majority (81 per cent) of buildings constructed in the post-code period, with the remaining 19 per cent distributed fairly equally among the other building types. MURBs also accounted for the largest share of the total square footage (58 per cent). Offices, retail, warehouses, and other commercial buildings each

[4] The median was used rather than mean due to the variability in the structures, functions, size and electricity consumption of the buildings in the samples. The median is less sensitive than the average (or mean) to extreme values and outliers, and can be a better indicator of central tendency when the distribution is skewed.

accounted for between 7 per cent to 11 per cent of the total floor area, and the remaining 7 per cent was shared by educational facilities, hospitals, hotels and restaurants.

Square footage by building type fluctuated over time and there was no single consistent pattern across building types. The trend in the square footage for MURBs drives the trend in total floor stock, with a large dip occurring in 2009, followed by continuous growth for the remainder of the period. Square footage also increased in retail buildings after 2009, but began to decline after 2011 until 2013 when it began to increase again. Growth in square footage for new warehouse and office buildings did not pick up as quickly as other building types, declining from 2008 to 2010 with peaks occurring in 2011 and 2012, respectively. The other commercial category showed a similar pattern, although it accounted for less floor area.

Objective 2: Estimate electricity usage intensity savings

EUI savings were calculated as the difference between the median EUI for buildings constructed in the pre-code period and buildings constructed in the post-code period.

Table 3 Pre-Code and Post-Code Gross Energy Savings per Square Foot – Electricity Use Intensity

Building Type	Pre-Code EUI (kWh/ft^2)	Post-Code EUI (kWh/ft^2)	ΔkWh/ft^2	Energy Efficiency Improvement (%)
MURB	6.4	5.8	0.6*	9
Office	14.6	11.5	3.1*	21
Retail	17.9	14.3	3.6*	20
Warehouse	9.8	9.2	0.6	6
Other Commercial	7.7	7.2	0.5	7

* Statistically significant at the 95 per cent confidence level. The remaining differences were not statistically significant at the 80 per cent confidence level.

The EUI savings for MURBs, offices, and retail buildings were statistically significant, while the results for warehouse and other commercial building types were not, due to the small number and diversity of the buildings in these two groups. There was no sample with which to conduct the EUI analysis for education, hospitals, and hotels/restaurants building categories, because the BC Assessment data was poor for these categories. Therefore, the EUI savings for these three building types were based on the engineering modelling analysis used to derive the reported gross savings.

Objective 3: Evaluated gross energy and peak demand savings

The evaluated gross energy savings for each building type in each fiscal year covered by the evaluation period are presented in Table 4. Reported savings were calculated based on a projection of annual growth in commercial floor stock and engineering estimates of EUI savings. Evaluated savings were based on actual floor stock of newly constructed buildings and EUI savings estimated from actual building electricity usage intensity data. Evaluated gross electricity savings ranged from 11 GWh/year to 30 GWh/year from F2010 to F2015, with the most savings occurring in F2013 and the least occurring in F2010. The high savings achieved in F2013 reflects the surge in savings that year for office buildings. Retail buildings had the highest total gross electricity savings (46.4 GWh/year) of all building types, followed by MURBs (29.9 GWh/year) and office (28.9 GWh/year).

Table 4 Summary of Reported and Evaluated Gross Energy and Peak Demand Savings

Calendar Year	Energy Savings (GWh/year)		Peak Demand Savings (MW)	
	Reported	Evaluated Gross	Reported	Evaluated Gross
F2010	10	11	1	2
F2011	18	24	3	4
F2012	16	23	2	4
F2013	17	30	2	5
F2014	17	22	2	4
F2015	18	23	3	4
Total	**96**	**132**	**14**	**21**

The cumulative variance between the reported energy savings and evaluated energy savings was 36 GWh/year. The largest variance occurred in F2013 with a difference of 13 GWh/year between reported and evaluated savings. The evaluated savings for MURBs, offices, and retail buildings were all higher than reported savings for a combined variance of 44.2 GWh/year. For MURBs, the EUI savings were over twice the value assumed in reported savings and the floor stock was 10 per cent higher than was forecast. Offices and retail buildings also had larger than reported EUI savings, although the new floor stock in these categories was only about half the forecasted value. Education buildings were responsible for the largest negative variance at -6.7 GWh/year, mainly due to a smaller floor stock than anticipated in reported savings.

2.4 Findings and Recommendations

Findings

1. The majority of building permits were issued in the Lower Mainland (69 per cent), followed by Vancouver Island (17 per cent). Based on the relative total square footage of these buildings, those constructed in the Lower Mainland were larger than those constructed on Vancouver Island.

2. The increasing trend in building permits that occurred after 2009 was driven by the increasing construction of MURBs, which accounted for the largest percentage of new buildings (81 per cent) during the post-code period. MURBs also accounted for the largest share (58 per cent) of total square footage.

3. Billing data revealed an average lag of approximately one year from permit issuance to construction completion. In addition, MURBs and office buildings had high vacancy rates during the first year after construction completion (i.e., the second year after permit issuance). From the third year onward, these two building types averaged an occupancy rate estimated at approximately 97 per cent annually.

4. The EUI savings estimated for each building type suggested that building performance improved after the code, improving energy efficiency by 9 per cent for MURBs, 21 per cent for office buildings and 20 per cent for retail buildings. Improvements in building performance for the warehouse and other commercial buildings categories were not statistically significant.

5. The evaluated gross energy savings and the corresponding peak demand savings from F2010 to F2015 were 132 GWh/year and 21 MW, respectively. The highest savings

were achieved in F2013, reflecting the spike in building permits for office development in 2012, taking into consideration the 12 months construction period.

6. The evaluated gross electricity savings were 36 GWh/year higher than the reported gross savings of 96 GWh/year. The largest difference occurred for MURBs, where the EUI savings were over twice the value assumed in reported savings and the floor stock was 10 per cent higher than was forecast. Offices and retail buildings also contributed to the positive variance through larger than reported EUI savings, although the new floor stock in these categories was only about half the forecasted value.

Recommendations

The following recommendations flow from the findings of this evaluation. Recommendation #1 is for the BC Hydro Codes and Standards group. Recommendation #2 is for Evaluation.

1. For MURBs and office buildings, consider adding another 12 months of lag time for reported savings to the 12 months already allowed for building construction to allow the building to achieve typical occupancy levels, or somehow account for partial occupancy during that period.

2. If cost-effective, consider using a combined approach in future evaluations of building code to include calibrated engineering simulation analysis for some building types where data is scarce, with the understanding that there will only be billing data for 12 months after building completion or typical occupancy levels.

2.5 Conclusions

The commercial building stock in B.C. became more energy efficient after energy efficiency was included in the 2008 BC Building Code. The greatest energy savings were achieved in retail buildings, followed by offices and MURBs.

3.0 Leaders in Energy Management – Commercial Program F2013-F2017

3.1 Introduction

This report presents the results of an impact evaluation of the BC Hydro Leaders in Energy Management – Commercial (**LEM-C**) program for BC Hydro fiscal years F2013 to F2017 (April 2012 to March 2017).

The LEM-C program targets BC Hydro's commercial segment, which consists of organizations in both the public and private sectors. The target market includes large customer organizations with combined annual electricity consumption greater than 4.0 GWh and small- and medium-sized businesses (**SMBs**) with annual electricity consumption less than 4.0 GWh. LEM-C is a comprehensive program that provides a suite of offers, tools and other assistance intended to help commercial customers implement energy-saving projects while also building energy management activities into their standard business practices over the long term.

During the evaluation period, the custom component of the program provided incentives to large commercial customers to implement energy efficiency projects. Incentives were determined on a per project basis based on its estimated energy savings and capital costs. Savings could also be achieved through program-enabled projects. These 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, energy study funding, Key Account Managers (**KAMs**) for large customers[5], and Business Energy Advisors (**BEAs**) for small- and medium-sized customers. Prescriptive incentives (Business Energy Savings Incentives or **BESI**[6]) were available to commercial customers of any size and covered simple, one-for-one replacements of inefficient technologies with energy-efficient ones, most commonly lighting. During the five-year evaluation timeframe, 4,865 energy efficiency and conservation projects implementing 17,365 energy conservation measures were completed at 5,561 unique sites of 1,460 parent organizations.

LEM-C also delivered initiatives designed to change attitudes, behaviours and practices within its large commercial customer organizations. The program undertook a strategic energy management approach designed to assist large customers with managing their energy consumption by planning for and tracking changes in consumption; adopting energy efficiency policies; implementing operational and maintenance changes; completing energy retrofits of existing buildings; changing employee behaviours; and assisting customers to integrate strategic energy management into their ongoing business practices and corporate culture. To support the adoption of strategic energy management, large commercial organizations had access to funding to hire qualified energy managers and conduct energy studies. Maintaining a qualified energy manager workforce was supported through BC Hydro-provided education and training. Funding through the Workplace Conservation Awareness (**WCA**) initiative was also available and aimed to harness employee engagement as a way to save energy and to establish a permanent culture of energy conservation within the organization.

5 Large customers are defined as organizations with electricity consumption of greater than 4 GWh per year.
6 Formerly known as Power Smart Express (**PSX**) until late F2016.

3.2 Approach

The evaluation addressed five objectives each with related research questions, as presented in Table 5.

Table 5 Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. Assess the customer experience with LEM-C program design and delivery	What are participant and non-participant experiences related to program awareness, understanding, and satisfaction for each of the program offers (custom, program enabled, and prescriptive)? Is there a difference between customers with and without a Key Account Manager? What are the main drivers of and barriers to program participation?
2. Assess the extent to which project-enabling activities supported the implementation of energy efficient projects and practices	What types of project-enabling activities were undertaken by the different customer segments? What factors had the greatest association with amount and type of project activity (e.g., energy managers, energy studies, KAM/Alliance/BEA involvement)? Was there a difference across commercial customer segments (e.g., public versus private sectors) and over time? To what extent and in what ways did BEAs influence project activities for small- and medium-sized businesses? To what extent are energy managers and energy studies associated with project activity and savings overall and over time? How much program-provided training and education was accessed by energy managers? How did the training affect the implementation of energy efficient projects and practices? What kinds of program-provided tools and resources were accessed by participants (e.g., SharePoint, webinars, training, others)? How did the tools and resources affect the implementation of energy efficient projects and practices? What kind of influence did customer recognition/appreciation advertising activities have on participating organizations (e.g., number and type of projects, energy savings, behaviour/attitude)?
3. Assess the extent to which strategic energy management practices were integrated into on-going business activities	What types of strategic energy management practices were integrated into business activities? Were there differing degrees of integration across customer groups (e.g., with/without KAM; public versus private sector; organization size or type)? Is there any evidence of activities or energy savings resulting from the expanded energy manager market (e.g., non-BC Hydro funded energy managers)? What are the similarities/differences in strategic energy management practices of participating organizations as compared to similar non-participating organizations?
4. Estimate gross electrical energy and peak demand savings	What were the evaluated gross energy and demand savings by fiscal year, and by custom (incentives, program enabled) and prescriptive (e.g., BESI) offers? What were the gross realization rates[7] by offer, and by end use (to the extent possible)?
5. Estimate net electrical energy and peak demand savings	How much free ridership occurred for the custom and prescriptive offers? How much participant spillover occurred for the custom and prescriptive offers? How much non-participant spillover occurred for the custom and prescriptive offers? What are the evaluated net energy savings and demand savings by fiscal year and by offer?

[7] The ratio of initial estimated savings to savings adjusted for data errors and measurement and verification results.

The data sources and analytical methods used to address the objectives are summarized in Table 6.

Table 6 Evaluation Objectives, Data Sources and Methods

Evaluation Objectives	Data	Method
1. Assess the customer experience with LEM-C program design and delivery	• 7 waves of program participant surveys covering F2013 to F2017 (n=686) • 1 wave of a non-participant survey covering F2014 to F2015 (n=349) • Trade allies survey F2015 (n=88)	• Cross tabulations
2. Assess the extent to which project-enabling activities supported the implementation of energy efficient projects and practices	• Program administrative records • Participant survey BEA questions (n=17) • 6 waves of Energy Manager surveys covering F2015 to F2017 (n=7 to n=45 per wave) • Participant interviews (n=10)	• Cross tabulations • Qualitative analysis
3. Assess the extent to which strategic energy management practices were integrated into on-going business activities	• Energy Management Assessment reports • Participant interviews (n=10) • KAM interviews (n=8)	• Descriptive quantitative analysis • Qualitative analysis
4. Estimate gross electrical energy and peak demand savings	• Program tracking data • Project files • Measurement and Verification results (n=999 measures)	• Extrapolation of Measurement and Verification results using stratified ratio estimation • Average peak-to-energy factors
5. Estimate net electrical energy and peak demand savings	• Results from Objective 4 • 7 waves of participant surveys covering F2013 to F2017 (n=686) • 1 wave of non-participant survey covering F2014 to F2015 (n=349)	• Survey-based free ridership and spillover algorithms • BC Hydro Standard Procedure for Cross Effects

3.3 Results

Results for Objective 1: Asses the customer experience with LEM-C program design and delivery

Awareness of the LEM-C offers was highest among custom participants at 93 per cent. Awareness was lower among prescriptive KAM and non-KAM participants at 79 per cent each. For non-participants, awareness of the program among customers eligible to participate in the custom offer was 74 per cent and much lower among customers eligible to participate in only the prescriptive offer at only 36 per cent. In terms of individual program components, among participants, awareness was highest for the role that KAMs play as liaisons for the program and for the prescriptive offer, and lowest for the custom incentive structure and the energy manager offer. Among non-participants, awareness was low for all of the individual program offers.

Overall satisfaction (somewhat plus very satisfied) was very high for all of the LEM-C offers at 95 per cent for custom participants, 88 per cent for prescriptive KAM participants and 92 per cent for prescriptive non-KAM participants. In terms of program experience, services provided by contractors and suppliers/distributors were both rated highly – above 80 per cent rated them as excellent or good – among all participant groups. Installing the energy efficient technology and the quality of the energy efficient technology were also both rated highly by all groups. Knowing how/who to contact was rated particularly highly by custom participants (90 per cent), but lower among both prescriptive KAM participants (68 per cent) and prescriptive non-KAM participants (56 per cent). Areas which rated lowest included direct mail/email about the program (for all offers), length of time to receive project approval (for custom), information about the program on the website (for custom), pre- and post-inspections (for prescriptive KAM), variety of products funded under the program (for prescriptive non-KAM), knowing how/who to contact at BC Hydro (for prescriptive non-KAM) and usability of the online application (for prescriptive non-KAM).

Among all groups, the factor that emerged as the greatest motivator to managing electricity was making operating costs as low as possible. This sentiment was echoed in the participant interviews with saving money noted as the primary motivator. Among the participant groups, the individual program offers were also motivators, as were energy managers and KAMs. Among both participants and non-participants, the largest barriers to managing electricity use were lack of funds for energy efficient retrofits, other operational priorities, and lack of financial incentives. Among non-participants, the main reason for not participating was that they needed more information about the program.

Results for Objective 2: Assess the project-enabling activities

More than half (55 per cent) of the organizations that participated in LEM-C had an energy manager or energy study. Just over one-quarter (27 per cent) had both. Public sector organizations were most likely to have had coverage by either an energy manager or energy study or by both. Interview results revealed that organizations highly value the role of the energy manager and that energy studies have been critical for identifying potential projects and creating a business case for energy management activities.

Analysis of program data showed that most of the expected savings were associated with either an energy manager (70 per cent) or an energy study (65 per cent), and often both (55 per cent). The highest percentage reduction in energy for organizations with energy managers compared to organizations without an energy manager occurred in healthcare, government and advanced education. Municipalities, property management, and retail organizations with energy managers, compared to those without an energy manager, showed the least difference in energy reduction, indicating that enabling activities may have less of an impact in these sectors.

Interviews with representatives of participating organizations and with KAMs indicated that energy managers are critical to facilitating and supporting the implementation of custom and prescriptive projects, as well as facilitating the adoption of strategic energy management practices.

In the interviews, respondents generally highlighted that Key Account Managers were critical to the success of their energy management activities as they facilitated communication between BC Hydro and the respondent’s organization, endorsed the credibility of the energy managers to senior management and assisted with funding applications. Among survey respondents who had used the BEA service, 41 per cent indicated that they would not have completed the project without the assistance of the BEA, while 35 per cent would have completed it on their own and the remaining 24 per cent were unsure. Satisfaction was high among those who used a BEA, with 82 per cent giving it a score of 8, 9 or 10 on a 10-point scale.

BC Hydro provided a comprehensive training plan to support energy managers in achieving conservation goals, including training sessions, on-line webinars as well as Energy Manager Forums. Interviews with Energy managers suggest that the training provided was generally viewed favourably by the energy managers. More experienced energy managers noted that training on BC Hydro’s administrative process requirements became less important with increased experience. Surveys conducted with energy managers revealed their levels of satisfaction with training sessions and the Energy Manager Forum to range between 7.5 to 9.0 on a 10-point scale.

Results for Objective 3: Assess strategic energy management practices

Among the participating organizations interviewed, there was generally a high level of commitment to strategic energy management. Most had been doing strategic energy management for several years and some processes had become embedded in the organization practices. Many reported having year-on-year targets that are reported and updated on an annual basis, and energy planning activities integrated into the capital planning process. Energy studies were a means used to identify potential projects. In contrast, KAMs interviewed indicated that, to their knowledge, non-participating organizations typically did not consider energy efficiency in their capital planning exercises. Instead these organizations took a more tactical approach, relying on funding for discrete projects on an ad hoc basis.

A number of interviewed participants identified operating practices as integral to strategic energy management activities and something that the energy managers had significant ability to influence. It was noted, however, that while the level of awareness related to energy management had increased within organizations, operational staff may not be fully engaged nor committed to energy management.

Most participating organizations conceded that in the absence of the BC Hydro program, the level of strategic energy management activity would diminish.

Energy Management Assessments (**EMAs**) are a diagnostic workshop conducted every two years to track progress in organizational adoption of strategic energy management. Analysis of EMA index scores dating back to F2006 revealed that as many as nine EMA sessions had been completed (one organization), although it was most common for organizations to have engaged in four to six sessions. The overall scores increased from an average of 0.9 to 1.5 after five sessions, moving these organizations as a whole from a tactical approach to energy management (scores in the 0.0 to 1.0 range) to a more strategic approach (scores in the 1.01 to 2.0 range). A few organizations achieved overall scores greater than 2.0, signifying that strategic energy management had been operationally integrated into business practices at the time of the assessment. Scores in the private sector tended to be higher and improved by a greater margin than those in the public sector. Within the private sector, the property management sector had the fastest progression, increasing from an average score of 1.0 to 2.2 after five sessions. Within the public sector, colleges and universities had the fastest progression, increasing from 0.9 to 1.7, after five sessions. Municipalities had the slowest progression, starting at an average score of 0.8 and increasing to 1.3 after five sessions.

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

Gross energy savings were determined from three end use samples of projects with M&V and extrapolated to the remaining projects in the population. The sample for realization rate estimation was comprised of projects accounting for 21 per cent of expected energy savings (statistically significant coverage). Once the three samples for realization rate estimation were established, stratified ratio estimation was applied.

LEM-C projects typically involved lighting and could be categorized as Light Emitting Diode (**LED**) lighting, non-LED lighting and other end uses. There was virtually no difference in the realization rate across the three types of end uses. The distribution of energy conservation measures and energy savings for the three end uses, tag-on[8] savings and program enabled (**PE**) projects where savings are assumed to persist for two years or less are shown in the table below.

[8] Tag-on savings are customer-funded activities that improve energy efficiency, which were recognized and reported by the program during post implementation review of custom lighting projects only. These savings are in addition to estimated spillover savings.

Table 7 Gross Realization Rates and Evaluated Energy Savings and Peak Demand Savings by End Use and Offer

End Use and Offer	Measure Count	Expected Savings (GWh/year)	Gross Realization Rate	Evaluated Gross Energy Savings (GWh/year)	Gross Peak Demand Savings (MW)
LED Lighting	7,695	162	**0.97**	158	25
Non-LED Lighting	7,014	103	**1.00**	103	16
Other End Uses	1,555	93	**0.96**	90	13
Tag-on Savings	n/a	7.3	Not evaluated	7.3	1
PE with ≤ 2 years savings persistence	1,101	42	Not evaluated	42	6
Overall Program	17,365	408	0.98	400	61

Objective 5: Estimate net electricity savings

Net electricity savings are the change in energy consumption and demand that is attributable to the program. They exclude free riders and include spillover. Free ridership was estimated separately for the three types of projects reported by the program: custom, prescriptive KAM and prescriptive non-KAM. The overall level of free ridership was estimated at 17 per cent for the program, ranging from 14 to 22 per cent between program offers. Participant spillover was estimated at 12 per cent and non-participant spillover was estimated at 7 per cent, for a total of 19 per cent. Together they result in a net-to-gross ratio of 102 per cent. Cross effects were calculated as 4 per cent for custom, 4 per cent for prescriptive KAM and 5 per cent for prescriptive non-KAM projects, for a downward adjustment of the evaluated gross energy savings of 13 GWh/year during the evaluation period. Evaluated net energy and peak demand savings[9] are shown in Table 8 and averaged 111 per cent of reported savings, showing that the program performed better than reported.

Table 8 Summary of Energy and Peak Demand Savings

Calendar Year	Net Energy Savings (GWh/year)		Peak Demand Savings (MW)	
	Reported	**Evaluated**	**Reported**	**Evaluated**
F2013	90.3	93.8	13.8	14.3
F2014	65.2	76.0	10.0	11.6
F2015	59.7	64.2	9.1	9.8
F2016	63.9	75.4	9.8	11.5
F2017	76.9	85.9	11.8	13.1

The variance between reported and evaluated net savings is primarily due to the evaluated net-to-gross ratio being higher than what was assumed for reported savings. The results reflect the continuous improvement approach taken by LEM-C program managers whereby the findings from previous impact and process evaluations were used to make adjustments to business planning assumptions, program design and delivery.

9 A conversion factor derived from load shape analysis used in DSM planning was applied. The factor was a weighted average of commercial lighting and other peak-to-energy factors for the period from F2013 to F2017.

3.4 Findings and Recommendations

Findings

Customer Experience with Program Design and Delivery

1. Overall satisfaction (somewhat plus very satisfied) was very high for all of the LEM-C offers at 95 per cent for custom participants, 88 per cent for prescriptive KAM participants and 92 per cent for prescriptive non-KAM participants.

2. Services provided by contractors and suppliers/distributors were both rated highly among all participant groups, as were installing the energy efficient technology and the quality of the energy efficient technology. Aspects with the lowest ratings were direct mail/email about the program, length of time to receive project approval (for custom participants), pre- and post-inspections (for prescriptive KAM participants) and variety of products funded under the program (for prescriptive non-KAM participants).

3. Among all groups, the factor that emerged as the greatest motivator to managing electricity use was making operating costs as low as possible. The largest barriers were lack of funds, other operational priorities, and lack of financial incentives.

Project-enabling Activities

4. The majority of projects (68 per cent) and expected savings (79 per cent) of organizations with annual consumption of 4 GWh per year and greater had an energy manager and/or had completed an energy study. Public sector organizations were most likely to have had coverage by either an energy manager or energy study or both, particularly healthcare, advanced education and school districts. Private sector companies had lower levels of coverage.

5. Overall, organizations with BC Hydro-funded energy managers were found to have completed more than twice the number of projects compared to organizations without an energy manager. To assess the effectiveness of energy managers and account for differences in consumption, energy savings relative to annual consumption in F2017 were examined. The results revealed greater proportional savings for organizations with an energy manager (11 per cent) than those without (8 per cent).

6. All energy managers were required to participate in training relevant to their respective sectors, which they generally viewed favourably. The energy managers interviewed noted that the training was most useful in the first years of participation, but became less relevant to their needs over time. The same was true for the various tools and templates provided by the program. Energy managers highly valued the Energy Manager Forum for knowledge transfer and sharing of ideas among their peers.

7. Business Energy Advisors conducted visits to approximately 500 commercial sites of which about 100 went on to complete projects with associated savings totaling approximately 4 GWh/year. Survey respondents identified energy saving opportunities (88 per cent) and being introduced to available incentives from BC Hydro (71 per cent) as the most valuable aspects of the BEA service.

Integration of Strategic Energy Management Practices

8. Overall, average EMA scores increased over time, with most organizations moving from a tactical approach (scores in the 0.0 to 1.0 range) to a more strategic approach (scores in the 1.01 to 2.0 range). A few organizations achieved assessment scores above 2.0, signifying that energy management had been operationally integrated into corporate

practices. None of the organizations had moved to a continuous improvement approach (i.e., scores above 3.0 range) where strategy energy management would be highly integrated into the corporate culture. Private sector organizations tended to score higher and improved by a greater margin than public sector organizations.

9. Organizations with an energy manager tended to be further ahead in integrating strategic energy management practices within the corporate planning process than those without one. Representatives of participating organizations noted that, if left without an energy manager, the level of strategic energy management would drop off. Organizational barriers to fully integrating strategic energy management included lack of senior management support and low engagement of operations staff.

10. Non-participating organizations did not typically set targets or incorporate energy efficiency into their corporate planning or policies. The exception was large institutions and national private sector organizations that already have a ‘green’ culture in place, and these typically have professional staff to implement strategic planning and policies.

<u>Gross Electrical Energy Savings</u>

11. The program gross realization rate calculated using the M&V results was 0.98, indicating that the energy conservation measures largely performed as expected. The realization rates by end use were 0.97, 1.0 and 0.96 for LED lighting, non-LED lighting and other end-uses, respectively.

12. Expected energy savings averaged 10 per cent of site energy consumption across all participants during the five-year evaluation period.

<u>Net Electrical Energy Savings</u>

13. The net-to-gross ratio excluding cross effects was 102 per cent based on an overall level of free ridership of 17 per cent, participant spillover of 12 per cent, and non-participant spillover of 7 per cent. Cross effects were 3.4 per cent.

14. Evaluated net savings during the evaluation period from F2013 to F2017 averaged 111 per cent of reported savings.

Recommendations

The following three recommendations are for the BC Hydro LEM-C program managers based on the findings of this evaluation.

1. Review and adjust project-enabling supports, such as training and knowledge sharing to reflect the changing needs of more experienced energy managers and mature organizations with regards to strategic energy management.

2. Develop a better understanding of building operators’ responsibilities, capabilities and training needs in order to better support their role in strategic energy management.

3. Improve consistency of linking energy manager, energy study and other enabling activities at the organization level to individual sites and projects in the program administrative database.

3.5 Conclusions

The BC Hydro's LEM-C program achieved 11 per cent more savings during fiscal years F2013 to F2017 than was expected. Energy managers and energy studies lead to enhanced strategic energy management practice and energy savings in participating organizations. The program also achieved high levels of customer awareness and satisfaction.

4.0 Television Market Evaluation F2015-F2018

4.1 Introduction

This is a market evaluation that examines changes in the market for new televisions in B.C. in the context of 2013 and 2015 provincial regulations for TV energy efficiency. The evaluation estimates the electricity savings in BC Hydro's service territory due to changes in the efficiency of TVs sold in B.C. from F2015 to F2018, which includes the influence of provincial TV regulations operating in the context of external drivers and the evolving global TV market. Trends in B.C.'s TV market are examined over a longer period, from the fourth quarter of F2010 to the end of F2018. The evaluation does not attempt to determine the share of savings directly attributable to changes in regulation or other specific actions.

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

BC Hydro demand side management programs targeting the TV market were available from F2009 to F2014, which is prior to the evaluation period.

The B.C. TV regulations establish maximum limits for TV power draw. The first B.C. energy efficiency regulation for TVs took effect in January 2012 for power draw in on mode only, followed by limits for power draw in standby and off modes.

4.2 Approach

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

Table 9 Evaluation Objectives and Research Questions

Evaluation Objective	Research Questions
1. TV market demand-side assessment	What are the trends in TV ownership among residential customers? What are the trends in TV usage among residential customers? What are the principal factors contributing to consumers' TV purchase decisions? How important is energy efficiency of TVs for customers? Has the level of importance changed over the years?
2. TV market supply-side assessment	What were annual sales of TVs in B.C. from F2011 to F2018? What were the trends in the characteristics (e.g., new technologies, screen size) of new TVs from F2011 to F2018? What were the trends in the energy efficiency of TVs sold from F2011 to F2018? What was the level of compliance with the regulations among TVs sold from F2011 to F2018?
3. Gross electricity savings	What were the overall electricity and peak demand savings due to changes in the B.C. TV market from F2015 to F2018?

Table 10 Evaluation Objectives, Data and Methods

Evaluation Objectives	Data	Method
1. TV market demand-side assessment	• Residential End Use Surveys (up to 2017) • 2016 Consumer Electronics Survey • Retailer interviews (n=2) • Regulator interviews (n=2)	• Frequencies; cross tabulations • Trend analysis • Qualitative analysis
2. TV market supply-side assessment	• Quarterly TV sales data for B.C. (F2010 - F2018) • Annual Electronics Floor Stock Study (2010 to 2017) • Online product information • Regulator interviews (n=2) • Retailer interviews (n=2)	• Trends analysis • Descriptive statistics • Frequencies; cross tabulations • Qualitative analysis
3. Gross electricity savings	• Quarterly TV sales data for B.C. (F2010 to F2018) • 2010 Residential Monitoring Study (48 homes) • 2015 Consumer Electronics Metering Study (53 homes)	• Engineering algorithms

Objective 1 entailed a quantitative analysis of survey results to examine trends in the TV stock installed in BC Hydro customers' homes and factors involved in TV purchasing decisions. Qualitative information obtained through retailer interviews supplemented the survey results regarding trends in factors influencing TV purchases.

Objective 2 was addressed through several steps.

- Estimate TV sales in the BC Hydro service territory by quarter for the period January 2010 through March 2018.
- Determine power draw by model for all TVs sold from F2015 to F2018.

- Apply hours of use estimates from two metering studies of non-random samples of homes.
- Estimate electricity consumption per unit and per square inch by model for all TVs sold.
- Estimate average unit electricity consumption for the entire market.
- Conduct qualitative analysis of interviews with retailers and regulator representatives to explore the regulatory environment and current trends in the TV market.

Objective 3 was addressed using engineering algorithms that compared the market average energy consumption of TVs sold in the base period (defined as January to March 2010), to the market average energy consumption of TVs sold in each year from F2015 to F2018. Electricity savings were adjusted for cross effects and the proportion of the residential population in B.C. that is served by BC Hydro. As noted above, electricity savings are gross estimates, and do not include adjustments for attribution to the B.C. TV regulation or other influences.

4.3 Results

The results of the evaluation are presented by objective.

Objective 1: Demand-side Assessment

As of 2017, the majority of households in the BC Hydro service area (95 per cent) had at least one TV that was being used at least occasionally, with the average household using two sets. Reflecting the rapidly changing TV market, the type of TV installed in BC Hydro customers' homes has changed substantially over the past ten years. The most noteworthy change has been the replacement of the previously standard CRT TV by LCD TVs, and now by LED TVs. The rapid decline of the CRT TV is particularly evident, plummeting from 98 per cent of households in 2001 to 10 per cent of households in 2017. This decline was accompanied by a rapid increase in LCD and LED models, going from 8 per cent of households in 2006 to 85 per cent in 2017.

In the Consumer Electronics survey, customers who had recently purchased a TV (n=38) were asked to identify the most important factors in making their TV purchase decisions. Price emerged to be the most important factor, with 59 per cent of respondents selecting price as one of the top three factors, followed by size (34 per cent) and picture quality (29 per cent). Energy efficiency was indicated as one of the top three factors by 14 per cent of respondents—less important than other features, but more important than brand and manufacturer's warranty. Caution should be used interpreting these results due to the small sample size.

Interviewees representing retailer and regulator perspectives suggested that the importance of energy efficiency in TVs to consumers' purchase decisions has changed over time as technology has progressed and TVs have become more energy efficient. Energy efficiency of the older, mostly obsolete CRT models that dominated the market until around 2003 was thought to matter more to consumers than the efficiency of the newer types of TVs now available, and picture quality has become increasingly important.

Objective 2: Supply-side Assessment

Total annual TV sales peaked in F2012 at 530,336 units.[10] After that, there was a declining trend in the number of TVs sold until F2017 which saw an increase of 10 per cent over F2016. The number of TVs sold in F2017 and F2018 appeared to stabilize around 355,000.

It is well recognized that TV technology has advanced rapidly over the past five to ten years. The functionality of TVs has advanced with application-loaded Smart TVs becoming the norm and connectivity to the internet becoming increasingly important.

Results of the annual floor stock study reveal that Organic LED (**OLED**) and Ultra High Definition (**UHD**) TVs have a greater showroom presence than in previous years. From 2014 to 2017, the percentage of LED-HD TVs displayed in retailer showrooms fell from 85 per cent to 52 per cent, while UHD models increased from 18 per cent in 2015 to 44 per cent in 2017. Recent advances in the LED technologies, such as OLED, QLED (Quantum Dot LED) or UHD[11], provide higher image quality on larger screens sizes and have higher power draw.

As explained by the interview participants, advances in TV display technology have generally led to gains in energy efficiency over the years. Consumption per square inch of screen decreased four-fold from the end of F2010 to the end of F2014, levelling off in F2016 to around 120 W per year per square inch. However, although the new technologies are more energy efficient than the old CRT technology, TV power draw increases with screen size. The TV sales data for B.C. shows that TVs with smaller sized screens (i.e., 40 inches or less) are being replaced with larger sized screens. At the end of F2010, 8 per cent of TVs sold had a screen size of greater than 50 inches as compared to 35 per cent of sales at the end of F2018.

Overall, there has been a general decline since F2014 in the proportion of TVs sold in B.C. that are Energy Star rated. The reason for this trend cannot be ascertained by the evidence used in this evaluation. However, during the interviews, retailer and regulator representatives indicated that the test procedures for measuring the energy efficiency of TVs are not well-suited to some of the new technologies or functionalities, such as network connectivity, making it difficult to apply energy efficiency standards in the same manner as has been done historically.

As noted earlier, from F2011 to F2018, there were three versions of the TV regulation for energy efficiency in B.C. The previous evaluation of the TV market conducted a detailed examination of compliance with the province's 2013 TV regulation. In general it was found that the share of TVs that met or exceeded the efficiency level specified by the 2013 regulation increased over the period from F2010 to F2014. By the first quarter of 2012, immediately following the regulation taking effect, compliance had reached 92 per cent climbing to 97 per cent by the fourth quarter of 2014. The current evaluation period encompasses the change to the regulation implemented in 2015, which dropped the limit on power draw in on mode. The high rate of compliance to the regulation continued through to the end of F2018, reflecting the fact that most TVs complied with the limit on power draw in standby and off modes that remained in the regulation. Analysis revealed a steady decline in the percentage of TVs sold that met the previous limit on power draw in on mode.

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[10] Note that BC Hydro serves approximately 1.7 million residential accounts. Sales levels of 0.5 million per year imply that most BC Hydro residential customers had purchased at least one new TV between F2011 and F2014. The higher sales in F2011 and F2012 are most likely related to the switch from analog to digital broadcasting that began in 2010 and possibly the desirability of the new LCD/LED technology that was entering the market.

[11] Note that Ultra High Definition models are also based on LED technology, while LED refers to standard High Definition models.

Objective 3: Gross Electricity Savings

The reported and evaluated gross electricity energy and peak demand savings are presented in Table 11.

Table 11 Summary of Energy and Peak Demand Savings

Fiscal Year	Gross Energy Savings (GWh/year)		Peak Demand Savings (MW)	
	Reported	Evaluated	Reported	Evaluated
F2015	64	50	15	12
F2016	65	45	15	11
F2017	69	42	16	10
F2018	64	33	15	8

Evaluated savings were 93 GWh/year less than the reported savings for the four year evaluation period. The evaluated gross savings were consistently lower than the reported savings, and the gap increased every year. In F2015 evaluated savings were 14 GWh/year lower than the reported savings for that year, followed by a gap of 20 GWh/year in F2016, 28 GWh/year in F2017 and 31 GWh/year in F2018.[12]

The main factors contributing to the variance between reported and evaluated savings are hours of use and annual sales figures. Reported savings were estimated based on 5.6 hours/day while evaluated savings used 5.0 hours/day based on more recent data. Projected TV sales used for reported savings were consistently higher than actual sales, by 11 per cent to 32 per cent depending on the year. By adjusting the assumptions used to calculate reported savings, it was estimated that, together, these two factors account for approximately 72 per cent of the variance.

The remaining 28 per cent of the variance can be attributed to several recent changes to TV characteristics, in particular the increase in screen size over the four year period and the introduction of slightly less energy efficient technology, both of which appear to have had the greatest impact in F2018. Note that increasing screen size has a negative influence on estimated savings because the baseline was taken as the market average consumption of models sold in F2010, which were on average smaller in size. A baseline that would have accounted for the steady trend of increasing screen size would produce a different result and larger savings.

Standby mode consumption was low (most were less than 0.5 watts per unit) and consistent across the evaluation years, and therefore, contributed only marginally to the variance.

[12] Differences from the above table are due to rounding.

4.4 Findings and Recommendations

Findings

Below are the main evaluation findings.

Demand Side Assessment

1. The type of TV installed in BC Hydro customers' homes has changed dramatically over the past ten years, reflecting the rapid changes in TV technologies. The most noteworthy change has been the move away from standard CRT TVs to LCD TVs and then to LED TVs.

2. Survey results for recent purchasers of new TVs revealed the top three drivers of TV purchase decisions to be, in order of importance: price, screen size, and picture quality. Energy efficiency was rated as a top consideration by only 14 per cent of survey respondents. These results were confirmed in interviews with TV retailers and regulators.

Supply Side Assessment

3. Overall, new TV sales have declined since 2012 and sales appear to have plateaued in F2017 and F2018.

4. The new TV market continues to change rapidly with the introduction of new technologies such as Smart TVs and Ultra High Definition.

5. New TV technologies are more efficient than the old CRTs, but larger screen sizes and improved picture quality require greater power. Therefore, although power draw per square inch has declined dramatically since 2010, the overall power draw of a television unit began to increase after 2015 as screen sizes got bigger and TV technology changed.

6. Since the beginning of F2015, there has been a decline in the proportion of new TVs sold that are Energy Star certified, from over 80 per cent to less than 50 per cent.

7. Retailers and regulators interviewed noted that energy efficiency of TVs is more complicated to measure because of new technologies, additional functionality and increase in screen size, and the tests need to be revised.

8. Compliance with the TV regulation has been over 90 per cent since the B.C. regulation took effect in 2012. Since 2015, when the on mode power limit was removed from the regulation, compliance has been almost 100 per cent. However, average power draw in on mode has begun to increase. From the start of 2016 to the end of 2018, the percentage of TVs sold with on mode power draw higher than the standard set forth in the previous regulation increased from 5 per cent to 25 per cent.

Gross Savings

9. Gross evaluated savings in the new TV market were 50, 45, 42, and 33 GWh/year, respectively, for each year from F2015 to F2018. In contrast, the reported savings for each year over the same period ranged from 64 GWh/year to 69 GWh/year.

10. The evaluated gross savings were consistently lower than the reported savings, and the gap increased in each year. In F2015 evaluated savings were 22 per cent lower than the reported savings for that year, followed by a gap of 31 per cent in F2016, 39 per cent in F2017 and 48 per cent in F2018. There were two main factors that contributed to the

variance. Reported savings were estimated based on 5.6 hours/day while evaluated savings used 5.0 hours/day based on more recent data. Projected TV sales used for reported savings were consistently higher than actual sales, by 11 per cent to 32 per cent depending on the year. Together, these two factors account for approximately 72 per cent of the variance. The remaining 28 per cent of the variance can be attributed to several recent changes to TV characteristics, in particular the increase in screen size over the four year period and the introduction of slightly less energy efficient technology, both of which appear to have had the greatest impact in F2018.

Recommendations

The following recommendations flow from the findings of this evaluation. Recommendations #1 and #2 are for the BC Hydro Codes and Standards group. Recommendation #3 is for Evaluation.

1. Given the rapid changes in TV technologies and features, review the assumptions and calculation inputs used in the energy savings forecast for the TV market on a regular basis.
2. Explore how standard test methods can be changed to better align with new TV technologies and uses.
3. Consider undertaking survey and/or residential monitoring or metering studies to examine and better understand current TV-usage behaviours and hours of use among BC Hydro customers.

4.5 Conclusions

The new TV market continues to change rapidly and new technologies are resulting in homes using larger screen sizes that provide high quality picture and additional features that are important to consumers. Energy efficiency has begun to decline in the on power mode, but efficiency in the off and standby power modes remains high. The changes in the TV market resulted in evaluated savings being lower than reported savings in the F2015 to F2018 period.

Glossary

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

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

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

Free Riders: Free riders are program participants who would have taken the 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 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.

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.