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A MEMBER OF THE FSC GROUP

2010 Residential and Small Commercial Demand Response Initiative and Hydro Ottawa peaksaver® Small Commercial Pilot Program Evaluation

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Final Report

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1 Executive Summary

This report documents the load impact analysis methodology and results for the Ontario Power Authority (OPA) residential and small commercial demand response initiative (*peaksaver*®). It also reports the results of a process evaluation done for the Hydro Ottawa (HO) small commercial *peaksaver*® pilot. Results are reported at the province level. Results at the settlement zone level have been provided electronically and are shown in Appendix D.

The *peaksaver*® program involves the installation of programmable communicating thermostats (PCTs) and/or direct load control switches (DLC switches, or just switches) in households and small to medium businesses (SMB) with central air conditioning (CAC). The control devices allow CAC to be cycled or thermostats to be adjusted when an event is triggered, thereby reducing energy demand associated with CAC load. Load control is administered by a set of aggregators who each use a different load control strategy. For customers with switches, 50% and 30% cycling is used. This applies to almost all customers served by Toronto Hydro. Customers with PCTs may be subject to several different strategies—either some form of temperature set-back, or 50% cycling.

There were three province-wide events during 2010: on May 26th from 6 PM to 8 PM; on July 6th from 3 PM to 7 PM; and on August 30th from 2 PM to 6 PM. Additionally, OPA called a one-hour general test event on May 20th at 2 PM. Finally, for the purpose of this evaluation, OPA called two Evaluation, Measurement and Verification (EM&V) events on August 4th from 2 PM to 6 PM and September 1st from 1 PM to 5 PM. The EM&V events only affected a sample of residential and SMB customers[1] selected for measurement, rather than the full *peaksaver*® population.

To evaluate the *peaksaver*® response of SMB customers, Freeman, Sullivan & Co. (FSC) selected a sample of SMB participants and installed end-use loggers on their CAC units to obtain data for use in both *ex post* and *ex ante* load impact analysis for 2010. This sample contained businesses served only by the Toronto Hydro and Hydro Ottawa local distribution companies (LDCs). These two LDCs contain about 90% of small-business *peaksaver*® control devices. Those served by Toronto Hydro are part of the main *peaksaver*® population, while those served by Hydro Ottawa are participants in the Hydro Ottawa *peaksaver*® pilot. The small-business load impact estimates presented here are based on analysis of this logger data.

Residential customers had similar loggers installed during the summer of 2009 for the 2009 *peaksaver*® evaluation.[2] Residential results for 2010 are based on analysis of that data, as well as analysis of whole-building smart meter data for a sample of Toronto Hydro customers.

In addition to estimating load impacts, FSC also analyzed the degree to which *peaksaver*® control devices received the signal to reduce load. FSC also conducted a survey of SMB *peaksaver*® customers following an EM&V event to assess the degree to which customers felt discomfort due to the event. A

[1] The 2010 EM&V sample included 371 SMB customers and 1407 residential customers.

[2] Data from 407 CAC loggers were used for the 2009 evaluation and for this evaluation.

control survey on the same group of *peaksaver*® customers was also conducted following a hot day with no *peaksaver*® event.

1.1 Residential *peaksaver*® Load Impact Summary

Table 1-1 shows the average *ex post* impact per residential customer for each *peaksaver*® event along with energy savings and average temperature over the event period. Results are weighted by the number of control devices in each settlement zone to reflect the whole province. The largest impact occurred on July 6th, which had an estimated impact of 0.53 kW per customer. Unsurprisingly, July 6th was one of the two hottest days of the summer, reaching an average temperature of 32°C during the four hour event.

The overall average event effect during province-wide events of 0.47 kW with an average event temperature of 31°C is higher than the average 2009 impact of 0.30 kW (calculated in last year's evaluation). This is not surprising given that the average event temperature during 2009 events was only 28°C. As will be discussed in the *ex post* section of this report, the impacts in Table 1-1 do not differ significantly from predictions made in the 2009 evaluation.

Table 1-1:
Average Residential per CAC Unit Reference Loads, Impacts and Temperatures During Event Hours (whole-province)

Type of Event	Event Date	Event Hours	Average Reference Load (kW)	Average Event Impact (kW)	Percent Impact (%)	Aggregate Energy Savings (MWh)	Average Temperature During Event (°C)
Whole Province	5/26/2010	6 PM-8 PM	1.13	0.43	38	163	29
	7/6/2010	3 PM-7 PM	1.42	0.53	37	157	32
	8/30/2010	2 PM-6 PM	1.19	0.44	37	84	32
	Average/Total	n/a	1.25	0.47	38	404	31
EM&V Test	8/4/2010	2 PM-6 PM	0.92	0.34	37	0.5	28
	9/1/2010	1 PM-5 PM	1.08	0.39	36	0.4	31
	Average/Total	n/a	1.00	0.37	37	1.0	29
Total	**Overall Average/Total**	n/a	1.15	0.43	37	405	30

The average impact during province-wide events of 0.47 kW represents a 38% load reduction. The percent load reduction was quite stable across events. It is not surprising that the average load reduction is significantly less than 50% even though a 50% cycling strategy is used. Under a 50% cycling strategy, the maximum load reduction is 50% and that is only achieved when the CAC unit would normally be running at a 100% duty cycle.[3] Temperatures in OPA's territory rarely reach levels that would cause CACs to run at a 100% duty cycle.

Energy savings is calculated by multiplying the average per CAC unit impact by the number of available control devices for each hour of each event, and also including the hours after the event to capture post-event snap-back. These values are then added up over each event day to get a total energy value.

Table 1-2 shows *ex ante* load impact estimates for residential customers. The highest average impact is 0.56 kW, occurring on a 1-in-10 August Peak Day. The *ex ante* weather profiles used for Tables 1-2 and 1-4 are not the same as those used in the 2009 evaluation. Appendix A contains a discussion of how the *ex ante* weather profiles were chosen. The highest aggregate impact from residential customers is 103 MW, also on a 1-in-10 August peak day.

Table 1-2:
Residential *peaksaver®* *Ex Ante* Load Impact Estimates
by Weather Year and Day Type
(Event Period 2-6 PM)

Type of Estimate	Day Type	Extreme Year (1-in-10)	Normal Year (1-in-2)
Per CAC unit (kW)	May Peak Day	0.29	0.22
	June Peak Day	0.42	0.29
	July Peak Day	0.54	0.33
	August Peak Day	0.56	0.37
	September Peak Day	0.28	0.24
Whole-Province Aggregate (MW)	May Peak Day	53	40
	June Peak Day	77	54
	July Peak Day	99	61
	August Peak Day	103	68
	September Peak Day	52	44

Results in Table 1-1 and 1-2 are based on CAC logger data collected during the summer of 2009 for the 2009 evaluation. In that evaluation, the sample of loggers was assumed to be representative of the control device population. Therefore, in the residential load impact estimates there is no adjustment made for broken or missing control devices. As mentioned below and discussed more fully in Section 3.1, there is such an adjustment made for SMB customers.

[3] The intensity at which a CAC is running is described by the duty cycle. A CAC compressor is either on or off at any given time, but if it is running more intensely, then it will be on for a greater fraction of the time. The duty cycle refers to the fraction of time the CAC is running. A 100% duty refers to a CAC running at maximum capacity.

1.2 SMB *peaksaver*® Load Impact Summary

Table 1-3 shows each event date with average per CAC unit event impacts and average temperature during event hours for the small commercial *peaksaver*® population. Total energy savings is also shown. As in the residential sample, the largest impact occurred on July 6th, which had an estimated impact of 0.61 kW per CAC unit. The average impact across province-wide events is 0.55 kW per CAC unit, which is 26% of CAC load.

For SMB customers, the issue of multiple CAC units per site is more important than for residential customers because more premises have multiple units. Estimates in this evaluation are performed at the level of the CAC unit and should apply well to SMB customers with only one unit or with multiple units. For example, for SMB customers with three CAC units, the impact per customer would be three times the impact per CAC unit.

As with residential customers, the percent reductions for commercial customers fall short of 50%, and for the same reason. There are two other contributing reasons for the shortfall though. As will be discussed further (see Sections 3.1 and 3.2), event impacts in Table 1-2 are influenced both by missing and broken control devices and by control device communication failure, which refers to the CAC load-control switch or PCT not receiving or reacting to the radio signal that starts an event. Communication failure was only observable for a fairly small number of customers and events in the commercial *peaksaver*® load-research sample. However, based on what was observable, communication failure appears to be a major issue in Toronto Hydro's territory and less important, but worth examining, in Hydro Ottawa's territory. The same is true of the issue of broken and missing control devices.

Also, there is a fair amount of variance in impacts for events at similar temperatures. This can be seen by comparing the July 6th event to the August 30th event. Sometimes it can be difficult to determine the cause of such variance. However, in this case it appears to be due to significantly higher temperatures during the time before the event on July 6th than on August 30th. On July 6th, the 12 hours before the event had an average temperature of 29°C, while on July 6th, the 12 hours before the event had an average temperature of only 26°C.

The energy savings results in Tables 1-1 and 1-3 imply that the *peaksaver*® program provided a total energy savings of 428 MWh during 2010.

Table 1-3:
Average SMB per CAC Unit Reference Loads, Impacts and Temperatures During Event Hours

Type of Event	Event Date	Event Hours	Average Reference Load (kW)	Average Event Impact (kW)	Percent Impact (%)	Aggregate Energy Savings (MWh)	Average Temperature During Event (°C)
Whole Province	5/26/2010	6 PM-8 PM	1.61	0.49	30	3.4	28
	7/6/2010	3 PM-7 PM	2.20	0.61	28	9.6	32
	8/30/2010	2 PM-6 PM	2.24	0.53	24	8.3	32
	Average/Total	n/a	2.10	0.55	26	21.3	31
EM&V Test	8/4/2010	2 PM-6 PM	2.05	0.46	28	0.7	28
	9/1/2010	1 PM-5 PM	2.29	0.50	31	0.7	31
	Average/Total	n/a	2.17	0.48	29	1.4	29
Total	**Overall Average/Total**	n/a	2.13	0.52	24	22.7	30

Table 1-4 shows *ex ante* load impact estimates for SMB customers for the province. The highest per CAC unit load impact occurs on a 1-in-10 August Peak Day, with an average impact of 0.64 kW. This leads to a 2.8 MW aggregate load impact from SMB customers given current customer characteristics and participation levels.

Table 1-4:
SMB *peaksaver*® *Ex Ante* Load Impact Estimates by Weather Year and Day Type (Event Period 2-6 PM)

Type of Estimate	Day Type	Extreme Year (1-in-10)	Normal Year (1-in-2)
Per CAC unit (kW)	May Peak Day	0.39	0.32
	June Peak Day	0.52	0.42
	July Peak Day	0.62	0.42
	August Peak Day	0.64	0.48
	September Peak Day	0.36	0.33
Whole-Province Aggregate (MW)	May Peak Day	1.7	1.4
	June Peak Day	2.3	1.9
	July Peak Day	2.7	1.9
	August Peak Day	2.8	2.1
	September Peak Day	1.6	1.5

Estimates in Tables 1-3 and 1-4 are based on a statistical model of CAC load developed for CAC units with control devices present and operable. Estimates from this model are adjusted downward to reflect missing, broken and disconnected control devices. The downward-adjusted estimates are shown in Tables 1-3 and 1-4. This implies that the load impacts per working control device are higher. Further explanation of the downward adjustment is presented in Section 3.1 and estimates of load impacts per working device are shown in Sections 5.3 and 5.4.

2 2010 *peaksaver®* Program and Population Overview

OPA's *peaksaver®* program involves the installation of programmable communicating thermostats (PCTs) and/or direct load control switches (switches) in households and small/medium businesses with central air conditioning (CAC).[4] The control devices allow CAC equipment to be cycled or thermostats to be adjusted when an event is triggered, thereby reducing energy demand associated with CAC load. The control devices allow CAC to be cycled or thermostats to be adjusted when an event is triggered, thereby reducing energy demand associated with CAC load. Load control is administered by a set of aggregators that each use a different load control strategy. For customers with switches, 50% and 30% cycling strategies are used. This applies to almost all customers served by Toronto Hydro. Customers with PCTs may be subject to several different strategies, such as:

- 0.5°C per hour temperature setback for each hour of the event;
- 2°C setback for the whole event; or
- 50% cycling. This is the strategy used for the commercial customers with PCTs analyzed in this report.

Events can be triggered in two ways. First, the Independent Electricity System Operator (IESO) can declare an "Energy Emergency Alert".[5] Second, an event can be called when the external temperature is above 30°C and primary demand is greater than 23,000 MW. There were three province-wide events during 2010: on May 26th from 6 PM to 8 PM; on July 6th from 3 PM to 7 PM; and on August 30th from 2 PM to 6 PM. Additionally, for the purpose of this study, OPA called two Evaluation, Measurement and Verification (EM&V) events on August 4th from 2 PM to 6 PM and September 1st from 1 PM to 5 PM. The EM&V events only affected a sample of customers selected for measurement, rather than the full *peaksaver®* population.[6]

Table 2-1 shows the number of active devices as of October 2010 by customer type, device type and settlement zone. As seen in Table 2-1, the majority of *peaksaver®* customers and devices are associated with residential households. The residential segment comprises 99% of all *peaksaver®* PCTs and 95% of all load control switches. The values in Table 2-1 are taken from the February 4th, 2011 *peaksaver®* Program Status & Capacity Report, with the exception of the Hydro Ottawa commercial device numbers, which were taken directly from the list of installed devices provided by Hydro Ottawa.

The distinction between CAC units and *peaksaver®* customers is important for SMB customers and much less so for residential customers. Although FSC did not receive a list of devices and customers for the full *peaksaver®* residential population, in the 2009 EM&V sample, there are about 1.04 devices per participant. In contrast, in the Toronto Hydro SMB population, there is an average of 4 devices per participant and in the Hydro Ottawa SMB population there is an average of 1.6 devices per participant. In this report, results are reported at the per device (or per CAC unit) level, and results are aggregated by

4 The program also includes some load control devices on electric water heaters, but no evaluation of those load impacts is reported here.

5 Conditions for such an alert being called are referenced in the IESO's Systems Operations Manual.

6 The 2010 EM&V sample included 371 SMB customers and 1407 residential customers.

multiplying by the total number of devices installed in the population. It is not clear why there are so many more devices per participant in the Toronto Hydro population than in the Hydro Ottawa population. However, it is clear that it is not due to the presence of just a few customers with many devices. The entire distribution of devices per customer is different between the two LDCs, with Toronto Hydro having a greater proportion of customers with two or more devices, three or more devices and so forth. Also, Toronto Hydro includes a significant number of customers with greater than 10 devices while the greatest number of devices for any Hydro Ottawa customer is 5. Load impact analysis is done at the level of the CAC and should not be affected by these differences.

Table 2-1:
***peaksaver®* Available Control Devices for CAC[7]**
January 2011

Settlement Zone	Residential			SMB			Total
	PCTs	Switches	Total	PCTs	Switches	Total	
East	6,548	7	6,555	23	-	23	6,578
Essa	4,413	12	4,425	22	-	22	4,447
Georgian Bay	4	-	4	-	-	-	4
Long Point	2,264	382	2,646	45	-	45	2,691
Niagara	1,460	183	1,643	6	-	6	1,649
Northeast	420	20	440	13	-	13	453
Northwest	-	-	-	-	-	-	-
Ottawa	21,519	6	21,525	939	-	939	22,464
South Central	22,020	1	22,021	113	-	113	22,134
Southwest	6,644	459	7,103	63	-	63	7,166
Toronto	42,657	62,314	104,971	42	2,960	3,002	107,973
West	11,573	1,381	12,954	200	-	200	13,154
Other	419	-	419	25	-	25	444
Grand Total	**119,941**	**64,765**	**184,706**	**1,491**	**2,960**	**3,525**	**189,157**

2.1 Report Organization

The remainder of this report is organized as follows. Section 3 describes the load research sample design and the experimental operation of the sample that generates the end-use load data used in the analysis of small-business customers. It also summarizes communication failures and other issues that were identified during the research. Section 4 summarizes the *ex post* evaluation methodology. This is a detailed section that describes the methodologies used and the validation tests performed. Section 5 contains the load impact estimates. Both *ex post* and *ex ante* estimates are presented for commercial customers, while only *ex post* estimates are provided for residential customers. *Ex ante* impacts for

[7] The *peaksaver®* program also has control devices installed on a reported 13,038 electric water heaters.

residential customers were estimated for the evaluation 2009 report.[8] Section 6 presents the results of a post-event survey that was performed to assess whether the *peaksaver*® program has any significant impact on customer comfort. The survey also assessed customer satisfaction with the program and with OPA in general. Detailed tables presenting *ex post* and *ex ante* impact estimates that conform to the requirements of the Ontario Load Impact Protocols[9] have been provided to OPA.

[8] Ontario Power Authority 2009 *peaksaver*® Residential Air Conditioner Measurement and Verification Study, by KEMA, May 17, 2010.

[9] Protocols for Estimating Load Impacts Associated with Demand Response Resources in Ontario, prepared for the Ontario Power Authority, December 31, 2009.

3 EM&V Sample and Experimental Design

The objectives of the main analytical section of this report are to measure *ex post* impacts for 2010 and *ex ante* impacts for residential and small to medium business (SMB) *peaksaver*® customers. This is accomplished using data collected during the 2009 evaluation for residential customers and using data collected during the summer of 2010 for SMB customers.

This section explains the sampling and measurement used to estimate load impacts for SMB customers. A discussion of the residential data is contained in Section 4, along with a discussion of the use of smart meter data to estimate 2010 residential load impacts.

3.1 Sampling, Recruitment and Installation for SMB Customers

Load impact estimates for SMB customers were derived from measurements of five-minute average CAC loads obtained from a sample of *peaksaver*® customers. Due to the low numbers of SMB devices associated with the other LDCs, these devices were only installed on businesses served by Toronto Hydro and Hydro Ottawa. This sample is referred to as the EM&V sample. To make the EM&V sample representative of SMB customers in Toronto, the recruitment sample for that LDC was stratified based on three industry classifications—office, retail and other—and the number of controlled CACs—1 to 3 and 4+. Initial industry classifications were made based on customer business names because no industry-specific classification codes (e.g., NAICs) were available from either Toronto Hydro or Hydro Ottawa.[10] In Toronto, stratification was used to order and prioritize recruiting so that the final recruited sample was as representative of the population as possible. Each stratification cell had a quota based on the cell's proportion in the whole population. These quotas were used by the recruiting team to determine which customers to call. For example, if the "1–3 CAC units, office" cell achieved its quota, then the recruiters stopped calling those customers.

For Hydro Ottawa, no stratification was used because the goal was to recruit 150 out of 400 total customers as of the time of recruiting. In a situation where a high recruiting success rate is necessary, stratification can slow the process substantially. Moreover, since the recruited population contained almost 40% of the total customer population, it was likely to represent most population segments of interest.

Prior to recruitment, FSC worked with OPA (and through OPA's Project Manager, with Toronto Hydro and Hydro Ottawa) to get corporate approval of the letter that was sent to the SMB *peaksaver*® populations of those two LDCs informing them of the opportunity to be part of the EM&V sample and offering an incentive in appreciation of their participation. In addition, a request was made that both TH and HO share a copy of the letter with their call center staff in the event that any of those *peaksaver*® SMB customers phoned the call center for confirmation of the legitimacy of the sampling effort.

Recruiting within the Hydro Ottawa service territory was very successful. With calls commencing on June 1st, FSC had already recruited 125 HO peaksaver SMB customers by the end of June 2nd. Getting the TH

[10] During FSC's participant survey, customers had their industry recorded for greater accuracy in later parts of the evaluation.

sample recruited turned out to be more time-consuming; while recruiting for the TH sample began as well on June 1st, the sample was not completed until June 16th.

Tables 3-1 through 3-4 show the proportions of control devices among SMB customers in Ottawa and Toronto, respectively, according to the classification scheme. Both the full population and the EM&V samples are shown. Tables 3-1 and 3-3 show percentages within both the population and the EM&V sample, while Tables 3-2 and 3-4 show device counts in the EM&V sample for each LDC.

For both LDCs, the sample is representative of the population in terms of the industry designations, but less so in terms of the number of devices per site. The sample under-represents sites with four or more control devices. Unfortunately, sample weights cannot solve this problem easily because the number of EM&V customers with four or more devices is so small that the weight assigned would be very large and would produce average results that were highly dependent on just a few customers. Therefore, reported results are un-weighted.

Table 3-1:
Hydro Ottawa Percentage of *peaksaver*® Devices in Population and Sample

Industry	Number of Devices Category				Total	
	1-3		4+			
	Sample (%)	Population (%)	Sample(%)	Population (%)	Sample (%)	Population (%)
Office	37	39	0	6	37	45
Retail	35	29	1	7	36	36
Other	26	18	0	1	26	19
Total	99	86	1	14	100	100

Table 3-2:
Hydro Ottawa Number of *peaksaver*® Devices in EM&V Sample

Industry	Number of Devices Category		Total
	1-3	4+	
Office	52	0	52
Retail	52	2	54
Other	39	0	39
Total	142	2	145

Table 3-3:
Toronto Hydro Percentage of *peaksaver*® Devices in Population and Sample

Industry	Number of Devices Category				Total	
	1-3		4+			
	Sample (%)	Population (%)	Sample (%)	Population (%)	Sample (%)	Population (%)
Office	32	34	3	14	35	48
Retail	35	23	2	13	38	36
Other	25	12	2	4	27	16
Total	93	70	7	30	100	100

Table 3-4:
Toronto Hydro Number of *peaksaver*® Devices in EM&V Sample

Industry	Number of Devices Category		Total
	1-3	4+	
Office	90	11	101
Retail	66	16	82
Other	40	3	43
Total	194	30	226

Hobo H22 50 Amp loggers were used to collect and store CAC load data. These loggers collect average electric current every five minutes. Current readings are used to calculate average power for each five-minute period using voltage and power-factor information collected from each CAC unit during installation.

Logger installations began on June 22nd and finished on July 15th with the majority of loggers installed by the time of the July 6th *peaksaver*® event. During installation, technicians came across 25 missing DLC switches, 8 disconnected switches and 13 broken switches in the Toronto Hydro territory and 2 missing PCTs in the Hydro Ottawa territory. In these cases, FSC provided OPA with a list of the CAC units so that OPA could remove them from the *peaksaver*® population lists.

Not all aggregators keep track of control devices that are deactivated, disconnected or broken. Only Hydro One and Enersource differentiate between the total number of devices that have been installed and the total that are available to be controlled. Even for those two aggregators it is likely that not all deactivated, disconnected or broken devices are accounted for. Technicians installing CAC loggers came across some sites where control devices were deactivated, disconnected or broken even though the site was listed as having a device available for load control.

For load impact estimates, a correction factor is used to address the fact that because technicians did not install loggers on CAC units without working control devices, the logger sample is not perfectly representative of the *peaksaver*® population. The logger sample contained only control devices that were not visibly disconnected, broken or missing, while the *peaksaver*® population contains disconnected, broken and missing control devices. Sites with these devices will provide load but no load impact. There is no point installing loggers on CAC units that cannot provide load control, but the final estimates must account for that decision. Therefore, the correction factor represents the estimated fraction of working control devices in each population based on what technicians encountered during installation of the data loggers. For Toronto Hydro SMB customers, the correction factor is:

$$\frac{251\ working\ switches}{297\ total\ switches\ encountered} = 0.85$$

For Hydro Ottawa SMB customers, the correction factor was determined to be much higher: 148/150=0.99.

After load impacts have had this factor applied, each load impact estimate is then an accurate estimate of the load impact per available device, where the number of available devices is defined as in the Program Status & Capacity Report.

The primary implication of the correction factor is that SMB load impacts per device for Toronto Hydro could be improved by roughly 15% by making sure that all control devices are functioning properly. For Hydro Ottawa, control devices already appear to be functioning quite well, so there is little to be gained by fixing broken ones. Another implication is that about 15% of Toronto Hydro customers have been compensated for being in the program, but provide no load impacts and feel no discomfort due to events.

Although there is some uncertainty, it seems likely that the greater proportion of non-working control devices among Toronto Hydro customers is due to those devices being older and located outdoors. The PCTs among Hydro Ottawa customers are indoors and are newer, on average. Also, because PCTs are used directly by customers for controlling their indoor temperature, the customer has an incentive to make sure the device works. On the other hand, the customer has no incentive to care if a DLC switch breaks.

The logger sample in the 2009 evaluation was assumed to be representative of the population of devices, with no further correction for missing, broken or disconnected switches. What evidence there is of this issue from that evaluation suggests that a correction factor of 98% or higher would be appropriate. Additionally, the comparison of impacts estimated using a representative sample of whole-building data (which automatically accounts for broken, missing or disconnected switches) with impacts estimated using the 2009 CAC logger data with no correction factor, suggests that the appropriate correction factor should have very little effect. This comparison is shown in Section 4.5. Impact estimates developed using whole-building data are quite close to those made using CAC logger data. Therefore, for residential customers, no correction factor is applied.

3.2 Control Device Success Rates for SMB Customers

Some load-control switches and PCTs used to activate events have internal data loggers that keep track of when the device received an event signal and how many minutes per hour the device operated.

A variety of issues can lead to a device not receiving a signal, but the reasons can be divided into three main categories. First, a device might not receive a signal because the signal was miss-addressed or not sent at all. Second, a device might not receive a signal because something blocked the signal from getting through, such as a thick wall. The second issue is thought to affect PCTs more frequently because they are located indoors while switches are located outdoors. Finally, the device may be broken in some way that is not visible from the outside but that keeps it from receiving signals.

Unfortunately, many of the devices in OPA's territory do not have the capability to record communication due to their age. In total, 132 devices in both LDCs (34% of the devices) had their internal communication data downloaded. Even within this group the data is inconsistent and has unexplained gaps. This has been FSC's experience with internal data loggers at a utility in the United States as well.

Table 3-5 displays the percentage of SMB devices that reported receiving the event signal for each LDC and each event. Whether a device received a signal was determined by whether the internal device log had recorded minutes operated during the event. Minutes operated refers to the number of minutes per hour that the device was being instructed to limit the CAC from running at its otherwise full potential. If the log was recording on an event day and showed no minutes operated, then it was assumed to have missed the event due to communication failure. In that case, the associated CAC unit would not have been controlled and would not have provided any load impact.

The sample size underlying each event and device type fluctuates because device data loggers are prone to have large gaps of recorded time. Device logs appear to be incomplete because they may reset for several reasons, at which point they do not record time until they receive a signal from the LDC. Devices will reset due to a loss of power (such as a power outage, a broken circuit or the CAC being turned off and on again) or when they do not hear a signal from the LDC for 2.5 hours or more. It is not clear how often such things occur. From work done elsewhere, it is clear that when a device's log was recording during an event and shows that it did not have minutes operated, then the device missed the event. However, it is not clear at this point whether a gap in the internal data log during an event is a reliable indicator that the device did not operate during the event. Therefore, there is no way to be sure about what happened during the times when events were called, but a given device's internal data log was not recording.

Based on the sample in Table 3-5, communication failure is common for both LDCs. However, for Hydro Ottawa, communication appeared to work well during the full-system events on May 26th, July 6th and August 30th. That suggests that the communication issues in Hydro Ottawa may be due to devices not receiving the signal that told them to be part of the EM&V group, rather than missing event signals.[11] It also suggests that the full program may have better performance than the load research sample.

[11] In order to be able to call a subset of devices for EM&V events, an addressing signal was sent out specifically to EM&V devices that directed the devices to respond to calls for EM&V events. If the device did not receive this addressing signal, then it would still respond to province-wide events, but not EM&V events.

Table 3-5: Number of Internal Device Logs Available During Each Event and Percentage That Operated During Each Event

Event	Event Type	Hydro Ottawa			Toronto Hydro		
		Devices with data during that event		Percentage of devices that operated, of those with data	Devices with data during that event		Percentage of devices that operated, of those with data
		Number	%		Number	%	
20-May-10	Test	71	49	28	NA	NA	NA
26-May-10	Province Wide	76	52	91	NA	NA	NA
6-Jul-10	Province Wide	68	47	96	NA	NA	NA
4-Aug-10	EM&V	59	41	78	18	7	50
30-Aug-10	Province Wide	73	50	95	29	12	45
1-Sep-10	EM&V	74	51	76	17	7	53

For Toronto Hydro, these communication numbers, along with the large number of non-functioning switches suggest that program performance is being degraded by old equipment. Although it is impossible to know how representative these numbers are of the whole Toronto Hydro LDC, it is the case that many of the devices in the sample did not have internal data recorders because they were too old.[12] This conclusion is corroborated by the large number of broken, disconnected or missing switches that technicians found. This conclusion is further corroborated by the fact that of the Toronto Hydro devices that were observed and did not successfully operate during at least one event, all of them missed all the events. Of the devices that were observed and successfully operated for at least one event, all devices operated during all events. This suggests that the Toronto Hydro DLC switches that fail to operate are incapable of receiving a signal rather than sporadically failing to receive a signal. The situation for Hydro Ottawa suggests that some devices only receive signals sporadically, with some devices successfully operating during certain events and not others. This is also consistent with what has been observed elsewhere: working switches seem to have very low rates of communication failure, while PCTs tend to fail to receive event signals more often.

For Toronto Hydro, the implication of this analysis and of the non-working switches discussed in Section 3.1 is that program performance could be improved substantially by replacing broken switches. This would be cheaper than recruiting new customers because these customers have already been paid to be in the program. Also, because DLC switches are located outdoors, new switches could be installed without having to make an appointment with customers.

Another implication of this analysis for the whole program is that it may be worth examining whether there are ways to cheaply improve communication among working devices. For example, if it is possible to send the signal for an event multiple times during each event, that can improve signal reception. Also,

[12] Switches installed prior to late 2006 did not have internal logging capabilities, while those installed thereafter did.

operational or programming errors by aggregators can lead to groups of devices not receiving event signals. Both of these issues have been observed elsewhere. Aggregators themselves may have some ideas as to other sources of communication failure.

It is worth noting here that DLC switches generally perform quite well in AC load control programs around North America. The issues identified here for Toronto Hydro point to switches having a natural rate of failure after several years. This should be taken into account when considering whether switches or PCTs are more cost-effective. The added cost of PCTs and the fact that PCTs tend to have lower rates of communication success should also be considered, however.

For the sake of load impact estimates, no further correction is needed to reflect this issue. The CAC logger data includes the effect of missed events in it because it records the load of CACs with control devices that failed to operate. Those loads are included in the modeling and have the effect of reducing average event impacts by the amount appropriate to reflect the effect of communication failures.

3.3 Estimating SMB Impacts for Non-Sampled Settlement Zones

As was the case for the 2009 evaluation, the recruited EM&V sample could not include SMB customers from OPA's entire territory due to the cost of recruiting and installing over a disperse population. In order to estimate SMB impacts for settlement zones not included in the EM&V sample, each un-represented settlement zone was assigned to either the Toronto Hydro portion of the sample or the Hydro Ottawa portion of the sample based on geographical proximity and the degree to which each zone was urban or rural. Then the regression model results developed for either Toronto Hydro customers or Hydro Ottawa customers were used to estimate SMB impacts for each un-represented settlement zone, based on its own respective set of weather conditions. A similar method was also used for the 2009 evaluation for the residential impacts. Appendix B includes the assignments between settlement zones and Toronto Hydro or Hydro Ottawa.

4 *Ex Post* Impact Analysis

This section describes the data and analysis used to produce the 2010 impact estimates and also provides validation for the statistical models used.

4.1 Analysis Dataset

The EM&V sample dataset contains hourly average CAC load data for July through September 2009 for 407 residential customers and for the same months in 2010 for 371 SMB customers. The residential dataset was collected by another firm for the 2009 *peaksaver*® evaluation and is documented in a separate report.[13]

The SMB sample initially consisted of a total of 399 installed data loggers; 148 in Hydro Ottawa's territory and 251 in Toronto Hydro's territory. Of these, 3 from Ottawa were pulled out early due to customer requests, 3 were missing in Toronto when the technician went for retrieval, 1 was broken in Toronto and 16 in Toronto were accidentally reset in the field by installation technicians, rendering their data unusable. Therefore, the final SMB analysis sample consists of 145 sets of CAC unit logger data for Hydro Ottawa and 226 for Toronto Hydro. Data was collected at five-minute intervals but averaged to an hourly level for the analysis. There is little modeling accuracy to be gained by examining data at smaller time intervals than one hour. The exact dates covered by each logger vary due to installation and retrieval schedules, but all loggers cover at least July 15th through September 30th, 2010.

4.2 Analysis Approach

Data from the loggers installed on the EM&V sample was analyzed using linear regressions done individually for each CAC unit in the two samples. Analyses for the residential and SMB samples were done in parallel and were very similar, so the modeling for both samples is described in this section. Corroboration for the results from this approach is provided with day-matching for both residential and SMB customers and with regressions on smart meter data for residential customers.

Day-matching is less reliable than regression because there aren't always comparable days. It also tends to produce more variance in impact estimates because the reference load consists of actual load on one day, rather than a predicted load based on the full summer's worth of data. However, when matching works well, it provides a very simple way to check the results of more complicated analyses, such as regression.

The smart meter regression results for residential customers are included for two reasons. First, they are included as a verification of the accuracy of the results based on 2009 logger data. Second, they are included to demonstrate the viability of using smart meter data to estimate event impacts. In the future this may eliminate the need to install loggers on an EM&V sample.

Each customer has a different usage pattern over time, and each customer's usage responds differently to changes in weather. This led us to estimate separate regressions for each CAC unit in both the

[13] Ontario Power Authority 2009 *peaksaver*® Residential Air Conditioner Measurement and Verification Study. Produced by KEMA, May 17, 2010.

residential and SMB EM&V samples, but using a common regression model in each case. For all CAC units, the factors used to estimate usage patterns were weather variables interacted with time indicators. These allow the model to take into account different reactions to weather conditions at different times of day, times of the week and times of year. For example, a residential customer's energy usage might respond strongly to high temperatures on a Saturday afternoon when they are at home, while it might not respond at all on a Wednesday afternoon when they are at work. All analysis and results are at the per CAC unit level, with the exception of smart meter results, which are at the premise level.

The subscript *t* indicates hour of the summer. Only non-holiday weekdays were modeled because no events were called on the weekend (weekend usage behavior is different from weekday usage). Table 4-1 defines the variables and describes the effects they seek to identify. The regression specification was:

$$kW\hbar_t = a + \sum_{\hbar=1}^{24} \mathrm{b}_{\hbar} \cdot \mathrm{wacdh_t} \cdot I_{\hbar} + \sum_{\hbar=1}^{24} \mathrm{c}_{\hbar} \cdot \mathrm{wacdh_t^2} \cdot I_{\hbar} \cdot I_c + d \cdot wacd\hbar_t \cdot \boldsymbol{I_e} + \boldsymbol{e} \cdot wacd\hbar_t \cdot \boldsymbol{I_{pe}}$$
$$+ \sum_{\hbar=15}^{20} \mathrm{f}_{\hbar} \cdot I_{\hbar} \cdot I_T + \varepsilon_t$$

Table 4-1:
Description of CAC Load Regression Variables

Variable	Description
a	Estimated constant.
$b - i$	Estimated parameter coefficients.
$wacd\hbar$	A weighted-average of the past 12 cooling degree hours using a base of 21°C. Weights decrease by 10% per hour so that more recent hours have stronger effects.[14]
I_c	Indicator for commercial customers. Interacted with hourly effects so that commercial, but not residential, customers have the effect of weighted-average CDH-squared.[15]
$I_{\hbar}$	Indicator variables representing the hours of the day, designed to estimate the effect of daily schedule on usage behavior and event impacts.
I_e	Indicator variables designed to model the effects of events.
I_{pe}	Indicator variable to model the effects of post-event periods. Decreases in magnitude over the 4 hours after the event at a rate of 67% per hour to reflect that snap-back should decrease fairly quickly.
I_T	Indicator variable that models the effects of the thunderstorm in Ottawa during the August 4, 2010 event.
ε_t	The error term, assumed to be a mean zero and uncorrelated with any of the independent variables.

14 The precise specification of temperature in the model leaves a large amount of leeway for analyst judgment. A 12-hour interval was chosen because it captures the vast majority of important variation in historical temperature, but still allows for ex ante predictions of afternoon event impacts without requiring assumptions about what the weather was on the day before. Whether cooling-degree hours or raw temperature is used for modeling has little impact on results.

15 Weighted-average CDH-squared is included in the model for commercial customers, but not for residential. It does improve the model fit for residential customers. This is not likely due to a difference between commercial and residential customers, but due to the fact that commercial customers experienced higher temperatures during the 2010 logger period than residential customers did during 2009. A squared CDH term primarily helps model fit in times of very high temperatures.

The conceptual basis for statistical analysis is that with large sample sizes, the effect of unobservable or omitted factors not related to the main effect will disappear due to the power of averaging. Presumably, many factors affect individual-customer CAC usage other than what can be included in a large-scale model. In a large sample, such as hundreds of customers over three months, it is likely that the effect of these omitted factors is small. However, in small samples, such as one or a few customers' regression models, these omitted factors could have an important effect. This means that results for sub-samples of the dataset should be viewed with increasing caution as the sub-samples decrease in size.

In models of CAC load, these omitted factors take two main forms:

- Individual-specific factors such as building schedules, vacation timing and individual temperature preferences; and
- Observable factors for which there is not enough data to model. A frequent example of this is relatively rare weather patterns that might occur only once in a summer, such as a thunderstorm in the middle of an event or a very hot day with a very cold morning. In the summer of 2010, a good example is the thunderstorm that hit Ottawa during the August 4th EM&V event.

This point about omitted factors is illustrated in Figures 4-1 and 4-2. Figure 4-1 shows hourly average CAC load for the residential EM&V sample on three non-event weekdays with very similar temperature profiles. The days are July 27th, August 19th and August 25th, 2009. The days' average temperatures are close, at 21°C, 22°C and 20°C, respectively. Their daily high temperatures are also almost identical at 26°C, 26°C and 25°C, respectively. Figure 4-2 shows their hourly temperatures for reference.

The point of the figures is to illustrate there can be large differences in CAC usage that may be unexplainable using simple functions of recent temperature. For example, August 19th has a peak load 50% greater than August 25th and more than 100% greater than July 27th. If we try to explain this difference based on the higher morning temperature on August 19th, then the puzzle becomes why August 25th has such higher load than July 27th, despite lower morning temperatures. These unexplainable differences provide calibration for the amount of accuracy and precision to expect from a model of CAC usage where the only observable variable is the weather.

An explanation might be found by examining whether the difference is due to temperatures the day before these days. However, every such variable added to the model increases the necessary data for the model to do a good job matching real patterns. In the case where load depends on the previous day, a good model requires information about both the current temperatures and temperatures perhaps as much as 36 hours in the past. If each CAC usage value requires 36 previous hours of temperature data to model, then the effective sample size of the dataset is much smaller than if CAC usage can be modeled well using the last 12 hours of temperature, for example. This is because there are 3 times as many non-overlapping 12-hour temperature blocks as there are 36-hour temperature blocks in the data.

In this analysis we attempt to strike a balance between using all the data by accounting for different effects of weather, and not over-straining the data by trying to make it fit patterns that are not well-represented. This necessarily means there will be unexplained variation; similar to the variation shown in Figure 4-1. The same point applies to the commercial CAC load model.

Figure 4-1:
Average Hourly Residential CAC Load on Three Days with Similar Temperatures

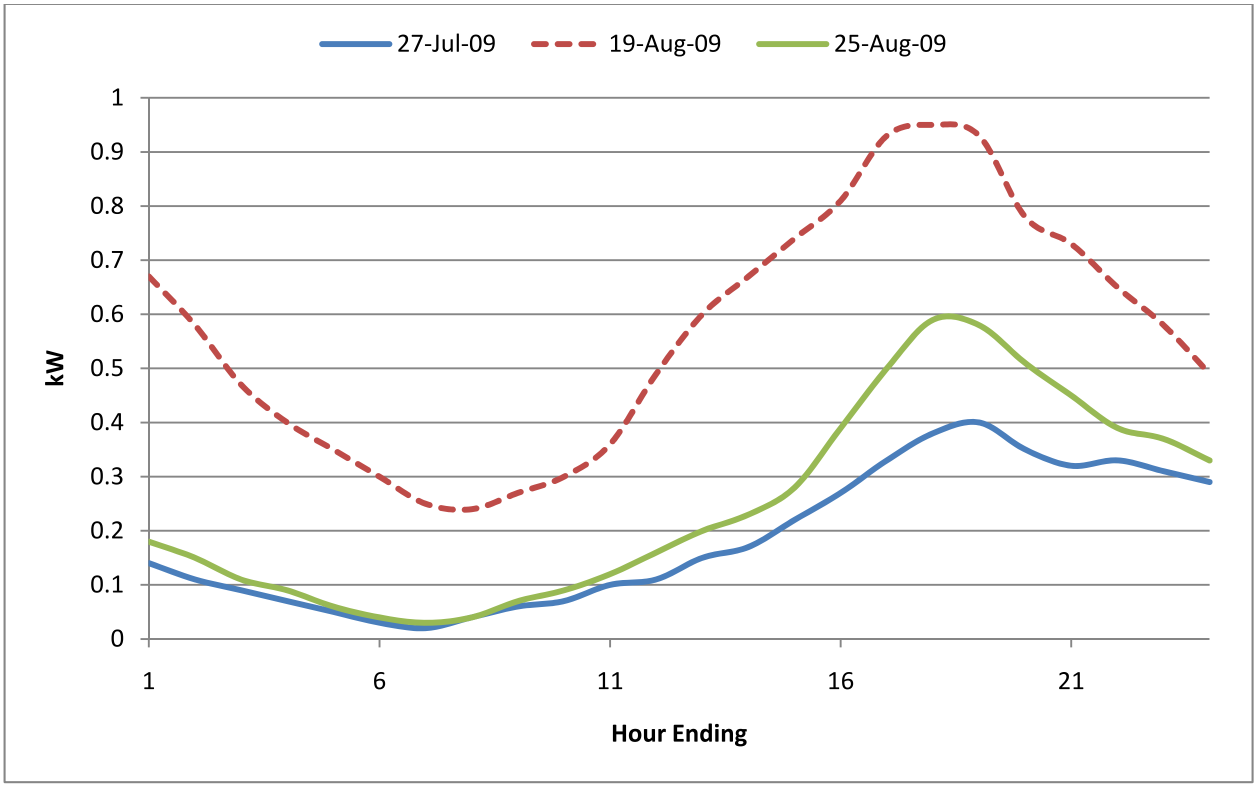
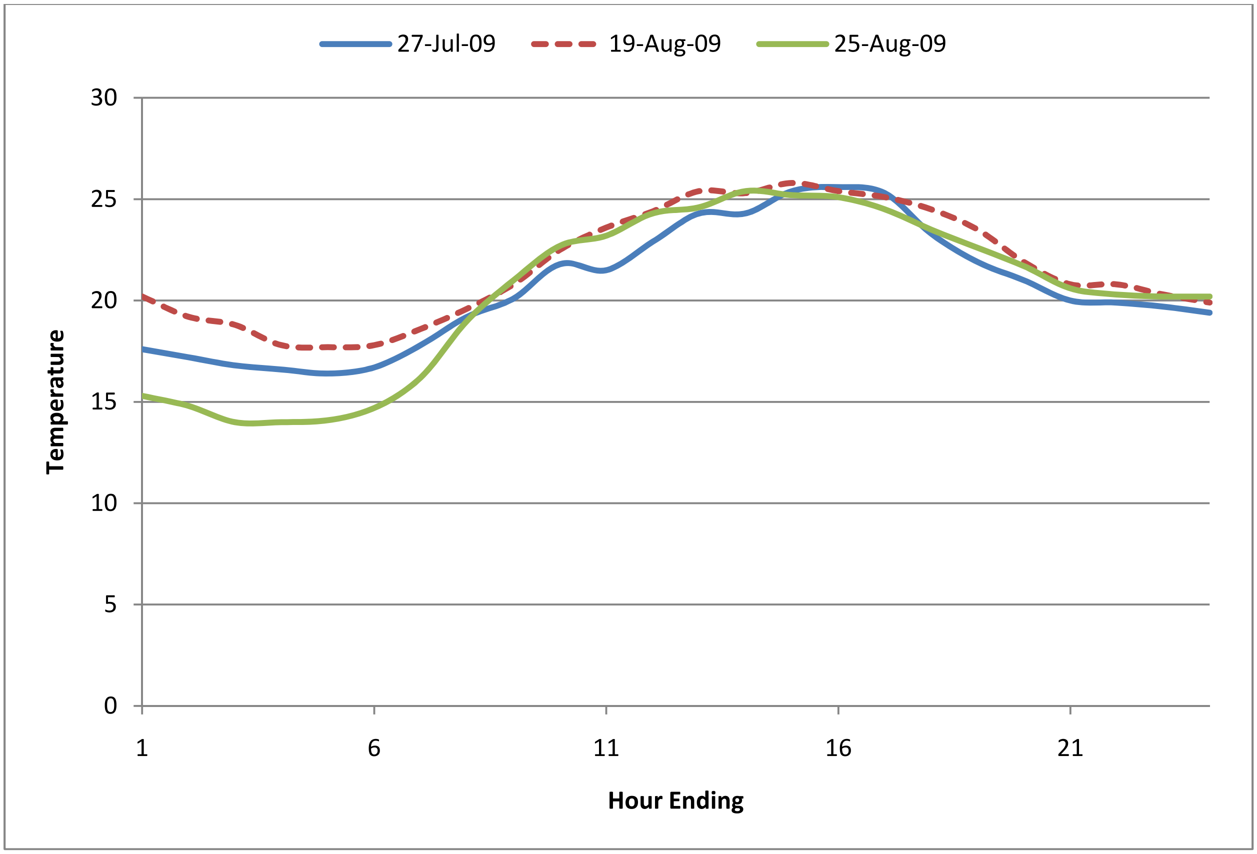


Figure 4-2:
Average Hourly Temperatures on the Three Days in Figure 4-1



4.3 Model Validation

In order for a model to be useful in the context of *peaksaver*®, it must make accurate predictions of CAC loads, primarily at high temperatures. Three methods of validation are used to assess this capability.

4.3.1 In-Sample Testing

First, at an individual level and an aggregate level, the model must explain a large degree of the observed variation in CAC load during the summer of 2010. The metric used for determining how much variation in load is explained by the model is R-squared. R-squared values are a function of the difference between predicted usage and actual usage. They vary from zero to one, with low values indicating that the model explains little variation and high values indicating that the model explains much of the variation in usage. The first test is a test of the in-sample R-squared of the model. That the test is in-sample means that the R-squared value is calculated over usage values that were used to make the model.

This is the simplest test for the model to pass and it is a necessary, but not sufficient condition for the model to be useful. A model with a high in-sample R-squared value can be developed by including a very large number of variables. In this case, the model will appear to explain a large degree of the variation in load, but it may be highly inaccurate in predicting for conditions outside of the data the model was fit to. This is known as over-fitting.

Although the regressions were performed at the individual CAC unit level, from a policy standpoint, the focus is less on how the regressions perform for individual CAC units than on how the regressions perform for the average participant and for specific customer segments. The average R-squared among individual residential CAC unit regressions is 44% and among commercial CAC unit regressions is 62%. At an aggregate level over the hours of the summer, the residential model has an R-squared value of 91% and the commercial model has an R-squared value of 90%.

4.3.2 Out-of-Sample Testing

As a second and more stringent test, the model must do well in out-of-sample testing on days included in the EM&V dataset. The procedure for out-of-sample testing consisted of running the regression models multiple times, each time holding back one of the hot non-event days of the summer from the estimation. Then predicted loads were compared to actual loads on the days held back. This is a true test of the regression model's predictive power for weather conditions actually observed during the periods recorded.

Figure 4-3 shows the actual average hourly energy use of residential CAC units on five hot out-of-sample days compared to the regression-predicted average energy use. The out-of-sample days were chosen randomly among the hottest 20 non-event weekdays of each summer's worth of data—2009 for the residential sample and 2010 for the SMB sample. The average high temperature for the 5 days was 28°C for both residential and commercial customers.[16] Figure 4-4 shows the same for SMB CAC units. The close match between predicted values and actual values reflects the ability of the regressions to predict accurately. In both cases, the predicted load is very close to the actual load. For residential customers, the actual load is, on average, about 4% higher than predicted load during the hours of 1 PM to 7 PM. For SMB customers, actual load is on average about 2% higher than predicted load during those hours.

[16] For residential customers, the five 2009 days are July 11th, August 1st, August 13th, August 15th and August 18th. For SMB customers, the five 2010 days are July 16th, July 27th, August 9th, August 10th and August 19th.

Figure 4-3:
Average Residential CACUnit Actual and Predicted Load for Out-of Sample Days

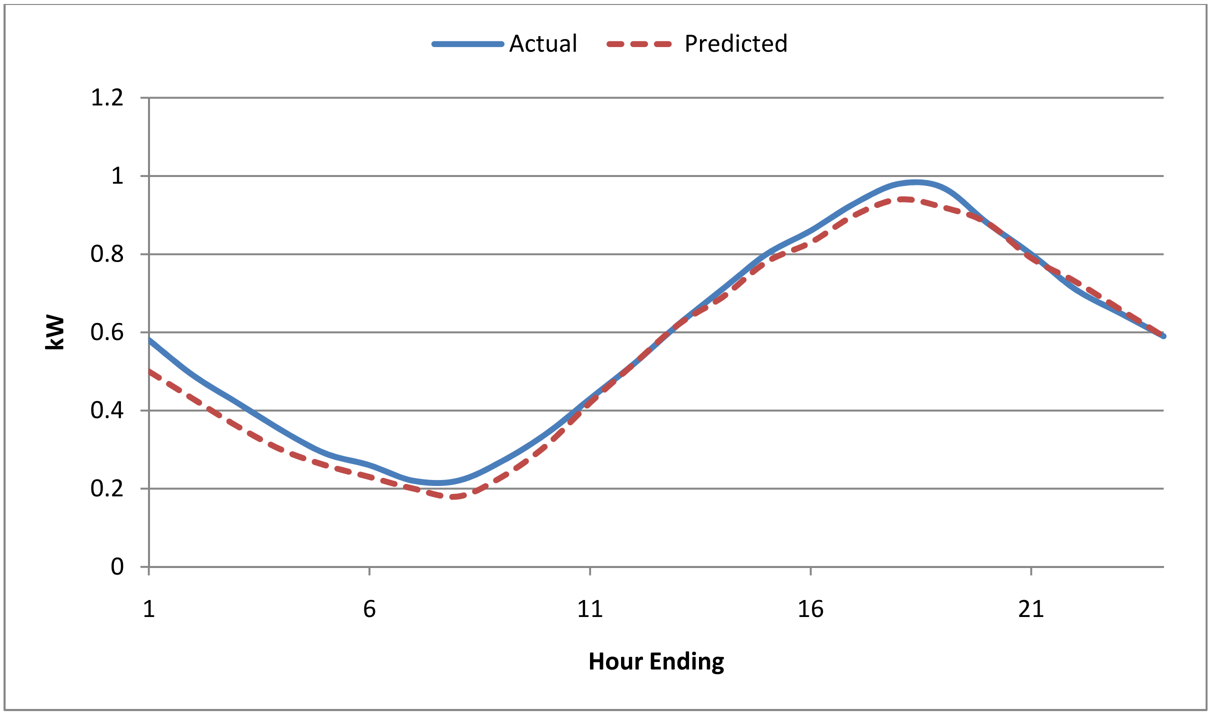
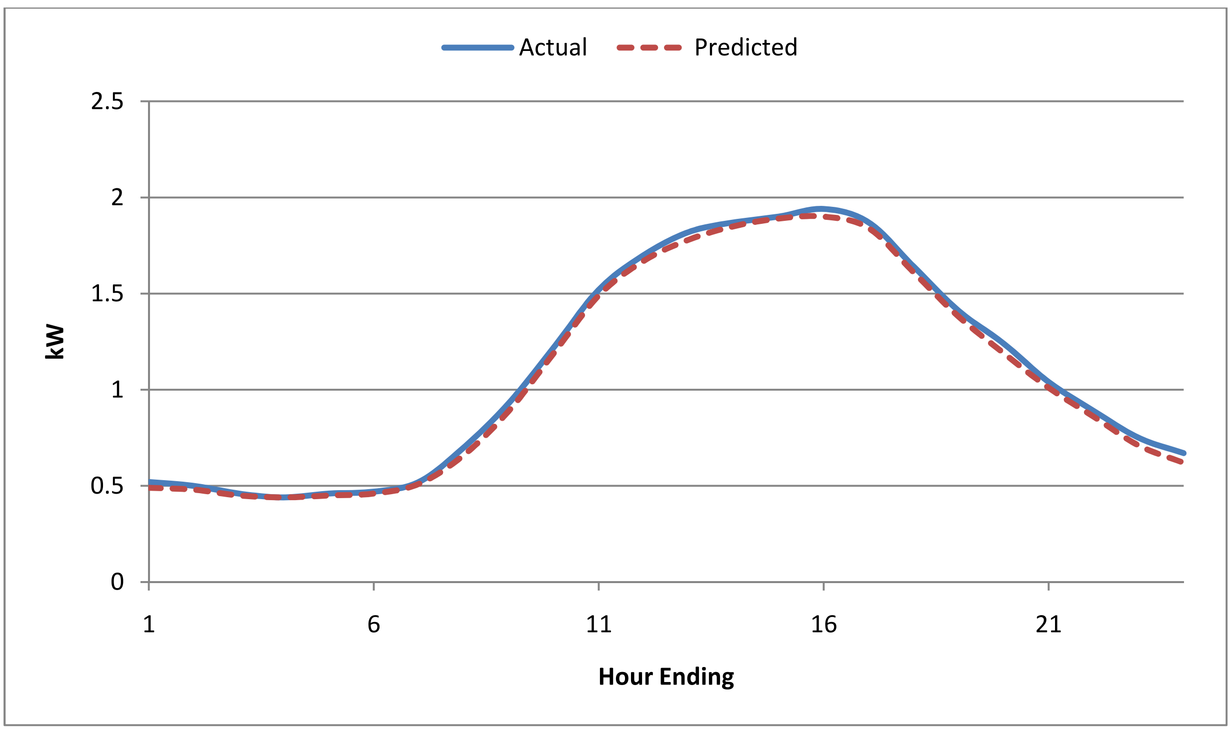


Figure 4-4:
Average SMBCAC Unit Actual and Predicted Load for Out-of Sample Days



The final test that the model had to pass is one of general plausibility in predicting for the *ex ante* weather conditions. This test is less well-specified, but consists of producing reasonable CAC load patterns as a function of weather, as compared to results in past years, results from other programs and general knowledge about how the program works. This reality-check test is a crucial way to test the assumptions that go into the model. The *ex ante* estimates that are presented in Section 5 were carefully reviewed and generally display the expected patterns across event conditions and are consistent with other studies after judgmentally accounting for expected differences due to weather conditions and other factors.

4.4 Air Conditioner Load Patterns

Residential CAC load is highly sensitive to weather conditions. Importantly, the load reduction capability of the program is directly tied to the amount of CAC load. The cycling and control algorithms tend to provide larger percent load reductions at higher temperatures when CAC duty cycles are higher.

Figure 4-5 illustrates the sensitivity of the CAC load to weather conditions for residential CAC units. The figure shows actual CAC loads among the 2009 EM&V sample, averaged for each hour of the day for days with high temperatures in the ranges shown. For residential CAC units, the program average CAC hourly demand is 85% higher on an afternoon with a maximum temperature above 30°C than on an afternoon with a maximum temperature between 26 to 28°C. Note that the summer of 2009 was cool, so there are fewer data points underlying the highest temperature curve in Figure 4-5 than underlying the lower temperature curves.

Small commercial CAC loads are less weather-sensitive than residential loads. Figure 4-6 illustrates temperature sensitivity for commercial CAC units. For commercial CAC units, loads on days above 32°C are only about 40% higher than on days between 26 and 28°C. Similarly, commercial CAC units have higher CAC load at temperatures below 24°C than residential CAC units do, as compared to respective loads at higher temperatures.

Figure 4-5:
Hourly Average per CAC Unit Load for Residential *peaksaver*® by Daily Maximum Temperature

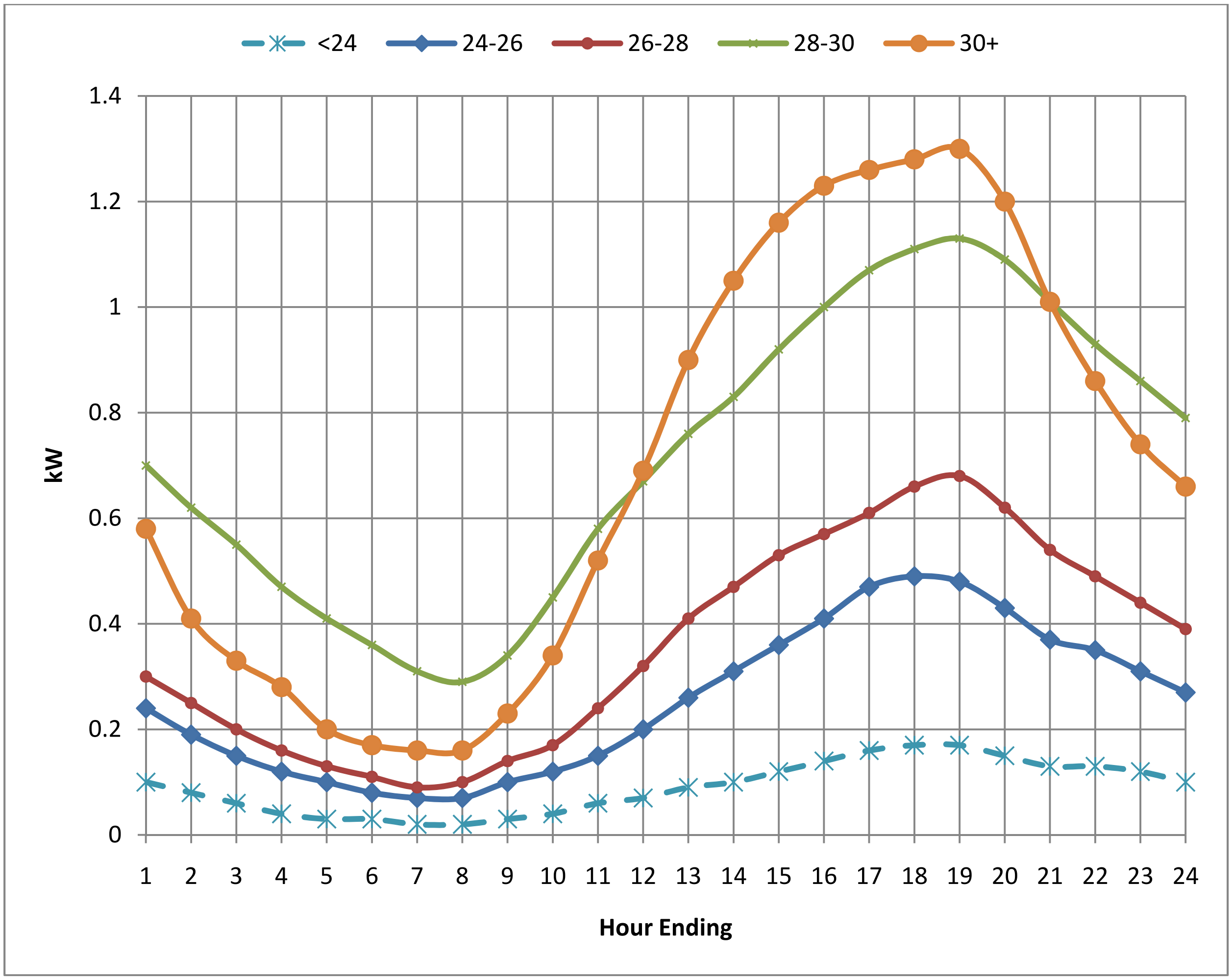
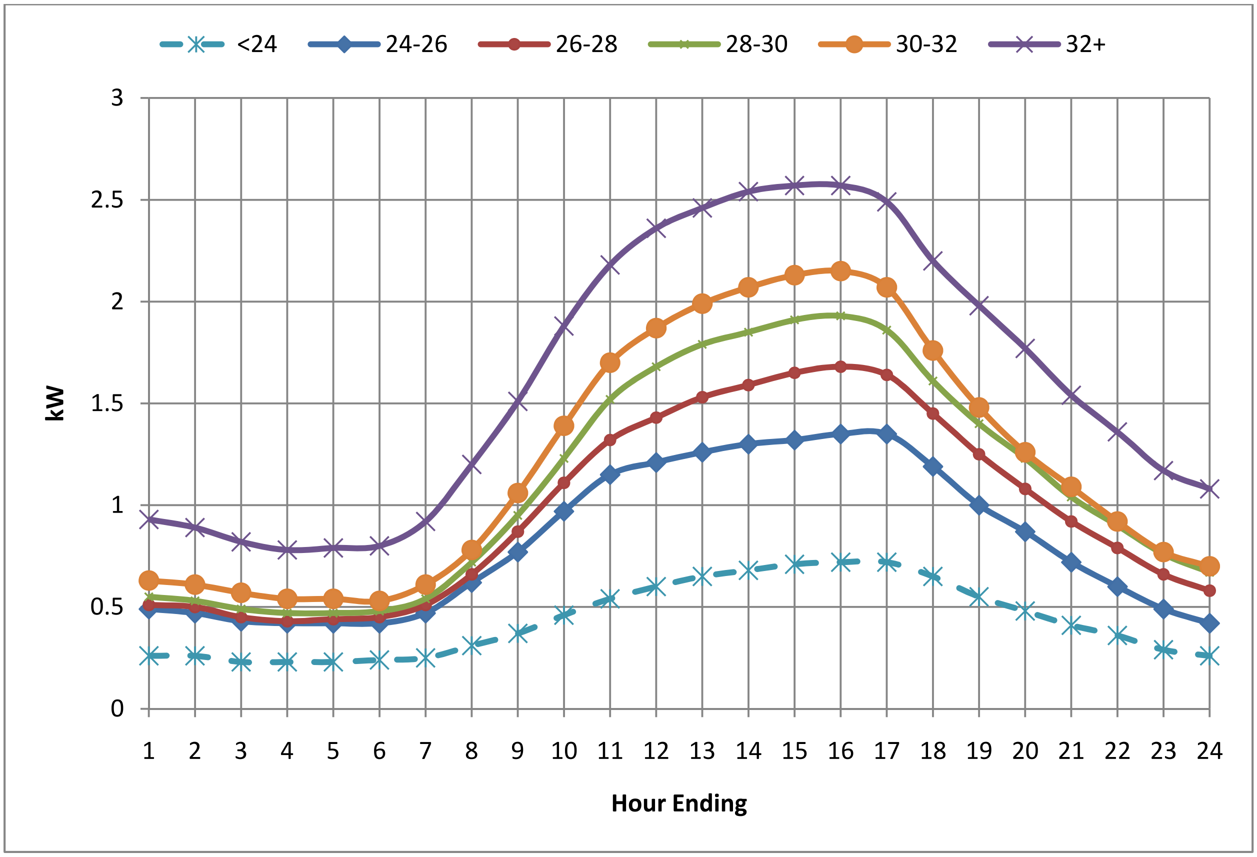


Figure 4-6:
Hourly Average per CAC Unit Load for SMB *peaksaver*® by Daily Maximum Temperature



Another important driver of commercial load size is industry. Figure 4-7 shows load profiles for the industry groupings as reported during the post-event survey. The industries that stand out the most are restaurants, with the highest average load, and religious organizations and public assembly areas with the lowest average load.

These industry load profiles have some ramifications for the loads and impacts observed across the LDCs. Figure 4-8 shows the distribution of industries within the EM&V sample for Toronto Hydro and Hydro Ottawa. Hydro Ottawa has a substantially greater proportion of restaurants in the EM&V sample, which may explain why that LDC has higher loads at high temperatures and higher load impacts.

The load profiles also suggest that some customers are likely to be more cost effective than others. For example, restaurants, retail and manufacturing establishments appear to have much more AC use and therefore greater potential load impact than religious organizations. Offices and warehouses are somewhere in between. The particularly low average AC load of religious institutions is something that has been observed for other AC load control programs as well. Those establishments often function primarily as free-riders on programs such as *peaksaver*®. Although they do not have substantial representation in this sample, the same is often true of schools and colleges.

Figure 4-7:
Hourly Average per CAC Unit Load for SMB *peaksaver*® by Industry Group

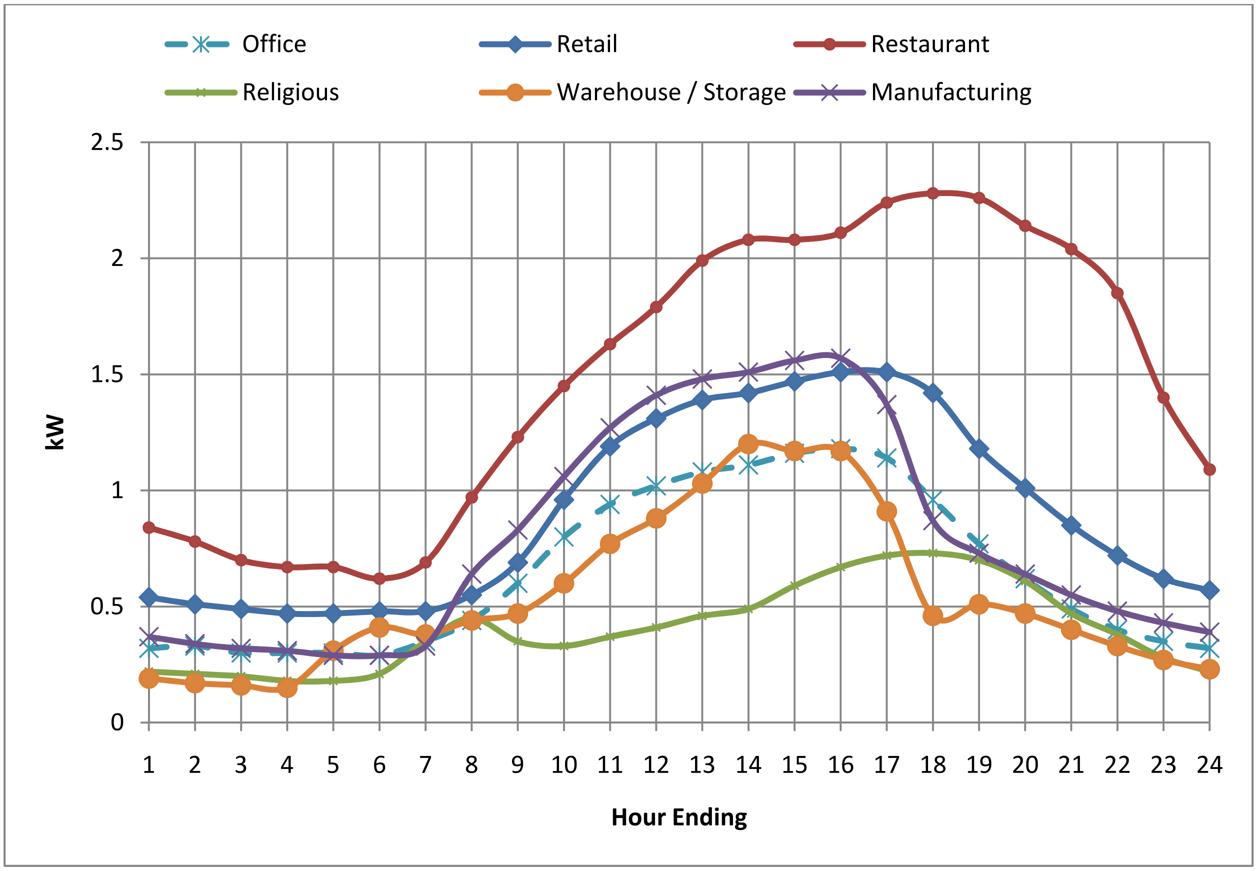
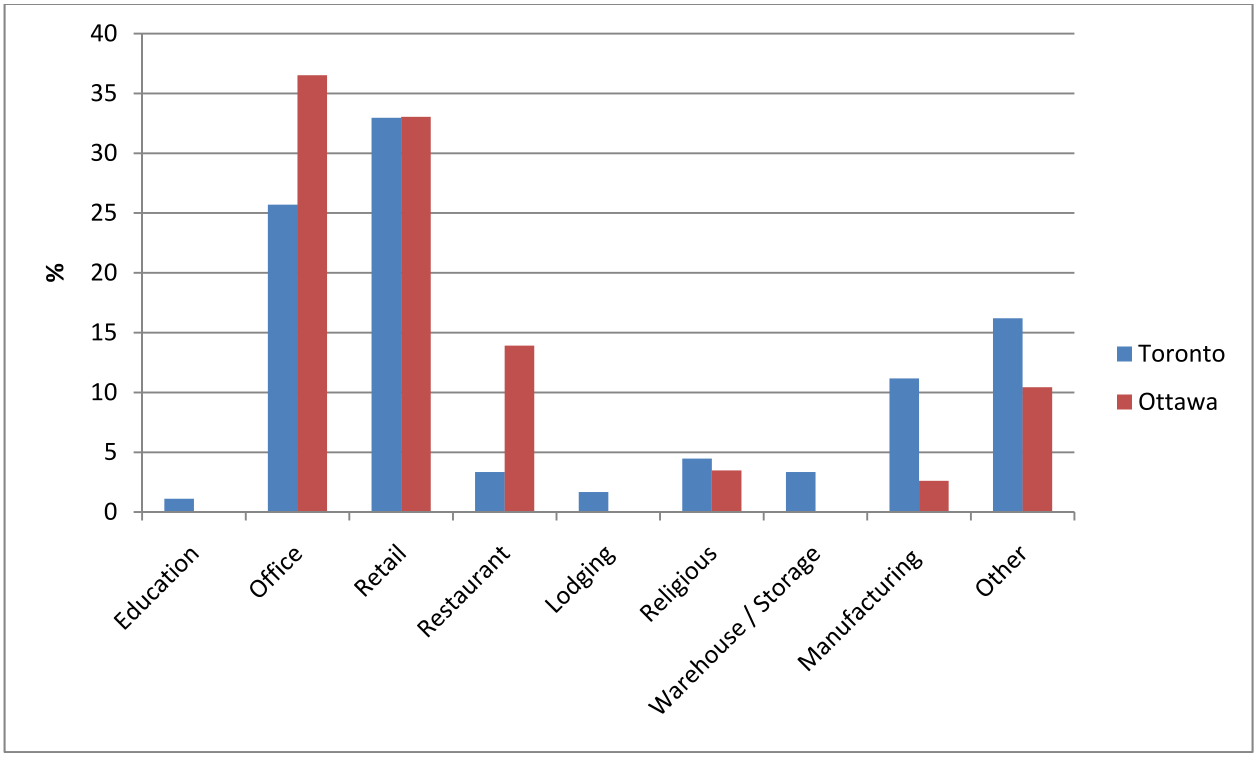


Figure 4-8:
Distributions of Industry Groups Across LDCs in the EM&V Sample



4.5 Whole-Building Regression Results for Residential Customers

The Toronto Hydro LDC has installed smart meters on most of its customers that produce hourly interval data. This means that although there is no CAC-logger sample for 2010 residential customers, there is a point of comparison available. Smart meter data for the summer of 2010 was obtained for two groups of Toronto Hydro customers. The first group was the 2009 EM&V sample and the second group was a randomly drawn group of 1000 Toronto Hydro *peaksaver*® customers, of which 884 actually had smart meter data available for the summer of 2010. The reason for two samples is that this provided an opportunity to see whether the 2009 EM&V sample recruiting process introduced any large selection bias into the impact estimates. Both samples were subjected to all 2010 *peaksaver*® events, both province-wide and EM&V test events.

Table 4-2 shows impact estimates for 2010 events for only the Toronto Hydro population based on three models and sets of data:

- The CAC-logger regression model based on 2009 data but using weather conditions for the 2010 event days;
- A regression model of 2010 smart meter data using the 2009 EM&V sample customers; and
- A regression model of 2010 smart meter data using the randomly-drawn sample of customers.[17]

[17] The smart meter regressions are almost identical to the CAC-logger regressions, except that they contain hourly indicator variables to model non-weather-sensitive load.

The differences between the models are small and only one difference is statistically significant at the 5% level: the difference between the CAC logger result and the smart meter result for the 2009 EM&V sample on July 6th. However, in a table with 18 pair-wise comparisons, it is expected that one would be statistically significant at that level due to chance alone.

Table 4-2 provides validation of the primary results, which is particularly useful because 2009 weather was cooler than the 2010 conditions the model is used to predict for. This means that the 2010 estimates are extrapolations. This extrapolation makes the estimates inherently more uncertain than would be the case if the hot weather was experienced over both summers.

It also reflects well on the 2009 EM&V recruiting process that results for a random sample produce impacts so similar to results from the recruited sample.

The results in the table are adjusted for the fact that there are 1.04 CAC units per customer in the residential population. That is, because the whole-building results are on a per customer basis, the CAC logger impact estimates have been adjusted upwards by 1.04, only for Table 4-2, to put them on a per-customer basis.

Table 4-2:
2010 Event Impact Comparisons for Toronto Hydro Residential Customers

Event	Average Temperature During Event	CAC Logger (2009 EM&V Group)	Smart meter (2009 EM&V Group)	Smart meter (Random Sample)
5/26/2010	30	0.47	0.59	0.53
7/6/2010	32	0.59	0.70	0.63
8/4/2010	29	0.40	0.44	0.39
8/30/2010	32	0.53	0.50	0.44
9/1/2010	31	0.44	0.49	0.44
Average	31	0.49	0.54	0.49

4.6 Regression Results Compared to Day-Matching

In addition to regression, day-matching impact estimates were also developed as a way of clarifying the regression-based estimates. In day-matching, the load on a day with similar temperatures is used to provide the reference load for each event day, and event effects are calculated by subtracting load levels between the two days. Day-matching is a corroborating analysis in the sense that it requires simpler assumptions and calculations than the regression model. However, the underlying data used is identical, and even the basic assumption underlying each model is similar: that load for the event day can be predicted by looking at what the same customers do on non-event days. In this sense, day-matching is not independent corroboration of the regression results.

Table 4-3 shows results of day-matching and regression analyses on the 2010 SMB EM&V sample. Day-matching was also done for the residential sample, but not presented here. Those results do not indicate any problems with the primary regression results and are available by request.

As shown in Table 4-3, the day-matching results agree well with the regression results. Figure 4-9 shows the actual loads on the event days and the matched days.[18] The differences between the regression results and the day-matching results can largely be explained by looking at Figure 4-9. The day-matching July 6th result is higher than the regression result and the reference load clearly has some upward bias on that day; as evidenced by the fact that the reference load is above the event-day load before the event. The reverse is true of the other three days. Table 4-4 shows the event days and the associated matched days with average daily temperatures and high temperatures for each.

Table 4-3:
Regression Impacts and Day-matching Impacts for the SMB EM&V Sample (kW, un-weighted and uncorrected for walk-away situations)

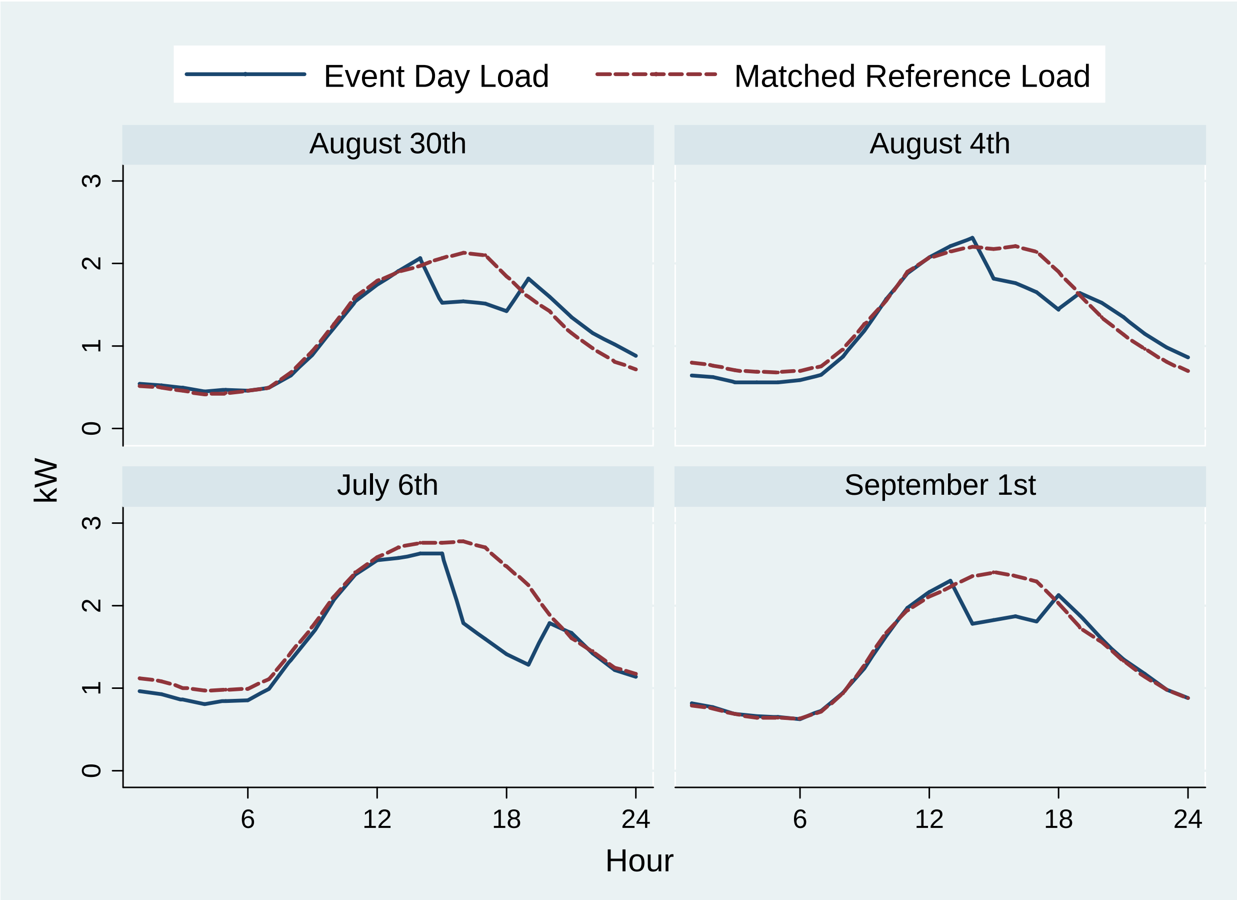
Event	Regression	Day-Matching
7/6/2010	0.80	1.03
8/4/2010	0.54	0.44
8/30/2010	0.63	0.54
9/1/2010	0.59	0.53
Average	0.64	0.63

Table 4-4:
Event Days and Matched Days Temperatures

Event Day	Average Temperature	High Temperature	Matched Day	Average Temperature	High Temperature
7/6/2010	29	33	7/8/2010	28	33
8/4/2010	26	32	8/5/2010	26	30
8/30/2010	28	34	7/27/2010	24	28
9/1/2010	27	32	8/31/2010	28	33
Average	27	33	n/a	26	31

18 The event on May 26th is not included because CAC loggers had not yet been installed.

Figure 4-9:
Day-Matching Loads for the SMB EM&V Sample



5 *peaksaver*® Load Impact Results

This section presents and discusses the load impacts for residential and commercial customers for the 2010 evaluation.

5.1 Residential *Ex Post* Impacts

Table 5-1 shows the average impact per customer for each *peaksaver*® event along with total energy savings and average temperature over the event period (Table 5-1 is a repeat of Table 1-1). The largest impact occurred on July 6th, which had an estimated impact of 0.53 kW per customer. Unsurprisingly, July 6th was one of the two hottest days of the summer, reaching an average temperature of 32°C during the four-hour event.

The overall average event effect during province-wide events of 0.47 kW with an average event temperature of 31°C is higher than the average 2009 impact of 0.30 kW (calculated in the 2009 load impact evaluation). This is not surprising given that the average event temperature during 2009 *peaksaver*® events was 28°C.

There is no mention in the 2009 evaluation of AC units with non-functioning control devices that were encountered. It is assumed that loggers were installed on chosen sample units, regardless of whether the control device was functional. Therefore, it is assumed that the CAC logger data from the 2009 evaluation is representative of the *peaksaver*® population and no correction factor for non-functioning devices is used here.

Table 5-1:
Average Residential per CAC Unit Reference Loads, Impacts and Temperatures During Event Hours (whole-province)

Type of Event	Event Date	Event Hours	Average Reference Load (kW)	Average Event Impact (kW)	Percent Impact (%)	Aggregate Energy Savings (MWh)	Average Temperature During Event (°C)
Whole Province	5/26/2010	6 PM-8 PM	1.13	0.43	38	163	29
	7/6/2010	3 PM-7 PM	1.42	0.53	37	157	32
	8/30/2010	2 PM-6 PM	1.19	0.44	37	84	32
	Average/Total	n/a	1.25	0.47	38	404	31
EM&V Test	8/4/2010	2 PM-6 PM	0.92	0.34	37	0.5	28
	9/1/2010	1 PM-5 PM	1.08	0.39	36	0.4	31
	Average/Total	n/a	1.00	0.37	37	1.0	29
Total	**Overall Average/Total**	n/a	1.15	0.43	37	405	30

The overall average impact of 0.43 kW represents a 37% load reduction. The percent load reduction was quite stable across events. It is not surprising that the average load reduction is significantly less than 50% even though a 50% cycling strategy is used. Under a 50% cycling strategy, the maximum load reduction is 50% and that is only achieved when the CAC unit would normally be running at a 100% duty cycle. Temperatures in Ontario rarely reach levels that would cause CACs to run at a 100% duty cycle.

The *ex post* impacts in Table 5-1 do not differ dramatically from predictions made in the 2009 evaluation. This is a useful comparison to make because it either validates or invalidates the previous year's predictions. In this case, it largely validates those predictions. For example, there were two province-wide events and one EM&V event in 2010 with average temperatures of 31°C or 32°C, and between them, the average impact was 0.47 kW. This value is close to the 2009 *ex ante* estimates at similar temperatures for 1-in-2 weather-year August (0.45 kW impact at 32°C) and June (0.48 kW impact at 31°C) peak days, and for 1-in-10 weather-year May peak day (0.47 kW impact at 32°C). There are some predictions in the 2009 results of *ex ante* impacts of roughly 0.45 kW at temperatures around 34°C. It is not clear why these estimates differ from the ones already mentioned (it does not appear to be due to pre-event temperatures), but based on 2010 results, they appear too low. The 2009 *ex ante* weather conditions do not cover temperatures in the high 20s, so it is difficult to compare the 2010 *ex post* impacts on the other event days to the *ex ante* impacts from 2009.

Energy savings in Table 5-1 is calculated by multiplying the average per CAC unit impact by the number of available control devices for each hour of each event, and also including the hours after the event to capture post-event snap-back. These values are then added up over each event day to get a total energy value.

5.2 Residential *Ex Ante* Impacts

A primary concern in this evaluation was whether the *ex ante* estimates from last year's evaluation were suitable or should be replaced with new *ex ante* estimates based on smart meter data or new modeling. Although the modeling effort in 2009 was found to be quite adequate, it was decided to use a new set of *ex ante* weather profiles that better capture the expected conditions during 1-in-2 and 1-in-10 conditions. The development of these profiles and the actual dates and temperatures chosen are discussed in Appendix A.

Table 5-2 shows the results of applying the load impact modeling for residential customers to the newly chosen *ex ante* weather profiles. These estimates have a range of values quite similar to what was estimated in the 2009 report. For example, in 2009 the highest estimated average load impact was 0.58 kW on a 1-in-10 August peak day. Here it is 0.56 kW on a 1-in-10 August peak day. The primary difference between the results here and those in the 2009 evaluation are that here the differences between 1-in-2 results and 1-in-10 and between results for different months more accurately reflect the differences likely to be seen in the future. For example, all the 1-in-2 impact estimates are lower than the respective 1-in-10 estimates for the same month. The highest estimated aggregate impact that the program is capable of producing is 103 MW on a 1-in-10 August peak day.

Table 5-2:
2009 Residential *peaksaver*® *Ex Ante* Load Impact Estimates by Weather Year and Day Type (Event Period 2-6 PM)

Type of Estimate	Day Type	Extreme Year (1-in-10)	Normal Year (1-in-2)
Per CAC unit (kW)	May Peak Day	0.29	0.22
	June Peak Day	0.42	0.29
	July Peak Day	0.54	0.33
	August Peak Day	0.56	0.37
	September Peak Day	0.28	0.24
Whole-Province Aggregate (MW)	May Peak Day	53	40
	June Peak Day	77	54
	July Peak Day	99	61
	August Peak Day	103	68
	September Peak Day	52	44

5.3 SMB *Ex Post* Impacts

Table 5-3 shows each event date with average per CAC unit event impacts and average temperature during event hours for the SMB *peaksaver*® population (Table 5-3 is a repeat of Table 1-2 with one added column). The table shows impact estimates both as directly estimated in the EM&V sample ("gross impact") and adjusted by the correction factor described in Section 3.1 ("net impacts"). The net impacts are the actual estimated impacts for the *peaksaver*® population.

As in the residential sample, the largest impact occurred on July 6th, which had an estimated impact of 0.61 kW per CAC unit. The average impact across province-wide events is 0.55 kW per CAC unit, which is 26% of CAC load.

As with residential customers, the percent reductions for SMB customers fall short of 50% and for the same reason. There is another contributing reason for the shortfall though. Event impacts in Table 5-3 are influenced by control device communication failure, which was only directly observable for a fairly small number of customers and events in the SMB *peaksaver*® load-research sample. However, based on what was observable through field work, communication failure appears to be a major issue in Toronto Hydro's territory and less important, but worth examining, in Hydro Ottawa's territory. The effects of communication failure are automatically incorporated into the *ex post* impact estimates because devices that fail to respond to an event simply show no impact in the AC data collected.

Table 5-3:
Average SMB per CAC Unit Reference Loads, *Ex Post* Impacts and Temperatures During Event Hours

Type of Event	Event Date	Event Hours	Average Reference Load (kW)	Average Event Impact (kW)	Percent Impact (%)	Aggregate Energy Savings (MWh)	Average Temperature During Event (°C)
Whole Province	5/26/2010	6 PM-8 PM	1.61	0.49	30	3.4	28
	7/6/2010	3 PM-7 PM	2.20	0.61	28	9.6	32
	8/30/2010	2 PM-6 PM	2.24	0.53	24	8.3	32
	Average/Total	n/a	2.10	0.55	26	21.3	31
EM&V Test	8/4/2010	2 PM-6 PM	2.05	0.46	28	0.7	28
	9/1/2010	1 PM-5 PM	2.29	0.50	31	0.7	31
	Average/Total	n/a	2.17	0.48	29	1.4	29
Total	**Overall Average/Total**	n/a	2.13	0.52	24	22.7	30

As discussed in Section 3.1, load impact estimates in Table 5-3 have had a correction factor applied to account for missing, disconnected and broken control devices. Table 5-4 shows estimated impacts prior to the correction factor being applied. This represents an estimate of the potential load impact per device if all broken, disconnected and missing devices were accounted for and removed from the list of available devices. As was discussed in Section 3.2, another issue that reduces load impacts is control device communication failure. The results in Table 5-4 include the effect of control device communication failure. There is not currently enough information to accurately estimate how large load impacts would be if there was no communication failure in the control device population. Impacts in Table 5-4 are roughly 10% greater than those in Table 5-3.

Table 5-4:
Average Commercial per CAC Unit Event Impacts If All Devices were Present and Operable (whole-province)

Type of Event	Event Date	Event Hours	Average Event Impact (kW)
Whole Province	5/26/2010	6 PM-8 PM	0.54
	7/6/2010	3 PM-7 PM	0.67
	8/30/2010	2 PM-6 PM	0.59
	Average/Total	n/a	0.61
EM&V Test	8/4/2010	2 PM-6 PM	0.51
	9/1/2010	2 PM-6 PM	0.55
	Average/Total	n/a	0.53
Total	**Overall Average/Total**	n/a	0.58

5.4 SMB *Ex Ante* Load Impacts

The *peaksaver*® program is intended to alleviate system stress during times of very high demand. The primary purpose of this evaluation is to predict load impacts during such conditions. These *ex ante* predictions cover a pre-chosen set of temperature profiles meant to mimic what could be expected for monthly system peak days that might occur for a normal year (1-in-2) and an extreme year (1-in-10). As noted above, a new set of *ex ante* weather conditions were chosen for this report and are documented in Appendix A.

Essentially, the procedure for *ex ante* estimation consists of making predictions for the *ex ante* weather dataset using the regression models produced in the *ex post* analysis.

Aggregate and per commercial customer load impacts are shown in Table 5-5. These estimates include the correction factor discussed in Section 3.1, which accounts for the fact that there is a significant number of non-working control devices among Toronto Hydro customers. Aggregate load impacts are based on an assumption of future enrollment that stays constant as of October 1st, 2010 and are therefore predicted to be constant for the foreseeable future. The maximum *ex ante* load impact to be expected is 2.8 MW, occurring on a 1-in-10 August day.

Table 5-5:
SMB *peaksaver*® *Ex Ante* Load Impact Estimates
by Weather Year and Day Type
(Event Period 2-6 PM)

Type of Estimate	Day Type	Extreme Year (1-in-10)	Normal Year (1-in-2)
Per CAC unit (kW)	May Peak Day	0.39	0.32
	June Peak Day	0.52	0.42
	July Peak Day	0.62	0.42
	August Peak Day	0.64	0.48
	September Peak Day	0.36	0.33
Whole-Province Aggregate (MW)	May Peak Day	1.7	1.4
	June Peak Day	2.3	1.9
	July Peak Day	2.7	1.9
	August Peak Day	2.8	2.1
	September Peak Day	1.6	1.5

Just as Table 5-4 showed *ex post* impacts in the case where all devices were present and operable, Table 5-6 shows the same for *ex ante* impacts. In general, impacts in Table 5-6 are roughly 10% than those in Table 5-5.

Table 5-6:
SMB *peaksaver*® *Ex Ante* per CAC Unit Load Impact Estimates if All Control Devices were Present and Operable by Weather Year and Day Type
(Event Period 2-6 PM)

Day Type	Extreme Year (1-in-10)	Normal Year (1-in-2)
May Peak Day	0.43	0.35
June Peak Day	0.57	0.46
July Peak Day	0.69	0.47
August Peak Day	0.71	0.53
September Peak Day	0.40	0.37

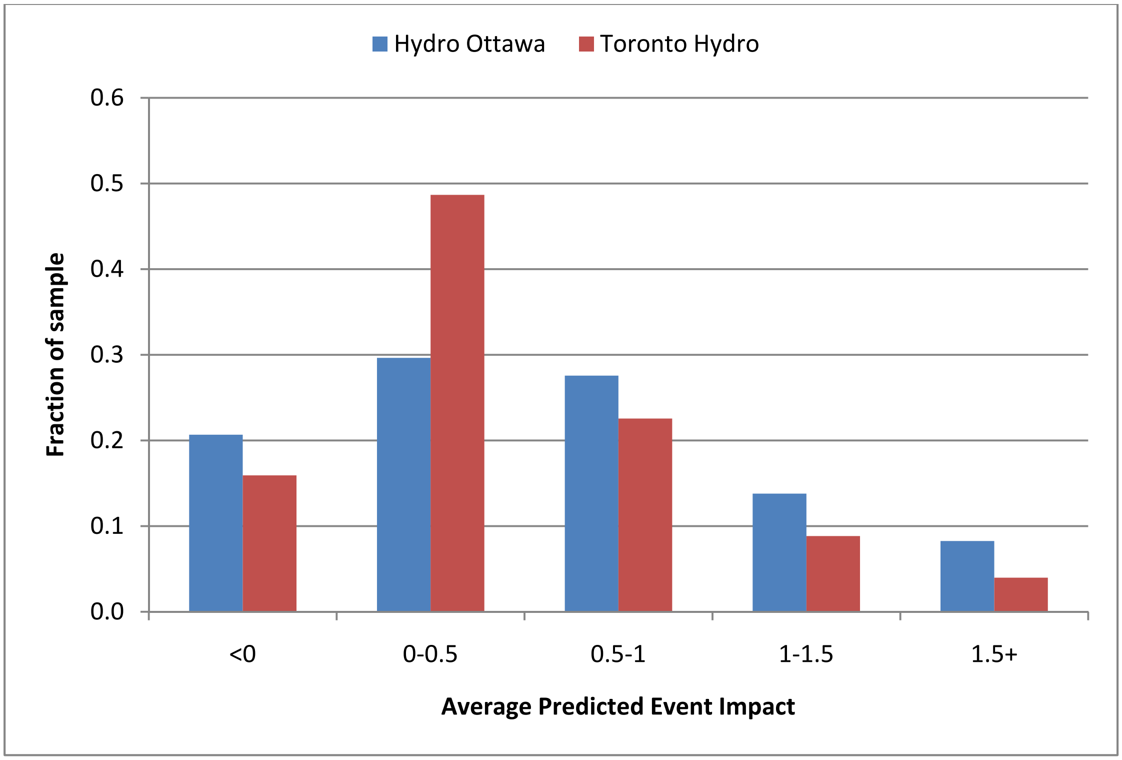
5.5 Distribution of Load Impacts Across Customers

Figure 5-1 shows the distribution of predicted SMB event impacts for a July 1-in-10 day at 3 PM.[19] As was discussed in the methods section, results from any given individual CAC unit regression may not be completely reliable due to omitted factors and small samples. Another way to put this, as it relates to Figure 5-1, is that over a longer period, many customers who had small event impacts during 2010 might turn out to have high impacts overall and vice versa. The reason for this is that customer behavior is variable and may not be perfectly represented by one summer's worth of data, particularly when the summer only contains a handful of hot days. This means that the values underlying Figure 5-1 are not completely reliable as predictors of future impacts on a customer-by-customer basis. However, with that caveat, Figure 5-1 suggests that a substantial number of customers in the program provide little impact, while a few customers may provide substantial impact. It is unknown whether many of these low-impact customers would provide more impact at times of very high temperature—beyond what was observed in the summer of 2010.

The fraction of low-impact customers appears much larger in Toronto Hydro's territory, which may be due to the broken switch and communication issues noted earlier. It is important to note that these are two separate issues. This evaluation contains measurements of both, as discussed in Section 3. A switch can be operable, but can still fail to receive an event signal and therefore not operate even though it has the ability to operate.

[19] A July 1-in-10 day was chosen as a fairly representative set of hot conditions that might be encountered fairly frequently—as evidenced by the fact that the impacts in Tables 5-2 and 5-4 for July 1-in-10 conditions are very similar to those in several other cells of the tables.

Figure 5-1:
Histogram of *Ex Ante* Event Impacts for Individual Commercial Customers By LDC



5.6 Recommendations for Load Impact Improvement and Estimation

Among Toronto Hydro customers, it appears that substantially increased impacts could be obtained through replacing old DLC switches that are no longer functional—either because they no longer can control the CAC or because they no longer respond to radio signals that alert them to events. It is worth considering the costs and benefits of a large scale effort to perform a full census of working devices among Toronto Hydro customers and to replace those that are not working. Although the analyses performed here that brought these issues to light were focused on SMB customers, this issue is important for residential customers as well.

The communication analysis suggests that switches that are operable work quite well, while PCTs tend to have more communication problems. Both communication and device breakage, along with the initial cost of purchase and installation of each device, should be considered in a cost-effectiveness calculation. In general, switches seem to have a good track record and are cheap and easier to install, but it does appear that they may start to fail after several years.

It may be worth examining whether there are ways to cheaply improve communication among working devices. For example, if it is possible to send the signal for an event multiple times during each event, that can improve signal reception. Also, operational or programming errors by aggregators can lead to groups of devices not receiving event signals. Both of these issues have been observed elsewhere. Aggregators themselves may have some ideas as to other sources of communication failure.

For future evaluations, impact estimates for residential customers should be developed using whole-building smart meter data. This eliminates the need to recruit a load research sample, and can improve sample sizes and representativeness. An effort should be made to obtain smart meter data from LDCs other than Toronto for future *peaksaver*® evaluations. Such a strategy can also potentially be used to test differences in impacts due to different customer treatments. For example, should the OPA be offering in-home-displays (IHD) as an accompaniment to *peaksaver*® load control in the future, use of smart meter data with large samples of customers has the potential to be a convenient and accurate way of measuring the impact of such an offering.

With a sufficiently large population of SMB customers with smart meters, the same strategy may be feasible there too. This strategy is more difficult for SMB customers because CAC load is typically a smaller fraction of building load than it is for residential customers. However, with a large enough sample size, event impacts should still be detectable. This strategy has not been used extensively elsewhere, but FSC will be using it in some of its 2011 evaluations.

Finally, for future evaluations and for program targeting, it would be worth recording the business type of each SMB customer that signs up for the program.

6 Post-Event Survey Results for SMB Customers

To measure both comfort during *peaksaver*® events and customer satisfaction with *peaksaver*®, the Population Research Systems (PRS) branch of the FSC Group conducted two surveys of *peaksaver*® customers who were part of the SMB EM&V sample. The first survey, which was conducted on August 5th and 6th, 2010 was a post-event survey in which customers were asked about their comfort level on August 4th, a *peaksaver*® event day for EM&V sample. The survey also contained questions about customer satisfaction with the *peaksaver*® program. The second survey, which was conducted on September 8th and 9th, 2010, was a control survey in which customers were asked about their comfort level on September 7th, a hot day on which no *peaksaver*® event was called (see below for a comparison of weather on the event day and control day). The second survey was conducted to provide a baseline level of hot-day discomfort by which to judge customer discomfort specifically caused by *peaksaver*® events. A copy of each survey is included in Appendix C.

Table 6-1 shows the number of surveys conducted by PRS on each date for each LDC.

Table 6-1:
SMB Survey Participants by LDC

LDC	First Survey Total	Second Survey Total	Customers Who Took Both Surveys
Hydro Ottawa	118	135	110
Toronto Hydro	200	224	185
Total	**318**	**359**	**295**

The total survey success rate was 80% for the first survey, 90% for the second survey and 74% of EM&V customers responded to both surveys.

Unfortunately, there are two complicating factors affecting the interpretation of survey results. First, there were not many hot days following the August 4th event in Ontario. The hot days that did occur were used as actual event days (e.g., August 30th and September 1st, 2010). This led to the choice between not having a control survey, or having a control survey on a day on which temperatures did not perfectly match the temperatures on the relevant event day. It was decided that the second option was better. That option at least provides some measure of baseline discomfort; even if that level is probably too low.

Second, there was a thunderstorm in Ottawa that caused temperatures to drop significantly during the event on August 4th. The storm also caused power outages in Ottawa. Both of these occurrences presumably affected customer discomfort levels, but it is difficult to say precisely how or how much.

6.1 Comfort During Events

In order to properly judge the amount of discomfort that customers experience due to a *peaksaver*® event rather than due to other factors, it is necessary to measure their comfort on an event-like day during which no event is called. Alternatively, a survey of non-participants can give the same information. In this case, because such a large proportion of the Hydro Ottawa population was recruited into the EM&V

sample, the possibility of developing a comparable control group from the remaining customers seemed unlikely.

Figures 6-1 and 6-2 show the temperatures for each hour of the day for each LDC on August 4th, the event day, and September 7th, the control day. Unfortunately, the control-day temperatures are noticeably different than the event-day temperatures. In Toronto, the control day is cooler than the event day during every hour except the hour ending at 6 PM. The average temperature in Toronto during the August 4th event hours of 2 PM to 6 PM was 29.3°C, which is fairly close to the average temperature during the same time period on September 7th in Toronto, 28.6°C. However, the earlier part of the day was much warmer on the event day. This is important for comfort levels because buildings act as heat integrators, which means that they accumulate heat and the indoor temperature will react to outdoor temperature with a lag. Comfort levels during an event period could definitely be affected by hot temperatures during the pre-event period because customers' buildings will have accumulated heat.

Humidity was not a major factor on either day for either LDC. Calculated heat index values are very close to temperature values for each hour of the day.

As mentioned above, a thunderstorm occurred in Ottawa during the first hour of the event on August 4th, which caused the large temperature reduction visible in Figure 6-2. Aside from the period during the thunderstorm, the event day was also hotter than the control day. The average temperature during the event period in Ottawa was 22.3°C, while it was 26.0°C during that period on the control day. Also mentioned above, there was a power outage in Ottawa that corresponded with the thunderstorm. These issues are important when interpreting differences in comfort level between the event day and the control day.

Figure 6-1:
Toronto Temperatures on Event Day and Control Day

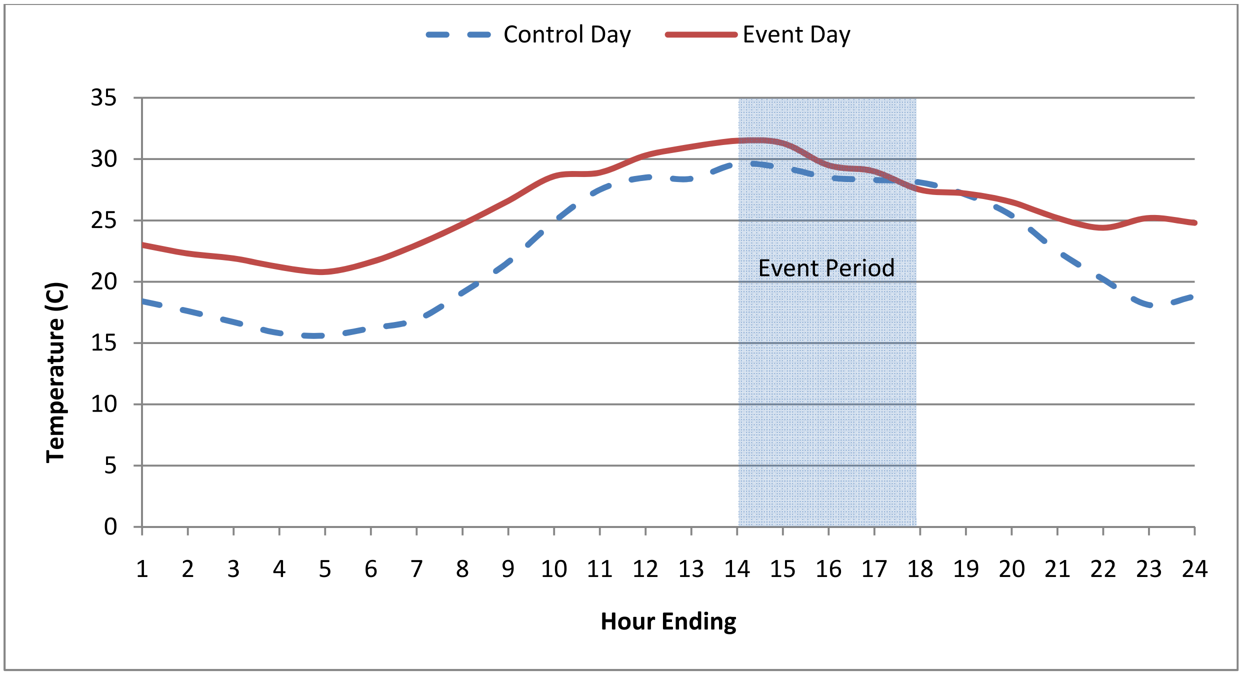
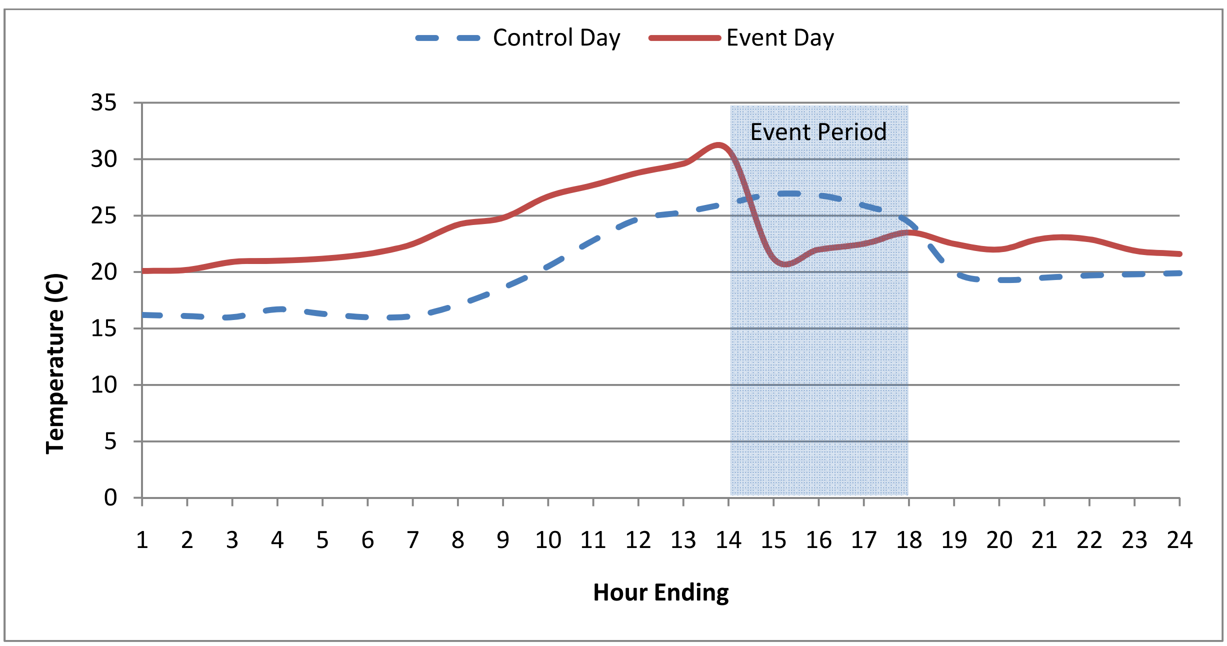


Figure 6-2:
Ottawa Temperatures on Event Day and Control Day



The first question on each survey asked respondents whether their CAC was operating on the day in question. Table 6-2 shows these responses.

Table 6-2:
Percentage of Respondents Reporting Air Conditioning Operated that Day

LDC	Event Day	Control Day
Hydro Ottawa	95	81
Toronto Hydro	95	69

For both LDCs, CAC usage was much lower on the control day than on the event day. This adds further to the evidence that the control day is only somewhat like the event day. On the control day, CAC usage was notably higher in Ottawa even though temperatures were higher in Toronto that day.

The second question of each survey was, "Was there any time on [Tuesday] when the temperature in your place of business was uncomfortable for you, your employees or your customers?"

Responses to this question are shown in Table 6-3. Among Hydro Ottawa's customers, the difference between the number of customers reporting discomfort on the event day and control day is 12%. Between the thunderstorm, which substantially cooled off the region just after the event began, and the power outages that may have increased discomfort, it is difficult to interpret this result. The results are more straightforward for Toronto Hydro's customers. The difference between the number of customers reporting discomfort on the event day and control day is 17%. This full difference cannot be attributed to the *peaksaver*® program though, because a significant amount of the difference is due to differences in discomfort before the event period. We examine this issue next.

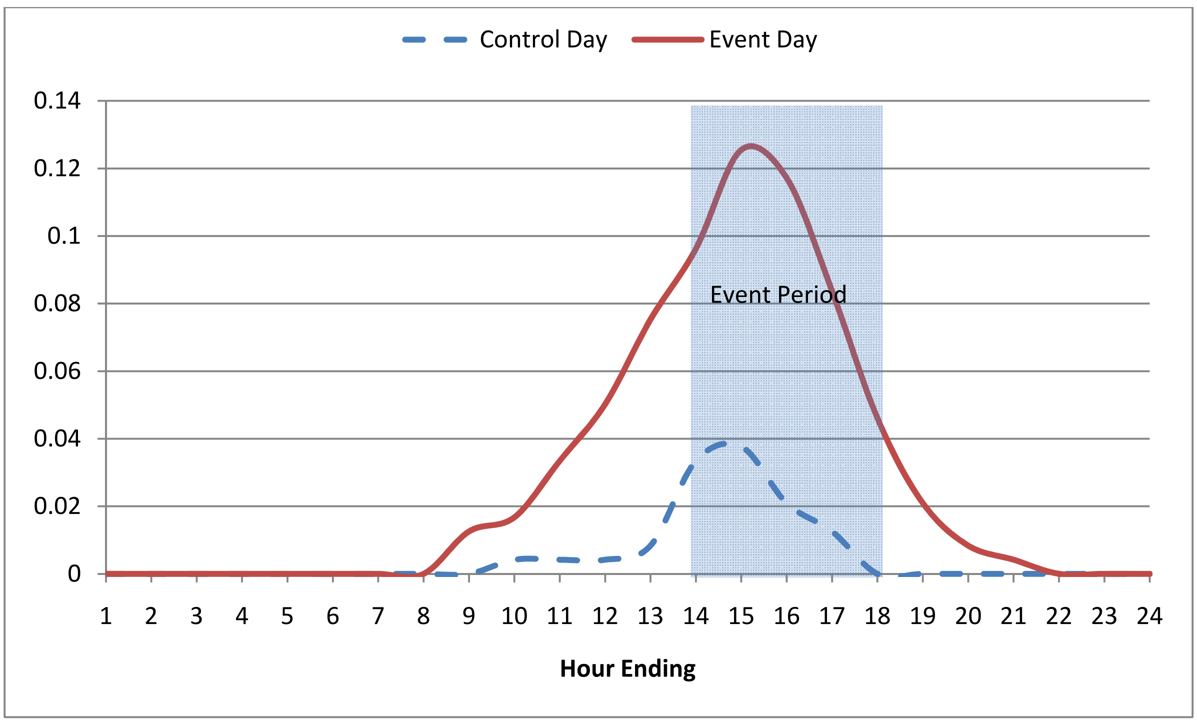
Table 6-3:
Percentage of Respondents Reporting Their Place of Business was Uncomfortable

LDC	Event Day	Control Day
Hydro Ottawa	25	13
Toronto Hydro	26	9

Answers to this question varied very little across business types. For all industries with significant representation in the survey, the fractions reporting some discomfort on the event day ranged between 15% for offices, food stores and health care establishments, to 35% for restaurants.

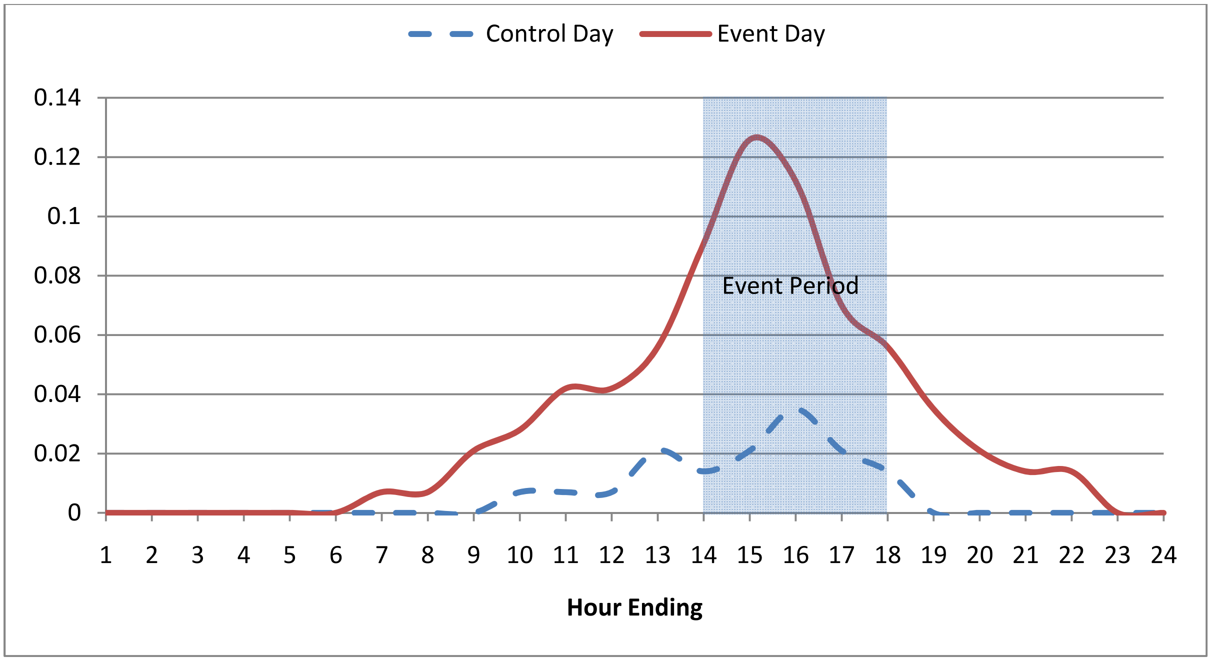
Customers who reported their place of business was uncomfortable were asked to report when the discomfort started and when it ended. This allows us to calculate what fraction of the population felt uncomfortable for each hour of the day. Figures 6-3 and 6-4 show these fractions for each LDC. For any given hour, the total fraction of customers reporting discomfort on the control day is lower than the fraction who reported discomfort at some point during the event day. For example, during the event hours (2 PM to 6 PM), the fraction of Toronto Hydro customers reporting discomfort varied between 5 and 13%, with an average over the event period of 9%. During the same hours on the control day, that fraction varied between 0 and 4%, with an average of 2%. The difference in the average fraction of customers reporting discomfort during event hours is only 7%. Because the temperature was noticeably lower on the control day, this difference is an upper bound on the impact of the *peaksaver*® event on customer discomfort. The remaining discomfort can be attributed to normal discomfort that customers feel on a hot day. If the control day had more closely matched the event day in temperature, then it is possible that reported discomfort levels on the control day would have been higher and the level of discomfort attributed to *peaksaver*® would be lower. We can get some sense for the discrepancy between the event day and the control day by looking at comfort level differences in the pre-event hours on each day. In the hour before the event, from 1 PM to 2 PM, 10% of Toronto Hydro customers reported discomfort, while during the same hour on the control day, only 3% did. When considered this way, it appears that the event had little or no effect on customer comfort—the average difference in the fraction of customers reporting discomfort is 7% during the event and 7% immediately before the event. It is possible though that customers remember discomfort due to the event, but there is inaccuracy in their reporting of their time of discomfort. In any case, if the control day had matched the event day, then Figures 6-3 and 6-4 would show the fractions of customers reporting discomfort several hours before the event being close to the same on the event day and the control day.

Figure 6-3:
Percentage of Toronto Hydro Customers Reporting Discomfort During Each Hour



During the event hours, the fraction of Hydro Ottawa customers reporting discomfort varied between 6% and 13%, with an average over the event period of 9%. During the same hours on the control day, that fraction varied between 1 and 3%, with an average of 2%. The difference in the average fraction of customers reporting discomfort during event hours is also 7% for the Hydro Ottawa LDC.

Figure 6-4:
Percentage of Hydro Ottawa Customers Reporting Discomfort During Each Hour



Although there is clearly a higher level of discomfort during the event day, it is possible that the difference is due to random variation in response. To address this question, we conducted a difference-in-means test for statistical significance. A difference-in-means test determines whether or not there is a statistically significant difference in discomfort levels between the event day and the control day. If the 95% confidence interval around the difference does not include zero, the difference is not likely due to random variation in response.

Figure 6-5 shows the difference in means plotted for each hour of the day for Toronto Hydro's customers, along with the lower and upper bounds of the 95% confidence interval for that difference during each half hour. Figure 6-6 shows a similar graph for Hydro Ottawa's customers. As the figures show, in each territory there was a period of time during that day when there was a statistically significant difference in discomfort levels (indicated by the fact that the lower confidence interval bound is above zero). This means that the difference in reported discomfort levels is unlikely due to random variation in responses alone. Among Toronto Hydro customers, this difference is statistically significant during a substantial portion of time before the event. This calls into question the validity of the control day, as has already been noted. Among Hydro Ottawa customers, the difference in discomfort levels is statistically significant primarily during the event. Towards the end of the event, when the thunderstorm should have cooled off Hydro Ottawa customers on the event day, differences in discomfort levels are not statistically significant.

Figure 6-5:
Differences in Reported Discomfort of Toronto Hydro Customers During Each Hour

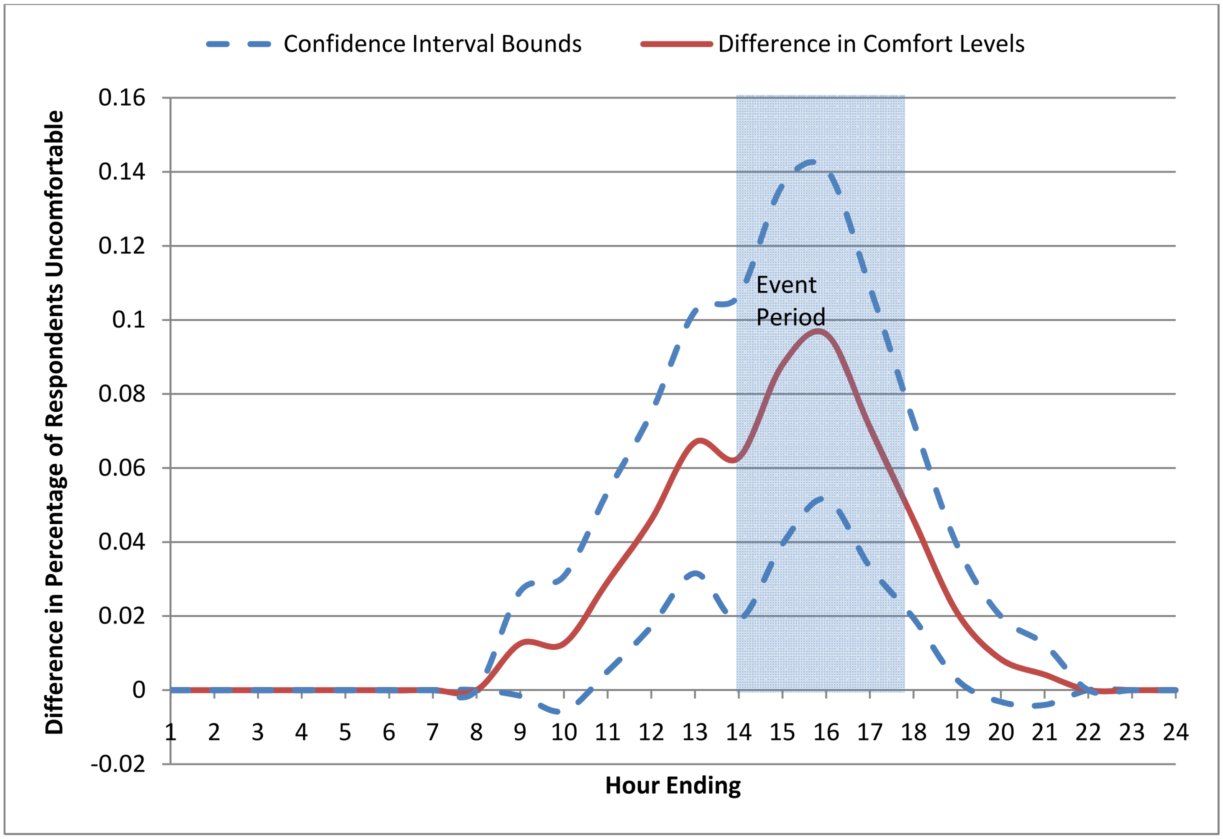
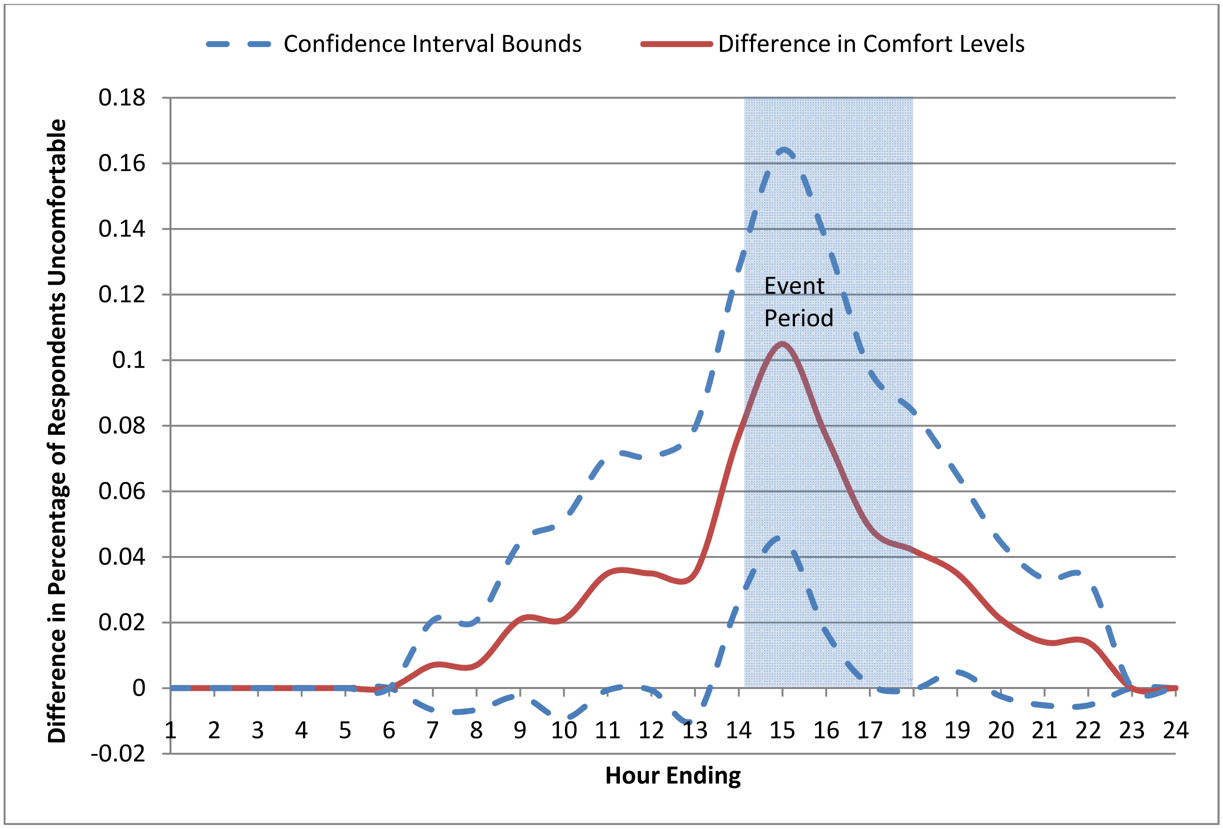


Figure 6-6:
Differences in Reported Discomfort of Hydro Ottawa Customers During Each Hour



If customers felt uncomfortable, they were asked why they thought it was uncomfortable. Of customers responding to the event day, 23% of Hydro Ottawa and 34% of Toronto Hydro customers specifically mentioned that they thought the LDC was controlling their CAC. On the survey about the control day, 22% of Hydro Ottawa customers and 15% of Toronto Hydro customers reported they thought it was uncomfortable because the LDC was controlling their CAC. This shows that customers do not have an acute sense of when their CACs are being controlled. In this instance, Hydro Ottawa customers were just as likely to believe their CACs were being controlled on the control day as on the event day. Part of this may be due, again, to the thunderstorm. However, Toronto Hydro customers also had a substantial number of customers who thought the CAC was being cycled when it was not. This also shows to what degree *peaksaver*® customers are likely to blame discomfort on *peaksaver*®—whether or not *peaksaver*® is actually activated.

The primary conclusion from the discomfort section of the survey is that the number of SMB customers who feel discomfort due to *peaksaver*® is fairly low. Between the question about discomfort anytime during the day, and the questions about when discomfort occurred, it appears the highest reasonable estimate for the percentage of customers who felt discomfort due to *peaksaver*® is 12% in Hydro Ottawa's territory and 17% in Toronto Hydro's territory. Using the hourly reports of discomfort, an estimate of 7% is reasonable; however, lower estimates could also be justified. Also, customers who feel discomfort have a noticeable propensity to blame the *peaksaver®* program even when no event has occurred.

The level of discomfort attributable to *peaksaver®* is similar to what was observed by FSC in a 2010 survey of SMB customers for Pacific Gas & Electric's SmartAC program.[20] In that survey, discomfort attributable to the event peaked at around 11% of the population, with an average level during the event of about 8%.

6.2 SMB Customer Satisfaction with *peaksaver®*

In addition to the questions about discomfort, the survey also asked SMB customers about their satisfaction with the *peaksaver®* program. The first question in this sequence was,[21] "In general, how satisfied would you say you are with your experience in the *peaksaver®* program?" The responses to this question, for the individual LDCs and in total are shown in Table 6-4. Between the two LDCs, Hydro Ottawa has somewhat higher average satisfaction levels with 77% of respondents reporting being either very satisfied or somewhat satisfied, as compared to 69% for Toronto Hydro. Both LDCs have very low levels of reported dissatisfaction, with 6% and 7% of Hydro Ottawa and Toronto Hydro customers, respectively; they reported either somewhat dissatisfied or very dissatisfied.

Table 6-4:
Percentage of Respondents Reporting Each Satisfaction Level

Satisfaction	Hydro Ottawa (n=118)	Toronto Hydro (n=200)	Total (n=318)
Very satisfied	51	38	42
Somewhat satisfied	26	31	29
Neither satisfied nor	17	26	23
Somewhat dissatisfied	3	4	3
Very dissatisfied	3	3	3

Following the satisfaction question, customers who indicated being somewhat or very satisfied were asked what they liked most about the *peaksaver®* program. All responses are included in Table 6-5. Note that respondents could list more than one reason for satisfaction. The responses do not differ enormously across the two LDCs. In neither LDC did many customers report that monetary incentive is a reason for satisfaction. However, in each LDC, saving money on the electric bill is a common reason given. The other responses included many customers who reported that they liked the convenience of the program or that they barely even noticed it. Also, in Ottawa, many customers reported that they liked receiving a programmable thermostat.

[20] 2010 Load Impact Evaluation for Pacific Gas and Electric Company's Smart AC Program, prepared by FSC Group, April 1, 2011.

[21] Customers are only asked this set of questions if they indicate they understood what *peaksaver®* is and how it works.

Table 6-5:
Percentage of Respondents Reporting Each Reason for Liking *peaksaver*®

Reasons to like *peaksaver*®	Hydro Ottawa (n=91)	Toronto Hydro (n=136)	Total (n=227)
Getting a monetary incentive from LDC	6	2	3
Helping LDC avoid power outages/shortages	12	13	13
Helping the environment	7	11	9
Saving energy	19	24	22
Saving money on my electric bill	16	26	22
Other	41	24	30

Customers who indicated being either somewhat or very dissatisfied were asked what they disliked about the program. Those responses are shown in Table 6-6. The responses are split fairly evenly between the four options for both LDC. Other responses attributed CAC technical difficulties to *peaksaver*® and some referred to discomfort; one said they never received the incentive cheque; and one said they never saw a reduction in their bill. Note, customers were allowed to give more than one response.

Table 6-6:
Percentage of Respondents Reporting Each Reason for Not Liking *peaksaver*®

Reasons to not like *peaksaver*®	Hydro Ottawa (n=7)	Toronto Hydro (n=12)	Total (n=19)
Discomfort	33	33	33
Inconvenience	13	24	19
Do not like being controlled	27	10	17
Other	27	33	31

The survey also contained a short sequence of questions to determine whether the *peaksaver*® program led to technical problems with SMB customers' CACs. First, customers were asked whether they had their CAC serviced since joining *peaksaver*®. In total, 35% of Hydro Ottawa customers and 52% of Toronto Hydro Customers answered yes to this question. Customers were then asked whether the service was routine or due to a specific problem. If the problem was specific, customers were asked about the nature of the problem. The key fact of this section is that only two Toronto Hydro customers and no Hydro Ottawa customers attributed any problems with their CAC to the *peaksaver*® program.

Finally, customers were asked if they believed that they were compensated fairly for taking part in *peaksaver*®. In total, 93% of Hydro Ottawa customers and 80% of Toronto Hydro customers said yes to this question. Of those customers who were not satisfied, six Toronto Hydro customers and one Hydro Ottawa customer reported not receiving an incentive cheque.[22] Those who did not believe they were compensated fairly were asked what level of compensation would be fair. Responses ranged from a low

[22] It is not clear whether the respondent was referring to the *peaksaver*® incentive cheque or the EM&V incentive cheque.

of $25 to a high of $500, with an average of about $200. It is important to note that these values are based on a small number of responses (only 15 customers stated a dollar value for fair compensation). Most customers who answered the question said, "I don't know" to the question of how much they should be compensated.

6.3 Conclusions from the Post-Event Survey

The main conclusion to draw from the post-event survey is that *peaksaver*® customers do not experience an inordinate amount of discomfort due to *peaksaver*®. Also, the levels of discomfort due to *peaksaver*® are similar to those seen in other load control programs. The vast majority of customers also believe that they are compensated fairly for their participation. Reported satisfaction with the program is also quite high.

7 Hydro Ottawa *peaksaver*® Pilot Process Evaluation

As part of the 2010 *peaksaver*® evaluation, the Ontario Power Authority (OPA) contracted with FSC to perform a process evaluation of the Hydro Ottawa *peaksaver*® pilot. The pilot focused on exploring delivery and marketing mechanisms designed to increase participation among the SMB community. This process evaluation discusses and analyzes the pilot's key elements, focusing on their impact on participation levels. These elements include:

- Direct mail marketing;
- One-on-one direct contacts supported with collateral materials and testimonials;
- Cross promotion with other OPA conservation programs also targeted at the SMB population;
- Testing the impact of different incentive levels on sign-up rates;
- Incorporating direct involvement of Ottawa's HVAC contractor community to attract additional SMB participation;
- Conducting focus groups to explore what *peaksaver*® SMB participants and non-participants like and dislike about the pilot; and
- A new program design element allowing eligible participants to have separate PCTs connected to each of their multiple central AC units rather than only one PCT for the entire business.

To explore these topics, several sources of information from OPA and Hydro Ottawa were drawn upon, including:

- Hydro Ottawa quarterly reports that summarized the pilot's progress towards attaining its goals; four reports were made available covering the following time periods 1) from pilot commencement through December 31, 2009, 2) first quarter 2010, 3) second quarter 2010 and 4) third quarter 2010, which marked the conclusion of the pilot;
- For those SMB customers that were contacted to join the program, Hydro Ottawa weekly non-participant statistics in terms of their rationale for not joining the pilot, running from the week of May 17, 2010 to the week of August 2, 2010;
- Hydro Ottawa collateral materials;
- OPA *peaksaver*® marketing materials made available to those LDCs interested in offering the traditional SMB *peaksaver*® program to their customers; and
- A series of previously commissioned OPA market research studies.

On-site interviews were also held on August 18, 2010 with several OPA staff and with HO and Honeywell staff. Honeywell was included because they were the marketing contractor used for the pilot. The OPA staff members interviewed were responsible for promoting *peaksaver*® among the province's LDCs. The HO and Honeywell staff members interviewed were responsible for managing and implementing the pilot.

Beyond these Ontario-specific resources, FSC also drew upon its findings from a 2009 SMB-focused direct load control program benchmarking study, in which over 25 North American utility programs were identified, and of those, program managers from 11 utilities agreed to be interviewed and share their insights.

7.1 Background on Pilot and *peaksaver*® Marketing

As is the case for most direct load control programs targeted to SMB customers in North America, the *peaksaver*® SMB group is much smaller than the residential group of customers. No Ontario LDC actively excludes SMB customers from *peaksaver*®, however very few emphasize SMB participation. Instead, they focus on the residential market. The only two exceptions are Hydro Ottawa and Toronto Hydro, which makes sense as they are two of the largest urban centers in the province.[23]

During its tenure, the Hydro Ottawa pilot successfully accomplished its primary goal of expanding the SMB *peaksaver*® participant base by recruiting 754 customers, representing 939 installed PCTs that control 1,648 tons of AC.[24] The SMB population is defined as commercial customers with less than 50 kW of peak demand. Recruitment was accomplished in large part through direct mail campaigns, which were augmented by one-on-one marketing to SMB customers by field technicians doing *peaksaver*® installations.

As discussed in the choice modeling section below, a $75 participation incentive (in addition to the free PCT) did not result in increased enrollment over the $25 incentive and free PCT. Customers appear to be motivated by the free PCT and by the energy conservation aspects of *peaksaver*®, rather than by the monetary incentive. Incentive levels associated with recruiting and retaining CAC load-control participants at other utilities vary widely, from providing a PCT without any additional incentive through to monthly bill credits that range from a few dollars to much more substantial amounts. Despite this wide variation in incentives, there has been almost no systematic testing of the effect of incentive levels on recruitment rates. Therefore, information about the optimal incentive level is quite limited.

OPA assists LDCs interested in offering the *peaksaver*® program to their customers by providing *peaksaver*® template marketing materials for the LDCs to adopt. These are available for both residential and SMB customers. The text and images provided can be used by the LDCs in their brochures and website visuals.

While OPA's *peaksaver*® marketing approach is mainly passive and tied to supporting the LDC's efforts, they do offer province-wide radio and print support. The radio spots and print advertisements are program specific and focus on the residential customers, as do the conservation programs.

To promote *peaksaver*® in 2010, OPA developed and funded radio and print ads. The print ads focused on the province-wide papers, such as Globe and Mail, National Post and Toronto Star. Radio spots were run in four week flights, with one conducted in late June and early July. Also in June, OPA ran two insertions in the Toronto Star as well as Globe and Mail.

Starting in 2009, OPA has provided a SMB *peaksaver*® page on their website, which directs the viewer to link to their respective LDC's *peaksaver*® webpage to obtain more information.

7.2 Marketing Channels and Results

Hydro Ottawa's marketing of the *peaksaver*® program was not designed with an experimental framework in mind. Nor was data collection on this marketing effort undertaken with the intent of future analysis. Nevertheless, useful insight can be obtained about the response to HO's mailing and calling efforts on behalf of *peaksaver*® by examining the patterns of *peaksaver*® sign-ups over time as they relate to

23 There are also 11 SMB *peaksaver*® participants in Horizon's program near Hamilton.

24 According to the installation report.

promotional mailings and phone calls. While bearing in mind the limitations of the data, there are a few conclusions about the effectiveness of these marketing efforts:

- HO's initial marketing effort had a very noticeable effect, leading to a sustained sign-up rate of 0.3-0.4% of the *peaksaver*® eligible population per week for several weeks in a row. This rate dropped off several weeks after the initial marketing effort ended;
- HO's telemarketing effort directed at Power Savings Blitz[25] (PSB) customers does not appear to have dramatically increased *peaksaver*® sign-up rates over what would occur with direct mail alone. This conclusion is quite tentative due to imperfect data on the telemarketing effort and due to potentially confounding outside factors (see section 7.2.2 for details);
- There appears to be a noticeable positive relationship between the fraction of businesses that receive direct mail promotions in a forward-sorting area and the fraction of businesses that sign-up for *peaksaver*® in the weeks immediately following. This relationship is also tentative due to potentially confounding outside factors, but appears to indicate that when an extra 100 pieces of mail are sent out, an extra 1.4 customers sign up for *peaksaver*®; and
- Larger monetary incentives do not appear to lead to higher sign-up rates.

7.2.1 Available Data and Limitations

The data sources available for this analysis were:

- The full list of *peaksaver*®-eligible businesses in HO's territory;
- The full list of commercial *peaksaver*® customers with the date of *peaksaver*® PCT installation and the forward-sorting area of the business address;
- The date, number of mail pieces sent and forward-sorting areas for each of HO's direct mailings from September 2009 through July 2010; and
- The approximate date of *peaksaver*® promotional phone calls made to PSB customers and the number of such calls for customers contacted in 2010. For PSB customers it was known which groups of customers were targeted by phone and at approximately what point in time. Customers were phoned in groups according to when they joined PSB. It is unknown precisely which customers were contacted. Also, the timing of the calls was only known based on the date when each list of customers was given by HO to Honeywell for calling. Calls were supposed to have taken place within roughly one week after the list changed hands. Also, calls to PSB customers took place in fall 2009, but only very approximate information is available about when and no information is available about which customers were called in that effort.

Importantly, there are several important sets of data that this analysis lacks. It is unknown which customers were exposed to marketing efforts other than direct mail and telemarketing. These efforts included:

- Poster ads on OCTranspo buses, radio and print ads;
- Personal visits to customers as a follow-up to the direct mail;
- Door-to-door cold sales calls conducted in neighborhoods where installers were working; and
- Inserts into customer bill invoices.

[25] Power Savings Blitz is an efficiency program that offers free upgrades and retrofits of lighting and water heating to small business customers.

7.2.2 Timeline of Marketing Efforts

HO began marketing *peaksaver*® to commercial customers in September of 2009. Table 7-1 displays the dates, quantities and target groups for the mailings and telemarketing efforts. In an initial set of mailings from September 22 to October 20, 2009, roughly 16,000 promotional mailers were sent out—enough to cover the entire set of *peaksaver*®-eligible commercial customers in the HO territory. A telemarketing effort aimed at Power Savings Blitz customers occurred at roughly the same time (the date shown in the table for this effort is only an estimate—the actual date was not available). These calls were far less numerous than the mailers sent out, but they were aimed at a group known to have an interest in energy savings. These efforts immediately led to customers signing up, with the first installations taking place on October 5, roughly two weeks after the mailings began. The mailings led to a period of about 7 weeks—from roughly November 1, 2009 to just before Christmas—when sign-ups occurred at a rate of approximately 40 per week, or 0.3-0.4% of the *peaksaver*®-eligible HO commercial customer population per week. This was followed by a period from Christmas until the end of February 2010, when very few customers signed up—less than 10 per week.

Concurrent with the initial direct mail effort, a telemarketing effort was directed at PSB customers, as well as personal visits directed at customers who had recently received direct mail. It is unclear which customers were contacted through these efforts or exactly when they took place.

On February 26, 2010 a period commenced during which roughly 1,500 promotional mailings were sent out every 2 to 4 weeks until the middle of July. Simultaneously, telemarketing efforts aimed at Power Savings Blitz customers occurred.

Table 7-1:
SMB Marketing Efforts by Hydro Ottawa

Date	SMB Customers Attempted to Contact	Mode of Communication
9/22/2009	5571	mail
9/29/2009	4182	mail
10/1/2009	377	phone
10/6/2009	2024	mail
10/13/2009	2960	mail
10/20/2009	1285	mail
2/26/2010	1567	mail
2/26/2010	210	phone
3/31/2010	1591	mail
4/16/2010	1559	mail
4/20/2010	277	phone
4/30/2010	1569	mail
5/14/2010	1475	mail
5/28/2010	1585	mail
6/11/2010	1556	mail
6/25/2010	1572	mail
7/9/2010	1565	mail
7/23/2010	1566	mail
8/4/2010	478	phone
8/17/2010	78	phone

Figure 7-1 shows the percentage of the *peaksaver*®-eligible population that was contacted by mail each week, the percentage that was contacted by phone and the percentage that had a *peaksaver*® device installed. Note that the percentage contacted by mail each week is charted on the left axis, while the other two values are on the right axis.

Unfortunately, because the marketing effort was rolled out without an emphasis on measuring its effectiveness, the conclusions one can draw from Figure 7-1 are few and somewhat tentative. The data are not amenable to a conventional discrete choice analysis[26] of the marketing effort for two reasons. First, due to the lack of full data on various marketing efforts, measured coefficients could be very misleading. Second, the lack of information on the customer population means that there are few

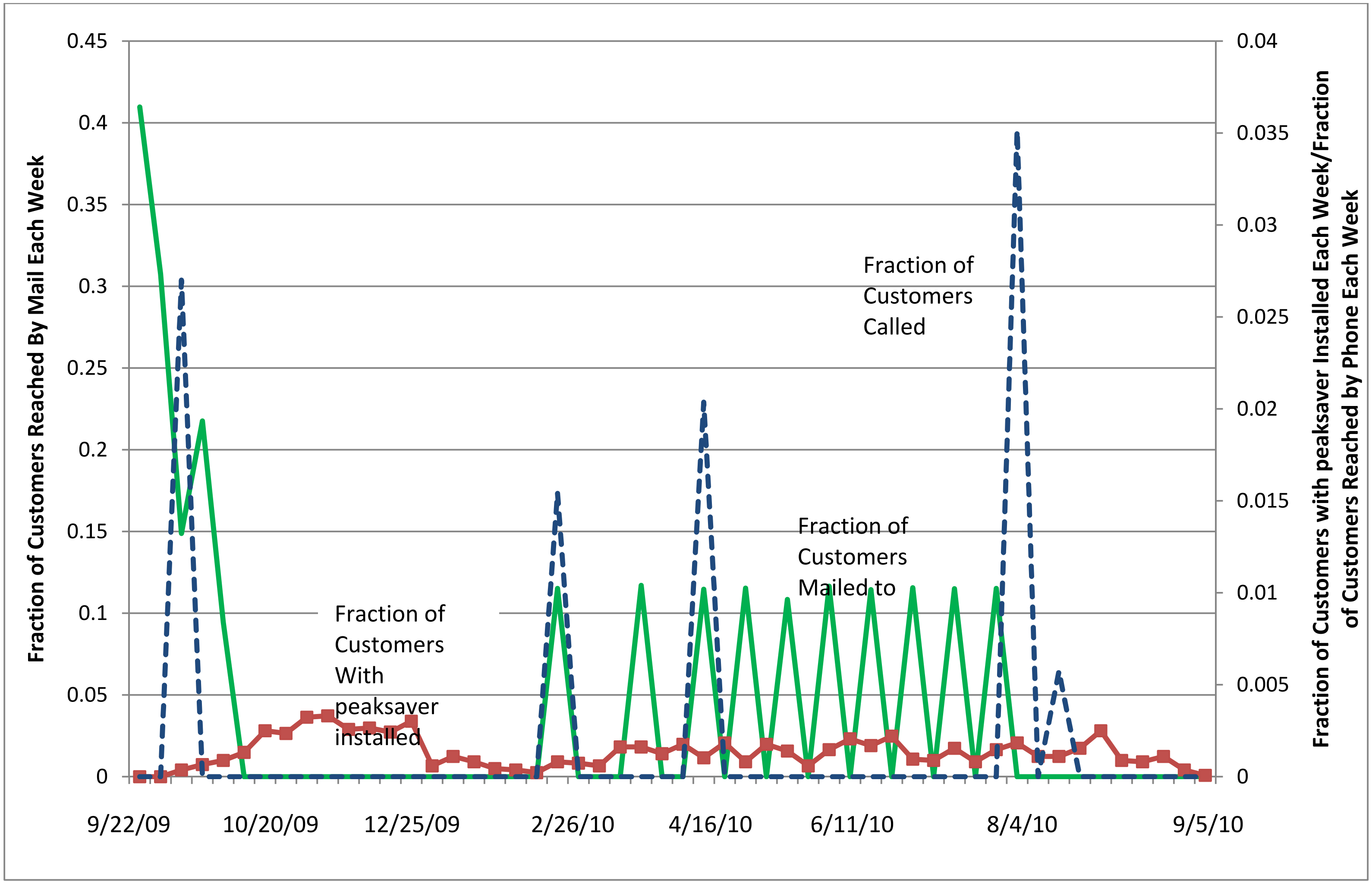
26 A discrete choice analysis consists of a model of choices that take on discrete values such as yes/no. Such a model requires extensive information about the characteristics of the entities making the choices. In this case, such information would consist of exactly which businesses were marketed to when and through what media, as well as characteristics of the businesses marketed to and the choices made by each about whether to sign-up.

methods to control for underlying differences between types of customers. As it is, both of these problems affect the analysis undertaken and force the conclusions to be quite tentative.

By comparing the installation rates at different periods of time when different marketing efforts had just taken place, one can develop some idea about the efficacy of these efforts. However, one must strongly qualify these conclusions due to the fact that over time customers in this population are signing up for *peaksaver*® and rendering themselves ineligible for signing up again. Because it is likely that customers with greater interest in such programs sign up first, comparing the efficacy of one marketing effort at one time to another that takes place later is not straightforward. The earlier marketing effort had the benefit of being directed at a population in which fewer people had yet to sign up.

Keeping that important qualification in mind, one can draw a few conclusions from Figure 7-1. First, and unsurprisingly, there is a very noticeable effect from the first set of mailings and phone calls that went out in fall 2009. The period of weeks immediately following those mailings have the highest *peaksaver*® installation rates of any time shown in the figure. Second, after the mailings stopped at the end of October, customers continued to sign up for several weeks, then installations dropped dramatically at Christmas and did not recover until marketing was resumed. The fact that installations picked up again several weeks later indicates that the drop-off around Christmas was due to a combination of the holiday season and the effect of the initial marketing effort wearing off rather than due to the interest in the population being exhausted.

Figure 7-1:
peaksaver® **Installations, Mailings and Phone Calls as a Fraction of Eligible Customers Over Time**



Finally, although the effect of the telemarketing campaign directed at Power Savings Blitz customers cannot be precisely quantified, a few useful things can be said about it. First, the telemarketing effort did not lead to *dramatic* increases in *peaksaver*® sign-up rates over what was achieved through mail alone. If it had, there would be noticeable spikes in installation rates during the weeks in early 2010 immediately after the calls were made. Instead, installation rates remain fairly flat after calls are made. For example, the installation rates in the weeks immediately after the telemarketing efforts of February 26 and April 20, 2010 are not noticeably larger than the rates in early April, or in June and July when no calls had been made recently. Note that mail promotions were taking place regularly during this entire period. There is a small uptick in the installation rate at the end of August 2010, which could be due to the phone effort of August 4 (which was about twice as large as the previous efforts) or could be due to random variation. In any case, even that uptick fails to make the weekly installation rate as high as it was when the mailing effort first began almost a year earlier.

Again, a limitation is the minimal information on the PSB telemarketing effort of fall 2009. There are results from customer surveys done at the time of installation by the installing technician that corroborate the conclusion that the telemarketing effort had a relatively small impact on *peaksaver*® installations. Table 7-2 shows the total number of customers in the survey reporting that they signed-up due to contact from various marketing modes as of September 2010. As shown, the telemarketing effort accounts for 11% of sign-ups. Presumably, the PSB customers are more motivated about energy savings than other customers. A substantial portion of that 11% might have signed up anyway due to one of the other marketing efforts. This suggests that 11% is an upper bound on the effect of the telemarketing effort. As indicated in Table 7-2, the vast majority of *peaksaver*® installations resulted from customers responding to direct mail or to direct sales by technicians.

Table 7-2:
SMB Customers Responding to Each Marketing Mode by September 2010

Marketing Mode	SMB Customers Reporting Responding	Percent of Total
Direct mail	325	41
Telemarketing to Power Saving Blitz Customers	84	11
Technician Direct Sales	306	39
Other	76	10
Total	**791**	**100**

Of the 84 customers who indicated they signed up due to the telemarketing effort directed at PSB customers, 62 (73%) signed up in the fourth quarter of 2009. The drop off in successful phone recruiting thereafter is due to HO and Honeywell having called the existing PSB participant list; subsequent calls were made to the new PSB recruits joining the program on a monthly basis. However, such calls may have come too quickly on the heels of signing up for PSB. A better approach might have been to allow the PSB recruits to settle into the program for a period of time, and then re-contact them regarding the *peaksaver*® option. This would also have the benefit of restocking the list of customer calls to be made, thereby improving the cost effectiveness of devoting resources to this effort. Another possibility would be to market *peaksaver*® at the time of PSB installations. To further examine the effect of phone marketing on sign-up rates, the phone and mail efforts that began on February 26, 2010 are analyzed further. At that date, there had been no direct mail or phone marketing done for at least the previous two months, and the weekly sign-up rate was very low. HO undertook both a mail effort and phone effort simultaneously beginning on that date. Notably, though, some forward sorting areas (FSAs) received mail only, some received no mail but did receive phone calls, some received both and some received none. By dividing the population into these four groups, a better idea of the effectiveness of each marketing mode can be developed. Table 7-3 shows three different measures across each group of FSAs, which is the geographic level at which the mailings were organized. First, it shows the percentage of customers in each set of FSAs who received mailings in the February 26 round of mailings. Second, it shows the percentage of customers in each set of FSAs who were called as part of the telemarketing effort. Finally, it shows the percentage of customers in each set of FSAs who enrolled in *peaksaver*® within the next five weeks. Note that the next wave of marketing was a set of mailings sent out on March 31, 2010, so customers signing up within five weeks of the February 26 marketing effort were likely responding to the February 26 effort.

The most important aspect of Table 7-3 is that the *peaksaver*® installation rates are very low—less than 1% of eligible customers. Therefore, conclusions are based on few customer sign-up decisions. Statistics calculated for yes or no decisions when one decision is very rare are subject to high variability, which means that differences between average values can easily be due to chance. To illustrate this, the raw number of *peaksaver*® installations underlying the installation rate calculation is shown in the final column. The number of installations is very small (less than 15 installations) for three of the four cells. Unsurprisingly then, if a difference-in-means test to check whether the differences in *peaksaver*® device installations are likely to be due to chance, finds only one set of installation rates in the table actually has a statistically significant difference—the difference between mail alone and phone alone (the second and third rows of the table). In this case, the difference has a p-value of 2%, thus, the difference is unlikely due to chance alone.[27]

Given that there are almost certainly important differences between the FSAs underlying these groups—such as differences in business types—it is prudent to conclude only that adding the telemarketing effort did not strongly affect the sign-up rate. This is particularly true given that the FSAs which directly received no marketing, had sign-up rates comparable to both the FSAs that received phone calls and to the FSAs that received both phone calls and mail.

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[27] A p-value is the probability that the estimated relationship occurs due to chance alone. A low p-value indicates that the result is not likely due to random chance.

Table 7-3:
Marketing Contacts During the 2/26/2010 Promotion and *peaksaver*® Device Installations within Five Weeks[28]

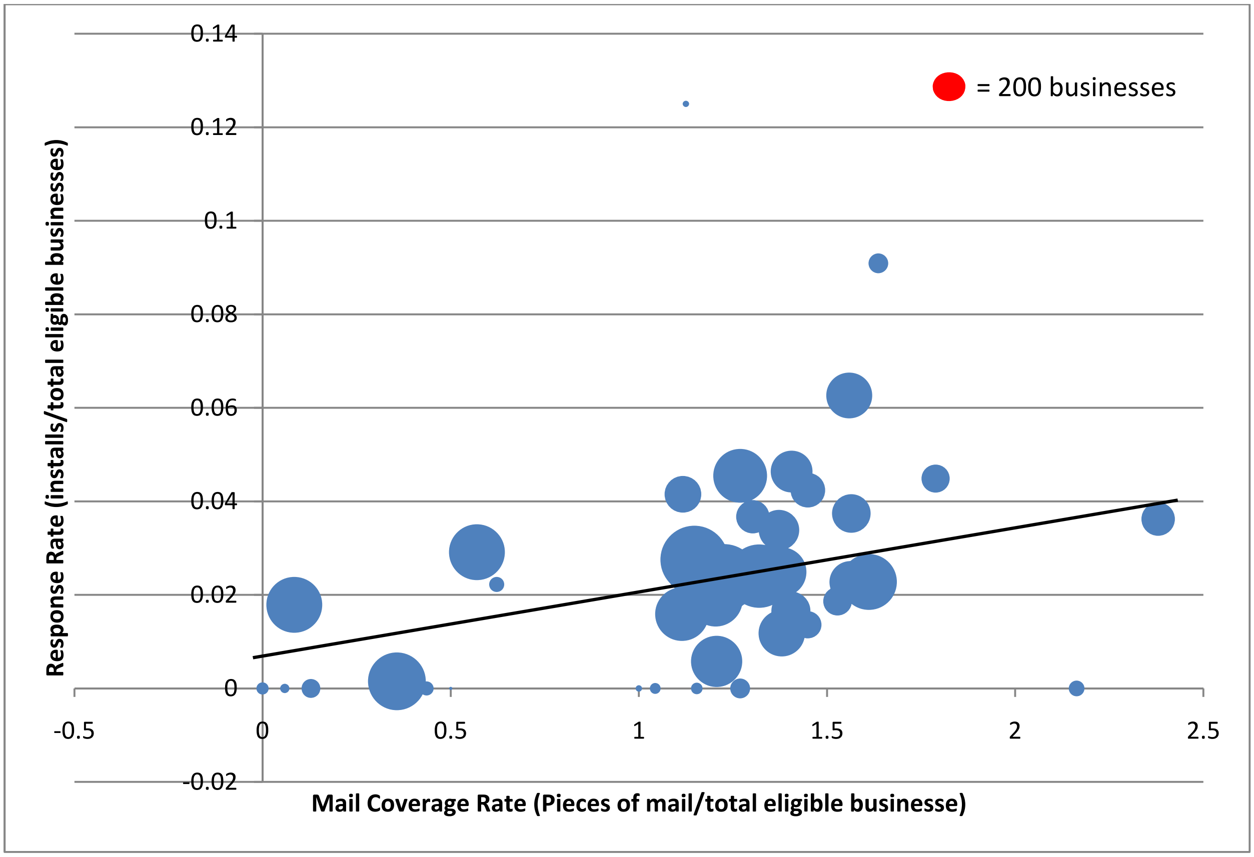
FSA Groups by Mode(s) of Contact	Percentage of *peaksaver*®-eligible customers			Number of eligible customers	Number of installations
	Receiving Mail	Contacted by Phone	*peaksaver*® Device Installed within Five Weeks		
No contact	0	0.0	0.60	498	3
Mail Only	100+	0.0	0.25	809	2
Phone Only	0	1.7	0.69	10,118	70
Mail and Phone	97	1.5	0.64	2,174	14

To examine the effect of the direct mail effort, it is useful to look at the relationship between the amount of mail sent out in the first wave of mailings and the proportion of eligible customers who signed up immediately afterward. Figure 7-2 shows the relationship between the fraction of the population that received promotional mailings in the set of mailings that went out during the period Sept 22-Oct 20, 2009 and the fraction of the population that had *peaksaver*® devices installed during the time from Sept 22 to Dec 25, 2009. Each bubble in the graph represents one FSA. The size of each bubble represents the number of *peaksaver*®-eligible businesses in the FSA. Note that the number of pieces of mail sent out exceeded the number of *peaksaver*®-eligible businesses in many FSAs. This is probably because Honeywell sent mailers to all commercial customers in each FSA, rather than just those thought to be *peaksaver*®-eligible (it could not be fully determined whether this was the case, but it seems likely). The graph also shows a regression line based on the best linear fit between the fraction of customers mailed to and the fraction of customers who had a *peaksaver*® device installed before Dec 25, 2009. The regression is weighted according to the number of businesses in the FSA.[29] The slope of the line is 0.014, which indicates that for every extra percentage point of the population that receives promotional mail, an extra 0.014% of the population signs up for *peaksaver*®, on average. Another way to put this is that for every extra 100 pieces of mail, 1.4 more customers are expected to sign up. One important caveat is that this relationship could also be due to an underlying correlation between the amount of mail sent out and the FSA's underlying level of interest in programs like *peaksaver*®. If the same FSAs that received a lot of mailings also happened to be the ones that contained many customers who are likely to sign-up for *peaksaver*®, then the relationship shown in the graph would not be a causal relationship. Another related issue is that it is not clear exactly why some FSAs received much less than one piece of mail per *peaksaver*®-eligible customer. Not knowing this leaves the possibility that there is another reason for the relationship in the graph other than that more mail leads to more sign-ups. Nevertheless, this result is worth reporting because the relationship seems very plausible and useful to know.

28 FSAs are grouped according to whether they received mailings, phone calls, both or none.

29 The weighted regression gives more weight to larger FSAs because those data points with larger populations underlying them are measured with higher precision.

Figure 7-2:
The Relationship Between the Amount of Mail Sent Out and *peaksaver*® Device Installations by FSA



Finally, although the majority of the population received a $25 incentive offer to sign-up for *peaksaver*®, a small group of FSAs containing 882 SMB customers received a $75 incentive offer during the fall 2009 wave of direct mail. This group of FSAs represented Kanata, a west-end suburban quadrant of the city. Again, because this group was not chosen randomly it is better to be conservative in comparing sign-up rates across the two sets of FSAs because there are probably underlying differences between the populations that contribute to differences in sign-up rates. That point would be more relevant if there was a large difference in the sign-up rate between FSAs that were offered $25 and FSAs that were offered $75. In fact, the FSAs that were offered $25 had 2.9% of eligible customers sign-up before 2010, while the FSAs that were offered $75 had 2.4% of customers sign-up. The difference between these two sign-up rates is not statistically significant. This also dovetails well with the findings reported in HO's quarterly marketing reports that surveyed customers do not report the monetary incentive as a major reason for signing up for the program.

7.3 SMB DLC Benchmarking Insights

7.3.1 Marketing Channels

In looking at the other utility DLC programs, it is clear that in most cases, the commercial component is small compared to the residential component. In addition, it is clear that most SMB DLC offerings are marketed primarily through direct mail. Direct mail is low cost and predictable, routinely garnering a 1-2% response rate, which is frequently sufficient for the utility to meet its recruitment goals.

Hydro Ottawa augmented their direct mail campaigns with outbound telemarketing to the Power Savings Blitz population and achieved modest results, as described above. Taking the values from Tables 7-1 and 7-2 as estimates of the number of customers contacted by phone and the number of customers signing up due to telemarketing, HO achieved a recruitment rate of 84/1420=6% due to telemarketing.

HO's telemarketing results dovetail reasonably well with FSC's recent experience with a more expansive SMB DLC outbound telemarketing campaign. In spring 2010, PG&E approached Population Research Systems (a component of the FSC Group) requesting assistance in conducting an aggressive outbound telemarketing campaign directed at selling SmartAC (PG&E's AC direct load control program) to small and medium businesses. Like Hydro Ottawa, the customers would receive a free and installed PCT along with a $25 incentive per installed unit. Importantly, like *peaksaver*®, SmartAC provides only a one-time incentive payment. PG&E initially provided a SMB customer list number with 10,000 accounts, along with all necessary customer contact information. The initial wave of telemarketing was preceded by a stand-alone tri-fold mailer (copies of marketing materials are included as an Appendix). The telemarketing campaign ran for 40 business days and yielded 860 successful recruits, for a recruitment success rate of 8.6%.

Importantly, in this case it is also known how many customers signed up out of the total number actually spoken to. Several barriers exist between calling the customer and being able to make the pitch for the program. In this case, 33% of customers called were ineligible due to not having AC or having moved out. An additional 16% could not be contacted because the provided contact information was invalid. Of the customers actually contacted, in 30% of cases, the decision-maker—the manager, for example—could not be reached. Of the cases where the correct decision-maker could be reached, 24% signed up for the program.

PG&E then provided PRS with an additional list of 10,000 accounts. In this case, the preliminary mailer was changed from a stand-alone brochure to a PG&E letter and brochure contained in a #10 business envelope. The second outbound telemarketing campaign ran for 35 business days and yielded 917 recruits—a success rate of 9.2%. As in the previous case, a large proportion of the sample was rendered invalid from a recruiting perspective due to ineligibility, bad contact information or the inability to reach the decision-maker. Of the cases where SmartAC was pitched to the decision-maker, 26% signed up.

This example shows that HO's experience in terms of sign-up rates due to telemarketing is similar to that seen elsewhere. However, it also shows the importance of targeting eligible customers, getting valid contact information and reaching the person who can make the decision.

7.3.2 Targeting

Respondents to FSC's direct load control program benchmarking study also provided information about how they target their programs to certain segments of the SMB population. Some target retail segments where customers make short visits, like convenience stores. Here the logic is that customers coming in from a very warm exterior environment to a cool store for a short period of time (under 5 minutes) will not likely notice whether the indoor temperature is set at 74 or 78°F.

Others target SMB customers who occupy facilities that while currently zoned for commercial use, were originally constructed for residential occupancy. Examples include beauty parlors, tax accountants and law offices. In this case, the goal is to utilize DLC switches specifically intended for residential AC units.

7.4 Marketing Initiatives

7.4.1 Allying with Ottawa's Business Improvement Associations (BIAs)

Hydro Ottawa approached the 16 BIAs within their service area to attempt to use them as marketing outlets for *peaksaver*®. Each BIA represents a local shopping district. Some other LDCs had success with this strategy. HO developed and distributed a November 18, 2009 email to each of the BIA managers soliciting their interest and co-sponsorship. Based on receiving no responses, HO attempted a new tactic of contacting each of the BIA managers by phone and subsequent emails but to no avail. As of second quarter 2010, HO stopped putting any effort into this activity.

It is interesting to note that in the SMB direct load control benchmarking, which FSC conducted in 2009, there was a theme among at least some of the responding utilities that they saw the value in pursuing community organization-based marketing through SMB-relevant channels such as the local Chambers of Commerce, Kiwanis, Lions Club and the like. While the interest was there, and the value proposition clear, none of the respondents had actively pursued this avenue because they were meeting their recruitment targets via direct mail campaigns. This perspective would likely change in the event that the recruitment goals for any given utility were increased to reflect issues around the availability of peaking capacity, and/or the inclusion of increased renewable resources within a given utility's resource portfolio.

7.4.2 Utilizing HVAC Trade Allies as a Marketing Partner

At the outset of the pilot, HO confirmed that they had hopes of pursuing a trade ally marketing initiative. HO staff reached out to the HVAC contractor community in various ways, while obtaining little to no traction with them. According to the HO staff, the HVAC community views them as competitors in providing PCTs to customers. Of course, the HVAC contractors might express a higher level of acceptance of the program if they were better integrated into its delivery, although it is not clear exactly how this would happen.

Hydro Ottawa's experience is not uncommon. Based upon the 2009-2010 load-control SMB benchmarking, which FSC conducted, there was also strong support among the interviewees in terms of looking for opportunities for marketing the program through appropriate trade allies, such as the local HVAC contractors. While most agreed this should be explored, the success in gaining access to customers through the trade allies was not good. While there were reports of effective co-branding and "win-win" situations, other stories were shared that resulted in little additional uptake, either because of limited staff resources within the utility to perform the "spade" work necessary to get such a network up and operational, or because of limited enthusiasm among trade "allies."

Some survey respondents saw their HVAC contractor community as far from an ally. Frequently, upon following up with interested customers, they were informed that the customer's HVAC contractor called into question whether or not the DLC switch or PCT would damage their HVAC system or potentially void their warranty. This scare tactic obviously had the desired outcome of tempering the customer's interest in participating in the program. One utility identified a way to work around this problem; rather than bring in a stand-alone contractor to be solely responsible for installing the DLC program's PCTs, they enlisted members of the HVAC community to provide that service.

7.4.3 Incorporate Testimonials into the Marketing Materials

In HO's application for OPA funding for this pilot, they indicate that SMB *peaksaver*® testimonials from trade allies or customers will be pursued for potential use at various trade shows, customer gatherings, in-store displays, etc. Due to resource and staffing constraints within HO, and the fact that their key goal of recruiting 750 SMB PCT units into the pilot was in large part met after 3 quarters of effort, HO decided not to pursue this marketing initiative.

According to several of the utilities surveyed, an alternative form of feedback that participants found attractive involves running appreciation advertisements in the local media as well as trade press. Doing so indicates to prospective customers that the participating business is doing its part and is supporting the energy efficiency ethic.

7.4.4 SMB Customer Feedback and Interaction Opportunities

The HO application also references pursuing customer feedback and interaction opportunities in order to help "…identify further promotional, testimonial, and recognition opportunities." While HO considered conducting focus groups in summer 2010, they decided not to based on their belief that the SMB *peaksaver*® participants had been saturated with respect to contacts with the program. HO was concerned about alienating the *peaksaver*® SMB customers and therefore did not conduct focus groups.

7.5 Marketing Barriers

The marketing barriers identified by HO and Honeywell staff during the August 18th interview sessions hold much in common with those brought up by utilities that participated in FSC's DLC SMB program benchmarking work.

7.5.1 Identifying the Decision-Maker

A key barrier identified by HO and the benchmarked utilities is finding the actual decision-maker associated with many SMB accounts – while many SMB customers represent single location owner-operated businesses, a good number are managed on behalf of an absentee owner, a chain of outlets or a holder of multiple franchises. In these cases, direct mailing to the store manager (or frequently the accounting staff of a multi-site business) is not effective in getting the SMB DLC offer in front of the decision-maker.

This was especially difficult for HO and its direct mail campaign because a large percentage of Ontario businesses operate as Limited Liability Corporations (LLCs) and have their HO accounts set up using that nomenclature. So, for example, HO's marketing materials were mailed to Ontario LLC 765223, located at a given street address. This made initially identifying the decision-maker (or even market segment from a targeting standpoint) impossible without either a site visit or utilizing reverse address listing resources in the hope that other mail going to that address utilizes the “doing business as” name, as well as contact.

The importance of identifying and contacting the decision-maker is further reinforced when looking at the summary statistics that Hydro Ottawa compiled regarding customers’ rationale for not participating in the pilot as collected by Honeywell staff. Between May 17th and August 2nd 2010, Honeywell collected the non-participation rationale from almost 700 customer contacts. After subtracting customers that were not eligible (i.e., no AC), 628 responses were tabulated. Of those, the following decision-maker access issues were cited: for 57% of responses the decision-maker could not be reached; 6% of responses were that they must consult with the head office; and 4% of responses were that the Property Manager/Landlord must be consulted. In more than two-thirds of cases, the customer contact was not empowered to make such a program participation commitment.

7.5.2 Getting the Decision-Maker’s Attention

For HO and the benchmarked utilities, SMB customers routinely focus on their core business decisions and view energy as a secondary topic. As has been seen in countless DSM programs, a customer’s interest in energy and the costs associated with it are often closely related to the fraction of operating costs that energy represents. If energy costs are relatively small, then customers tend to focus on managing other aspects of the business. This is often only exacerbated by the fact that many customers do not have a good understanding of their energy use or how they are charged for it.

7.5.3 Holding the Decision-Maker’s Attention

While HO along with their implementation contractor Honeywell streamlined the recruitment and PCT installation scheduling process used in the *peaksaver®* SMB pilot, other utilities have identified a barrier tied to holding the decision-maker’s attention across the time involved in completing the recruitment, enrollment and control equipment installation process. As one utility put it “…keeping them focused, as well as getting things scheduled…the visits, the agreement signing, the equipment installation….it’s a hassle and intrudes on the SMB customer’s business.”

7.6 Recommendations and Conclusions from the HO *peaksaver®* Pilot

Several important conclusions can be drawn from this analysis of HO’s *peaksaver®* pilot and other North American load control programs.

First, it is not clear whether direct mail or telemarketing is more cost effective, and that comparison is worth making. If one mode of marketing was clearly cheaper than the other, then it would probably make sense to use it exclusively. In recent telemarketing efforts for SmartAC by PRS (the market research arm of FSC), costs per recruited customer have been in the $40-50 range. However, these costs could be improved substantially if the call lists included only customers who were likely to have CAC and if they included more accurate contact information. Both of these issues should be a high priority for any telemarketing effort.

Secondly, targeting customers likely to have AC and likely to be large users of AC can be done fairly accurately based on a summer's worth of smart meter interval data. This is an exercise that FSC has done for two California utilities to address AC load control targeting. Accurate targeting could improve the cost effectiveness of both telemarketing and direct mail efforts.

Thirdly, in the HO pilot, a higher monetary incentive did not have any effect on recruitment success. However, in the pilot, customers received a free PCT, which was a motivating factor for many of them. In a situation where only a load control switch was being offered, a larger incentive payment might have an effect on recruitment.

Finally, it should be known that efforts to learn from the HO pilot were set back by the fact that marketing and recruitment was undertaken without planning for how the pilot would provide new information about which efforts worked well and which did not. In the future, to learn which marketing efforts are effective, it would be worthwhile to plan the marketing in an experimental or quasi-experimental fashion. For example, deliberately mailing to one random group of FSAs, while telemarketing towards another group at the same time would provide a useful comparison of the effectiveness of each strategy. Although there are short-term costs and logistical difficulties associated with experiments, they can be very useful in providing reliable knowledge about what works and what does not.

Also, it appears that there was no systematic effort to retain the data necessary for analyzing marketing effectiveness. For example, in this case only very limited information was available about the telemarketing effort. This limited the conclusions that could be drawn about its effectiveness. In the future, it would be useful to keep track of exactly which customers were targeted by which marketing efforts and on what dates. It would also be useful to keep track of which customers responded to which efforts, wherever possible. Again, the short term costs of such efforts can have high future pay-offs.

Appendix A. Development of *Ex Ante* Weather Profiles

In order to predict the likely load impacts arising from *peaksaver*® under various weather conditions, *ex ante* predictions are made for weather conditions meant to represent conditions likely to be experienced during monthly peak days during a typical year and during a particularly high load year. Specifically, the typical year is meant to contain weather conditions as severe as those that would be experienced roughly half the time during each month. The high load year is meant to contain weather conditions as severe as those that would be experienced roughly 1 year out of 10, for each month.

For the 2009 evaluation, *ex ante* weather profiles were chosen based on the decision to treat 2005 as a 1-in-2 year and 2006 as a 1-in-10 year in terms of system load. The weather conditions during the monthly system peak days for each of those years were then used as the *ex ante* weather conditions. This procedure worked quite well for providing predictions of load impacts over a range of conditions, particularly the very hot conditions that the program is most important during. The only drawback to using one particular year for each set of conditions is that natural variation in conditions led to some unexpected weather patterns, such as the 1-in-2 conditions being hotter than the 1-in-10 conditions for some months, or for September to have hotter conditions than July, for example.

A new methodology was chosen this year that does very little to change the range of conditions selected, but that satisfies the expected patterns in weather between months and between 1-in-2 and 1-in-10 years.

A.1. *Ex Ante* Weather Selection Methodology

To choose *ex ante* weather conditions that would properly reflect conditions likely to be experienced during each monthly peak day under 1-in-2 and 1-in-10 conditions, hourly weather data was downloaded for each of OPA's settlement zones for the years 2000 through 2010. The hourly data was averaged over the settlement zones using *peaksaver*® device counts as weights.[30] This produced a dataset of hourly province-wide average temperatures for 11 years. Next, the day in each month in each year with the highest peak temperature was chosen and designated as the monthly peak day for that month of that year. Then, the peak days were ranked according to peak temperature separately for each month. Within each month's ranking, the sixth hottest day and the second hottest day were chosen as 1-in-2 and 1-in-10 monthly peak days, respectively.

A.2. Weather Selection Results

The actual days chosen are shown in Table A-1, along with the province-wide average peak temperature on each day. The full set of hourly weather conditions for each settlement zone and for the whole province is shown as part of the load impact tables in Appendix D.

As compared to the *ex ante* weather conditions used in the 2009 report, these conditions have a similar range and a similar peak during the August 1-in-10 peak day. The primary difference between these conditions and those used for the 2009 evaluation is that here every 1-in-2 monthly peak day has a lower

[30] Ideally, full population numbers would be used as weights to reflect the fact that the important issue is how high system load is on a given day. However, those numbers were not available quickly enough. This proxy is unlikely to produce inaccurate results because the weights do not differ drastically from the actual population values.

peak temperature than the corresponding 1-in-10 day. Also, August and July always have higher peak temperatures than May, June and September. These characteristics more accurately reflect weather that is likely to be observed in the future.

Table A-1:
Selected 1-in-2 and 1-in-10 *Ex Ante* Monthly Peak Days

Month	1-in-2		1-in-10	
	Date	High Temperature	Date	High Temperature
May	5/21/2009	28	5/24/2007	31
June	6/15/2001	30	6/26/2007	34
July	7/3/2003	31	7/2/2002	34
August	8/17/2009	32	8/8/2001	37
September	9/1/2000	28	9/6/2007	31

Appendix B. Mapping Between LDCs and Settlement Zones

For general background information, Table B-1 shows the settlement zones served by each LDC. Note that some LDCs serve more than one zone. This information comes from the January 2011 Program Status and Capacity Report.

Table B-1:
Settlement Zones Served by Each LDC

LDC	Settlement Zone
Barrie Hydro (PowerStream)	Essa
Bluewater Power Distribution Corporation	West
Brampton	Toronto
Brant County Power Inc.	Long Point
Brantford Power Inc.	Long Point
Burlington Hydro Inc.	South Central
Cambridge and North Dumfries Hydro Inc.	South Central
Canadian Niagara Power (Port Colborne)	Niagara
Centre Wellington	Southwest
Chatham-Kent Hydro	West
Clinton Power	West
Collus	Essa
Cooperative Hydro Embrun	Ottawa
ELK Energy Inc.	West
Enersource Hydro Mississauga	Toronto
Enwin Utilities Ltd.	West
Erie-Thames Power	West
Essex Powerlines	West
Festival Hydro Inc.	Southwest
Greater Sudbury Hydro Inc. & West Nippising	Northeast
Grimsby	Niagara
Guelph Hydro Electric Systems Inc.	South Central
Haldimand County Hydro Inc.	Long Point
Halton Hills Hydro	South Central
Horizon Utilities	South Central
Hydro One	East
Hydro One	Southwest
Hydro One	Essa
Hydro One	Ottawa
Hydro One	Northeast

LDC	Settlement Zone
Hydro One	Northwest
Hydro One	South Central
Hydro One	Georgian Bay
Hydro One	Long Point
Hydro One	West
Hydro One	Niagara
Hydro One	Toronto
Hydro Ottawa	Ottawa
Innisfil Hydro Distribution Systems	Essa
Kitchener-Wilmot Hydro Inc.	Southwest
Lakefront	East
Middlesex Power Distribution	West
Midland	Essa
Newmarket Hydro + Tay Hydro Electric	Toronto
Niagara Peninsula Energy	Niagara
Niagara-on-the-Lake	Niagara
Norfolk Power Distribution Inc.	Long Point
Oakville Hydro	South Central
Orangeville	Southwest
Oshawa PUC Networks Inc.	Toronto
Parry Sound Power Corp.	Essa
Peterborough Distribution Inc.	Essa
PowerStream	Toronto
St. Thomas Energy Inc.	West
Tillsonburg	Long Point
Toronto Hydro	Toronto
Veridian Connections	Toronto
Wasaga Distribution	Essa
Waterloo North Hydro Inc.	South Central
Welland Hydro	Niagara
West Perth Power	West
Woodstock	West

As discussed in section 3.3, collected data was assigned to represent settlement zones where no data was collected. Table B-2 contains these assignments.

Table B-2:
Assignments Between Un-represented Settlement Zones and Toronto Hydro or Hydro Ottawa Modeling Results

Settlement Zone	Assigned Model Group
Northwest	Ottawa
Northeast	Ottawa
Essa	Ottawa
East	Ottawa
Georgian Bay	Toronto
Bruce	Toronto
Southwest	Toronto
South Central	Toronto
West	Toronto
Long Point	Toronto
Niagara	Toronto

Appendix C. Post-Event and Control Surveys

C.1. Post Event-Survey

The first survey was given on August 5th and 6th 2010, following the August 4th event.

INTRODUCTION

Hello, my name is (______) and I am calling from Population Research Systems on behalf of [Toronto Hydro or Hydro Ottawa]. Your business is a participant in [Toronto Hydro or Hydro Ottawa]'s peaksaver air-conditioning load control program and I'd like to ask you a few questions about your experience and satisfaction this program. This will take only a few minutes and will help us to better understand your service needs and what we can do to better meet them.

For this survey, I need to speak to the person who was generally in charge of your business operations on [Tuesday]. Are you the person who was generally in charge of your business operations on [Tuesday]?

No – ask for the person who was generally in charge of business operations on [Tuesday] and repeat introduction

Yes – Go to next question

This will just take a few minutes, can we do it now?

No – reschedule

Yes – Proceed with interview

I want to ask you some questions about your cooling system and the way you use it.

1. Was your business's air-conditioning operating on [Tuesday]?
   a. Yes
   b. No
2. Was there any time on [Tuesday] when the temperature in your place of business was uncomfortable for you, your employees or your customers?
   a. No – Go to Q6
   b. Yes
3. (only if Q2=b) During what hours were you, your employees or your customers uncomfortable?
   a. Uncomfortable start ____
   b. Uncomfortable end ____

3a .What, if anything, did you do to try and make your employees or your customers more comfortable? (Open Ended)

   a. Nothing
   b. Turned on fans
   c. Tried to adjust thermostat
   d. Closed blinds
   e. Other________

4. Is the temperature in your place of business often uncomfortable during those hours or was [Tuesday] an unusual day?
    a. Often uncomfortable during those hours
    b. It was an unusual day
5. What do you think caused the temperature in your place of business to be uncomfortable? (open ended)
    a. Air conditioner unit was not on
    b. Air conditioner doesn't work properly
    c. [Toronto Hydro or Hydro Ottawa] was controlling air conditioner (go to Q9)
    d. It was a very hot day
    e. Other (specify) ____
6. (Ask only if Q5 is not equal to c) Do you recall any occasions in the past 6 months when you thought [Toronto Hydro or Hydro Ottawa] might be reducing your air conditioner use?
    a. No Skip to Q9.
    b. Yes
7. (ask only if Q6 = b) About how many times do you think this might have occurred?
    a. ______ number of times
    b. Don't know/Not sure
8. (Ask only if Q6 =b) Can you tell me the last time you think this might have happened? (open ended)
    a. (BLANK)
    b. Any time mentioned within the last 5 days
    c. Any time mentioned within the past 2 weeks
    d. Any time mentioned within the past month
    e. Any time mentioned within the past 3 months
    f. Any other time
    g. [Tuesday]
9. Did you notice anything different about the way your air conditioner operated on [Tuesday]?
    a. No
    b. Yes – Describe _______________________________________

9a.Your business is participating in [Toronto Hydro or Hydro Ottawa]'s peaksaver program. Are you familiar with this program?
    a. No
    b. Yes (go to Q10)

9b. (Ask only if 9a = a). In the peaksaver program a device is installed that allows [Toronto Hydro or Hydro Ottawa] to reduce your air conditioner use during times when the system is very heavily loaded. This helps prevent power outages and makes everyone's electricity more affordable. Do you understand this idea?

  c. No
  d. Yes

10. In general, how satisfied would you say you are with your experience in the peaksaver program? Are you?
    a. Very satisfied
    b. Somewhat satisfied
    c. Neither satisfied nor dissatisfied
    d. Somewhat dissatisfied
    e. Very dissatisfied
11. (ask only if Q10 is a or b) What is it that you like most about this program? (do not read options)
    a. Getting an incentive from [Toronto Hydro or Hydro Ottawa]
    b. Helping [Toronto Hydro or Hydro Ottawa] avoid power shortages/outages
    c. Helping fight global warming/climate change
    d. Helping the environment
    e. Saving my energy
    f. Saving money on my electric bill
    g. Other (record) ____
12. (ask only if Q10 is d or e) What is it that you dislike about this program? (do not read options)
    a. Discomfort
    b. Inconvenience
    c. Do not like being controlled
    d. Other (record) ____
13. Have you had your air conditioner serviced since you joined the peaksaver program?
    a. Yes
    b. No
14. (ask only if Q13 = a) Was there a specific problem that led you to do that or was it normal maintenance?
    a. Normal maintenance
    b. Specific problem
15. (ask only if Q14 = b) What was the nature of the problem?
    a. (Describe) ____________________________________
16. Do feel that you were compensated fairly for taking part in this program? (If customers asks to be reminded of compensation, look up amount)
    a. Yes
    b. No
17. (ask only if Q16 = b) What would be a fair amount of compensation?
    a. Record amount__________

18. Do you lease or own your facility? *(mark one)*
    a. Lease
    b. Own
    c. Other, specify
    d. 88. Refused
    e. 99. Don't know
19. How many locations does your company have in Ontario? *(mark one)*
    a. 1
    b. 2 to 4
    c. 5 to 10
    d. 11 to 25
    e. Over 25
    f. 88. Refused
    g. 99. Don't know
20. How many of these locations are participating in the peaksaver program?
    a. 1
    b. 2 to 4
    c. 5 to 10
    d. 11 to 25
    e. Over 25
    f. 88. Refused
    g. 99. Don't know
21. About how many employees do you have at this location? *(mark one)*
    a. 1 to 5
    b. 6 to 10
    c. 11 to 20
    d. Over 20
    e. 88. Refused
    f. 99. Don't know
22. Approximately, what percentage of your facility's annual operating cost is associated with your electricity bill? *(mark one)*
    a. 0-9%
    b. 10-19%
    c. 20-29% / 25%
    d. 30-39%
    e. 40-49%
    f. 50-59%

g. 60-69%
h. 70-79% / 75%
i. 80-89%
j. 90-100%
k. 88. Refused
l. 99. Don't know

Close: That's all the questions I have. On behalf of [Toronto Hydro or Hydro Ottawa] I'd like to thank you very much for participating in this survey. The information you have provided will be very helpful in meeting your needs in the future.

C.2. Control Survey

The second survey was given on September 8th and 9th 2010, asking about the control day, September 7th.

INTRODUCTION

Hello, my name is (______) and I am calling from Population Research Systems on behalf of [Toronto Hydro or Hydro Ottawa]. Your business is a participant in [Toronto Hydro or Hydro Ottawa]'s peaksaver air-conditioning load control program and I'd like to ask you a few questions about your experience and satisfaction this program. This will take only a few minutes and will help us to better understand your service needs and what we can do to better meet them.

For this survey, I need to speak to the person who was generally in charge of your business operations on [Tuesday]. Are you the person who was generally in charge of your business operations on [Tuesday]?

No – ask for the person who was generally in charge of business operations on [Tuesday] and repeat introduction
Yes – Go to next question

This will just take a few minutes, can we do it now?

No – reschedule
Yes – Proceed with interview

I want to ask you some questions about your cooling system and the way you use it.

23. Was your business's air-conditioning operating on [Tuesday]?
    a. Yes
    b. No
24. Was there any time on [Tuesday] when the temperature in your place of business was uncomfortable for you, your employees or your customers?
    a. No – Go to Q6
    b. Yes
25. (only if Q2=b) During what hours were you, your employees or your customers uncomfortable?
    a. Uncomfortable start ____
    b. Uncomfortable end ____

3a .What, if anything, did you do to try and make your employees or your customers more comfortable? (Open Ended)
    f. Nothing
    g. Turned on fans
    h. Tried to adjust thermostat
    i. Closed blinds
    j. Other________

26. Is the temperature in your place of business often uncomfortable during those hours or was [Tuesday] an unusual day?
    a. Often uncomfortable during those hours
    b. It was an unusual day
27. What do you think caused the temperature in your place of business to be uncomfortable? (open ended)
    a. Air conditioner unit was not on
    b. Air conditioner doesn't work properly
    c. [Toronto Hydro or Hydro Ottawa] was controlling air conditioner (go to Q9)
    d. It was a very hot day
    e. Other (specify) ____
28. (Ask only if Q5 is not equal to c) Do you recall any occasions in the past 6 months when you thought [Toronto Hydro or Hydro Ottawa] might be reducing your air conditioner use?
    a. No Skip to Q9.
    b. Yes
29. (ask only if Q6 = b) About how many times do you think this might have occurred?
    a. ______ number of times
    b. Don't know/Not sure
30. (Ask only if Q6 =b) Can you tell me the last time you think this might have happened? (open ended)

a. (BLANK)
b. Any time mentioned within the last 5 days
c. Any time mentioned within the past 2 weeks
d. Any time mentioned within the past month
e. Any time mentioned within the past 3 months
f. Any other time
g. [Tuesday]

31. Did you notice anything different about the way your air conditioner operated on [Tuesday]?
    a. No
    b. Yes – Describe ___________________________________

9a.Your business is participating in [Toronto Hydro or Hydro Ottawa]'s peaksaver program. Are you familiar with this program?

e. No
f. Yes (go to Q10)

9b. (Ask only if 9a = a). In the peaksaver program a device is installed that allows [Toronto Hydro or Hydro Ottawa] to reduce your air conditioner use during times when the system is very heavily loaded. This helps prevent power outages and makes everyone's electricity more affordable. Do you understand this idea?

g. No
h. Yes

32. How would you like to see [Toronto Hydro or Hydro Ottawa] improve the program? [open ended]
33. Given the opportunity, would you sign up for the peaksaver program again?
    a. Yes
    b. No

Close: That's all the questions I have. On behalf of [Toronto Hydro or Hydro Ottawa] I'd like to thank you very much for participating in this survey. The information you have provided will be very helpful in meeting your needs in the future.

Appendix D. Load Impact Tables

D.1. Residential Ex Post Impacts

Table D-1:
Residential Hourly Ex Post Load Impact Results for May 26, 2010

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.01	0.01		20
2	0.01	0.01		19
3	0	0		19
4	0	0		19
5	0.01	0.01		18
6	0.01	0.01		19
7	0.03	0.03		22
8	0.08	0.08		24
9	0.19	0.19		26
10	0.35	0.35		28
11	0.49	0.49		29
12	0.6	0.6		30
13	0.72	0.72		31
14	0.82	0.82		31
15	0.9	0.9		31
16	0.95	0.95		31
17	1.07	0.68	0.39	30
18	1.16	0.74	0.42	30
19	1.14	0.69	0.45	28
20	1.14	0.68	0.46	27
21	1.04	1.36	-0.32	25
22	0.98	1.21	-0.23	24
23	0.88	1.05	-0.17	23
24	0.77	0.87	-0.11	22

Table D-2:
Residential Hourly Ex Post Load Impact Results for July 6, 2010

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.17	0.17	.	25
2	0.16	0.16	.	24
3	0.15	0.15	.	24
4	0.14	0.14	.	24
5	0.17	0.17	.	23
6	0.31	0.31	.	24
7	0.32	0.32	.	25
8	0.48	0.48	.	27
9	0.64	0.64	.	29
10	0.91	0.91	.	30
11	1.08	1.08	.	32
12	1.15	1.15	.	32
13	1.25	1.25	.	33
14	1.27	1.27	.	33
15	1.3	1.3	.	33
16	1.3	0.81	0.49	33
17	1.41	0.89	0.52	32
18	1.5	0.95	0.55	32
19	1.45	0.88	0.57	30
20	1.43	1.85	-0.41	29
21	1.31	1.62	-0.31	28
22	1.24	1.48	-0.24	26
23	1.14	1.32	-0.19	25
24	1	1.13	-0.13	24

Table D-3:
Residential Hourly Ex Post Load Impact Results for August 30, 2010

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.03	0.03	.	21
2	0.03	0.03	.	21
3	0.02	0.02	.	20
4	0.02	0.02	.	20
5	0.02	0.02	.	20
6	0.03	0.03	.	20
7	0.06	0.06	.	21
8	0.11	0.11	.	24
9	0.25	0.25	.	28
10	0.45	0.45	.	30
11	0.64	0.64	.	31
12	0.76	0.76	.	32
13	0.89	0.89	.	33
14	1	1	.	33
15	1.08	0.7	0.38	33
16	1.12	0.69	0.43	32
17	1.25	0.78	0.47	32
18	1.33	0.84	0.5	30
19	1.29	1.66	-0.37	28
20	1.28	1.56	-0.28	27
21	1.19	1.41	-0.23	26
22	1.13	1.31	-0.18	25
23	1.03	1.18	-0.15	24
24	0.91	1.02	-0.11	24

D.2. SMB Ex Post Impacts

Table D-4:

SMB Hourly Ex Post Load Impact Results for May 26, 2010

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.46	0.46	.	21
2	0.45	0.45	.	20
3	0.42	0.42	.	19
4	0.4	0.4	.	19
5	0.41	0.41	.	19
6	0.41	0.41	.	20
7	0.47	0.47	.	22
8	0.66	0.66	.	24
9	0.95	0.95	.	26
10	1.31	1.31	.	28
11	1.66	1.66	.	29
12	1.87	1.87	.	30
13	2.03	2.03	.	31
14	2.1	2.1	.	32
15	2.16	2.16	.	31
16	2.22	2.22	.	31
17	2.17	2.17	.	30
18	1.95	1.95	.	30
19	1.72	1.21	0.51	28
20	1.5	1.02	0.48	27
21	1.29	1.4	-0.11	25
22	1.12	1.18	-0.06	24
23	0.95	0.99	-0.04	23
24	0.83	0.85	-0.02	22

Table D-5:
SMB Hourly Ex Post Load Impact Results for July 6, 2010

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.74	0.74	.	25
2	0.74	0.74	.	25
3	0.71	0.71	.	24
4	0.7	0.7	.	24
5	0.71	0.71	.	23
6	0.71	0.71	.	24
7	0.84	0.84	.	25
8	1.09	1.09	.	28
9	1.39	1.39	.	29
10	1.78	1.78	.	30
11	2.07	2.07	.	32
12	2.25	2.25	.	32
13	2.33	2.33	.	33
14	2.36	2.36	.	33
15	2.4	2.4	.	33
16	2.43	1.83	0.6	33
17	2.35	1.73	0.62	32
18	2.12	1.5	0.63	32
19	1.89	1.3	0.59	30
20	1.67	1.78	-0.11	29
21	1.47	1.54	-0.07	28
22	1.32	1.36	-0.04	27
23	1.18	1.21	-0.03	26
24	1.06	1.08	-0.02	24

Table D-6:
SMB Hourly Ex Post Load Impact Results for August 30, 2010

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.65	0.65	.	21
2	0.62	0.62	.	21
3	0.57	0.57	.	20
4	0.54	0.54	.	20
5	0.54	0.54	.	20
6	0.53	0.53	.	20
7	0.6	0.6	.	21
8	0.79	0.79	.	24
9	1.09	1.09	.	27
10	1.47	1.47	.	29
11	1.82	1.82	.	31
12	2.03	2.03	.	32
13	2.15	2.15	.	33
14	2.23	2.23	.	33
15	2.29	1.81	0.48	33
16	2.34	1.82	0.52	32
17	2.28	1.72	0.55	32
18	2.05	1.48	0.56	30
19	1.8	1.89	-0.09	28
20	1.58	1.64	-0.06	27
21	1.39	1.42	-0.04	27
22	1.23	1.25	-0.02	25
23	1.07	1.09	-0.01	25
24	0.95	0.96	-0.01	24

D.3. Residential *Ex Ante* Impacts

Table D-7:

Residential Hourly *Ex Ante* Load Impact Results for May, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0	0	.	18
2	0	0	.	16
3	0	0	.	15
4	0	0	.	14
5	0	0	.	12
6	0	0	.	14
7	0	0	.	17
8	0	0	.	19
9	0.02	0.02	.	21
10	0.06	0.06	.	23
11	0.16	0.16	.	26
12	0.25	0.25	.	27
13	0.34	0.34	.	28
14	0.42	0.42	.	28
15	0.49	0.32	0.17	28
16	0.54	0.34	0.21	28
17	0.64	0.4	0.24	28
18	0.72	0.45	0.26	28
19	0.72	0.92	-0.2	27
20	0.73	0.89	-0.16	25
21	0.69	0.82	-0.13	24
22	0.67	0.78	-0.11	23
23	0.62	0.71	-0.09	22
24	0.54	0.54	.	21

Table D-8:
Residential Hourly *Ex Ante* Load Impact Results for June, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.02	0.02	.	20
2	0.02	0.02	.	20
3	0.02	0.02	.	19
4	0.02	0.02	.	20
5	0.02	0.02	.	19
6	0.03	0.03	.	19
7	0.03	0.03	.	21
8	0.05	0.05	.	22
9	0.13	0.13	.	25
10	0.25	0.25	.	26
11	0.37	0.37	.	27
12	0.46	0.46	.	28
13	0.56	0.56	.	29
14	0.64	0.64	.	30
15	0.72	0.48	0.25	30
16	0.77	0.49	0.28	30
17	0.86	0.55	0.31	29
18	0.93	0.6	0.34	28
19	0.93	1.18	-0.25	27
20	0.94	1.14	-0.2	27
21	0.88	1.04	-0.16	25
22	0.84	0.97	-0.13	24
23	0.75	0.86	-0.1	23
24	0.66	0.67	-0.01	22

Table D-9:
Residential Hourly *Ex Ante* Load Impact Results for July, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0	0	.	18
2	0	0	.	18
3	0	0	.	17
4	0	0	.	17
5	0	0	.	16
6	0	0	.	16
7	0	0	.	18
8	0.01	0.01	.	21
9	0.09	0.09	.	25
10	0.21	0.21	.	26
11	0.35	0.35	.	28
12	0.45	0.45	.	29
13	0.55	0.55	.	29
14	0.66	0.66	.	31
15	0.76	0.49	0.27	31
16	0.83	0.51	0.31	31
17	0.95	0.6	0.36	31
18	1.05	0.66	0.39	30
19	1.05	1.35	-0.3	29
20	1.07	1.31	-0.24	28
21	1.02	1.21	-0.19	26
22	0.99	1.15	-0.16	25
23	0.93	1.06	-0.13	25
24	0.84	0.93	-0.1	24

Table D-10:
Residential Hourly *Ex Ante* Load Impact Results for August, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.11	0.11	.	24
2	0.1	0.1	.	23
3	0.09	0.09	.	23
4	0.07	0.07	.	21
5	0.07	0.07	.	21
6	0.11	0.11	.	21
7	0.11	0.11	.	21
8	0.16	0.16	.	24
9	0.24	0.24	.	25
10	0.39	0.39	.	27
11	0.54	0.54	.	29
12	0.65	0.65	.	30
13	0.76	0.76	.	31
14	0.84	0.84	.	32
15	0.91	0.59	0.32	32
16	0.93	0.58	0.35	30
17	1.05	0.66	0.39	31
18	1.14	0.72	0.42	30
19	1.14	1.47	-0.33	30
20	1.17	1.43	-0.26	28
21	1.1	1.31	-0.21	27
22	1.08	1.26	-0.17	27
23	1.01	1.16	-0.14	25
24	0.92	1.04	-0.12	25

Table D-11:
Residential Hourly *Ex Ante* Load Impact Results for September, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0	0	.	20
2	0	0	.	19
3	0	0	.	19
4	0	0	.	19
5	0	0	.	18
6	0	0	.	18
7	0	0	.	18
8	0	0	.	20
9	0.04	0.04	.	22
10	0.12	0.12	.	25
11	0.22	0.22	.	26
12	0.31	0.31	.	27
13	0.41	0.41	.	28
14	0.48	0.48	.	28
15	0.55	0.36	0.19	28
16	0.6	0.37	0.23	28
17	0.7	0.44	0.26	28
18	0.77	0.48	0.29	28
19	0.75	0.97	-0.22	26
20	0.76	0.93	-0.17	25
21	0.71	0.84	-0.14	23
22	0.68	0.79	-0.11	22
23	0.62	0.71	-0.09	22
24	0.54	0.55	-0.01	21

Table D-12:
Residential Hourly *Ex Ante* Load Impact Results for May, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0	0	.	15
2	0	0	.	14
3	0	0	.	14
4	0	0	.	14
5	0	0	.	13
6	0	0	.	13
7	0	0	.	14
8	0	0	.	17
9	0.01	0.01	.	21
10	0.05	0.05	.	23
11	0.16	0.16	.	26
12	0.29	0.29	.	29
13	0.44	0.44	.	31
14	0.56	0.56	.	31
15	0.66	0.43	0.23	31
16	0.73	0.45	0.27	30
17	0.84	0.53	0.31	30
18	0.93	0.59	0.34	29
19	0.93	1.2	-0.26	28
20	0.96	1.16	-0.21	27
21	0.9	1.07	-0.17	25
22	0.87	1.01	-0.14	23
23	0.8	0.91	-0.11	21
24	0.7	0.7	.	19

Table D-13:
Residential Hourly *Ex Ante* Load Impact Results for June, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.01	0.01	.	21
2	0	0	.	20
3	0	0	.	19
4	0	0	.	19
5	0	0	.	18
6	0	0	.	18
7	0.02	0.02	.	21
8	0.07	0.07	.	24
9	0.18	0.18	.	27
10	0.35	0.35	.	28
11	0.52	0.52	.	30
12	0.65	0.65	.	32
13	0.78	0.78	.	32
14	0.88	0.88	.	32
15	0.97	0.63	0.34	32
16	1.05	0.65	0.4	34
17	1.19	0.75	0.44	32
18	1.31	0.83	0.48	32
19	1.31	1.68	-0.37	31
20	1.35	1.64	-0.29	30
21	1.27	1.51	-0.24	28
22	1.25	1.45	-0.2	28
23	1.18	1.35	-0.17	27
24	1.09	1.23	-0.14	27

Table D-14:
Residential Hourly *Ex Ante* Load Impact Results for July, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.22	0.22	.	27
2	0.22	0.22	.	26
3	0.21	0.21	.	26
4	0.19	0.19	.	25
5	0.23	0.23	.	24
6	0.39	0.39	.	24
7	0.4	0.4	.	25
8	0.56	0.56	.	27
9	0.71	0.71	.	28
10	0.98	0.98	.	30
11	1.15	1.15	.	32
12	1.22	1.22	.	33
13	1.32	1.32	.	33
14	1.34	1.34	.	34
15	1.37	0.89	0.48	34
16	1.37	0.85	0.52	34
17	1.5	0.94	0.56	34
18	1.61	1.02	0.6	34
19	1.59	2.04	-0.45	33
20	1.6	1.95	-0.35	32
21	1.5	1.78	-0.28	30
22	1.46	1.69	-0.23	29
23	1.37	1.56	-0.19	28
24	1.25	1.42	-0.16	27

Table D-15:
Residential Hourly *Ex Ante* Load Impact Results for August, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.14	0.14	.	24
2	0.11	0.11	.	23
3	0.09	0.09	.	22
4	0.08	0.08	.	22
5	0.08	0.08	.	21
6	0.14	0.14	.	22
7	0.13	0.13	.	21
8	0.2	0.2	.	25
9	0.34	0.34	.	28
10	0.58	0.58	.	31
11	0.78	0.78	.	32
12	0.93	0.93	.	34
13	1.1	1.1	.	35
14	1.21	1.21	.	36
15	1.32	0.86	0.46	37
16	1.4	0.87	0.53	37
17	1.59	1	0.59	36
18	1.74	1.1	0.64	35
19	1.71	2.21	-0.49	33
20	1.76	2.14	-0.39	32
21	1.66	1.97	-0.31	30
22	1.62	1.88	-0.26	29
23	1.52	1.73	-0.22	28
24	1.4	1.58	-0.18	28

Table D-16:
Residential Hourly *Ex Ante* Load Impact Results for September, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0	0	.	16
2	0	0	.	15
3	0	0	.	15
4	0	0	.	15
5	0	0	.	14
6	0	0	.	14
7	0	0	.	14
8	0	0	.	17
9	0.01	0.01	.	19
10	0.04	0.04	.	23
11	0.13	0.13	.	25
12	0.25	0.25	.	28
13	0.39	0.39	.	30
14	0.51	0.51	.	31
15	0.62	0.4	0.22	31
16	0.7	0.43	0.27	31
17	0.82	0.51	0.31	30
18	0.93	0.58	0.34	30
19	0.95	1.23	-0.28	30
20	1	1.22	-0.22	29
21	0.97	1.15	-0.19	27
22	0.98	1.14	-0.16	26
23	0.94	1.08	-0.14	25
24	0.87	0.97	-0.1	24

D.4. SMB *Ex Ante* Impacts

Table D-17:
SMB Hourly *Ex Ante* Load Impact Results for May, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.31	0.31	.	18
2	0.31	0.31	.	16
3	0.31	0.31	.	15
4	0.31	0.31	.	14
5	0.31	0.31	.	12
6	0.31	0.31	.	14
7	0.31	0.31	.	17
8	0.34	0.34	.	19
9	0.45	0.45	.	22
10	0.68	0.68	.	23
11	1.03	1.03	.	26
12	1.27	1.27	.	27
13	1.48	1.48	.	28
14	1.6	1.6	.	28
15	1.71	1.44	0.27	28
16	1.8	1.49	0.31	29
17	1.79	1.45	0.34	28
18	1.61	1.25	0.36	28
19	1.41	1.48	-0.07	27
20	1.25	1.3	-0.05	25
21	1.07	1.11	-0.03	24
22	0.92	0.94	-0.02	23
23	0.78	0.79	-0.01	22
24	0.68	0.69	-0.01	21

Table D-18:
SMB Hourly *Ex Ante* Load Impact Results for June, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.31	0.31	.	21
2	0.32	0.32	.	20
3	0.32	0.32	.	19
4	0.32	0.32	.	20
5	0.34	0.34	.	19
6	0.35	0.35	.	19
7	0.4	0.4	.	21
8	0.55	0.55	.	22
9	0.82	0.82	.	25
10	1.16	1.16	.	26
11	1.5	1.5	.	28
12	1.7	1.7	.	28
13	1.86	1.86	.	29
14	1.93	1.93	.	30
15	2.01	1.64	0.38	30
16	2.06	1.65	0.42	30
17	2.01	1.57	0.44	29
18	1.78	1.33	0.45	28
19	1.57	1.65	-0.09	27
20	1.38	1.43	-0.06	27
21	1.19	1.22	-0.04	25
22	1.02	1.04	-0.02	24
23	0.88	0.89	-0.01	23
24	0.79	0.8	-0.01	22

Table D-19:

SMB Hourly *Ex Ante* Load Impact Results for July, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.31	0.31	.	18
2	0.31	0.31	.	18
3	0.31	0.31	.	17
4	0.31	0.31	.	17
5	0.31	0.31	.	16
6	0.32	0.32	.	16
7	0.32	0.32	.	18
8	0.39	0.39	.	21
9	0.61	0.61	.	25
10	0.95	0.95	.	26
11	1.34	1.34	.	28
12	1.58	1.58	.	29
13	1.77	1.77	.	29
14	1.91	1.91	.	31
15	2.02	1.66	0.36	31
16	2.1	1.69	0.41	32
17	2.07	1.62	0.45	31
18	1.87	1.4	0.47	30
19	1.65	1.73	-0.08	29
20	1.47	1.52	-0.05	28
21	1.28	1.32	-0.04	26
22	1.14	1.16	-0.02	25
23	1	1.01	-0.01	25
24	0.9	0.91	-0.01	24

Table D-20:

SMB Hourly *Ex Ante* Load Impact Results for August, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.33	0.33	.	24
2	0.35	0.35	.	23
3	0.37	0.37	.	23
4	0.37	0.37	.	21
5	0.4	0.4	.	21
6	0.42	0.42	.	20
7	0.48	0.48	.	21
8	0.69	0.69	.	24
9	0.98	0.98	.	25
10	1.35	1.35	.	27
11	1.72	1.72	.	29
12	1.94	1.94	.	30
13	2.09	2.09	.	31
14	2.15	2.15	.	32
15	2.21	1.77	0.44	32
16	2.23	1.76	0.47	30
17	2.17	1.67	0.5	31
18	1.94	1.43	0.51	30
19	1.72	1.81	-0.09	30
20	1.53	1.58	-0.06	28
21	1.35	1.39	-0.04	28
22	1.21	1.24	-0.02	27
23	1.08	1.1	-0.02	26
24	0.99	1	-0.01	25

Table D-21:

SMB Hourly *Ex Ante* Load Impact Results for September, 1-in-2 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.31	0.31	.	20
2	0.32	0.32	.	19
3	0.31	0.31	.	19
4	0.32	0.32	.	19
5	0.32	0.32	.	18
6	0.34	0.34	.	18
7	0.36	0.36	.	19
8	0.43	0.43	.	20
9	0.6	0.6	.	22
10	0.88	0.88	.	25
11	1.21	1.21	.	26
12	1.43	1.43	.	27
13	1.61	1.61	.	28
14	1.7	1.7	.	28
15	1.79	1.5	0.29	28
16	1.85	1.52	0.33	28
17	1.83	1.47	0.35	28
18	1.63	1.26	0.37	27
19	1.41	1.48	-0.07	26
20	1.23	1.27	-0.04	24
21	1.04	1.07	-0.03	23
22	0.88	0.89	-0.02	22
23	0.73	0.74	-0.01	21
24	0.64	0.65	-0.01	21

Table D-22:
SMB Hourly *Ex Ante* Load Impact Results for May, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.31	0.31	.	15
2	0.31	0.31	.	14
3	0.31	0.31	.	14
4	0.31	0.31	.	14
5	0.31	0.31	.	13
6	0.31	0.31	.	13
7	0.31	0.31	.	14
8	0.31	0.31	.	17
9	0.39	0.39	.	21
10	0.62	0.62	.	23
11	0.96	0.96	.	26
12	1.29	1.29	.	29
13	1.58	1.58	.	31
14	1.77	1.77	.	31
15	1.9	1.58	0.32	31
16	1.99	1.62	0.38	31
17	1.98	1.56	0.41	30
18	1.78	1.34	0.43	29
19	1.58	1.66	-0.08	29
20	1.4	1.45	-0.05	27
21	1.21	1.25	-0.04	25
22	1.05	1.07	-0.02	23
23	0.89	0.9	-0.01	22
24	0.76	0.77	-0.01	20

Table D-23:
SMB Hourly *Ex Ante* Load Impact Results for June, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.32	0.32	.	21
2	0.32	0.32	.	20
3	0.32	0.32	.	19
4	0.32	0.32	.	19
5	0.33	0.33	.	18
6	0.34	0.34	.	19
7	0.39	0.39	.	22
8	0.56	0.56	.	24
9	0.88	0.88	.	27
10	1.27	1.27	.	28
11	1.67	1.67	.	30
12	1.92	1.92	.	32
13	2.08	2.08	.	32
14	2.16	2.16	.	32
15	2.22	1.78	0.45	32
16	2.3	1.8	0.5	34
17	2.25	1.71	0.54	32
18	2.04	1.47	0.57	32
19	1.83	1.93	-0.1	31
20	1.64	1.7	-0.07	30
21	1.46	1.5	-0.04	29
22	1.35	1.37	-0.03	29
23	1.24	1.25	-0.02	28
24	1.15	1.16	-0.01	27

Table D-24:
SMB Hourly *Ex Ante* Load Impact Results for July, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.34	0.34	.	27
2	0.38	0.38	.	26
3	0.41	0.41	.	26
4	0.45	0.45	.	25
5	0.51	0.51	.	24
6	0.56	0.56	.	24
7	0.72	0.72	.	26
8	1.01	1.01	.	27
9	1.36	1.36	.	29
10	1.77	1.77	.	30
11	2.08	2.08	.	32
12	2.27	2.27	.	33
13	2.35	2.35	.	33
14	2.39	2.39	.	34
15	2.43	1.85	0.58	34
16	2.47	1.85	0.62	34
17	2.39	1.75	0.64	34
18	2.18	1.52	0.65	34
19	1.98	2.09	-0.12	33
20	1.78	1.86	-0.07	32
21	1.62	1.67	-0.05	30
22	1.5	1.52	-0.03	29
23	1.38	1.4	-0.02	28
24	1.29	1.3	-0.01	27

Table D-25:
SMB Hourly *Ex Ante* Load Impact Results for August, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.33	0.33	.	24
2	0.35	0.35	.	23
3	0.36	0.36	.	22
4	0.37	0.37	.	22
5	0.4	0.4	.	21
6	0.44	0.44	.	22
7	0.52	0.52	.	22
8	0.76	0.76	.	25
9	1.12	1.12	.	28
10	1.57	1.57	.	31
11	1.95	1.95	.	32
12	2.19	2.19	.	34
13	2.32	2.32	.	35
14	2.38	2.38	.	36
15	2.43	1.86	0.58	37
16	2.49	1.85	0.63	37
17	2.42	1.75	0.67	36
18	2.23	1.54	0.69	35
19	2.04	2.17	-0.13	33
20	1.87	1.95	-0.08	32
21	1.73	1.78	-0.05	30
22	1.62	1.64	-0.03	29
23	1.5	1.52	-0.02	29
24	1.42	1.44	-0.01	29

Table D-26:

SMB Hourly *Ex Ante* Load Impact Results for September, 1-in-10 Weather Conditions

Hour	Reference Load (kW per CAC unit)	Load with DR (kW per CAC unit)	Load Impact (kW per CAC unit)	Temperature (°C)
1	0.31	0.31	.	16
2	0.31	0.31	.	15
3	0.31	0.31	.	15
4	0.31	0.31	.	14
5	0.31	0.31	.	14
6	0.31	0.31	.	14
7	0.31	0.31	.	14
8	0.31	0.31	.	17
9	0.34	0.34	.	19
10	0.5	0.5	.	22
11	0.8	0.8	.	25
12	1.12	1.12	.	28
13	1.42	1.42	.	30
14	1.63	1.63	.	30
15	1.8	1.51	0.29	31
16	1.92	1.58	0.34	31
17	1.93	1.54	0.39	30
18	1.75	1.33	0.42	30
19	1.58	1.65	-0.08	31
20	1.42	1.47	-0.05	29
21	1.26	1.3	-0.03	27
22	1.14	1.17	-0.02	26
23	1.02	1.03	-0.01	25
24	0.94	0.95	-0.01	25