

The New Frontier in Energy Efficiency: Estimating the Impact of a Consumer Electronics Program

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ABSTRACT

BC Hydro's Consumer Electronics program is a multi-year energy acquisition initiative which encourages residential customers to purchase new energy-efficient televisions and recycle older less efficient televisions. Although a number of utilities have similar programs, there appear to be few if any published studies of the impacts of a consumer electronics program. The purpose of this paper is to report on a comprehensive evaluation of BC Hydro's Consumer Electronics program. Key conclusions are as follows. (1) The Power Smart Consumer Electronics Program has achieved considerable success in altering product purchase behaviour for energy efficient televisions. (2) The program has evolved over time in response to changes in market conditions, with the current program focusing on the promotion of the highest tier of energy-efficient televisions. (3) To estimate energy and capacity savings, engineering algorithms informed by a customer survey, a trade ally survey, a showroom presence study and on-site metering were used. Evaluated energy savings for fiscal year 2010 were 6.1 GWh per year, while evaluated peak savings were 1.5 MW.

Introduction

This paper provides an evaluation of the impacts and effects of BC Hydro Power Smart's Consumer Electronics program for BC Hydro's fiscal year 2010 (F2010), which was the first year of this initiative. The Power Smart Consumer Electronics program is a multi-year energy acquisition and market transformation initiative that encourages its customers to purchase energy-efficient televisions and recycle unneeded televisions. The program goals are to: (1) generate energy savings and increase the market penetration of more efficient televisions by partnering with retailers to influence the consumer television buying decision; (2) generate energy savings by reducing the number of obsolete televisions in the home; and (3) increase consumer awareness of energy efficiency by calling attention to the electricity use of televisions, both in older televisions in the home and new televisions being purchased. This paper focuses only on program impact on the new television purchase component and not on the television recycling component.

BC Hydro has employed a phased strategy to transform the television market and acquire energy and capacity savings. During program development, a number of barriers to the development of an energy efficient television market were examined. These barriers included awareness, availability and affordability of energy efficient televisions. The program addressed these barriers through four main components: (1) specifications development for energy efficient televisions; (2) information and promotions; (3) financial incentives; and (4) retailer training. The target market for the program included both residential customers and supply chain actors, including manufacturers, retailers, and recyclers. In June 2007, the Consortium for Energy Efficiency (CEE) launched the Consumer Electronics initiative. The ENERGY STAR® 3.0 (ES) specification for televisions came into effect in November 2008, and it was followed by a series of voluntary standards developed by the CEE, with each tier being more stringent in terms of energy use requirements than the previous tier. The Power Smart Consumer Electronics program was launched on April 1, 2009, with an initial mid-stream or retailer incentive of \$20.00 per CEE Tier 2 television, with the CEE Tier 2 specification being 15% more energy efficient than Energy Star 3.0. Given the rapid evolution of the television market and energy efficiency of televisions, there has been a frequent revision of the Power Smart Consumer Electronics Program mid-stream retailer offer in terms of television specifications and incentives.

Literature Review

From 2006 to 2008, Southern California Edison (SCE) ran pilot business and consumer electronics programs as part of the Innovative Designs for Energy Efficiency Activities (IDEEA). Based on this work, Pacific Gas & Electric (PG&E) and the Sacramento Municipal Utility District (SMUD) launched a pilot Business and Consumer Electronics (BCE) program in the fall of 2008. In September 2009, the Northwest Energy Efficiency Appliance (NEEA) joined the BCE program. In January 2010, PG&E, SCE and San Diego Gas & Electric (SDG&E) began operation of the statewide BCE program. Because consumer electronics programs are relatively new, there are few published process or impact evaluations available. However, several recent studies done by the Consortium for Energy Efficiency (2008), for Pacific Gas and Electric and Southern California Edison [Research into Action (2010), Research into Action and EMI (2012)] and for the Northwest Energy Efficiency Alliance [Opinion Dynamics Corporation (2010), Energy Market Innovations (2011)] have provided useful information from both a market characterization and a market transformation perspective. Some key findings from these studies include the following.

(1) Retailer Engagement. BCE depends upon effective relationships with retailers including recruiting retail and manufacturing partners, offering retailer incentives and providing marketing materials. In return, retail partners provide sales and shipments data and allow access to their stores for promotional materials.

(2) Qualifying Products and Incentives. Qualifying televisions, desktop computers and monitors are eligible for incentives, using Energy Star as a basis for determining specifications. For 2009, the initial BCE specification was set at ES 3.0 + 15%, and, in 2010, a base incentive level was set at ES 4.1 while an aspirational incentive was set at ES 5.1.

(3) Market Progress. In 2010, the number of incented products were as follows: for PG&E 549 thousand televisions, 66 thousand monitors and 10 thousand desktops; for SCE 218 thousand televisions, 12 thousand monitors, and 4 thousand desktops.

(4) Program Strengths. BCE has created strong and productive relationships with sellers and provided value for both the BCE Alliance and Energy Star, which led to increased market share for qualifying energy efficient televisions and produced a large amount of valuable data.

(5) Program Weaknesses. BCE has remained television-focused and made less progress with other products, faces regulatory constraints which may slow the development of additional programs, and faces evaluation risks.

Method and Approach

For this study, there were two main objectives and five evaluation activities. The first objective was to develop a method for evaluating energy savings associated with a midstream marketing program, where consumers do not see the incentive. The second objective was to develop estimates of the energy and peak savings as a result of the Consumer Electronics program. The five evaluation activities were as follows: (1) conduct a program review; (2) undertake a detailed supply-side assessment; (3) undertake a detailed demand-side assessment; (4) measure hours of use and peak demand; and (5) estimate energy and peak savings. The study approach used multiple lines of evidence, since no single line of evidence provided information on all of the evaluation issues for this study of the television market.

Program Review. To conduct the program review and develop the program logic model, we reviewed program documents, interviewed BC Hydro program staff, and conducted a literature review focusing on recent studies and reports on televisions. Information from the Consortium for Energy Efficiency was particularly useful.

Supply-Side Assessment. To undertake the supply-side assessment, we tabulated and examined relevant results of the Showroom Presence study of appliance and television stock behaviour in representative samples of retail sales establishments (about 35-40 participants per year) and undertook a Trade Allies Survey (5 purchasing managers of major retail chains, representing 70% of program sales).

Demand-Side Assessment. To undertake the demand-side assessment, we tabulated and examined relevant results of the Television Baseline survey which had about 600 participants.

Hours of Use. To produce and analyze information on hours of use profiles by season, we conducted a one-year metering study of hours of use for televisions.

Energy and Demand Savings. To estimate demand and energy savings, we used engineering algorithms as shown below, which were based on on-site metering, in-store stocking studies and customer surveys. Incented units is the number of televisions receiving mid-stream incentives, unit power savings is the average difference in watts between the base unit and the average incented unit, hours of use is the average on-site measured hours of use, cross effects adjustment is one minus increased electrical consumption for space heating, and net to gross is the ratio of program attributable units to the number of incented units.

$$\Delta kWh = \text{incented units} * \text{unit power savings} * \text{hours of use} * \text{cross effects adjust} * \text{net to gross}.$$

$$\Delta kW = \text{incented units} * \text{unit power savings} * \text{peak coincidence} * \text{cross effects adjust} * \text{net to gross}.$$

Table 1. Evaluation Activities, Data Sources and Methods

Activities	Data Source	Method
1. Program review	Program staff interviews Program documents Literature review	File and document review
2. Supply-side assessment	Showroom Presence study Trade Ally survey	Cross tabulations
3. Demand-side assessment	Television Baseline survey	Cross tabulations
4. Hours of use and peak demand	Residential appliance and electronics monitoring study	Load shape analysis
5. Energy and peak demand	Above sources	Engineering algorithms

Results

Program Review. At the time of program launch in 2009, market analysis indicated that there were several barriers to the development of an energy efficient television market in the retail television market in British Columbia, including low awareness of Energy Star and of CEE qualified televisions among consumers, relatively low availability of televisions with high energy efficiency levels in retail stores, and relatively high prices for high energy efficiency televisions, although higher prices for energy efficient televisions may be related to a wider range of product features. BC Hydro has employed a phased strategy to transform the television market and acquire energy and capacity savings. The program has successfully addressed market barriers through four main components: specifications development, information and promotions, financial incentives, and retailer training.

Specifications Development. Power Smart has actively participated in the development of the

Consortium for Energy Efficiency Consumer Electronics Initiative. This initiative has two major objectives: first, to facilitate efficiency program efforts to increase the sales and market share of energy efficient consumer electronics; and, second, to develop consistent definitions and criteria for energy efficiency in the consumer electronics market and identify those products which meet the energy efficiency standards. Areas of focus include: televisions, set-top boxes, computers and peripherals, internal power supplies, and external power supplies.

Information and Promotions. Consumer awareness and education with respect to energy efficient televisions was addressed through advertising and point of sales material. Working directly with retailers, Power Smart ensured that in-store signage and advertising material called attention to specific energy efficient televisions. Messaging included television energy use, energy efficiency and specifications and electronics recycling options. Web based information included television buying tips such as: (1) size matters; (2) account for room and TV lighting; (3) invest in energy efficiency; (4) consider the features you need; and (5) calibrate your TV. Retailer point of purchase material and a general public awareness campaign targeted consumers making a new television purchase and consumers with multiple televisions in their homes. In 2010, retail representatives visited stores a minimum of three times to provide training and conduct audits of point of purchase material.

Financial Incentives. Adoption, availability and accessibility of televisions that are 15% more efficient than Energy Star qualifying televisions were addressed through retailer incentives to stock and sell televisions meeting the higher efficiency specification. The program offers base incentive levels, with higher incentive levels offered for promotional activities greater than the base level. The incentive program requires that retail partners provide a variety of promotional activities and post a variety of point of purchase material.

Retailer Training. Power Smart provides comprehensive training program for retail sales staff at both big box stores and independent retailers. The purpose of this training is to provide retail sales staff with the information they need to support BC Hydro's goal of increasing sales of Energy Star electronic products. Online training was developed in mid-2009, and store staff can go online at any time and complete the Consumer Electronics training module. Between November 2009 and March 2010, more than 275 employees completed the Consumer Electronics module.

Table 2. Program Logic Model

	Specification development	Information and promotions	Financial incentives	Retailer training
Inputs	Participate in voluntary standard development through the Consortium for Energy Efficiency	Develop information and promotional materials and hold community events	Varying mid-stream offers to retailers with offer dependent on degree of retailer engagement	Education and training for salespersons
Outputs	Develop clear and well defined energy standards	Customer product awareness increased	Increased retailer stocking of qualifying televisions	Salesperson awareness and knowledge increased
Purposes	Voluntary standards reflect technically and/or economically feasible innovations	Increased consumer intent to purchase qualifying energy efficient televisions	Increased consumer purchase of qualifying televisions	Increased retailer selling effort for energy efficient televisions
Goals	Significantly impact market penetration of energy efficient televisions Acquire cost effective energy savings			

Logic Model. The logic model for the new energy efficient television component of the Consumer Electronics Program focusses on input, output, purpose and goal statements for each of the four main activities. The program rationale was examined using this program logic model, which was developed from interviews with staff, interviews with trade allies, a documents review and a literature review. This review and analysis confirmed that the basic program logic was valid. There were strong linkages among inputs, outputs, purposes and goal statements. Indicators for key components of the logic model were clear, well defined and measurable.

Supply-side assessment. The supply side assessment was based on two separate data sources, a Showroom Presence Study and a Trade Ally Survey. The Showroom Presence Study focused on prices and quantities of televisions found through detailed data collection in 40 retail establishments. Although these studies have been undertaken for major appliances and lighting for about ten years, televisions were added to the set of products of interest for the in-store data collection only in 2009. The next table shows estimated sales of televisions by CEE energy efficiency tier.

Table 3. Projected Television Sales by CEE Specification

	2009		2010	
	Share of shelf space (%)	Estimated sales (000)	Share of shelf space (%)	Estimated sales (000)
Base	36	156	18	84
Tier 1	25	108	10	46
Tier 2	39	169	38	177
Tier 3	0	0	24	112
Tier 4	0	0	10	46
Total	100	433	100	465

The next table shows the estimated prices of television by CEE specification.

Table 4. Projected Television Prices by CEE Specification

	2009		2010	
	Share of shelf space (%)	Estimated prices (\$)	Share of shelf space (%)	Estimated prices (\$)
Base	36	836	18	640
Tier 1	25	1,375	10	1,083
Tier 2	39	1,260	38	1,195
Tier 3	0	-	24	1,114
Tier 4	0	-	10	1,390
Total	100	1,134	100	1,084

The Trade Ally Survey focused on marketing executives and managers responsible for consumer electronics with the major retail chains in British Columbia. This survey was administered in October 2012, and it had five respondents, who represented companies with 70% of program sales. Respondents were asked to describe the Power Smart Consumer Electronics program energy efficient television marketing materials used by their company. Flyers, in-store displays, the web, and brochures and pamphlets were the program materials used the most by retailers.

Table 5. Program Materials Used by Retailers (%)

	Web	In-store display	Flyers	Special offers	Brochures/pamphlets	Other
Share	40	60	80	20	40	20

Because the Consumer Electronics program is primarily a midstream incentive program, it was critical to understand trade ally perceptions of the effectiveness of the program. Trade Ally Survey respondents were asked three questions which were first weighted to produce three measures of program attribution (net to gross) and then averaged to produce a single net to gross measure. The shares represent the number of respondents providing an answer in a particular response category divided by the total number of responses for that question. The questions were: (1) how effective were program marketing materials in promoting sales of energy efficient televisions; (2) how influential were current Power Smart program incentives in encouraging their company to purchase and stock more energy efficient televisions; and (3) how influential were current program activities in encouraging the retailer to sell more energy efficient televisions. The overall net to gross ratio from this analysis was 74%.

Table 6. Net to Gross Analysis

Effectiveness measure		Very effective	Somewhat effective	Not too effective	Not at all effective	Attribution rate
Program marketing materials effectiveness on energy efficient television promotion	Share	0.50	0.50	0.00	0.00	
	Weight	1.00	0.67	0.33	0.00	
	Weighted share	0.50	0.34	0.00	0.00	0.84
Program incentives effectiveness on energy efficient purchase and stocking by company	Share	0.00	0.75	0.00	0.25	
	Weight	1.00	0.67	0.33	0.00	
	Weighted share	0.00	0.50	0.00	0.00	0.50
Program activities effectiveness on encouraging retailer to sell more efficient	Share	0.60	0.40	0.00	0.00	
	Weight	1.00	0.67	0.33	0.00	
	Weighted share	0.60	0.27	0.00	0.00	0.87
Average of the three effectiveness criteria						0.74

Demand-side assessment. To understand the pre-program consumer situation with respect to televisions, a comprehensive Television Baseline survey of 622 residential customers was undertaken in August 2008. Selected findings for this survey were as follows.

Number Owned. Respondents were asked “how many televisions, if any, do you have in your home (including those that are either typically unused, rarely plugged in, or in home storage)?” Ninety-seven percent of the 641 baseline survey respondents stated that they had at least one television, while the remaining 3% stated that they did not have a television.

Table 7. Number of Televisions Owned

Number Owned	Frequency	Share (%)
0	19	3.0
1	192	30.0
2	230	35.9
3	117	18.3
4	60	9.4
5	17	2.7
6	4	0.6
7	2	0.3
Total		100.0

Most Recent Purchase. Those respondents who had purchased a television in the previous two years were asked what type of television their most recent purchase was. The responses are shown in the next table. Twenty-four percent purchased a basic CRT television, 52% purchased a LCD television, 16% purchased a plasma television, and 4% purchased a rear projection television.

Table 8. Most Recent Purchase

Type	Frequency	Share (%)
Basic CRT	65	24
LCD	140	52
Plasma	43	16
Rear projection	10	4
Other	3	1
Don't know	6	2
Total	267	100

Factors Affecting Most Recent Purchase. Those respondents who had purchased a television in the previous two years were asked "what was the most important factor [in their] decision to choose that particular television, instead of choosing another television"? Responses are shown in the table below. Thirty-five percent said that the most important factor was the price, 16% said it was picture quality, 13% said it was features, 12% said it was overall quality, 11% said it was size, 6% said it was brand name and 3% said it was energy efficiency.

Table 9. Factors Affecting Most Recent Purchase

Feature	Frequency	Share (%)
Price	94	35
Picture quality	43	16
Features	34	13
Overall quality	33	12
Size	30	11
Brand	15	6
Energy efficiency	7	3
Other don't know	11	4
Total	267	100

Hours of use and peak demand. A Residential Monitoring Study was undertaken to measure television hours of use. This 12 month monitoring study of hours of use for lighting and appliances was conducted in 48 households, with valid data collected for 45 televisions. The primary objective of the research was to determine the daily, seasonal, and annual operating patterns for televisions. Data was collected using Dent time of use loggers for the period between June 2010 and July 2011. Participating homes were visited five times over the course of the study for equipment installation, with an initial visit to install equipment, three interim visits to download data and ensure that equipment was operating properly, and a final visit to download data and for equipment removal. The following table provides summary information on: (1) metered hours of use for televisions with hourly load by season and the annual average, and (2) the percentage of share of televisions on during daily peak by season (4:00 pm to 8:00 pm). It may be worth noting that BC hydro has a winter peak, so that the winter share of televisions on during the peak period during the winter is the relevant share for calculating the impact of the Consumer Electronics program on peak demand.

Table 10. Hours of Use and Peak Share

	Spring	Summer	Fall	Winter	Annual average
Daily hours of use (hr.)	5.5	4.8	6.2	6.2	5.6
Share on during peak (%)	44.6	32.4	46.0	49.7	41.7

Energy and peak savings. Energy and peak savings for new energy efficient televisions were estimated in several steps, using the algorithms provided above. First, the number of incented televisions by CEE Energy Specification Tier was calculated for F2010 using program records of total incented units, combined with shelf space share information collected from the Showroom Presence Study of Appliances and Electronics. Second, the unit energy and peak savings by CEE Energy Specification Tier were estimated as the difference in power consumption of the incented unit and the Tier 1 baseline level, using the information from the Showroom presence Study for delta watts and the Residential Monitoring Study for hours of use and peak coincidence. Third, the net to gross ratio was calculated based on the results of the Trade Ally Survey. Fourth, cross-effects adjustment was applied based on engineering calculations, where it is worth noting that since BC Hydro is a winter peaking utility, only the impact on the residential space heating load is viewed as relevant in the calculation of cross effects. Fifth, engineering algorithms were used to estimate energy and capacity savings. As shown in the table below, total net energy savings for fiscal year 2010 were 6.1 GWh, and total net peak savings were 1.5 MW. Finally, it may be worth repeating that this paper covers only the impact of BC Hydro's Consumer Electronics program on energy and peak savings due to the new television program component, and it does not cover the television recycling program component.

Table 11. Energy and Peak Savings

CEE specification	Incented units (000)	Unit power savings (W)	Annual hours of use	Peak coincidence factor	Cross effects	Net to gross	Net energy savings (GWh/y)	Net peak savings (MW)
Tier 2	58	22	2,044	0.497	0.92	0.74	1.8	0.4
Tier 3	37	45	2,044	0.497	0.92	0.74	2.3	0.6
Tier 4	15	94	2,044	0.497	0.92	0.74	2.0	0.5
Total	110						6.1	1.5

Conclusions

Conclusion 1. Program Design.

BC Hydro has actively participated in the development of standards for energy efficient televisions through discussions with trade allies and through participation in the activities of the CEE. The design of the Power Smart Consumer Electronics Program represents best practices as exemplified by the work of the CEE Consumer Electronics Initiative. The program logic model review and analysis confirmed that the basic program logic was valid. There were strong linkages among inputs, outputs, purposes and goal statements. Indicators for key components of the logic model were clear, well defined and measurable. The Power Smart Consumer Electronics program has evolved over time in response to changes in market conditions, with the current program focusing on the promotion of the highest tier of energy-efficient televisions.

Conclusion 2. Program Implementation.

The Power Smart Consumer Electronics program has achieved considerable success in altering product purchase behaviour for energy efficiency televisions. Analysis of the Showroom Presence study data shows that the share of Base plus Tier 1 sales fell from 61% in 2009 to 28% in 2010. Conversely, the share of energy efficient Tier 2 through Tier 4 televisions increased from 39% in 2009 to 72% in 2010. Interviews with trade allies responsible for about 70% of program sales confirmed that: (1) program marketing materials were effective in promoting sales of energy efficient televisions; (2) program incentives were influential in encouraging their company to purchase and stock more energy efficient televisions; and (3) program activities were influential in encouraging the retailer to sell more energy efficient televisions.

Conclusion 3. Program Energy and Capacity Savings.

To estimate energy and capacity savings, engineering algorithms informed by a customer survey, a trade ally survey, a showroom presence study and metering were used. Because the program focusses on mid-market incentives, the analysis of program attribution was based on a trade allies survey. There were 110,000 televisions which received incentives in the year evaluated. Average unit energy savings were 55.5 kWh per year, and average unit peak savings were 13.6 watts. Total evaluated energy savings for F2010 were 6.1 GWh per year, while evaluated peak savings were 1.5 MW. These are significant savings for a new residential DSM program in a middle-sized jurisdiction.

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