BC Hydro
Power smart

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January 15, 2026

Keshni Nand
Registrar
British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Keshni Nand:

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 F2025 Demand Side Management Milestone Evaluation Summary Report dated January 2026.

Directive 66 "directs BC Hydro to file the executive summaries of its milestone evaluation reports and full final evaluation reports of all its Power Smart programs". The terminology "Power Smart programs" includes rates and programs undertaken to conserve energy or promote energy efficiency.

The F2025 Demand Side Management Milestone Evaluation Summary Report summarizes the evaluations completed during fiscal 2025 for the following:

1. Appliances Standard: F2010 (Q4) to F2024.
2. General Service Lamps: F2018 to F2023.
3. Television Market: F2019 to F2023.
4. Leaders in Energy Management-Commercial (LEM-C): F2021 to F2023.

For further information, please contact Alicia Henderson at bchydroregulatorygroup@bchydro.com.

Yours sincerely,

Chris Sandve
Chief Regulatory Officer

sg/cm

Enclosure

Demand Side Management Milestone Evaluation Summary Report F2025

January 2026

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1 Introduction

This report summarizes the milestone evaluations of demand-side management (**DSM**) initiatives completed by BC Hydro in fiscal year 2025 (**F2025**). 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:

1. Objectivity and Neutrality: Evaluations are to be objective and neutral.
2. Professional Standards: Evaluation work is guided by industry standards and protocols.
3. Qualified Practitioners: BC Hydro employs qualified staff and consultants to conduct evaluations.
4. Appropriate Coverage: BC Hydro strives to achieve defined coverage levels for its evaluation of DSM initiatives.
5. Business Integration: The evaluation function is integrated into BC Hydro's DSM business process of planning, implementation, reporting and evaluation.
6. 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:

1. Appliances Standard: F2010 (Q4) to F2024
2. General Service Lamps: F2018 to F2023
3. Television Market: F2019 to F2023
4. Leaders in Energy Management-Commercial: F2021 to F2023

2 Appliances Standard: F2010 (Q4) to F2024

2.1 Introduction

This market and impact evaluation examines the annual sales, stock turnover and gross electricity savings for residential-grade clothes washers, dishwashers, freezers, and refrigerators in BC Hydro's service territory. These savings are associated with regulations introduced through the B.C. Energy Efficiency Act and the Federal Energy Efficiency Act which regulate appliance efficiency.

Energy efficiency regulations governing Minimum Energy Performance Standards (**MEPS**) for these appliances have been enacted by both the provincial and federal governments since 2010 and include:

- Canada's Federal Energy Efficiency Regulation Amendment 10 (FA10) effective January 1, 2010 (for residential dishwashers only),
- The B.C. Energy Efficiency Standards Regulation B.C. 14/2015 (BCA5) effective February 4, 2015, and
- Canada's Federal Energy Efficiency Regulation Amendment 13 (FA13) effective June 28, 2017.

This evaluation focuses on electricity savings up to, but not beyond, the minimum energy performance level dictated by these standards. It does not include incremental savings from appliances exceeding these standards and does not attempt to determine the share of savings directly attributable to regulatory changes.

The evaluation period spans from F2010 (Q4) to F2024. However, as the regulations impact the appliances based on their manufacturing dates, and the compliance date differs for each appliance group, their specific evaluation period varies. The estimated savings for dishwashers cover the period from F2010 (Q4) to F2024, clothes washers from F2016 to F2024, and refrigeration products including freezers and refrigerators from F2018 (Q2) to F2024.

2.2 Approach

The table below provides the objectives, research questions, data sources, and methods for this evaluation.

Table 2.1 Evaluation Objectives, Research Questions, Data and Methods

Evaluation Objectives and Research Questions	Data Sources	Methods
Objective 1: Supply-side assessments for clothes washers, dishwashers, refrigerators and freezers		
What were the trends in the energy efficiency of appliances shipped? What were the trends in product characteristics (e.g., new technologies, size, capacity) for each type of appliance over the general evaluation period?	▪ BC Hydro Floor Stock Studies (2009-2023) ▪ Natural Resources Canada (NRCan) National Energy Use Database	▪ Frequencies ▪ Trends analysis
Objective 2: Demand-side assessment for clothes washers, dishwashers, refrigerators, and freezers		
How important is energy efficiency for residential customers when purchasing a new appliance? Has the level of importance changed over the general evaluation period? What were the sales and total stock of each appliance type in residential customer homes from F2010 (Q4) to F2024?	▪ Major Appliances Recycling Roundtable Annual Reports ▪ BC Hydro Appliance Standards Survey (2024) ▪ BC Hydro Residential End-Use Studies (2006 to 2023) ▪ BC Hydro Commercial End-Use Study (2019) ▪ BC Hydro Appliance Rebate Program Surveys (2016 & 2018)	▪ Frequencies ▪ Cross tabulations ▪ Extrapolation ▪ Stock and flow model estimates

Evaluation Objectives and Research Questions	Data Sources	Methods
Objective 3: Gross electrical energy and peak demand savings for clothes washers, dishwashers, refrigerators and freezers		
For units sold into BC Hydro residential homes, what were the gross electrical energy and peak demand savings due to changes in the stock in B.C. from F2010 (Q4) to F2024 for each appliance covered by the regulation? What were the total savings?	▪ BC Hydro Floor Stock Studies (2009-2023) ▪ Natural Resources Canada (NRCan) National Energy Use Database ▪ California Energy Commission Modernized Appliance Efficiency Database System ▪ Major Appliances Recycling Roundtable Annual Reports ▪ BC Hydro Appliance Standards Survey (2024) ▪ BC Hydro Residential End-Use Studies (2006 to 2023) ▪ BC Hydro Commercial End-Use Study (2019) ▪ U.S. Department of Energy Technical Support Documentation ▪ Canadian Standards Association (CSA) Testing Procedures Documentation	▪ Engineering algorithms ▪ Extrapolation

2.3 Results

Results for Objective 1: Supply-Side Assessments

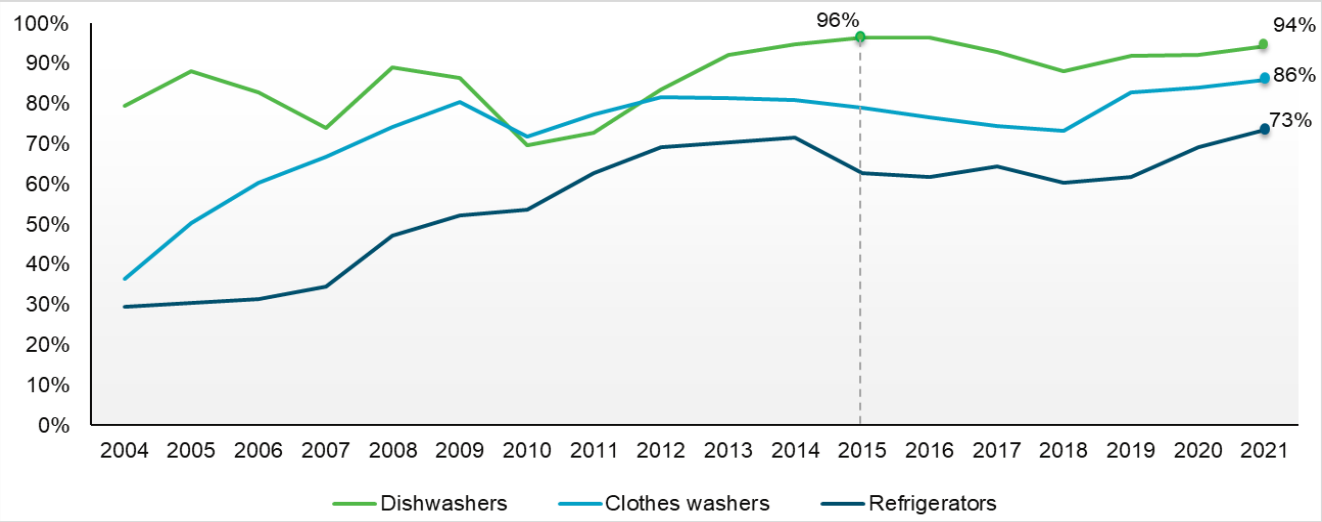
Trends in the Energy Efficiency of Appliances

The NRCan national energy use database provided the percentage of appliances in total shipments by region/province from 2004 to 2021 that were certified as ENERGY STAR.[1] This data informed the trend lines of ENERGY STAR distributions for dishwashers, clothes washers, and refrigerators shipped specifically to B.C., as illustrated in Figure 2.1.

This information was important for estimating an appliance's gross unit electricity savings, given that ENERGY STAR-certified appliances are typically at least 15% more energy efficient than those meeting only the MEPS. Specifically, for the period prior to a regulation's inception, shipment data helped estimate the percentage of units likely already compliant with the associated regulation, meaning replacements after the regulation would often result in no additional savings.

[1] ENERGY STAR is a government-backed program that certifies and labels products, homes and buildings that meet specific energy efficiency standards. It was established by the U.S. Environmental Protection Agency (EPA) in 1992, and adopted in Canada, to encourage manufacturers to develop more efficient technologies and provide consumers with information to make informed purchase decisions.

Figure 2.1 ENERGY STAR® Certified Appliances as a Percentage of Total Shipments in B.C. (%)



Source: NRCan Energy Consumption of Major Household Appliances Shipped in Canada, 2000–2021 – Table 1

Highlights of these trends include:

- In 2004, about 80% of dishwashers in the B.C. market were ENERGY STAR qualified. This percentage dropped to 70% in 2010. One possible reason for this decrease might be tied to the federal regulation enacted in 2010. Because the minimum performance level for standard-size dishwashers under the regulation was the same as the basic ENERGY STAR rating, there was little incentive for manufacturers to pursue the ENERGY STAR certification for these particular appliances. The peak certification level reached 96% in 2015 and remained at approximately 90% or higher thereafter.
- In 2021, 73% of shipped refrigerators, 86% of shipped clothes washers and 94% of shipped dishwashers were ENERGY STAR certified.
- The percentage of shipped clothes washers and refrigerators certified as ENERGY STAR have shown steady growth over the past two decades.

Floor stock studies provided an additional data source in understanding the supply-side of the market. For instance, during the evaluation period, ENERGY STAR certification ranged from low 70% to mid-90%. For top-loading units, certification was lower, ranging from low 30% to mid-60%.

Trends in Product Characteristics

NRCan shipment distribution by appliances type also enhanced understanding of technological transformations over time. This informed the estimation of an appliance's unit electricity consumption (UEC) pre- and post-standard for Objective 3 calculations. As one example, upright freezers evolved over the past 20 years from mainly being the manual defrost variety to mainly being auto-defrost.

Compact size freezers gained in popularity, while chest freezers declined. Again, these are among the many factors and product characteristics that directly impact energy consumption.

Results for Objective 2: Demand-Side Assessments

Importance of Energy Consumption When Purchasing a New Appliance – The extent that customer households adopt appliances considered to be energy efficient, and the magnitude of the chosen efficiency, has been increasingly framed over the past 20 years by the implementation of government standards. Within this framework, however, consumers have always been able to choose and purchase an appliance based on their own preferences and criteria, which may or may not include its level of efficiency. This section presents research

findings from the past and present in regards to the importance that residential customers reportedly place on energy efficiency when purchasing a new appliance.

A Longitudinal View on the Importance of Energy Consumption When Purchasing a New Appliance – There has been no wholesale change dating back to 2006 when tracking began on the Residential End-Use Study (REUS) in the importance that residential customers reportedly place on energy consumption when buying a new appliance. Total agreement that it is *'an important consideration in their decision'* has always measured at the low to mid 80% level.

This serves as a high level, all-in-one indicator of consumer sentiment over time. As explained below, however, an appliance's energy efficiency is seen to be comparably less important when considered 'head-to-head' with other potential purchase criteria.

A Hierarchical View on the Most Important Criteria When Purchasing a New Appliance – The 2024 Appliance Standards Survey asked customer households their last major appliance purchase in the past three years. For their last type purchased, a household was then queried to select – from a prepopulated list – the one most important criterion in their decision to choose that particular model. The intent behind this approach was to circumvent the potential for households to indiscriminately rate all of the potential purchase elements as important in their decision.

Table 2.2 below details the findings for each of six appliances investigated. For each of them, 'energy efficiency' was selected by only a minority of households as having been the 'most important' factor in their purchase decision. Size or capacity, price, overall quality and brand name all emerge to be comparably more important. In fact, these findings are fairly consistent with those gleaned from earlier BC Hydro research studies.

With 15 to 18% of mentions, energy efficiency was comparably more important for clothes washers and clothes dryers than the other four appliances investigated.

Table 2.2 Hierarchical View on the Most Important Criteria When Purchasing a New Appliance

	Refrigerator	Compact Bar Fridge	Standalone Freezer	Dishwasher	Clothes Washer	Clothes Dryer
	n=790	n=51	n=156	n=307	n=362	n=114
	%	%	%	%	%	%
Size / capacity	28	41	55	6	19	14
Price (exclude. any after purchase rebates)	17	37	23	23	21	19
Overall quality	15	2	7	33	25	28
Brand name / good brand	13	9	4	20	11	8
Energy efficiency	11	5	9	10	15	18
Features	9	6	<1	6	8	7
Colour	2	0	0	<1	<1	0
Manufacturer's warranty	2	0	1	<1	1	5
Eligible for a rebate	<1	0	0	<1	0	<1
Other	1	0	<1	1	0	<1
Total	100	100	100	100	100	100

Sales, Total Stock and Retired Stock of Appliances by Fiscal Year

For each appliance type, the tables in this section present their estimated annual sales – by volume – into BC Hydro customer homes, as well as their total accumulated stock (installation) by fiscal year dating back to

F2016. Although not an official evaluation question, the estimated number of appliances retired by residential customers is also presented as these volumes were needed to discount any new sales that could have possibly replaced any retired units already compliant to the code.

Be reminded that the evaluation period of interest for automatic dishwashers began in F2010 (Q4) and for clothes washers F2016 (Q1). For refrigerators and freezers, it was later in F2018 (Q2). However, annual sales estimates of the appliances, as well as their total stock, dating back to F2009 were required to inform baseline inputs prior to any of the standards having taken effect.

Dishwashers – Table 2.3 details the estimated sales of dishwashers into BC Hydro customer households by fiscal year dating back to F2016, as well as their total stock and retired stock.

Table 2.3 Estimated Sales, Total Stock and Retired Stock by Fiscal Year: Dishwashers

Dishwashers									
	F2016	**F2017**	**F2018**	**F2019**	**F2020**	**F2021**	**F2022**	**F2023**	**F2024**
Sales volume	99,100	110,900	112,900	117,900	122,100	133,900	132,000	121,800	124,100
Total stock	1,350,700	1,361,500	1,407,300	1,454,700	1,503,900	1,540,000	1,580,400	1,615,600	1,647,800
Retired stock	86,700	100,100	67,100	70,500	72,900	97,800	91,600	86,600	91,900

As with the other appliances, there has been a general upward trend in the sales volumes. This has primarily been in step with the year-to-year growth of accounts – new homes being built and connecting to BC Hydro's electrical grid. However, the higher volumes are also partially due to small increases in per capita adoption of the appliances.

Looking specifically at F2024, the sales of dishwashers were estimated to have been 124,100 units and the retirements were estimated to have been 91,900 units – each the third highest of the five appliances investigated. The net of these two estimates increased the total stock of dishwashers from 1,615,000 units at year-end F2023 to 1,647,800 units at year-end F2024 – again, the third highest of the five appliances.

Clothes Washers – Table 2.4 details the estimated sales of clothes washers into customer households by fiscal year dating back to F2016, as well as their total stock and retired stock.

In F2024, the sales of clothes washers were estimated to have been 135,500 units, and the total stock at year-end was estimated to have been 1,845,500 units – each the second highest, but well behind refrigerators.

Table 2.4 Estimated Sales, Total Stock and Retired Stock by Fiscal Year: Clothes Washers

Clothes Washers									
	F2016	**F2017**	**F2018**	**F2019**	**F2020**	**F2021**	**F2022**	**F2023**	**F2024**
Sales volume	107,500	117,400	120,000	126,600	139,600	151,600	145,400	133,300	135,500
Total stock	1,603,700	1,639,000	1,660,800	1,683,300	1,705,200	1,741,200	1,781,700	1,816,400	1,845,500
Retired stock	72,700	82,100	98,200	104,100	117,700	115,600	104,900	98,600	106,400

Freezers – Table 2.5 below details the estimated sales of freezers into BC Hydro customer households by fiscal year dating back to F2016, as well as their total stock and retired stock.

Table 2.5 Estimated Sales, Total Stock and Retired Stock by Fiscal Year: Freezers

	Freezers								
	F2016	**F2017**	**F2018**	**F2019**	**F2020**	**F2021**	**F2022**	**F2023**	**F2024**
Sales volume	41,400	51,500	58,000	50,800	56,900	89,400	87,100	85,700	75,400
Total stock	987,700	996,700	1,031,500	1,067,600	1,106,900	1,147,100	1,191,000	1,231,500	1,270,100
Retired stock	32,400	42,500	23,200	14,700	17,600	49,200	43,200	45,200	36,800

Refrigerators – Table 2.6 details the estimated sales of refrigerators into customer households by fiscal year dating back to F2016, as well as their total stock and retired stock.

For every fiscal year, refrigerator sales volume and total stock were higher than those of the other four appliances investigated. This was expected given their ubiquitous use in residential settings. While annual retirement levels ranked second or third for several years, they climbed to the highest position beginning in F2021.

Table 2.6 Estimated Sales, Total Stock and Retired Stock by Fiscal Year: Refrigerators

	Refrigerators								
	F2016	**F2017**	**F2018**	**F2019**	**F2020**	**F2021**	**F2022**	**F2023**	**F2024**
Sales volume	127,900	133,300	137,300	142,400	150,600	167,700	160,600	143,400	149,100
Total stock	2,278,200	2,333,800	2,380,400	2,428,600	2,479,100	2,519,600	2,566,200	2,603,900	2,642,000
Retired stock	71,700	77,700	90,700	94,200	100,100	127,200	114,000	105,700	111,000

In F2024, the refrigerator sales were estimated at 149,100 units, and retirements were approximately 111,000 units. The net of these two estimates increased the total stock of refrigerators from 2,603,900 units at year-end F2023 to 2,642,000 units at year-end F2024 – again, the highest of the five appliances.

Compact Bar Fridges – Table 2.7 details the estimated sales of compact bar fridges into customer households by fiscal year dating back to F2016, as well as their total stock and retired stock.

Note that in the next steps of calculating electricity savings, all estimates for compact bar fridges were combined with those for refrigerators.

Table 2.7 Estimated Sales, Total Stock and Retired Stock by Fiscal Year: Compact Bar Fridges

	Compact Bar Fridges								
	F2016	**F2017**	**F2018**	**F2019**	**F2020**	**F2021**	**F2022**	**F2023**	**F2024**
Sales volume	37,300	44,000	42,100	36,400	34,500	40,000	45,800	38,800	35,700
Total stock	270,100	286,300	303,100	320,500	336,600	372,400	410,300	445,900	469,700
Retired stock	19,900	27,800	25,300	19,000	18,400	4,200	7,900	3,200	11,900

Results for Objective 3: Gross Electrical Energy and Peak Demand Savings

This section uses estimated annual sales volumes and retirement volumes for the evaluated appliances to calculate gross electricity savings associated with the enacted regulations. Notably, these volumes pertained to all new and retired units in the market, regardless of their efficiency level.

An additional key input into the calculation of gross electricity savings is the unit savings based on estimates of unit electricity consumption (UEC) before and after the implementation of the various standards. As a reminder, this evaluation focuses on electricity savings of appliances up to, but not beyond, the minimum energy performance level as dictated by the provincial and federal standards. Although such appliances are included in

the count of sales, the unit electricity savings does not include any incremental savings from the adoption of those with an even higher level of energy efficiency.

Not all units sold contributed to gross energy savings. Compliant products retired and replaced during the evaluation period may not have generated the same level of savings as non-compliant products. These products were examined separately and excluded from total sales if no savings were realized.

Total Gross Electrical Energy Savings

As detailed in Table 2.8 on the following page, the total evaluated gross electrical energy savings for the four major appliances accumulated to 283 GWh per year over the entire evaluation period F2010 (Q4) through F2024. A brief synopsis for each appliance is presented below.

Dishwashers – The energy efficiency regulation for dishwashers came into effect in F2010 (Q4) and the total accumulated savings were estimated to have been 59 GWh per year. This contributed 21% of the total evaluated savings for all four appliances.

Clothes washers – The next regulation of interest to take effect pertained to clothes washers in F2016. The associated gross savings since the standard's implementation were estimated to have accumulated to 150 GWh per year – 53% of the total evaluated savings.

Freezers and Refrigerators – The efficiency standard for freezers and refrigerators came into effect in F2018 (Q2). After accounting for cross effects, the total estimated gross energy savings for freezers were 39 GWh/year and 35 GWh per year for refrigerators, contributing 14% and 12% of the total evaluated savings, respectively.

Table 2.8 details the evaluated gross electrical energy savings for each of the four appliances under review by fiscal year and in grand total.

Table 2.8 Total Gross Electrical Energy Savings of Evaluated Appliances

Fiscal Year	Gross Energy Savings (GWh/year)				
	Dishwashers	Clothes Washers	Freezers	Refrigerators	Total
F2010 (Q4)	0.5	--	--	--	0.5
F2011	2.2	--	--	--	2.2
F2012	2.3	--	--	--	2.3
F2013	2.2	--	--	--	2.2
F2014	2.2	--	--	--	2.2
F2015	2.1	--	--	--	2.1
F2016	4.6	7.5	--	--	12.1
F2017	5.8	9.9	--	--	15.7
F2018	5.8	11.6	3.5	4.1	25.0
F2019	6.0	18.4	4.5	5.4	34.3
F2020	5.9	23.0	4.6	5.2	38.7
F2021	5.8	23.5	6.5	5.3	41.1
F2022	5.4	20.8	7.0	5.4	38.6
F2023	4.5	17.7	6.9	4.7	33.8
F2024	3.5	17.9	6.3	4.7	32.4
Total	59	150	39	35	283

Individual estimates may not sum to the totals as shown due to the rounding of values (estimates in the total line have been rounded).

Total Gross Peak Demand Savings

The cumulative gross demand savings for the entire evaluation period were estimated at 52 MW. The contributions were as follows: clothes washers accounted for 25 MW, dishwashers for 18 MW, freezers for 5 MW, and refrigerators for 4 MW.

Table 2.9 Total Gross Peak Demand Savings of Evaluated Appliances

Fiscal Year	Gross Demand Savings (MW)				
	Dishwashers	Clothes Washers	Freezers	Refrigerators	Total
F2010 (Q4)	0.2	--	--	--	0.2
F2011	0.7	--	--	--	0.7
F2012	0.7	--	--	--	0.7
F2013	0.7	--	--	--	0.7
F2014	0.7	--	--	--	0.7
F2015	0.6	--	--	--	0.6
F2016	1.4	1.3	--	--	2.7
F2017	1.7	1.7	--	--	3.4
F2018	1.7	2.0	0.4	0.5	4.6
F2019	1.8	3.1	0.5	0.6	6.0
F2020	1.8	3.9	0.6	0.6	6.9
F2021	1.7	4.0	0.8	0.6	7.1
F2022	1.6	3.5	0.8	0.6	6.5
F2023	1.4	3.0	0.8	0.6	5.8
F2024	1.1	3.0	0.8	0.6	5.5
Total	18	25	5	4	52

Individual estimates may not sum to the totals as shown due to the rounding of values (estimates in the total line have been rounded).

2.4 Findings and Recommendations

The main findings of the evaluation are summarized below by evaluation objective.

Supply-Side Assessments

1. The ENERGY STAR Initiative in Canada for major appliances has made significant progress over the past two decades. Between 2004 and 2021, the share of shipped appliances certified as ENERGY STAR rose from 80% to 94% for dishwashers, from 36% to 86% for clothes washers, and from 29% to 73% for refrigerators. Early purchases of ENERGY STAR appliances were sometimes already compliant with federal and provincial regulations before these standards came into effect.
2. Over the evaluation period, newer features and technologies had been designed and built into the appliances. For example, auto defrost upright freezers became more popular in the market than manual defrost models since 2015. Additionally, the floor stock studies show that front-loading clothes washers are more energy-efficient than top-loading models.

Demand-Side Assessments

3. There has been no wholesale change in customer agreement that *'energy consumption is an important consideration in their decision when buying a new appliance'*, with this agreement measuring above 80% for nearly 20 years.
4. However, when presented with many other potential factors in a purchase decision, only a minority of customers point to an appliance's energy efficiency as being the most important criteria. Size or capacity, price, overall quality and brand name all emerge to be comparably more important.
5. Refrigerators consistently had the highest sales and stock levels across all fiscal years. This was to be expected given their ubiquitous use in residential settings. Their annual retirement levels were second or third position for several years but climbed to highest beginning in F2021.
    - Looking strictly at F2024, the sales of refrigerators were estimated at 149,100 units and the total stock at year-end was estimated at 2,642,000 units.
    - The sales of clothes washers were estimated at 135,500 units in F2024, and the total stock at year-end was estimated at 1,845,500 units – each the second highest of the five appliances.
    - The sales of automatic dishwashers were estimated at 124,100 units in F2024, and the total number of installations was estimated at 1,647,800 units – the third highest of the five appliances.
    - Sales volumes for freezers and compact bar fridges in F2024 were comparably much lower than other appliances at 75,400 units and 35,700 units, respectively. Their total stock at year-end was estimated to have been 1,270,100 units and 469,700 units, respectively.

Gross Electrical Energy and Peak Demand Savings

6. Total evaluated gross electrical energy savings for the four major appliances amounted to 283 GWh/year from F2010 (Q4) to F2024. Clothes washers contributed 150 GWh/year, dishwashers 59 GWh/year, freezers 39 GWh/year, and refrigerators (with and without freezer compartments) 35 GWh/year, respectively.
    - These savings were 53 GWh per year lower than reported gross savings of 336 GWh per year.
    - Much of this variance is tied to clothes washers and a key input gleaned from the survey research for the estimation of their gross unit electricity savings. Specifically, the findings show BC Hydro residential customers conduct about 25% fewer washing cycles per year than the CSA testing assumptions.
7. Associated peak demand savings were estimated to have accumulated to 52 MW based on peak-to-energy factors.[2] The contributions were as follows: clothes washers accounted for 25 MW, dishwashers for 18 MW, freezers for 5 MW, and refrigerators for 4 MW.
    - This was 9 MW lower than reported gross demand savings of 61 MW.

Recommendations

The following recommendations flow from the findings of this evaluation.

1. Continue data sharing between Evaluation and Codes & Standards teams to inform estimates of reported and forecast savings.

[2] The relevant peak-to-energy factors are 0.17, 0.3, and 0.12 MW per GWh for clothes washers, dishwashers, and freezers and refrigerators (with and without freezers), respectively. These ratios were derived from hourly end-use load shapes from the NEEA residential metering study of 2014.

2. Revise historical and forecasted savings reporting for the Appliance Regulation to align with the results of this evaluation for the product categories in scope.

2.5 Conclusions

Since the inception of the appliance standards under review from F2010 (Q4) to F2024, the total evaluated gross electrical energy savings for residential clothes washers, dishwashers, freezers, and refrigerators amounted to a cumulative 283 GWh per year, with corresponding gross demand savings of 52 MW.

3 General Service Lamps: F2018 to F2023

3.1 Introduction

This market and impact evaluation examines changes in the market and in-home installation trends for residential lighting in British Columbia from April 2017 through March 2023, representing BC Hydro's fiscal years 2018 through 2023. It also presents evaluated gross savings in the residential sector from the reduction in electricity usage of general service lamps (GSL) that followed the introduction of energy efficiency regulations. Estimates of gross savings at industrial and commercial facilities are not included. A prior evaluation of general service lamps was completed in December 2017, covering savings up to F2017.

Phase 1 of British Columbia's GSL Regulation came into force on January 1, 2011. The GSL Regulation provided minimum energy performance standards for a range of medium base screw type electric lamps, effectively banning 75 to 100 Watt incandescent lamps. Phase 2 of the regulation came into force in January 2015 when national minimum energy performance standards for 40 to 60 Watt general service lamps came into effect, which effectively banned 40 to 60 Watt incandescent lamps.

BC Hydro includes gross electricity savings from the GSL Regulation in its reported and forecast demand-side management (DSM) savings.

3.2 Approach

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

Table 3.1 Evaluation Objectives, Research Questions, Data Sources and Methods

Evaluation Objectives and Research Questions	Data Sources	Method
Objective 1: Supply side analysis		
What are retailers shelf share trends by lamp and technology type? What are price trends by lamp type?	▪ Shelf Stock Studies from F2012 to F2022 (n=approximately 40 stores per year)	▪ Cross tabulations ▪ Trend analysis
Objective 2: Demand side analysis		
What are long-term trends in the types of lamps used in the home? How many customers purchased and installed various lighting products? What are customer storage behaviours related to various lighting products?	▪ Telephone surveys of residential customers for F2011, F2012, F2013 (n=approximately 400 to 600 responses per survey) ▪ Online surveys of residential customers for F2016 to F2022 (n=approximately 900 to 5,500 responses per survey) ▪ Residential End Use Studies from F2002, F2004, F2007, F2009, F2011, F2013, F2015, F2017, F2020, F2023 (n=approximately 4,200 to 8,900 responses for the lighting section)	▪ Cross tabulations ▪ Trend analysis
Objective 3: Gross energy savings from conversion of incandescent lamps		
How much conversion of 40, 60, 75 and 100 Watt incandescent lamps to other lamp types occurred in the homes of BC Hydro customers between F2018 and F2023 What is the wattage of 40, 60, 75 and 100 Watt replacement lamps?	▪ F2017 Residential Audit (233 homes) ▪ F2024 Residential Audit and Monitoring Study (n=53 homes) ▪ Residential End Use Surveys from F2017, F2020, F2023 (n=approximately 6,900 to 8,900 responses for the lighting section)	▪ Engineering algorithms

Evaluation Objectives and Research Questions	Data Sources	Method
▪ **Objective 3: Gross energy savings from conversion of incandescent lamps**		
What are the gross energy savings associated with conversion of 40, 60, 75 and 100 Watt lamps to other wattages? What are the reasons behind any variance between reported and evaluated gross savings?	▪ BC Hydro Annual Report for F2023	▪

3.3 Results

Results for Objective 1: Supply Side Analysis

The shares of lamp retail shelf space occupied by different lighting products within BC Hydro's service territory have been tracked in shelf space studies since F2012. Incandescent lamps held the majority share at 51% in F2012, but this decreased to just 13% by F2022. Likewise, Compact Fluorescent Lamps (CFL) also saw a declining trend, decreasing from about a 25% share in F2012 through F2014 to just 3% by F2022. During the same period, the share of LED lamps rose rapidly from just 4% in F2012 to 67% by F2022.

Results for Objective 2: Demand Side Analysis

Between F2002 and F2020, total lamps installed in the home, as tracked in Residential End Use Studies (**REUS**), generally increased, reaching approximately 40 lamps per home in the F2017 and F2020 studies. However, there was a slight decrease in F2023 to approximately 38 lamps per home, which was likely partially the result of an increased prevalence of integrated LED light fixtures, which are measured separately from bulbs and tubes in the study.

Over the same period, the average number of incandescent lamps per home (both those covered by the GSL regulation and those exempt from it) decreased steadily, dropping from 25.3 in F2002 to 5.4 by F2023, with the decrease starting well before the Phase 1 and Phase 2 regulations. The incidence of having at least one incandescent lamp in the home also decreased, from 100% of homes in F2002 to 48% of homes by F2023. This period also saw the rise and fall of CFLs, from an average of less than 1 per home in F2002 to a high of 9.9 in F2013, followed by a drop to 3.2 by F2023. Halogens followed a similar pattern, increasing from an average of 2.4 lamps per home in F2002 to a high of 6.1 in F2015, followed by a decrease to 2.5 by F2023. These decreases were offset by a rapid increase in the installation of LEDs, with an average of 23.7 LEDs installed per home by F2023.

Results for Objective 3: Gross Energy Savings from Conversion of Incandescent Lamps

The gross savings analysis involved seven steps: 1) estimate the total number of incandescent lamps installed in homes in each year of interest, 2) determine the distribution of incandescent lamp wattages installed in homes, 3) estimate the average number of incandescent lamps per home by wattage, 4) calculate the power draw of GSL replacement lamps, 5) identify hours of use and peak coincidence, 6) adjust for cross effects, and 7) calculate evaluated gross savings.

The evaluated savings were calculated at 578.4 GWh per year (104% of reported savings), for an overall variance of 20.7 GWh per year. The associated peak capacity savings were evaluated at 123.2 MW based on changes in lamp counts, replacement wattages, and a peak coincidence factor obtained from the F2024 Residential Audit

and Monitoring Study (F2024 Monitoring Study). The peak capacity savings were 72% of reported savings due to a lower-than-expected peak coincidence factor measured from the F2024 Monitoring Study.

Table 3.2 Summary of Demand Side Analysis and Gross Energy Savings

	Energy Savings (GWh/yr)		Peak Capacity Savings (MW)	
F18 to F23	**Reported**	**Evaluated**	**Reported**	**Evaluated**
Phase 1 lamps	75.0	100.6	23.3	21.4
Phase 2 lamps	482.7	477.9	148.1	101.8
Total	**557.7**	**578.4**	**171.4**	**123.2**

Overall, the number of regulated incandescent lamps installed in homes decreased from 11.7 to 4.9, for a total reduction of 6.8 for both Phase 1 and Phase 2 lamps during the evaluation period. Reported savings assumed that by F2023, there would be a reduction of 14.2 million regulated lamps in BC Hydro's service territory. This evaluation estimated that by F2023, the reduction was 13.3 million regulated lamps. Overall, the decrease in lamp replacement contributed to a downward adjustment of 20.5 GWh per year from reported savings. This negative adjustment was offset by an upward savings adjustment of 8.7 GWh per year resulting from the higher wattage difference found in the evaluation. Lighting hours of use measured in the F2024 Monitoring Study were found to be 6% higher than identified in a previous study, which resulted in a 30.8 GWh per year upward savings adjustment. This increase in hours of use was associated with the increase in in-home business activities in recent years, as many employees transitioned to remote work and hybrid work after the COVID-19 pandemic. Finally, based on the most recent data from REUS 2023, cross effects were found to be slightly lower than the estimate used for reported savings, resulting in a 1.7 GWh per year positive savings adjustment.

3.4 Findings and Recommendations

Supply Side Analysis

1. The retail shelf space of incandescent lamps has continued to decrease and as of F2022 represented only 13% of total lighting shelf space, down from 51% a decade earlier. The shelf space of LEDs has continued its rise, from 4% of shelf space in F2012 to 67% in F2022, indicating that a shift towards energy efficient lighting has occurred in the market at the retail level.
2. The price of A-shaped LEDs has continued to decrease in recent years, although at a much lower rate than previously. In contrast, the price for A-shaped incandescent has slowly been increasing over the past decade.

Demand Side Analysis

3. The average number of incandescent lamps per home (both those covered by the GSL regulation and those exempt from it) has decreased steadily, dropping from 25.3 in F2002 to 5.4 by F2023. However, 48% of homes continue to report having at least one incandescent lamp installed in the home.
4. The share of customers who purchased at least one incandescent lamp in a given year has been steadily decreasing, down from 44% in F2012 to 10% in F2023. Among those customers who purchased at least one incandescent lamp, the average number of lamps purchased during the year has also decreased over the past decade, from 11.0 in F2012 to 4.9 in F2023.

5. Customers still have a high number of incandescent lamps in storage – an estimated 5.1 million across BC Hydro's service territory. However, some of these lamps may have been ones previously removed and replaced with other lamp types; customer intentions of installing these lamps were not explored.

Gross Energy Savings from Conversion of Incandescent Lamps

6. As of F2023, there were an average of 0.4 Phase 1 regulated incandescent lamps and 4.5 Phase 2 regulated incandescent lamps remaining in the home.
7. Cross effects through interactions with space heating and cooling systems were estimated to reduce gross savings by 5.7%.
8. The average lighting daily hours of use have increased by 6%, from 2.56 to 2.70 hours per day, between the F2011 and F2024 Residential Monitoring Studies conducted by BC Hydro. The increase in hours is likely due to the pandemic, which caused a major shift in how and where people spent their time, as many employees transitioned to remote work.
9. Evaluated cumulative gross electric energy savings in residential homes from changes in general service lighting were 578.4 GWh per year from F2018 to F2023, which represents 104% of reported savings. The evaluated peak capacity savings were 123.2 MW. The peak capacity savings were 72% of the reported due to a lower-than-expected peak coincidence factor measured from the F2024 Monitoring Study.

Recommendations

The following recommendations flow from the findings of this evaluation.

1. In future survey research and/or in-home audits, collect additional information on bulb shape, base size and special features in order to better understand the stock of incandescent bulbs still remaining in residential homes.
2. Continue to share information between Evaluation and Codes & Standards on available data that can inform estimates of reported and forecast savings.

3.5 Conclusions

There have been significant changes in the market for general service lamps between F2018 and F2023, with shifts occurring from incandescent to LED lamps, both on store shelves and installed in homes. Evaluated gross savings during this period were found to be 104% of reported savings at 578.4 GWh per year and 72% of reported peak capacity savings at 123.2 MW.

4 Television Market: F2019 to F2023

4.1 Introduction

This market evaluation assesses changes in market conditions for televisions (TVs) sold in British Columbia and energy savings in the context of the 2011 and 2015 provincial regulations on TV energy efficiency—covering BC Hydro's fiscal years 2019 through to 2023. This evaluation is a continuation of two similar TV market evaluations conducted for F2013 to F2015 and F2016 to F2018.

TV efficiency regulations first came into effect in British Columbia in 2012, and were later modified in 2013 and 2015. Supporting and facilitating the development and adoption of energy efficient standards and regulations of consumer products—by funding market and technical research and delivering Demand Side Management programs—is one pillar of BC Hydro's energy conservation and efficiency strategies. Given the energy efficiency regulation in place and the pace of TV market transformation during the five-year period covered by the evaluation, BC Hydro did not offer any incentive programs targeting televisions sold in British Columbia during this time period.

This evaluation estimates the electricity savings in BC Hydro's service territory resulting from changes in energy efficiency of TVs sold in British Columbia. The energy efficiency improvement stems not only from the provincial TV regulation but also from the federal level[3] as well as from the technological evolution and competition in the global TV market. The evaluation does not attempt to determine the share of electricity savings directly attributable to changes in regulation or other specific actions.

4.2 Approach

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

[3] Although the regulations on TV energy efficiency were introduced at different times by the provincial and the federal government, they set the same requirements for regulating the power consumption of TVs. This evaluation refers to the B.C. regulation as it was introduced prior to the federal regulation. It should be acknowledged that the on-going market assessment pertains to the regulations at both levels of government.

Table 4.1 Evaluation Objectives, Research Questions, Data Sources and Methods

Evaluation Objectives and Research Questions	Data Sources	Methods
Objective 1: TV market supply-side assessment		
What were the trends in TV characteristics (e.g., new technologies, screen size) from F2019 to F2023? How did the level of efficiency of TVs sold in B.C. from F2019 to F2023 compare to the 2012 TV energy efficiency regulation?	▪ **Sales data collected by Circana for 2018, 2019, 2021, 2022 and 2023** ▪ **Consumer Electronics Survey (CES) 2016**	▪ **Market sales data trends analysis** ▪ **Qualitative analysis**
Objective 2: TV market demand-side assessment		
What were the average annual sales of TVs from F2019 to F2023, broken down by type (e.g. LCD, LED, QLED, OLED, etc.) and by size (e.g., 55”, 65”, 70”, etc.)? What are the trends in TV ownership among residential customers?	▪ BC Hydro REUS 2020 & 2023	▪ Frequencies ▪ Trend analysis ▪ Qualitative analysis
Objective 3: Gross electric energy and peak demand savings		
What were the gross electric energy and peak demand savings due to changes in the B.C. TV market from F2019 to F2023?	▪ TV power consumption information collected from Appliance Efficiency Database maintained by California Energy Commission ▪ F2024 Residential Audit and Monitoring Study ▪ BC Hydro REUS 2010, 2017, 2020 & 2023 ▪ Codes and Standards savings forecast workbook	▪ Engineering algorithms

4.3 Results

Results for Objective 1: TV market supply-side assessment

Over the evaluation period, display technologies such as OLED or QLED have become more widely available in the market which results in better colour ranges. Higher image resolution has also greatly improved the TV viewing experience. These were the most significant improvements in display technology—a major driver for consumers to buy or replace TVs and for TV manufacturers to charge a higher per unit price and maintain product profitability. Another major development of TV products was built-in internet access. Web-enabled applications like various video streaming services became available on TVs and enhanced their functionality. Overall, TV products have undergone significant innovations over the last 10 to 15 years.

Results for Objective 2: TV market demand-side assessment

The long-term trend of TV annual sales in British Columbia is in a slow decline. In the early 2010s, TV sales increased with the advent of new products like flat panel TVs with LCD and LED display. There was likely a substantial amount of upgrade purchases of these types of TVs to replace older models. Sales slowed down in the following years with the exception of F2021 when the COVID-19 pandemic lockdown appears to have stimulated TV purchases. It is foreseeable that demand for TVs will be incremental as the upgrade cycle driven by new technologies has tapered off and new demand will be mainly driven by natural replacement (of non-functional TVs), incremental installations in homes or organic increases of population and residential homes.

Results for Objective 3: Electricity savings

The evaluated gross run rate energy savings and peak demand savings are listed in Table 4.2. The evaluated savings were 38.6 GWh/year, which is 43.2 GWh/year less than the reported savings for the five-year evaluation period. The evaluated savings are lower for the first three years of the evaluation period. These negative variances are mainly due to the higher estimated counts of TVs used in the calculation of reported energy savings. The variance is considerably higher for F2019 as the reported savings assumed that all TVs sold in F2019 would result in energy savings. In the evaluation, it was estimated that by the end of F2018, all non-standard compliant TVs were replaced and cleared out of the market. Starting in F2019, only TVs bought as incremental installations contributed to energy savings. Peak demand savings are calculated from gross energy savings based on the peak demand to energy conversion factor of 0.209 MW/GWh, which is based on the hourly load shape for TVs from the NEEA residential metering study, 2014.

Table 4.2 Summary of Energy and Peak Demand Savings, F2019 to F2023

	Gross Energy Savings (GWh/yr)			Gross Peak Demand Savings (MW)		
	Reported	Evaluated	Variance	Reported	Evaluated	Variance
F2019	41.5	7.4	-34.1	8.7	1.6	-7.1
F2020	16.6	7.3	-9.3	3.5	1.5	-2
F2021	11.6	8.2	-3.4	2.4	1.7	-0.7
F2022	5.6	8.6	3	1.2	1.8	0.6
F2023	6.5	7.1	0.6	1.4	1.5	0.1
Total	**81.8**	**38.6**	**-43.2**	**17.2**	**8.1**	**-9.1**

4.4 Findings and Recommendations

Below are the main evaluation findings.

Supply Side Assessment

1. The TV market in British Columbia is dominated by a few global TV manufacturers who are locked in intensive competition to supply TVs with more versatile functionality, better display quality and advanced technologies.
2. Energy efficiency of TVs has improved significantly with the advent of LED displays. Although unit energy consumption has increased due to larger TV screens, the energy efficiency measured by power consumption per square inch of screen size meets or exceeds the requirements of the B.C. provincial regulations for TV energy efficiency established in 2012.

Demand Side Assessment

3. Overall, new TV sales were stable during the evaluation period with the exception of F2021 when the COVID-19 pandemic broke out and TV sales saw a boost due to the lockdown.
4. Customers adopted TVs with bigger screens during the evaluation period. The average size of TVs purchased by customers increased from 50 inches to 52 inches over the evaluation period.

Gross Energy and Peak Demand Savings

5. The unit energy consumption of TVs purchased during the evaluation period ranged from 88 kWh to 112 kWh per year. As the size of TVs purchased during the evaluation period have increased, the unit energy consumption has increased accordingly.
6. The replacement of old and non-standard compliant TVs was estimated to take about 8 years and this process completed by F2018. Starting in F2019, only TVs bought as incremental installations contributed to energy savings. In the case of TVs bought to replace existing TVs, both the old and new unit were compliant with the standard and there were no energy savings as the result of the replacement. In other words, if TVs being replaced were standard-compliant, the energy savings had already been captured in previous evaluations when they were bought as new TVs.
7. The average hours of use (on-mode) of TVs was estimated at 3.9 hours based on the residential home monitoring study and customer surveys.
8. The evaluated gross energy savings were found to be 38.6 GWh/year compared to reported savings of 81.8 GWh/year for F2019 to F2023. Peak demand savings were evaluated at 8.1 MW compared to 17.4 MW of reported demand savings.

Recommendations

The following recommendations flow from the findings of this evaluation.

1. With support from the Evaluation team, review the forecast methodology to see if it can be improved by comparing it with the stock and flow model used in this evaluation.
2. Revise TV viewing hours to 3.9 hours per day for forecasting energy savings.
3. Adjust reported energy savings for the evaluation period.

4.5 Conclusions

The TV market in British Columbia continued to see technological advancements, particularly in display technologies such as LED, OLED and QLED, which made TV products more energy efficient. As a result, energy efficiency of TVs exceeds the requirements set by the B.C. provincial regulations on TV energy efficiency implemented in 2012. TV manufacturers have driven their product development with a focus on better picture display quality, bigger screen sizes and more functionalities such as internet connectivity and video-streaming services. Customers' preference for and increasing sales of bigger TVs have partially offset the gains in efficiency. The evaluated gross energy savings from F2019 to F2023 were found to be 38.6 GWh/year compared to reported savings of 81.8 GWh/year. Peak demand savings were evaluated at 8.1 MW compared to 17.4 MW of reported demand savings.

5 LEM-Commercial: F2021 to F2023

5.1 Introduction

This report presents the results of an impact evaluation of the BC Hydro Leaders in Energy Management – Commercial (**LEM-C**) program for fiscal years F2021 to F2023 (April 1, 2020 to March 31, 2023). The scope of the evaluation includes electrical energy efficiency and conservation savings at commercial sites that were reported under the LEM-C program during the evaluation period. This evaluation does not include savings reported under the Continuous Optimization offer, which is evaluated separately.

LEM-C is available for commercial customers in both the public and private sectors, including small and medium businesses through to large commercial customers with BC Hydro Key Account Managers (**KAMs**). The public sector includes institutions (healthcare, advanced education, K-12 schools) and government (municipal, provincial and federal infrastructure). Private sector participants are diverse, covering a wide range of businesses and services, including property management, offices, food and non-food retail, hospitality, restaurants, telecommunications, and services.

Large commercial organizations have access to one of two Energy Manager options: partial funding for a full-time Energy Manager or an unfunded Energy Manager Associate[4]. Small and medium businesses have access to Business Energy Advisors funded by BC Hydro. Commercial customers can also access funding for energy studies and several enabling tools that support energy management[5].

The program also supports ENERGY STAR Portfolio Manager, an interactive energy benchmarking tool provided through Natural Resources Canada that can be used to track and assess energy and water consumption across a portfolio of buildings. ENERGY STAR Portfolio Manager can help users identify under-performing buildings, verify efficiency improvements, and prioritize efficiency investments by comparing building performance to a benchmark or to other buildings in the organization's portfolio.

LEM-C also helps customers focus on opportunities to optimize their capital expenditures and leverage BC Hydro incentives to address financial barriers to implementing energy efficiency projects. Incentives are available for custom projects and the amount is determined on a per project basis based on estimated energy savings and capital costs. During the evaluation period, custom project incentives were available to large commercial customers with a Key Account Manager (**KAM**) and annual consumption above 4 GWh. The Social Housing Retrofit Support Program offer was also available specifically for social housing organizations that operated multi-unit residential buildings and included funding for an energy study and funding to support the implementation of recommendations from the energy study, as well as rebates on a variety of high-efficiency upgrades. Business Energy Savings Incentives (**BESI**) were available to commercial customers of any size and provided prescriptive incentives for simple, one-for-one replacements of inefficient technologies with energy-efficient ones, most commonly lighting. Energy savings were also achieved through program enabled projects, which are custom projects that did not receive direct capital incentive funding from BC Hydro, but were enabled

[4] Energy Manager Associates have access to most of the supports available to BC Hydro funded Energy Managers except the funding itself. To participate, organizations must have a Key Account Manager and must designate a lead person to identify and implement energy savings solutions within operations, as well as take steps to develop an integrated culture of energy conservation.

[5] In addition to Energy Managers and energy studies, enabling activities also include tools such as: the Conservation & Energy Management Hub online tool (CEM Hub), the Energy Wise Network, energy management consulting services and online energy tracking.

by other BC Hydro resources and supports, such as an Energy Manager or energy study. Program enabled savings also included deemed savings related to the use of ENERGY STAR Portfolio Manager by eligible participants.

5.2 Approach

The table on the following page presents the evaluation objectives, related research questions, data sources, and methods for this evaluation.

Table 5.1 Evaluation Objectives, Research Questions, Data Sources and Methods

Evaluation Objectives and Research Questions	Data Sources	Methods
Objective 1: Assess the customer experience with LEM-C program design and delivery		
What is participant satisfaction for each of the custom, Social Housing, strategic energy management (SEM), and BESI offers? What are the main drivers of and barriers to program participation? Are there differences across commercial customer segments (sub-sector, KAM'd customers, small and medium businesses (SMBs), social housing organizations)?	▪ 6 waves of program participant surveys (F2021 to F2023) ▪ Non-participant survey (F2022) ▪ F2021 Small/Medium Businesses non-participant survey ▪ F2022 participant interviews ▪ Energy Manager surveys (F2021 to F2023)	▪ Cross tabulations ▪ Qualitative analysis
Objective 2: Examine short/mid-term outcomes associated with enabling activities at the project and organization level		
To what extent were Energy Managers and energy studies associated with the number of projects and energy savings? To what extent did energy management activities differ between program participants and non-participants?	▪ Project files ▪ Participant surveys (F2021 to F2023) ▪ Non-participant survey (F2022)	▪ Cross tabulations
Objective 3: Evaluate deemed energy savings of ENERGY STAR Portfolio Manager participants		
What were the gross and/or net energy savings from Portfolio Manager participants with deemed savings?	▪ ENERGY STAR Portfolio Manager data (F2021 to F2023) ▪ Reported capital project data	▪ Difference in median Energy Use Intensity ▪ Difference between treatment and comparison group ▪ Discrepancy analysis of participants
Objective 4: Estimate gross electrical energy savings for capital projects		
What were the gross realization rates and evaluated gross savings by end use? What were the evaluated gross energy savings for custom projects (including Social Housing), program enabled projects, and prescriptive capital projects (BESI-KAM, BESI-non-KAM)? What were the gross savings for social housing projects?	▪ Program tracking data ▪ Project files ▪ Measurement and Verification (M&V) results	▪ Extrapolation of M&V results using stratified ratio estimation ▪ District Energy project: engineering review/estimates
Objective 5: Estimate net electrical energy savings due to capital projects		
How much free ridership occurred for custom, program enabled, prescriptive capital, and social housing projects? How much participant and non-participant spillover occurred for the custom and prescriptive offers? How much participant spillover occurred for the social housing offer? What are the evaluated net energy savings for custom, program enabled, prescriptive capital projects and social housing projects?	▪ Results from Objective 4 ▪ Participant surveys (F2021 to F2023) ▪ Non-participant survey (F2022) ▪ Project tracking files	▪ Survey-based free ridership and spillover algorithms ▪ BC Hydro Cross Effects Calculation Guidelines
Objective 6: Estimate total gross and net electrical energy and peak capacity savings due to the LEM-C program		
What were the total evaluated gross energy savings realized by the program by fiscal year? What were the total evaluated net energy and peak capacity savings realized by the program by fiscal year? What is the variance between the expected and evaluated savings? What are the reasons for the variance?	▪ Results from Objectives 3, 4 and 5 ▪ Average peak-to-energy factors	▪ Engineering estimation ▪ Variance calculation

5.3 Results

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

Overall Satisfaction. Overall satisfaction ('very satisfied' plus 'somewhat satisfied') was high for all of the LEM-C offers at 89% for custom participants, 83% for BESI KAM participants, and 86% for BESI non-KAM participants. Organizations that participated specifically in the Social Housing Offer (n=15, a subgroup of the custom offer), provided an overall satisfaction rating of 85%, with a high percentage (62%) reporting to be 'very satisfied'.

Program Experience. Results varied by participant group, with custom participants providing their highest ratings for service provided by BC Hydro personnel (95% rating it as 'excellent' or 'good') and knowing how/who to contact at BC Hydro (87%). BESI KAM participants provided their highest ratings for service provided by product suppliers/distributors (89%) and installing the energy efficient technology (88%). BESI non-KAM participants provided their highest ratings for service provided by contractors (95%) and service provided by product suppliers/distributors (91%). Elements which rated low across all groups include the variety of products funded under the program, direct mail/email information about the program and the level of incentives.

Drivers of Program Participation. 'Decreasing operating expenses' emerged as a top reason for participating across all three participant groups, with 84% of custom participants, 86% of BESI KAM participants and 80% of BESI non-KAM participants selecting it as one of their main reasons. Among custom participants, 'implementing energy efficient technology' (84%) and 'receiving incentives' (72%) were other top reasons. Among BESI KAM and non-KAM participants, 'improving lighting at the business' was the other main reason, at 90% and 75%, respectively.

Barriers to Program Participation. The main barriers to participating in the program among non-participants included not owning the building (25%) and needing more information about energy efficiency upgrades (23%). Other top reasons that related specifically to the program included needing more information about the program (17%), not knowing how to apply (8%), and thinking their site is not eligible to participate (6%). Other broader top reasons included high initial cost (19%), long payback period (12%), and lack of staff time (12%). In terms of general barriers to managing electricity consumption, lack of funds available for energy-efficiency retrofits and other operation priorities were among the top reasons for all three participant groups, as well as for non-participants. Insufficient financial return-on-investment was an issue for custom and BESI KAM participants, while lack of knowledge about where the opportunities were was an issue for BESI non-KAM participants and for non-participants. Aside from the barriers above, a total of 26% of non-participants reported that they didn't participate because of having already done energy efficiency upgrades at the building.

Results for Objective 2: Examine short/mid-term outcomes associated with enabling activities at the project and organization level

Strategic energy management aims to change attitudes and behaviours toward energy efficiency, leading to changes in processes and practices and ultimately resulting in energy savings. The strategic energy management initiative provided participants with a suite of tools and offers intended to help build energy management into their ongoing business practices. The evaluation focuses on participation in enabling activities and energy savings rather than the long-term outcomes of strategic energy management practices.

A total of 67% of the energy savings from capital projects were contributed from sites with an Energy Manager, which is lower than the previous evaluation (82%), primarily due to the removal of a program requirement that

limited access to custom project incentives to organizations that had an Energy Manager or an Energy Manager Associate.

A total of 80% of the energy savings from capital projects were contributed from sites with an energy study, which comprised of 31% with an energy study only and 49% with both a BC Hydro-funded Energy Manager and an energy study.

Results for Objective 3: Evaluate deemed energy savings of ENERGY STAR Portfolio Manager participants

The Strategic Energy Management (**SEM**)-Portfolio Manager reported savings, as determined by the program administrators, relied on a deemed energy savings estimate of 2.4% of annual energy consumption with one year of persistence for qualifying participants. A total of 2,214 buildings were included in the deemed savings claims for SEM-Portfolio Manager during the evaluation period.

In this evaluation, savings for participants in SEM-Portfolio Manager, incremental to those from capital projects, were estimated by assessing the performance of participating buildings relative to a benchmark energy use intensity (**EUI**) for a similar building, and comparing this to the performance of a non-participant group of buildings. The evaluated participant coverage was limited to participating buildings that met basic energy benchmarking requirements and for which a benchmark EUI was available through ENERGY STAR Portfolio Manager. The evaluated gross energy savings were calculated from the difference in median percent deviation from the benchmark EUI between the treatment and comparison group. The final net results were adjusted to account for energy impacts from known capital projects already reported by the program and expressed as the evaluated net realization rate. The results were estimated by fiscal year and are given in the table below.

Table 5.2 Results of Energy Savings from SEM-Portfolio Manager and Realization Rates by Fiscal Year

		F2021	F2022	F2023	Overall (F21 to F23)
Expected Energy Savings of All Participants (GWh/yr)	[A]	6.5	8.4	16.0	Note[1]
Expected Energy Savings of Evaluated Participants[6] (GWh/yr)	[B]	3.4	3.4	4.8	Note[1]
Evaluated Gross Energy Savings (GWh/yr)	[C]	9.2	3.2	11.4	Note[1]
Evaluated Net Energy Savings (GWh/yr)	[D]	7.2	2.4	10.2	Note[1]
Evaluated Participant Coverage[7] (%)	[B]/[A]	52%	40%	30%	37%
Evaluated Gross Realization Rate (%)	[C]/[B]	273%	94%	237%	205%
Evaluated Net Realization Rate (%)	[D]/[C]	79%	76%	89%	84%
Total Realization Rate (%) [2]	[D]/[A]	111%	29%	64%	64%

Notes: 1-Savings are not additive across fiscal years because of one-year persistence and repeat participants.

[6] "Evaluated Participants" are the subset of participants that the evaluation determined it was appropriate to claim and evaluate energy savings from. Some participants, for example, had no benchmark energy use intensity in ENERGY STAR Portfolio Manager and the evaluation determined it was inappropriate to claim savings from these participants, since the purpose of this tool is to provide a benchmark to compare a building's energy performance against, which leads to actions that result in energy savings.

[7] This reflects the percentage of total participants for whom the evaluation determined it was appropriate to claim energy savings. See footnote 6 above.

2- The Total Realization Rate is the product of Evaluated Participant Coverage, Gross Realization Rate and Net Realization Rate.

The overall results for the evaluation period from F2021 to F2023 show an evaluated participant coverage of 37%, a gross realization rate of 205%, and a net realization rate of 84%, for a total realization rate of 64% of expected savings. The low evaluated participant coverage was primarily due to the exclusion of buildings that had no benchmark energy use intensity estimated in ENERGY STAR Portfolio Manager. The evaluated gross realization rate was high because of the larger than expected difference in performance between the treatment and comparison group, but it should be noted that this factor carries the greatest uncertainty. The evaluated net realization rate reflects the adjustment for energy impacts from known capital projects, which reduced the evaluated gross savings by 16%.

There are three main limitations that warrant caution with the interpretation of results and the assessment of their internal and external validity. First, although the results did meet the BC Hydro evaluation standard on precision and confidence[8] for each sample, the comparison group was matched for building size but could not matched for building type due to small samples. Second, the attribution of changes in energy consumption between the two groups to savings from SEM-Portfolio Manager was not supported by additional lines of evidence, such as evidence of actual differences in energy management activities and practices, but should be. The third limitation is that the results rest on performance metrics which are derived from self-reported data that has not been validated or verified by certified energy professionals.

Results for Objective 4: Estimate gross electrical energy savings for capital projects

The overall gross realization rate of capital projects for the period F2021 to F2023 was estimated as the ratio of evaluated to expected gross savings for all measures included in the evaluation analysis. The overall realization rate for capital projects was calculated at 97%. Social Housing Offer accounted for 1.2 GWh per year of the evaluated gross energy savings. Table 5.3 summarizes the expected and evaluated gross energy savings for capital projects by type of end use.

Table 5.3 Expected and Evaluated Gross Energy Savings from Capital Projects by End Use

Type of End Use	Expected Savings (GWh/yr)	Evaluated Gross Realization Rate (GRR)	Evaluated Gross Savings (GWh/yr)
LED Lighting	76.1	92%	69.8
Non-LED Lighting	5.6	119%	6.7
Other End Uses	20.5	98%	20.1
Tag-on Savings[1]	-	99%	2.2
Overall Capital Projects LEM-C (F2021 to F2023)	102.2	97%	98.8

Note 1: Tag-on savings are reported spillover resulting from project work done above and beyond a project's original contract scope

Results for Objective 5: Estimate net electrical energy savings due to capital projects

Net electricity savings are the change in energy consumption and demand attributable to the program. They exclude free riders and include spillover. The overall level of free ridership was estimated at 22% for capital projects, ranging from 18 to 23% between program offers. Participant spillover was estimated at 3% and non-participant spillover was estimated at 8%, for a total of 11%. Cross effects were calculated as 5% for custom, 7% for BESI KAM and 8% for BESI non-KAM projects. As shown in Table 5.4, together these factors result in a

[8] BC Hydro targets relative precision of 20% or better at a confidence level of 80% or better.

downward adjustment of the evaluated gross energy savings of 15.5 GWh per year during the evaluation period and a net-to-gross ratio of 84%.

Table 5.4 Cross Effects, Free Ridership, Spillover, and Net-to-Gross Ratio by Program Offer

Program Offer	Custom	BESI KAM	BESI Non-KAM	Tag-on[1]	LEM-C F21 to F23 (Calculated)
Evaluated Gross Energy Savings (GWh/yr)	64.3	9.2	23.1	2.2	98.8
Net-to-Gross Ratio	82%	88%	88%	94%	84%
Evaluated Net Energy Savings (GWh/yr)	52.8	8.1	20.3	2.1	83.3

Note 1: Tag-on savings are reported spillover resulting from project work done above and beyond a project's original contract scope

Results for Objective 6: Estimate total gross and net electrical energy and peak capacity savings due to the LEM-C program

Table 5.5 summarizes the reported and evaluated net energy savings and peak demand savings for the LEM-C program by fiscal year. Peak demand savings were estimated based on applying a peak-to-energy factor of 0.151 MW per GWh.[9]

Table 5.5 Summary of Net Energy and Peak Capacity Savings – Incremental Savings

	Net Energy Savings (GWh/yr)			Net Peak Capacity Savings (MW)		
Fiscal Year	Reported	Evaluated	Variance	Reported	Evaluated	Variance
F2021	39.8	38.3	(1.4)	6.0	5.8	(0.2)
F2022	43.1	34.9	(8.2)	6.6	5.4	(1.3)
F2023	40.7	33.7	(7.0)	6.1	5.0	(1.1)

Overall, the program achieved 87% of reported savings during fiscal years F2021 to F2023. The program variance is primarily due to lower than expected savings from SEM-Portfolio Manager, lower than expected evaluated gross savings from capital projects, higher than expected free ridership of custom program enabled projects, and lower than expected spillover of Custom and BESI projects.

5.4 Findings and Recommendations

Customer experience with program design and delivery

1. Overall satisfaction was high for all of the LEM-C offers with 89% of custom participants, 83% of BESI KAM participants, and 86% of BESI non-KAM participants reporting to be 'very satisfied' or 'somewhat satisfied' with the program.

[9] The weighted average peak-to-energy factor of 0.151 MW per GWh was calculated based on the peak-to-energy factor of 0.158 MW per GWh for commercial lighting and 0.139 MW per GWh for the commercial rate class.

2. Results for various aspects of customer experience varied by participant group, with custom participants providing their highest ratings for service provided by BC Hydro personnel and knowing how/who to contact at BC Hydro. BESI KAM participants provided their highest ratings for service provided by product suppliers/distributors and installing the energy efficient technology, while BESI non-KAM participants provided their highest ratings for service provided by contractors and service provided by product suppliers/distributors. Elements which rated low across all groups include the variety of products funded under the program, direct mail/email information about the program, and the level of incentives.

Short/mid-term outcomes associated with enabling activities at the project and organization level

3. Among program participants that had a BC Hydro Key Account Manager, 60% of the sites had an Energy Manager or an Energy Manager Associate, and these managers were associated with 67% of the energy savings. The coverage is lower than the last evaluation, primarily due to the removal of a program requirement stating that organizations had to have an energy manager as an eligibility condition to participate in the custom incentive offer, which was in place during the last evaluation period.

Additional electrical energy savings enabled through participants using ENERGY STAR Portfolio Manager

4. Participants for which deemed savings from SEM-Portfolio Manager were reported included 2,214 buildings. An analysis of participating buildings for attribution of savings to parallel initiatives and against Portfolio Manager criteria for benchmarking led to the elimination of a number of buildings, resulting in only 44% of buildings, accounting for 37% of expected savings, being retained for evaluation.

5. The analysis of deviations between actual energy use intensity and the benchmark energy use intensity estimated by ENERGY STAR Portfolio Manager for individual buildings showed a statistically significant difference between the treatment group and a comparison group and indicated a gross realization rate of 205% for energy savings.

6. The evaluated savings from SEM-Portfolio Manager were above and beyond savings achieved through reported capital projects for the same buildings. An overall net realization rate of 84% was found after adjustment to account for the impact of known capital projects from energy efficiency and electrification completed by evaluated participants during the evaluation period.

7. The total realization rate was estimated by fiscal year for an average of 64% and ranging from 29% to 111%, primarily due to the low evaluated participant coverage.

8. The net evaluated savings from SEM-Portfolio Manager resulted in a building electrical energy reduction of 3.8% on average, based on the gross and net realization rates of evaluated participants in this evaluation during F2021 and F2023 which was higher than the deemed expected savings of 2.4%.

Gross electrical energy savings for capital projects

9. Between F2021 and F2023, 1,611 capital projects were implemented through the LEM-C custom incentives, program enabled, and prescriptive incentives (BESI) program offers. Capital projects were mostly lighting retrofits, with LED lighting and Non-LED lighting respectively representing 73% and 7% of evaluated gross energy savings. A mix of other end uses accounted for the remaining 20% of savings.

10. The gross realization rate of energy savings from capital projects was 97%, indicating that the energy conservation measures largely performed as expected. The most common reasons identified through measurement and verification for why measures did not perform as expected were changes in baseline conditions and hours of use.

11. Evaluated gross energy savings from capital projects were 98.8 GWh from F2021 to F2023. Capital projects resulted in an average reduction in site energy consumption of 5% for program participants over the three-year evaluation period.

12. A district energy project started generating energy savings during the evaluation period but was only partially completed at the time of evaluation, with full completion expected in 2025. This evaluation applied the Initial Review Savings of 3.74 GWh per year as the gross electrical energy savings, with a net to gross ratio deemed to be 1.

Net electrical energy savings due to capital projects

13. The net-to-gross ratio was 84% based on an overall level of free ridership of 22%, participant spillover of 3%, and non-participant spillover of 8%. Cross effects through interactions with space heating and cooling systems were estimated to reduce gross savings by 6%. Evaluated net energy savings from capital projects were 83.3 GWh from F2021 to F2023.

14. Evaluated net energy savings from capital and district energy projects were summed up to 87.0 GWh from F2021 to F2023.

Estimate total gross and net electrical energy and peak capacity savings due to the LEM-C program

15. Evaluated net energy savings for LEM-C were 38.3 GWh per year in F2021, 34.9 GWh per year in F2022, and 33.7 GWh per year in F2023, which averaged 87% of reported savings.

16. Net peak capacity savings were estimated at 5.8 MW in F2021, 5.4 MW in F2022, and 5.0 MW in F2023, based on applying the average peak-to-energy factor of 0.158 MW per GWh and 0.139 MW per GWh derived from the load shapes for commercial lighting and the commercial rate class.

Recommendations

The following recommendations flow from the findings of this evaluation. Recommendations #1, #2, #3 and #4 are for program management and recommendations #5 and #6 are for Evaluation.

1. Clarify and strengthen the program logic about the criteria used to include buildings in the claim for deemed savings by aligning them with industry recognized requirements for strategic energy management. For example, the program could require engagement in energy benchmarking instead of merely requiring data entry in ENERGY STAR Portfolio Manager.

2. Provide evidence supporting the ENERGY STAR Portfolio Manager deemed energy savings, such as documentation of potential and achieved energy efficiency projects and activities.

3. Ensure that customers included in ENERGY STAR Portfolio Manager deemed savings claims enter all building parameters and upload all energy consumption data (electricity and fossil fuels) required to estimate the benchmark EUI.

4. If no benchmark Energy Use Intensity (**EUI**) is available for a specific property type in ENERGY STAR Portfolio Manager, explore alternate pathways to estimate a benchmark EUI for these buildings so that deemed savings for these buildings can be evaluated.

5. Develop additional lines of evidence to support program attribution for ENERGY STAR Portfolio Manager savings, for example through surveys or interviews with participants.

6. In future evaluations, consider quantifying progress towards the long-term outcomes of strategic energy management practices.

5.5 Conclusions

BC Hydro's Leaders in Energy Management – Commercial program achieved 87% of reported savings during fiscal years 2021 to 2023. Overall satisfaction with the program continued to be high. Sites with an Energy Manager had higher levels of program activity and additional savings were achieved among participants engaging in strategic energy management.

6 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.

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 DSM action, even in the absence of the DSM program. These actions are not attributable to the program.

General Service Lamp (GSL): Natural Resources Canada defines the General Service Lamp as an electrical device that provides functional illumination and has a luminous flux of at least 310 lm but not more than 2,600 lm, a nominal voltage of at least 110 V but not more than 130 V or a nominal voltage range that lies at least partially between those voltages and a screw base.

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 action taken by the participants in a demand side management program or initiative irrespective of why they participated.

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.

Realization Rate: The ratio of initial estimates of savings to savings adjusted for measurement and verification results and data errors. 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.