SDG&E 2008 Summer Saver Program Impact Evaluation

Final Report

Submitted to San Diego Gas & Electric

Burlington, Massachusetts, April 1st, 2009

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1. Executive Summary

This report provides the *ex post* and *ex ante* impact estimates for San Diego Gas & Electric's residential and commercial Summer Saver Program. The Program serves more than 20 thousand participants (16,437 residential, 3,916 commercial) and controls almost 100 thousand tons of cooling load (63,499 residential, 36,103 commercial) by cycling the operation of the air conditioning system[1]. Both customer classes have two choices of cycling level when a demand response event is called. Residential customers can choose between 50 percent and 100 percent cycling levels. Commercial customers choose between 30 percent and 50-percent cycling levels. All participating customers receive a year-end bill credit based on the rated cooling size of the controlled unit, the cycling level, and whether they are willing to be cycled on weekends (normal operations are weekdays only).

The summer of 2008 was an unusually mild summer in the San Diego area. Weather data series reveal a lack of extreme temperatures during July, August and September and less variation over the day compared to recent years. SDG&E did not dispatch the Summer Saver Program until October 1st, the day that ultimately proved to be the annual system peak for SDG&E[2], and again on October 8th, both on Wednesdays. In all, only two Program events were called during the 2008 cooling season. We provide *ex post* impact estimates for the residential and commercial populations for both event days of the summer.

Ex ante impact estimates are provided for monthly peaks and the average day for 1-in-2 and 1-in-10 weather years[3]. *Ex ante* results are provided at the residential and commercial program levels and cycling regime levels. Program level *ex ante* impacts are provided through 2011, after which projected enrollment is forecasted to remain constant. *Ex ante* impact results are provided for the Summer Saver program alone and also net of the effects of programs overlapping both the commercial and residential programs.

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[1] "Cycling" is a demand response control technique. A remotely controlled switch at the air conditioning unit limits the percentage of each half hour that the unit can run. A 30 percent cycling regime cycles of the unit off for 30 percent of each half an hour.

[2] SDG&E's system peak for 2008 occurred at 3:30 pm was 4,351 MWs

[3] As specified by the Demand Response Protocols (herafter, DR Protocols). Load Impact Estimation for Demand Response: Protocols and Regulatory Guidance. ATTACHMENT A. California Public Utilities Commission, Energy Division. March, 2008.

1.1 *Ex Post* Results

SDG&E established M&V samples for the Summer Saver program in 2006 and 2007. Premise-level 15-minute kWh interval data are collected for both commercial and residential M&V sample participants. For the residential M&V sample participants, the largest AC unit at the location was also metered, providing end-use 15-minute kWh interval data in addition to the premise-level meter data. The results for this year's evaluation are estimated using models estimated with the premise-level interval metered data. The end-use data is plays a role in identifying the magnitude of unit connected load.

Table 1-1 and Table 1-2 provide the event day characteristics for the residential and commercial programs. The event timing and duration on the event days was the same for both programs. Sample counts and sample and program tons are, of course, unique to each program. Average daily temperature is the population-weighted average of premise-specific daily average temperature used for modeling purposes for that day. Because residential and commercial participants are distributed differently across the weather stations, these weighted average temperatures may differ between the residential and commercial samples.

Table 1-1
2008 Residential Summer Saver Event Characteristics

Date	Event Start	Duration (Hours)	Cycled Group	Sample Counts			Sample Tons	Program Tons	Average Daily Temperature	Mean Tons per Premise	Mean Tons per Unit
				Cycled Group	Comparison Group	Total					
10/01/2008	1:00 PM	4	A	117	120	237	907	63,499	80.9	3.8	3.4
10/08/2008	1:00 PM	4	B	121	116	237	907	63,499	78.6	3.8	3.4

Table 1-2
2008 Commercial Summer Saver Event Characteristics

Date	Event Start	Duration (Hours)	Cycled Group	Sample Counts			Sample Tons	Program Tons	Average Daily Temperature	Mean Tons per Premise	Mean Tons per Unit
				Cycled Group	Comparison Group	Total					
10/01/2008	1:00 PM	4	A	110	105	215	3,533	36,085	80.9	16.4	3.8
10/08/2008	1:00 PM	4	B	105	110	215	3,533	36,085	79.5	16.4	3.8

Table 1-3 and Table 1-4 provide the customer enrollments and total tonnage by cycling regime and weekend enrollment for Residential and Commercial program.

Table 1-3
2008 Number of Residential Customers Enrolled and Tonnage by Cycling Regime

Cycling Percent	Cycle Plan	Customers Enrolled	Total Tonnage
50%	Weekday and Weekend	833	3,188.8
	Weekday Only	10,099	38,534.3
100%	Weekday and Weekend	4,210	16,611.4
	Weekday Only	1,295	5,164.5

Table 1-4
2008 Number of Commercial Customers Enrolled and Tonnage by Cycling Regime

Cycling Percent	Cycle Plan	Customers Enrolled	Total Tonnage
30%	Weekday and Weekend	73	701.2
	Weekday Only	1,301	12,128.3
50%	Weekday and Weekend	80	609.0
	Weekday Only	2,458	22,646.4

Table 1-5 and Table 1-6 present the kW per ton *ex post* impact estimates for the residential and commercial programs for the day of the system peak, October 1st.

Table 1-5
Residential kW per ton *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, Combined 50 and 100 Percent Cycling Regimes

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	0.23	0.22	0.01	69.46	-0.05	-0.01	0.01	0.04	0.07
1-Oct	2	0.18	0.20	-0.02	68.68	-0.09	-0.05	-0.02	0.01	0.04
1-Oct	3	0.16	0.17	-0.01	67.30	-0.07	-0.03	-0.01	0.01	0.05
1-Oct	4	0.15	0.17	-0.01	66.71	-0.07	-0.04	-0.01	0.01	0.05
1-Oct	5	0.15	0.16	-0.01	67.36	-0.07	-0.03	-0.01	0.01	0.05
1-Oct	6	0.18	0.19	-0.01	68.19	-0.07	-0.04	-0.01	0.01	0.05
1-Oct	7	0.23	0.24	-0.01	74.31	-0.07	-0.03	-0.01	0.02	0.05
1-Oct	8	0.24	0.24	0.00	81.95	-0.06	-0.03	0.00	0.02	0.06
1-Oct	9	0.27	0.29	-0.02	88.28	-0.08	-0.05	-0.02	0.00	0.04
1-Oct	10	0.34	0.31	0.04	92.29	-0.02	0.01	0.04	0.06	0.09
1-Oct	11	0.36	0.37	-0.01	94.43	-0.05	-0.03	-0.01	0.01	0.04
1-Oct	12	0.43	0.44	0.00	94.46	-0.03	-0.01	0.00	0.01	0.02
1-Oct	13	0.48	0.50	-0.01	94.84	-0.04	-0.02	-0.01	0.00	0.01
1-Oct	14	0.56	0.47	0.09	93.92	0.02	0.06	0.09	0.12	0.16
1-Oct	15	0.59	0.48	0.12	93.95	0.04	0.09	0.12	0.15	0.20
1-Oct	16	0.63	0.49	0.14	90.66	0.05	0.10	0.14	0.17	0.22
1-Oct	17	0.66	0.46	0.20	86.60	0.12	0.17	0.20	0.24	0.29
1-Oct	18	0.66	0.68	-0.02	83.31	-0.10	-0.05	-0.02	0.02	0.07
1-Oct	19	0.65	0.72	-0.07	79.21	-0.16	-0.11	-0.07	-0.03	0.02
1-Oct	20	0.65	0.62	0.03	76.38	-0.06	0.00	0.03	0.07	0.13
1-Oct	21	0.60	0.52	0.08	73.75	0.00	0.04	0.08	0.11	0.16
1-Oct	22	0.49	0.46	0.03	71.93	-0.04	0.00	0.03	0.06	0.10
1-Oct	23	0.40	0.36	0.04	69.26	-0.03	0.01	0.04	0.07	0.11
1-Oct	24	0.32	0.27	0.05	67.69	-0.01	0.03	0.05	0.08	0.11
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		9.62	9.00	0.61	175.28	n/a	n/a	n/a	n/a	n/a

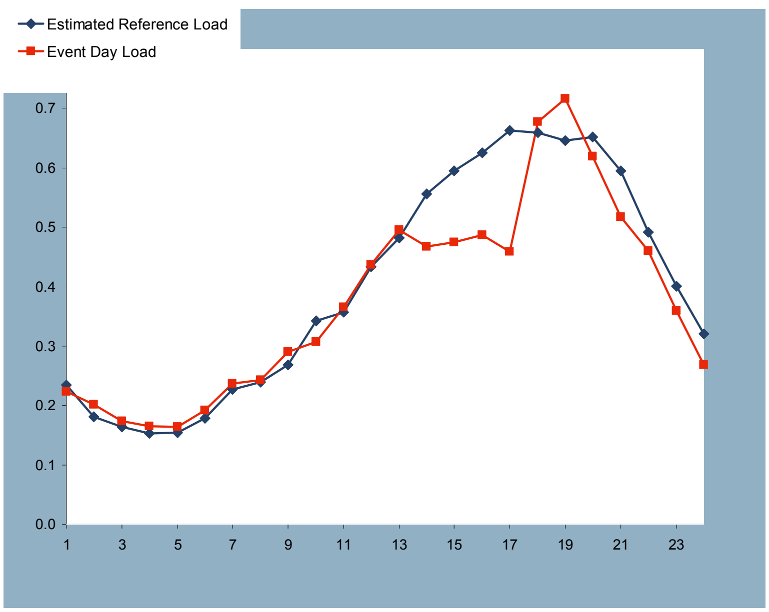
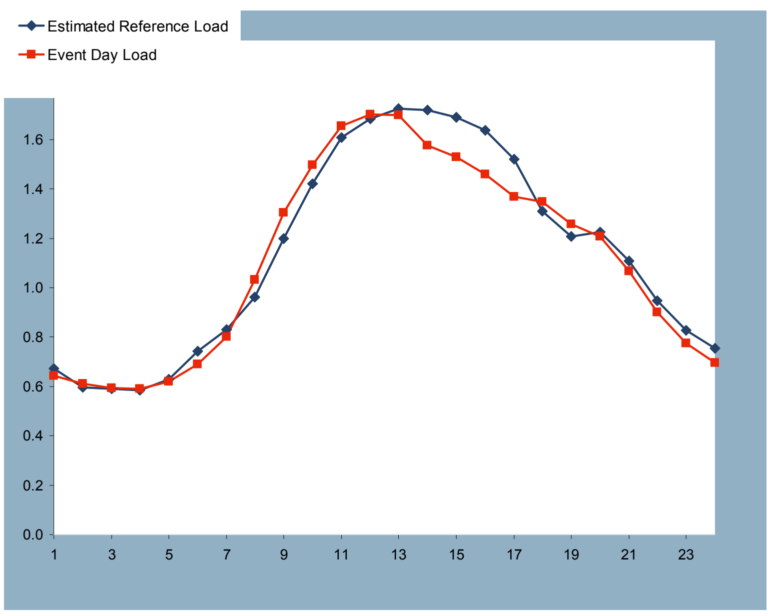


Table 1-6

Commercial kW per ton *Ex Post* Impacts, Tabular and Plot

October 1st, Day of System Peak, 50 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	0.67	0.64	0.03	71.99	-0.06	-0.01	0.03	0.07	0.12
1-Oct	2	0.60	0.61	-0.02	71.48	-0.09	-0.05	-0.02	0.02	0.06
1-Oct	3	0.59	0.59	0.00	70.01	-0.08	-0.04	0.00	0.03	0.08
1-Oct	4	0.59	0.59	-0.01	69.05	-0.09	-0.04	-0.01	0.03	0.07
1-Oct	5	0.63	0.62	0.01	69.99	-0.08	-0.03	0.01	0.04	0.09
1-Oct	6	0.74	0.69	0.05	69.81	-0.04	0.01	0.05	0.09	0.15
1-Oct	7	0.83	0.80	0.03	76.45	-0.07	-0.01	0.03	0.07	0.13
1-Oct	8	0.96	1.03	-0.07	82.30	-0.13	-0.09	-0.07	-0.05	-0.01
1-Oct	9	1.20	1.30	-0.11	87.96	-0.16	-0.13	-0.11	-0.09	-0.06
1-Oct	10	1.42	1.50	-0.08	91.15	-0.12	-0.10	-0.08	-0.06	-0.03
1-Oct	11	1.61	1.66	-0.05	91.80	-0.09	-0.07	-0.05	-0.03	-0.01
1-Oct	12	1.69	1.70	-0.02	92.25	-0.04	-0.03	-0.02	-0.01	0.00
1-Oct	13	1.73	1.70	0.03	92.52	0.01	0.02	0.03	0.04	0.05
1-Oct	14	1.72	1.57	0.15	91.31	0.11	0.13	0.15	0.16	0.18
1-Oct	15	1.69	1.53	0.16	90.40	0.10	0.13	0.16	0.19	0.22
1-Oct	16	1.64	1.46	0.18	86.72	0.09	0.14	0.18	0.21	0.26
1-Oct	17	1.52	1.37	0.15	83.79	0.07	0.12	0.15	0.19	0.24
1-Oct	18	1.31	1.35	-0.04	80.47	-0.12	-0.07	-0.04	0.00	0.05
1-Oct	19	1.21	1.26	-0.05	77.72	-0.14	-0.09	-0.05	-0.01	0.05
1-Oct	20	1.23	1.21	0.02	75.75	-0.09	-0.03	0.02	0.06	0.12
1-Oct	21	1.11	1.07	0.04	74.28	-0.05	0.00	0.04	0.08	0.13
1-Oct	22	0.95	0.90	0.05	72.81	-0.04	0.01	0.05	0.08	0.13
1-Oct	23	0.83	0.77	0.05	71.21	-0.03	0.02	0.05	0.09	0.14
1-Oct	24	0.75	0.69	0.06	70.51	-0.02	0.03	0.06	0.09	0.14
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		27.19	26.62	0.57	150.57	n/a	n/a	n/a	n/a	n/a



The event hours are the shaded rows, hours ending 14 through 17. System peak load occurred during hour ending 16.

Along with the impact estimates, the tables provide the estimated reference loads (load that would have occurred with no control) and the observed loads during the events. The uncertainty adjusted load impact, also shown in the table, can be thought of as a set of confidence intervals. The 10^{th} and 90^{th} percentiles are the limits of an 80 percent confidence interval for the mean impact estimate.

The residential program 50 percent and 100 percent cycling groups generated estimated impacts of 0.10 and 0.22 kW per ton, respectively, for hour ending 16. The overall residential impact estimate is 0.14 kW per ton. Impacts for all overall residential event hours are statistically significantly different from zero at the 80 percent confidence level.

Commercial programs 30 percent and 50 percent cycling groups generated estimated impacts of 0.12 and 0.18 kW per ton, respectively, for hour ending 16. We do not generate an overall impact for the commercial program[4]. Impacts for all 50 percent cycling group event hours are statistically significantly different from zero at the 80 percent confidence level.

Table 1-7 and Table 1-8 summarize the event results at the unit level. Average tons per unit is 3.4 and 3.8 for residential and commercial units, respectively.

Table 1-7
Residential Event Average per Unit Impact estimates

Cycle Regime	Date	Estimated Unit-level Load Impact (kW)
50 Percent	10/1/2008	0.32
	10/8/2008	0.20
100 Percent	10/1/2008	0.73
	10/8/2008	0.48
Combined	10/1/2008	0.46
	10/8/2008	0.30

[4] The 2008 commercial M&V sample did not include commercial participants with the 30 percent cycling option. The availability of the 30 percent option post-dates the creation of the commercial M&V sample. Section 4.1 gives more background on this situation.

Table 1-8
Residential Event Average per Unit Impact estimates

Cycle Regime	Date	Estimated Load Impact (kW)
50 Percent	10/1/2008	0.60
	10/8/2008	0.53

1.1.1 Comparison of 2007 and 2008 *Ex Post* Impact Results

KEMA also evaluated the SDG&E's Summer Saver program for the 2007 cooling season[5]. The DR protocols were filed after that work was begun, but the basic goals of the DR protocols were incorporated into the evaluation. In addition, very similar methods were used to estimate *ex post* impacts for the 2007 and 2008 seasons. The results for the 2007 program provide a context within which to understand the 2008 impact results. This section compares the per-ton impact results estimated using premise-level data from 2007 and 2008.[6] Table 1-9 and Table 1-10 compare 50 percent cycling regime impacts for the residential and commercial programs. There was no commercial 30 percent cycling regime sample for either 2007 or 2008. The residential 100 percent cycling sample was relatively small in 2007 and was increased substantially for 2008.

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[5] The 2007 Summer Saver Impact Evaluation report was not finalized and posted to calmac.org at the time of submission of this report.

[6] For the 2007 evaluation, the final residential impact results were developed using the end-use data. The end-use estimates exhibited a higher level of precision and the end-use modeling process included features we were unable to incorporate into the premise-level modeling effort at that time. For the 2008 evaluation, we are reporting final impact estimates for the residential program at the premise-level. See section 3.2.5 for a discussion of this decision.

Table 1-9
Residential per ton kW Impacts, Peak Days 2007 and 2008
50 Percent Cycling Regime

Hour	50 Percent Cycling Impact		Daily Average Temperature	
	2007	2008	2007	2008
14	n/a	0.07	84.1	80.9
15	0.21	0.06		
16	0.39	0.10		
17	n/a	0.16		

Table 1-10
Commercial per ton kW Impacts, Peak Days 2007 and 2008
50 Percent Cycling Regime

Hour	50 Percent Cycling Impact		Daily Average Temperature	
	2007	2008	2007	2008
14	n/a	0.15	80.8	80.9
15	0.21	0.16		
16	0.22	0.18		
17	n/a	0.15		

The system peak day impact estimates for 2008 are substantially lower than the impacts estimated for the 2007 system peak day, particular for the residential program. Because the weather was more mild and the 2008 system peak later in the year, we expected program impacts for 2008 to be lower than the 2007 impacts. The commercial program had a slight drop despite having almost identical weather. The residential program had a substantial drop, with a 3.2 F drop in daily average temperature.

The residential reduction in impacts goes beyond the magnitude of reduction expected for the lower temperature. Cooling usage levels in the pre-event hours dropped more precipitously than predicted by the 2008 cooling models indicate for a decline of 3.2 degrees, a drop of 50 percent compared to an expect drop of approximately 20 percent. This is evidence that a greater than expected number of residential customers already had their AC units turned off.

On the other hand, The 2007 peak day estimates derived from the premise level models were almost twice the size of any other day's impacts. This could be an artifact of a slight change in model structure. The 2007 premise-level estimates do not include the connected load constraint incorporated for the 2008 impact.

1.2 *Ex Ante* Impact Results

The evaluation reports *ex ante* impact estimates for the Summer Saver Program consistent with requirement set out in the DR Protocols. The protocols require *ex ante* estimates for all feasible combinations of the following

- Six monthly peak event days and one average event day,
- 1-in-2 and 1-in-10 weather conditions,
- Enrolled ton projections from 2009 through 2018[7],
- Per ton, Full program and net of overlapping programs.

The DR Protocols are not explicit regarding which views of the *ex ante* will be used for the purpose of planning. Here we produce, for the sake of example, the 1-in-2 average day kW per ton *ex ante* impact estimates for commercial and residential programs. For the 2007 program SDG&E produced their own *ex ante* estimates.

[7] The summer saver program is presently slated to end in 2016. The enrolled ton projections are constant after 2011. We produce a single set of results for all the years beyond 2011.

Table 1-11
Residential kW per ton *Ex Ante* Impacts, Tabular and Plot
1-in-2 Weather, Average Day, Combined 50 and 100 Percent Cycling Regimes

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10	1	0.21	0.21	0.00	69.35	0.00	0.00	0.00	0.00	0.00
1-Jul-10	2	0.19	0.19	0.00	68.68	0.00	0.00	0.00	0.00	0.00
1-Jul-10	3	0.17	0.17	0.00	68.30	0.00	0.00	0.00	0.00	0.00
1-Jul-10	4	0.16	0.16	0.00	67.56	0.00	0.00	0.00	0.00	0.00
1-Jul-10	5	0.16	0.16	0.00	66.86	0.00	0.00	0.00	0.00	0.00
1-Jul-10	6	0.18	0.18	0.00	66.30	0.00	0.00	0.00	0.00	0.00
1-Jul-10	7	0.22	0.22	0.00	67.05	0.00	0.00	0.00	0.00	0.00
1-Jul-10	8	0.23	0.23	0.00	73.00	0.00	0.00	0.00	0.00	0.00
1-Jul-10	9	0.25	0.25	0.00	79.61	0.00	0.00	0.00	0.00	0.00
1-Jul-10	10	0.29	0.29	0.00	85.36	0.00	0.00	0.00	0.00	0.00
1-Jul-10	11	0.33	0.33	0.00	88.79	0.00	0.00	0.00	0.00	0.00
1-Jul-10	12	0.36	0.36	0.00	88.65	0.00	0.00	0.00	0.00	0.00
1-Jul-10	13	0.40	0.40	0.00	89.13	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	14	0.44	0.36	0.08	88.84	0.08	0.08	0.08	0.09	0.09
1-Jul-10	15	0.49	0.38	0.11	87.80	0.10	0.11	0.11	0.11	0.12
1-Jul-10	16	0.53	0.39	0.14	86.72	0.13	0.13	0.14	0.14	0.15
1-Jul-10	17	0.57	0.41	0.15	85.92	0.14	0.15	0.15	0.16	0.17
1-Jul-10	18	0.58	0.60	-0.02	83.33	-0.04	-0.03	-0.02	-0.02	-0.01
1-Jul-10	19	0.56	0.61	-0.06	79.65	-0.07	-0.06	-0.06	-0.05	-0.05
1-Jul-10	20	0.50	0.53	-0.03	75.86	-0.03	-0.03	-0.03	-0.02	-0.02
1-Jul-10	21	0.45	0.46	-0.01	73.57	-0.02	-0.01	-0.01	-0.01	0.00
1-Jul-10	22	0.41	0.41	0.00	71.97	-0.01	0.00	0.00	0.00	0.00
1-Jul-10	23	0.34	0.34	0.00	70.64	0.00	0.00	0.00	0.00	0.00
1-Jul-10	24	0.27	0.27	0.00	70.06	0.00	0.00	0.00	0.00	0.00
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10		8.31	7.94	0.36	119.66	n/a	n/a	n/a	n/a	n/a

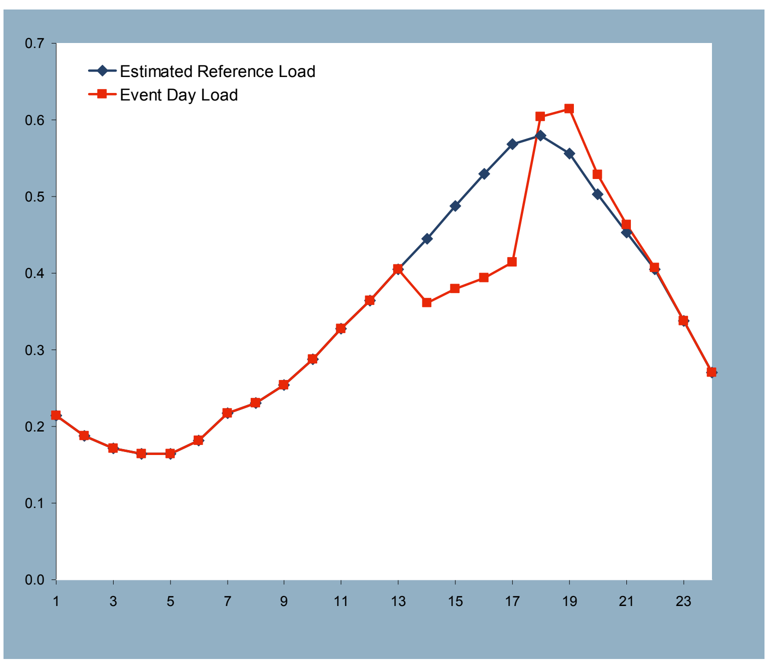
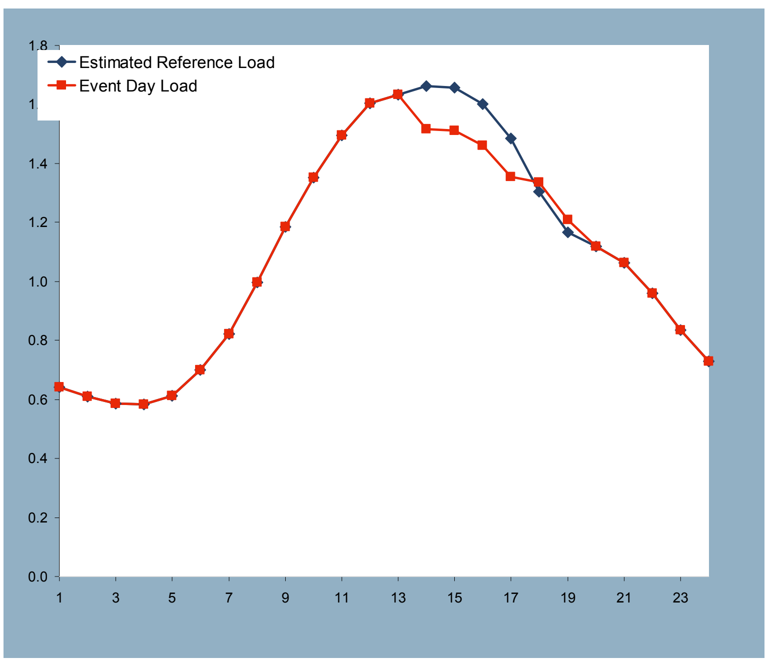


Table 1-12
Commercial kW per ton *Ex Ante* Impacts, Tabular and plot
1-in-2 Weather, Average Day, 50 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10	1	0.64	0.64	0.00	70.18	0.00	0.00	0.00	0.00	0.00
1-Jul-10	2	0.61	0.61	0.00	69.78	0.00	0.00	0.00	0.00	0.00
1-Jul-10	3	0.59	0.59	0.00	69.52	0.00	0.00	0.00	0.00	0.00
1-Jul-10	4	0.58	0.58	0.00	68.96	0.00	0.00	0.00	0.00	0.00
1-Jul-10	5	0.61	0.61	0.00	68.32	0.00	0.00	0.00	0.00	0.00
1-Jul-10	6	0.70	0.70	0.00	67.80	0.00	0.00	0.00	0.00	0.00
1-Jul-10	7	0.82	0.82	0.00	68.51	0.00	0.00	0.00	0.00	0.00
1-Jul-10	8	1.00	1.00	0.00	72.57	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	9	1.19	1.19	0.00	77.65	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	10	1.35	1.35	0.00	82.04	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	11	1.49	1.49	0.00	85.08	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	12	1.61	1.61	0.00	85.66	-0.01	-0.01	0.00	0.01	0.01
1-Jul-10	13	1.63	1.63	0.00	85.59	-0.01	-0.01	0.00	0.01	0.01
1-Jul-10	14	1.66	1.52	0.15	85.41	0.13	0.14	0.15	0.15	0.16
1-Jul-10	15	1.66	1.51	0.15	84.61	0.13	0.14	0.15	0.15	0.16
1-Jul-10	16	1.60	1.46	0.14	83.86	0.13	0.13	0.14	0.15	0.16
1-Jul-10	17	1.49	1.36	0.13	83.32	0.12	0.12	0.13	0.13	0.14
1-Jul-10	18	1.30	1.34	-0.03	81.59	-0.04	-0.04	-0.03	-0.03	-0.02
1-Jul-10	19	1.17	1.21	-0.04	78.11	-0.05	-0.05	-0.04	-0.04	-0.03
1-Jul-10	20	1.12	1.12	0.00	74.83	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	21	1.06	1.06	0.00	72.91	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	22	0.96	0.96	0.00	71.92	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	23	0.84	0.84	0.00	71.13	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	24	0.73	0.73	0.00	70.52	-0.01	0.00	0.00	0.00	0.01
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10		26.40	25.92	0.49	87.92	n/a	n/a	n/a	n/a	n/a



1.3 Comparison of *Ex Post* and *Ex Ante* Estimates

Despite the relative mild and low variation temperatures in the 2008 cooling season the *ex ante* models based on the 2008 weather appears to do a reasonable job of estimating impacts across a range conditions. Figure 1-1 and Figure 1-2 compare results for the *ex ante* model with *ex post* results from 2007 for the residential and commercial 50 percent cycling groups. The figures plot hour ending 17 per ton kW with respect to daily average temperature.

Figure 1-1
Comparison of 2007 *Ex Post* with 2008 *Ex Ante*
Residential 50 Percent Cycle Impacts for Hour Ending 17

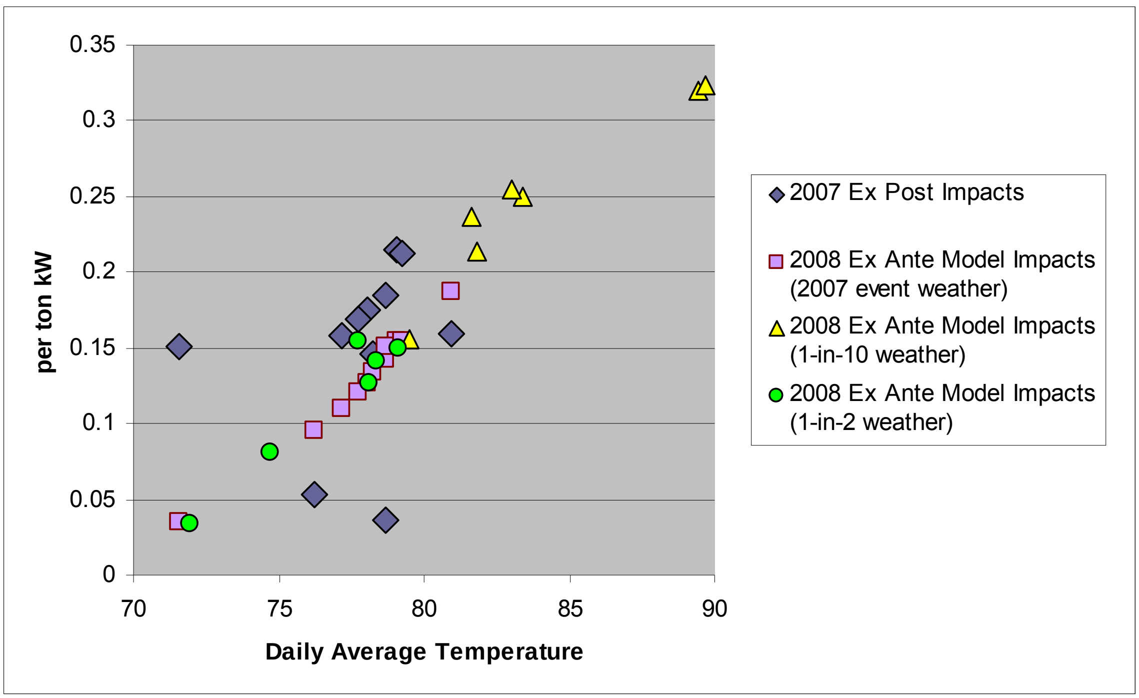
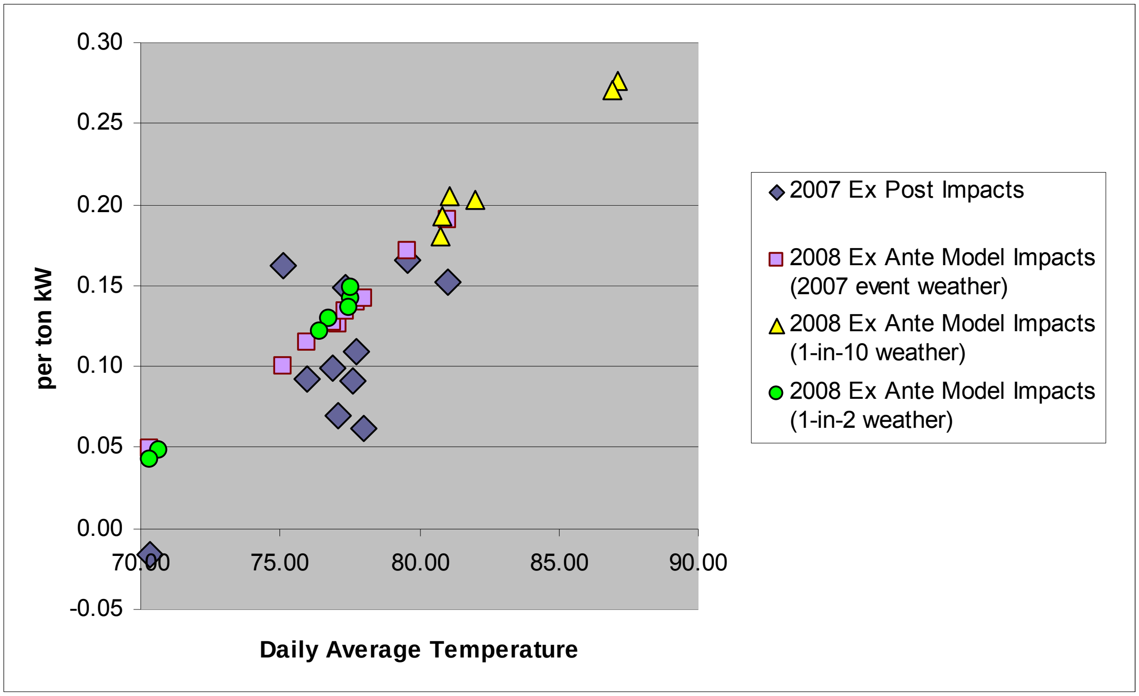


Figure 1-2
Comparison of 2007 *Ex Post* with 2008 *Ex Ante*
Commercial 50 Percent Cycle Impacts for Hour Ending 17



The figures plot the *ex post* impact results for the eleven events that took place in 2007. These are portrayed with dark blue diamonds. We estimated *ex ante* impacts with the 2008 ex ante model for those same eleven days using the 2007 event day weather as the input to the 2008 *ex ante* model. At every temperature for which there is an ex post result there is an ex ante result portrayed in a purple square. Finally, to give a fully picture of the 2008 ex ante model results, we include the 2008 ex ante model 1-in-2 and 1-in10 weather year estimates as well. These are included in green circles and yellow triangles, respectively.

We use 2007 *ex post* impacts for comparison because there were only two 2008 *ex post* events that were held in October and do not apper to be representative of typical behavior. These plots comparing to 2007 indicate two important points:

- The *ex post* impacts have a lot of variation
- *Ex ante* follow a trend line generally consistent with the scatter of the *ex post* results.

It's important to recognize that 2008 had very little hot weather and relatively little temperature variation over the whole season. As a result, it's difficult to estimate the models definitively, particularly for applications at higher temperatures such as 1 in 10. Moreover, customer behavior may have been different in 2008 as a result of the extended mild weather, compared to what would occur at similar temperatures in the middle of a hot summer. Despite this, the *ex ante* model appears to produce reasonable estimates relative to the 2007 *ex post* estimates.

In 2009 we hope to both continue to refine the models, and potentially to have hotter days that will better inform the models.

1.4 Methodology

The 2008 Summer Saver impact evaluation provides both *ex post* and *ex ante* impact estimates for the residential and commercial Summer Saver programs. The *ex post* results are based on observed whole premise usage compared to modeled load and comparison group load in a difference of differences framework. With this framework, impacts are estimated from the difference between the estimated uncontrolled load and the observed load. Any systematic modeling error or unusual conditions affecting all units, unrelated to the control event, is adjusted for by subtracting the comparison group difference from the cycled group difference.

The *ex ante* results use the same premise-level cooling load models developed for the *ex post* estimates. Duty cycle analysis provides estimates of savings given the estimated cooling model and connected load. Calibration to observed *ex post* impacts provides an estimate of where the savings fall between the extremes of fixed non-adaptive control and perfect adaptive control.

2. Introduction

2.1 Program Background

The SDG&E Summer Saver program serves both residential and commercial customers. Both customer classes have two choices of cycling level. Residential customers choose between 50 percent and 100 percent cycling levels. Commercial customers choose between 30 percent and 50-percent cycling levels. All participating customers receive a year-end bill credit based on the size of the controlled unit, cycling level, and whether they are willing to be cycled on weekends. Residential bill credits can range from $25-$46 for 50-percent cycling to $194 for a large unit at 100 percent cycling level with weekends included. Commercial bill credits are $9 to $15 per ton depending on cycling level.

3. Methods

The estimation of direct load control (DLC) program impacts depends on a sound estimate of baseline usage during an event period. A variety of methodological approaches are available to the evaluator to solve this challenge. The DR Protocols outline many of these approaches. For this impact evaluation, KEMA used a difference of differences approach that combines both unit-level regressions and an un-cycled comparison group. This approach combines the strengths of these two approaches. The regression based estimate of load for the controlled group provides a baseline from which impacts are estimated. The regression based estimate of load for the un-controlled group provides a baseline from which regression errors are estimated. The result is a regression based result informed by the comparison group baseline.

The commercial and residential Summer Saver programs each have multiple cycling regimes. The commercial program has 30- and 50-percent cycling options while the residential program offers 50- and 100-percent cycling options. To produce a program level result that reflects the specific mix of each regime on each event day, we develop separate estimates for each cycling regime. These separate estimates are then combined weighted by the number of tons in each regime for that event.

The commercial estimate is complicated by the lack of 30-percent cycling participants in the commercial M&V sample. This issue is expected to be solved in the next year, when a new sample will be selected. For this evaluation, we will not produce true *ex post* estimates for 30-percent cycling. We provide placeholder *ex post* impact estimates, using *ex ante* projections of 30-percent cycling impacts based on the available data for 50-percent cycling participants applied to the weather conditions on the 2008 event days. This approach makes the commercial 30-percent impact estimates consistent with the methodology chosen for this evaluation. Aside from the *ex ante* framework, this approach only assumes that 50 and 30 percent cycling regime customers have the same usage characteristics. This is a necessary, but unsubstantiated, assumption to produce results. If customers in the 30 percent cycling regime have higher rates of usage than their 50 percent cycling regime counterparts, it is possible this placeholder estimate will underestimate load impacts.

3.1 Modeling Cooling Load

The purpose of the load model is to characterize the premise- or unit-level load as a function of weather and other available data. Specifically, the load model provides an estimate of reference, or baseline, load during load events when the premise or unit load is artificially reduced. In addition, the modeled load allows for the calculation of potential savings under conditions other than the specific conditions faced during the period for which data is available. In particular, this refers to calculating *ex ante* load impacts using weather series from extreme years.

Multiple considerations drive the specific modeling approach chosen for this evaluation.

- Modeling individual premise or unit load provides the most accurate characterization of unique premise-level cooling conditions and behavior. Pooled models, by necessity, apply the same assumptions to all premises. In the case of cooling, where the combination of cooling behavior and building envelope are so dynamic, it particularly fruitful to characterize cooling load at the premise or unit level.
- The load model must provide an hourly day shape that approximates load across a wide range of conditions as a function of temperature. A flexible hourly day shape does not necessitate hourly temperatures or degree days. A house is a temperature integrator and all temperature effects with respect to cooling are lagged to some degree depending on the thermal properties of the building. In general, daily degree days explain cooling behavior as well as hourly without adding confounding lagged effects.
- The load model must be reliable under extreme conditions. Extreme conditions are, by definition, less well represented in the available data. Load modeling for demand response program evaluations faces the added challenge that many of the extreme days are event days and thus not available for estimating reference load. Importantly, though, at some extreme temperature, air conditioners reach a maximum load. A simple, linear

load model will eventually overestimate cooling load if unit connected load (load at 100 percent duty cycle) is not included in the process.[8]

The load modeling approach used for this evaluation addresses all of these considerations. The premise- or unit-level model is flexible to the premise-specific cooling behaviors and conditions. The model is also used within the constraints of estimated connected load, thus addressing linear models' potential for over-estimating load under extreme conditions.

3.1.1 The Load Model

The general load model estimates load as a function of temperature. Specifically, temperature enters the model as cooling degree days. Daily average temperature, calculated as the average of the maximum and minimum daily temperatures, is compared to a base temperature to calculate cooling degree days[9]. Individual premises use cooling differently, so it is essential to identify the appropriate cooling degree day base for the individual premise. We calculate degree days using base temperatures ranging from 64º to 84º F. For each premise, we estimate multiple versions of the model each using degree days calculated with a different base. We then choose the best model for the premise from among these models. We identify the best model and base temperature by comparing the mean average percentage error of all the models estimated for that premise.

All variables are included in the model so as to estimate hourly levels for all 24 hours. Daily degree days and are interacted with an hourly dummy so individual hourly levels are estimated. Weekday/weekend variables are likewise interacted with daily degree days and estimated at hourly levels for all 24 hours. The model can be fit to either end-use or premise-level data.

The basic load model for whole premise data is:

$$L_{jhd} = \alpha_{jh} + \beta_{jh} C_d(\tau_{Cj}) + \delta_{jh} W_d + \varphi_{jh} C_d(\tau_{Cj}) W_d + \varepsilon_{jhd}$$

[8] It's worth noting that simply including quadratic terms in the model does not necessarily address this problem and could, potentially, exacerbate the issue. The truncation of AC load at connected load (even when dealing with premise-level data) is an empirical fact that is best addressed explicitly.

[9] The base temperature effectively represents the outdoor temperature at which cooling begins at the premise.

where

L_{jhd}	=	sum of 15-minute interval AC or whole premise consumption at hour *h* of day *d* for unit *j*;
$C_d(\tau_{Cj})$	=	cooling degree-days at the cooling base temperature τ_{Ci} for unit *j*, on day *d*, based on daily average temperature;
W_d	=	0 for weekdays, 1 for weekends;
ε_{jhd}	=	regression residual;
$\alpha_{jh}, \beta_{jh}, \delta_{jh}, \varphi_{jh}$	=	coefficients determined by the regression; and
τ_{cj}	=	base temperature determined by choice of the optimal regression.

The degree-day variables are calculated as:

$$C_d(\tau_{Cj}) \quad = \quad \max(F_d - \tau_{Cj}, 0)$$

where F_d is daily average temperature calculated as the average of the daily maximum and minimum temperature Fahrenheit.

When this model is used for end-use data the variables not interacted with cooling degree days should be effectively zero and thus these variables are removed from the model.

3.1.2 Estimated Load from the Load Model

The best model for each unit includes a set of estimated parameters as well as the chosen degree day bases. Unit or premise-level load for a weekday event day is estimated using the following model:

$$\hat{L}_{jhd} = \hat{\alpha}_{jh} + \hat{\beta}_{Cjh} C_d\left(\tau_{Cj}\right)$$

where the hat variables on the right hand side represent estimated parameters from the regressions and $\hat{L}_{jhd}$ is the estimated load for unit *j* in hour *h* on day *d*.

Cooling load for any given hour is

$$\hat{L}_{Cjhd} = \hat{\beta}_{Cjh} C_d \left(\tau_{Cj}\right)$$

3.1.3 Connected Load

Estimating cooling load with the cooling load model assumes a linear relationship between average hourly cooling load and temperature. This is a common assumption in cooling load models. It is a reasonable assumption when the unit is running between zero and 100 percent of the time. That is, the cooling load model is effectively estimating the unit duty cycle (in kW terms) when the unit is at a duty cycle between 0 and 100 percent. Once a unit reaches 100 percent duty cycle, however, that linear relationship that characterized the partial duty cycle phase is no longer appropriate. At 100 percent duty cycle, units run at what is referred to as connected load regardless of the temperature. Connected load has a much flatter slope with respect to tempearature, generally increasing one percent per hourly temperature degree, though this slope varies across units. Once temperature conditions have passed some hot threshold, this constrained estimate of connected load is a more appropriate estimate of load than that provided by the cooling load model.

The implications of this for load modeling in a demand response context are clear. The cooling load model discussed above is only the appropriate model within the limitations of connected load, when the duty cycle is between 0 and 100 percent. The cooling slopes estimated in that model are not applicable after the temperature has reached the point at which that unit is estimated to run at 100 percent. Applying a linear load model to extreme temperature scenarios, whether event days in the current year or hot conditions faced in an extreme year, has the potential to produce inflated load estimates beyond connected load. As temperatures increase, all unconstrained linear models will eventually over-estimate load. Properly sized units will reach connected load at temperatures within the range of extreme actual weather series.

Despite the importance of taking connected load into consideration in an impact evaluation, developing estimates of connected load can be challenging. If instantaneous, small interval end-use kW meter data is available, then connected load can be estimated separately from AC cooling load. For the kWh end-use data available for the SDG&E residential M&V sample, it is more challenging to identify the connected load of a unit. We estimate connected load as the 99^{th} percentile of all non-zero 15-minute intervals. This assumes the unit does occasionally run for the full recorded 15-minute interval. The 99^{th} percentile successfully characterizes a unit's maximum load but ignores random outliers in the data. While this approach does provide the approximate magnitude of the connected load, it does not provide enough data with which to estimate the connected load trend.

Practically speaking, this approach identifies the maximum load level achieved by the unit across the cooling season. Assigning this load level as the unit's constant connected load has no affect on the *ex post* impact estimates[10]. In the context of *ex ante* estimates,

the connected load-constrained model is used to calculate loads beyond the maximum temperatures experienced during the cooling season. For these estimates, using a constant estimate of connected load does not account for increase in connected load with the marginal increase in temperature.

For this evaluation, the residential end-use data provides the estimate of connected load for the residential premise-level data. The commercial, premise-level data, without related end-use data, presents a challenge with respect to determining connected load. For the commercial impact evaluation two different approaches were combined to get the best possible estimate of connected load.

The first approach uses all available non-event day data to establish a premise specific estimate of connected load. The whole premise load model decomposes premise load into base load and cooling load. Removing base load from observed load isolates the "observed" cooling load. The 99th percentile approach used for end-use data is then applied to this data. In this case, assuming all units do occasionally run for a full half an hour *and* the model's characterization of baseload is approximately correct, this approach provides a reasonable estimate of maximum cooling load while ignoring random outliers in the data.

The second approach uses the residential end-use estimate of connected load kW per ton as a proxy for commercial connected load per ton. The AC units on the small commercial premises are primarily units of similar size to the residential units, less than five tons. Though a large percentage of the commercial units are three phase units, the kW per ton estimates from the

[10] In fact, this estimate of connected load was initially developed primarily to avoid the unit-level, pre-event adjustment pushing unit load beyond realistic levels.

single phase units still translates with minimal adjustment.[11] The limitation of this approach is characterizing a distribution of commercial connected loads with a mean estimate of connected load. Even if the mean estimate is correct, half of the units are constrained to a connect load that is too low. This could lead to underestimation of reference load.

The solution is to consider both approaches to measuring commercial connected load and choose the greater, or least constraining, of the two estimates of connected load for each premise. This allows us to maintain the important empirical limitations of connected load on our linear model estimates while minimizing the danger of underestimating load on extreme days.

3.2 Calculating Impacts

The difference of differences approach combines estimated load from the load model with observed load for the controlled and comparison groups. This section develops the difference of difference methodology used for this analysis. In addition, an adjustment to load model based estimates is introduced.

3.2.1 Using Load estimates to Estimate Load Reduction

The estimated load from the kW model provides a baseline or reference load with which to compare event period reductions. This simple approach is the basis for a sound estimate of load reduction for a program like this. The addition of a comparison group refines the result from this simple approach by controlling for various systematic effects. We refer to the comparison group addition as an error correction.

The simple method calculates an uncorrected impact estimate per ton using the reduced group only:

[11] To determine the impact of three phase motors on the connected load, we looked at single and three phase compressors rated 1.5 to 5 tons. We obtained performance data for compressors designed for R-22 and R-410a refrigerants and determined the kW/ton based on the EER for each design and rating. We compared the kW/ton for single phase units with the kW/ton for three phase units and determined a ratio for each unit rating and refrigerant design. Finally, we calculated a weighted average of these ratios based on the quantity of units of each size and phase in the commercial sample. This weighted average is 0.983.

$$S_{Rh} = \sum_{j \in R} \left(\widehat{L}_{jh} - L_{jh} \right) \Big/ \sum_{j \in R} T_j$$

where

S_{Rh} = the uncorrected load impact per ton estimate of the reduced group,

$\widehat{L}_{jh}$ = the load model estimate of hourly load,

L_{jh} = observed hourly load, and

T_j = unit or premise tons in the reduced group.

The model estimates for each premise tell us what would have happened without the reduction. The differences between predicted and observed load for each premise are the estimated uncorrected savings. The premise-level impacts are averaged with respect to tons over the group to get the mean uncorrected hourly load impact estimate per ton. This estimate is uncorrected because no comparison-group adjustment has been made.

3.2.2 Including a Comparison Group

Any load model will have some estimation error. The load model used in this analysis is relatively simple, using just the time of day and the daily average temperature. Effects of humidity, sunshine, and wind are not explicitly accounted for in the model. If the event day is windy or includes a late afternoon shower, usage might be lower than the temperature model would indicate. Furthermore, there may be behavioral changes related to events in the news or holiday schedules that would be similar across homes.

The comparison approach provides an alternative to modeling these kinds of effects directly. The comparison group approach takes advantage of the fact that the limitations of the model, modeling error for a given day and hour, caused by these systematic effects, will be similar across all premises. The average modeling error for the un-controlled comparison group provides an estimate of the average modeling error for the reduced group. As a result, the model estimate does not need to be perfect, only consistent, across the two sample groups.

The average modeling error for the comparison group is calculated.

$$S_{Ch} = \sum_{j \in C} \left(\hat{L}_{jh} - L_{jh} \right) \Big/ \sum_{j \in C} T_j ,$$

where

S_{Ch}	=	the average modeling error, and
T_j	=	unit or premise tons in the comparison group.

If the load model perfectly estimated load, the model estimate for each comparison group premise or unit would be identical to the observed load. The mean "impact" across the comparison group, S_{Ch}, would equal zero and there would be no need for correction.

However, we do not expect the model to be perfect. We use the comparison group average error to estimate the average error for the reduced group. The correction is made by removing the comparison group modeling error from the uncorrected load impact per ton estimate of the reduced group

$$S_h = S_{Rh} - S_{Ch} .$$

If the model, on average, over-estimates the comparison group's actual load for a particular interval, then it will also give too much impact credit to the reduced group. In this case, the error adjustment will be positive and will be subtracted from the inflated reduced group estimate. If the model is low, a negative error adjustment is removed (a double negative) so the original reduced impact estimate is increased.

3.2.3 Adjusting Estimated Load to Pre-Event Observed Load

The premise- or unit-level load models estimate an average hourly load as a function of outdoor temperature. The models cannot address day-to-day variation at the premise-level. The same day, pre-event adjustment approach provides an additional adjustment for the event period using the two hours prior to the start of the event. The mean difference between modeled and observed load during that period is used to adjust the magnitude of the estimated baseline for the event.

The adjustment is calculated:

$$A_j = \frac{1}{n_h}\left[\sum_{h\in P}\left(\hat{L}_{jh}\right) - \sum_{h\in P}\left(L_{jh}\right)\right],\ j \in R$$

where

A_j	=	the additive adjustment,
P	=	the two-hour period prior to the reduced event, and
n_h	=	the number of intervals in period P.

The reduced group adjusted load estimate, then, is calculated:

$$S'_{Rh} = \sum_{j\in R}\left(\hat{L}_{jh} - A_j - L_{jh}\right) \Big/ \sum_{j\in R} T_j$$

where S'_{Rh} and an identically adjusted S'_{Ch} are the same day adjusted impact estimates for the re-set and comparison groups, respectively.

3.2.4 Using Connected Load to Improve Pre-event Adjustment

When working with AC unit data, this adjustment is only appropriate within the bounds of normal unit connected load. The bounded adjustment is calculated

$$S'_{Rh} = \sum_{j\in R}\left(\max\left\{\min\left(\hat{L}_{jh} - A_j, C_j\right), 0\right\} - L_{jh}\right) \Big/ \sum_{j\in R} T_j$$

where C_j was the unit-specific estimate of connected load.

The adjusted load impact per ton estimates, whether bounded or not, are combined the same as above, by taking the difference of these two differences.

$$S'_h = S'_{Rh} - S'_{Ch}.$$

The result is adjusted and corrected estimates of impact per ton for all included units or premises.

3.2.5 AC Non-Users

Not all AC units in the program have the potential to provide savings during a cycling event. For the residential estimates, we identified units that were never used during the cooling season. Non-use was defined as no usage greater than 0.005 kWh for any interval on a day with daily average temperature greater than 75.

For the residential program AC unit data, load estimates were only developed for units that showed some AC usage and thus some potential for savings. The overall impact estimate developed below was then adjusted down to reflect the percentage of units or premises with zero impact.

The percentage of apparent non-users in the residential end-use data was 14 percent, 34 out of 244 units. For the late events of the summer of 2008 the number of non-users on the event day increased dramatically to 74 and 101, for October 1st and 8th, respectively.

A comparison of premise-level and end-use data shows many of these premises have what appears to be cooling load despite the lack of cooling load in end-use data. While it's possible that the metered end-use data is correct in these instances (for instance, only other non-metered units are in use throughout the summer) it's also possible that the meters are faulty. The premise-level data should be more reliable. In addition, with the advent of AMI systems the bulk of impact evaluations such as this will use premise-level data rather than more expensive end-use data. For this reason, the residential impact estimates in this report are based on premise-level data.

3.2.6 Combining Multiple Cycling Regimes

The Summer Saver Commercial and Residential programs each have two cycling regimes: for commercial, 30 and 50 percent, and for residential, 50 and 100 percent. The impact results for these two regimes were estimated separately using the process discussed above. For the residential program, where impact results were available for both cycling regimes, the full program *ex post* impact results were produced by combining the cycle regime level results weighted by the levels of participation in each cycle-level group.

Although for commercial the 30-percent cyclers represented a third of the population in the summer of 2008, the M&V sample includes insufficient 30-percent cycling participants to independently estimate impact for that regime. Instead of attempting to estimate the impact for this group directly, we will report results using our *ex ante* methodology, as discussed in the next section. For this reason, we did not produce *ex post* overall program results for commercial.

We expect this issue to be resolved in 2009, when SDG&E will have completed a new sample selection that includes a larger number of participants in the 30-percent cycling regime.

3.3 *Ex Ante* Estimates

The *ex ante* impact estimates take advantage of a duty cycle framework to estimate switch-related impacts. This is possible, even using whole premise data, as long as a reasonable estimate of cooling connected load is established. A premises duty cycle is represented as cooling load as a percentage of connected load. For the *ex ante* impact estimates, all participants can be included in the estimate regardless of which event(s) they were controlled during.

The *ex ante* estimates are further complicated by the use of adaptive switches. The initial algorithm is relatively simple, based on an average run-time over some number of stored learning days. Ultimately, though the algorithms for adaptive switches are proprietary. The adaptive switches have varying ways of dealing with unexpected data.[12] Generally, adaptive switches default to the traditional straight 50 percent cycling approach (here referred to as the legacy approach) when the adaptive algorithm is not successful.

3.3.1 Impact of Adaptive Switches

For each particular unit, the impact of an event depends on, among other factors, the success of the adaptive algorithm in the switch. Because that information is not available, in calculating the aggregate impact, we need to take into consideration the range of possible outcomes. In particular, we can create upper and lower bounds for the estimates, based on a range of outcomes, and estimate the overall impact as a combination of both. This approach depends on observed event impacts to calibrate the estimate of a blending parameter, α. For this part of

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[12] "This Ideal Control Day AA mode also has Compensators built into the Algorithms and code to automatically adjust for Outlier and Temperature Variances. This allows for a truer control scenario based on the stored "Ideal Control Days"." Adaptive Algorithms Yield Greater Performance, Related whitepaper at http://www.comverge.com/products/adaptive-algorithm.cfm

the *ex ante* estimate we leverage 2007 results. This section discusses the method we used in our models.

The theoretical upper bound of our impact estimates is given by an adaptive switch that operates under the relatively ideal knowledge of weather conditions contained in our load models. We call this the "adaptive switch" impact because it represents the adaptive switch ideal. Under these circumstances, the switch will always reduce the load according to the cycling regime. The switch will adjust the expected duty cycle to the prevailing conditions and reduce that duty cycle by, say, 30 percent. This is shown in the following equation:

$$\hat{\Delta}^{A}_{jdh} = c_j \hat{L}_{jdh}$$

where:

j	=	the cross-sectional unit or customer
d	=	the day of the year
h	=	the hour of the day
$\hat{\Delta}^{A}_{jdh}$	=	the impact for an adaptive switch
c_j	=	the cycling strategy of the customer
$\hat{L}_{jdh}$	=	the predicted load for the customer on the day of interest for the hour of interest

On the other extreme, when no previous data is available or the algorithm fails, adaptive switches function as legacy switches. For legacy switches, impacts only accrue after duty cycle has surpassed the non-cycle portion of the duty cycle; That is, for the 30 percent cycling regime, only after units are running at greater than 70 percent duty cycle will impacts accrue. Legacy impacts are calculated as

$$\hat{\Delta}^{L}_{jdh} = \max\left(0, \hat{L}_{jdh} - (1 - c_j)CL_j\right)$$

where:

j	=	the cross-sectional unit or customer
d	=	the day of the year
h	=	the hour of the day
$\hat{\Delta}^{L}_{jdh}$	=	the impact for a legacy switch
c_j	=	the cycling strategy of the customer

$\hat{L}_{jdh}$	=	the predicted load for the customer on the day of interest for the hour of interest
CL_j	=	the connected load for the customer

3.3.2 Combining the Adaptive and Legacy Impacts

Having calculated the theoretical bounds for impacts with the legacy and adaptive cycling estimates, we now need to find a single point estimate for the *ex ante* impact. We assume that the *ex ante* impact is a linear combination of the adaptive and legacy switches.

$$\hat{\Delta}_{jdh} = \alpha_c \hat{\Delta}^A_{jdh} + (1-\alpha_c)\hat{\Delta}^L_{jdh}$$

where:

j	=	the cross-sectional unit
h	=	the hour of the day
d	=	the day of the year
c	=	cycling strategy
$\hat{\Delta}_{jdh}$	=	the overall predicted impact at cycling strategy *c*
$\hat{\Delta}^A_{jdh}$	=	the predicted impact for adaptive switches at cycling strategy *c*
$\hat{\Delta}^L_{jdh}$	=	the predicted impact for legacy switches at cycling strategy *c*
α_c	=	the fraction of impact from adaptive switches at cycling strategy *c*

Because we have the observed impact from our *ex post* estimates, we can rearrange the above equation and solve for α_c:

$$\alpha_c = \frac{\hat{\Delta}_{jdh} - \hat{\Delta}^L_{jdh}}{\hat{\Delta}^A_{jdh} - \hat{\Delta}^L_{jdh}}$$

We calculate the overall α_c for each cycling strategy *c*, via ratio estimation:

$$\alpha_c = \frac{\sum_{jdh}\left(\hat{\Delta}_{jhdc} - \hat{\Delta}^L_{jdhc}\right)}{\sum_{jdh}\left(\hat{\Delta}^A_{jdhc} - \hat{\Delta}^L_{jdhc}\right)}$$

Because we believe that the effectiveness of the adaptive switches varies under different temperature conditions, we calculate α_c separately for each temperature level F, across units and event hours. The calculation uses a ratio estimator:

$$\alpha_c(F) = \frac{\sum_j \sum_h \sum_{d \in d(F)} (\hat{\Delta}_{jhdc} - \Delta^{50}_{jhdc})}{\sum_j \sum_h \sum_{d \in d(F)} (\Delta^{A}_{jhdc} - \Delta^{50}_{jhdc})}$$

Where the summations are over all units, and all days and hours with daily average Temperature equal to F*, and*:

j	=	the cross-sectional unit or customer
h	=	the hour of the day
d	=	day
F	=	daily average temperature
$\hat{\Delta}_{jdh}$	=	the predicted impact
Δ^{A}_{jdh}	=	the predicted impact for adaptive switches
Δ^{50}_{jdh}	=	the predicted impact for legacy switches
$\alpha_c(F)$	=	the fraction of impact from the adaptive switch for cycling strategy c at temperature F

We then fit an ordinary least-squares model with α as a function of daily temperature:

$$\alpha_c(F) = \beta_0 + \beta_1 F_d + \varepsilon_t$$

Where:

$\alpha_c(F)$	=	the fraction of impact from the adaptive switch at temperature F.
β_0	=	the model intercept
β_1	=	the coefficient of temperature
F_d	=	average daily temperature
ε_t	=	regression residual

The results of this regression are provided inTable 3-1 and Table 3-2. For example, at a daily average temperature of 80º F, the combined residential *ex ante* estimate is 57 percent adaptive impact estimate and 43 percent legacy estimate.

Table 3-1
Residential Estimated Alpha
(Proportion of Adaptive *Ex Ante* Impact Estimate in Combined *Ex Ante* Estimate)

Daily Average Temperature	Proportion	
	Adaptive Switch	Legacy Switch
	$\alpha_c(F)$	1- $\alpha_c(F)$
60	28%	72%
65	35%	65%
70	42%	58%
75	49%	51%
80	57%	43%
85	64%	36%
90	71%	29%

Table 3-2
Commercial Estimated Alpha
(Proportion of Adaptive *Ex Ante* Impact Estimate in Combined *Ex Ante* Estimate)

Daily Average Temperature	Proportion	
	Adaptive Switch	Legacy Switch
	$\alpha_c(F)$	1- $\alpha_c(F)$
60	48%	52%
65	51%	49%
70	53%	47%
75	55%	45%
80	57%	43%
85	59%	41%
90	62%	38%

Finally, we calculate the overall *ex ante* impact using the predicted value, $\hat{\alpha}_c(F)$, at each daily temperature F:

$$\hat{\Delta}_{jhd} = \hat{\alpha}_c(F_d)\Delta^A_{jhd} + (1-\hat{\alpha}_c(F_d))\Delta^{50}_{jhd}$$

In practice, $\hat{\alpha}_c(F)$, is only calculated for the commercial and residential participants cycled at 50 percent. There is no difference between adaptive and straight 100 percent cycling, so blending is unnecessary for the residential 100 percent cycling participants. The are no 30 percent commercial participants in the M&V sample, so it is impossible to estimate a unique $\hat{\alpha}_c(F)$ for the 30 percent commercial *ex ante* impact estimates. The $\hat{\alpha}_c(F)$ for 50 percent commercial participants is used for the 30 percent commercial participants.

3.3.3 Estimating Post-Event Snapback

Because the air conditioner units are curtailed during the event, they will attempt to compensate the foregone cooling soon after the event is over. This reaction is called snapback effect, and its understanding is of particular importance for utilities because they must be prepared to meet the increased demand.

The small number of event days in 2008 makes it difficult to develop any robust model of the relationship between foregone cooling, customer characteristics, event conditions, and the snapback effect. We therefore opt for a simpler method, which is to calculate the post-event spike in demand from this year's peak day. More specifically, for each hour after the event we calculate the ratio of snapback and the reduction incurred during the event hours. The equation below aims to capture this idea:

$$\delta_{ck} = \frac{-\hat{\Delta}_{ck}}{\sum_{h\in H}\hat{\Delta}_{ch}}$$

where:

c	=	the cycling strategy
k	=	the post-event hour
h	=	the event-period hour
H	=	the event-period hours
δ_{ck}	=	the snapback proportion for cycling c at post-event hour *k*

$\hat{\Delta}_{ck}$ = the impact at post-event hour k

then each hour post-event is adjusted by subtracting the corresponding snapback for that period:

$$\hat{\Delta}'_{ck} = \hat{\Delta}_{ck} - \delta_{ck} \sum_{h \in H} \hat{\Delta}_{ch}$$

The estimated values for δ_{ck} are shown in Table 3-3 and Table 3-4 below, for residential and commercial sectors, respectively.

Table 3-3
Residential Post-Event Snapback as Percentage of Event Impact

	Snapback	
Hour Ending	50% Cycling	100% Cycling
18	8.8%	0.0%
19	7.8%	17.2%
20	0.0%	12.3%
21	0.0%	4.8%
22	0.0%	0.8%

Table 3-4
Commercial Post-Event Snapback as Percentage of Event Impact

	Snapback	
Hour Ending	50% Cycling	100% Cycling
18	5.7%	5.7%
19	7.5%	7.5%
20	0.0%	0.0%
21	0.0%	0.0%
22	0.0%	0.0%

By using the methods delineated above, we are able to construct estimates for *ex ante* impacts that take into consideration the truncation at connected load, different cycling strategies, variable adaptive switch success, and the post-event snapback effect.

3.4 Uncertainty Adjusted Load Estimates

In addition to the standard average estimate of *ex post* and *ex ante* load impacts, the Protocols require uncertainty adjusted load impact estimates.

The Protocols discuss a number of ways of calculating the uncertainty adjusted load impact estimates. This evaluation uses the first option listed, based on the use of the standard errors of the aggregate estimates of the load impact[13]. In the model used in this evaluation, the standard errors of the aggregated impact estimates encompass both between- and within-unit variances for the participants for each hour.

Each participant's impact estimate includes the estimation error for that participant (the error in estimating the participant's load.) This is the within-unit variance.

The standard errors explicitly measure the variation in impacts across participants – the between-unit variance. Thus the modeling errors for individual participants are entrained in the standard errors calculated across participants.

Using the aggregate standard errors to calculate uncertainty adjusted-load impacts requires that we assume that the aggregate estimation error is normally distributed with mean zero. That is, we exclude any explicit bias correction. This assumption is standard for regression-based error measures. The normal distribution assumption is reasonable for estimates that are averaged over large numbers of similar units. Bias is inherently not measurable, but the estimation process, including sampling, data collection, data cleaning, and model development and testing were designed to limit bias as much as possible. With this mean-zero normal distribution assumption, the uncertainty adjusted percentiles are simply the percentiles of a t distribution, based on the estimated standard errors and centered on the impact estimate for that hour.

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[13] Bullet 1, footnote 38, page 53 of the Protocols (*Load Impact Estimation for Demand Response: Protocols and Regulatory Guidance*. California Public Utilities Commission. Energy Division. April, 2008)

4. Data

4.1 Meter Samples

SDG&E maintains M&V meter samples for the Summer Saver program. The samples were developed and deployed in 2006 and 2007. At that time the majority of participants, both residential and commercial, were cycled at 50 percent. The evaluation starts from the assumption that the sample was initially representative of the population

Subsequent to that time, significant numbers of residential participants opted for cycling at 100 percent, while similar numbers of commercial participants opted for cycling at 30 percent. For the 2008 cooling season, approximately two-thirds of both the residential and commercial populations were cycled at 50 percent. For the 2008 cooling season, SDG&E developed additional residential sample for participants opting for 100 percent cycling. As a result, the residential sample has sufficient numbers to estimate impacts for the two levels of cycling consistent with contract requirements with the DR technology requirements.

The commercial sample, on the other hand, continues to be populated by participants on the 50-percent cycling regime. This necessitates an alternative approach to estimating impacts for the 30-percent cycling regime leveraging results from the 50 percent regime participants. This problem will be remedied with a new M&V sample in development for the 2009 cooling season.

4.2 Interval Data

SDG&E provided interval data for the samples of residential and commercial participants. All data are provided in 15-minute kWh intervals. The residential interval data include both whole premise and end-use data. The end-use data are the load data from the larger AC unit if multiple AC units exist at the site. Only whole premise interval data are available for the commercial sample.

A variety of checks were performed on the residential interval data. The most important checks were:

- Premise-level data greater than zero,
- End-use usage levels consistently below premise-level data usage levels.

In addition, AC units with low to no usage through the summer were flagged. We observed the premise-level data for indications of cooling load not captured in the end-use data. Concern over likely cooling usage in the premise-level data and not in evidence in the end-use data was one motivation for using the premise-level data for the impact estimates.

Three residential premises were removed from the analysis because of discrepancies between the AC and premise-level data. One other premise was removed because it had substantial amounts of zero premise-level data. In addition, for the premise-level analysis, two premises were removed because they had net-metering which made the data unusable for this evaluation.

Only premise-level data was available for commercial M&V sample. There were no premises with substantial amounts of zero data.

4.3 Weather

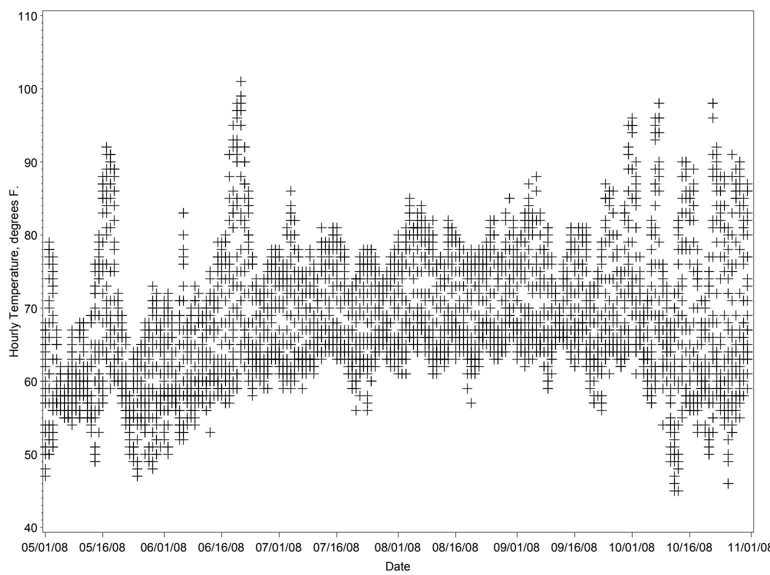
SDG&E provided hourly temperature data for ten weather stations that cover the SDG&E service territory. SDG&E also provided a lookup with which to match all participating sample customers to the appropriate weather station. The weather series were complete and covered the full period addressed by this analysis, May 1st 2008 through October 31st 2008. Table 4-1 provides the counts of premises for both the residential and commercial M&V samples in the 10 San Diego weather stations. Unfortunately, the Summer Saver program population are not mapped to weather stations so it is impossible to compare the sample weather station distribution to the population distribution.

Table 4-1
San Diego Weather Stations with Premise Counts and Percentages

Weather Station	Premise Counts and Percentages			
	Residential		Commercial	
KCRQ	16	7%	22	8%
KCZZ	1	0%	0	0%
KMYF	21	9%	31	11%
KNKX	30	13%	89	33%
KOKB	1	0%	4	1%
KRNM	62	26%	22	8%
KSAN	4	2%	59	22%
KSDM	17	7%	14	5%
KSEE	83	35%	28	10%
KSNA	2	1%	2	1%

San Diego experienced a relative mild summer in 2008. Notably, the summer had very few days of extreme weather during July, August and September . Figure 4-1 provides a plot of hour temperatures (º F) for Miramar weather station. The plot illustrates that between mid June and the end of September there were no maximum temperatures greater than 90º F. The lack of temperature extremes during the majority of the cooling season is particularly dramatic compared to mid June and October when temperatures climbed well into the nineties even topping 100 in June. All of the San Diego weather stations experienced the same pattern to some degree.

Figure 4-1
Plot of Hourly Temperature for Miramar Weather Station (KNKX)



4.3.1 Weather Conditions

According to the DR Protocols, the *ex ante* estimates should be based on historical weather conditions that are supposed to represent a range of day types. SDG&E provided 1-in-2 and 1-in-10 weather conditions for average day (1) and monthly peaks (6), totaling 14 sets of hourly temperature for all the weather regions covered the program. SDG&E developed the 1-in-2 and 1-in-10 weather years for the *ex ante* impacts. Average days for 1-in-2 and 1-in-10 weather years were created from an average of hourly temperature across the 10 SDG&E weather stations on the top nine system usage days in 2004 and 2007, respectively. The 1-in-2 and 1-in-10 monthly peaks are assembled from different years. The monthly system peak usage for the last seven years was ranked. The 1-in-2 weather year was the median monthly peak in the order. The 1-in-10 weather year was the top monthly peak in the order.

Using these data we calculated premise-level cooling load for all sample units for all the *ex ante* dates. All dates were calculated as weekday, even if some of them were originally Saturday or Sunday. The same set of weather conditions and cooling load estimates was used to calculate *ex ante* impacts for each projection year, as discussed in the next section.

4.4 Projections of Program-Level Tonnage

In the *ex ante* projections, the only factor changing from year to year is the program-level tonnage, for residential and commercial sectors. SDG&E provided projections of tons from 2009 to 2018. There are three points that should be made about how the tonnage is handled.

First, the projections of tonnage only vary until 2011, after which they become constant. We will therefore generate a single set of results for years 2011 to 2018.

Second, Summer Saver will overlap with overlap with other programs starting in 2009. The residential program will overlap with Peak Time Rebate (PTR) and the commercial program will overlap with the Critical Peak Pricing program (CPP). SDG&E calculated a net measurement of tons so that tonnage from AC Saver and the overlapping programs are not double counted. We report results both the full and net measurements of Summer Saver tons.

Finally, because the projections were created at the aggregate level of the program, there is no information about the proportion of low and high cycling tonnage in each sector. As an approximation, we use the *ex post* proportion of low and high cycle tons in our *ex ante* impact estimates.

The projections of tonnage by year are presented in Table 4-2 and Table 4-3 , for each sector and broken by cycling regime.

Table 4-2

Residential *Ex Ante* Cycling Regime Tons and Proportions

		50% Cycling			100% Cycling			Overall	
Year	Month	Net	Gross	Percent	Net	Gross	Percent	Net	Gross
2009	6	46,964	46,964	66%	24,511	24,511	34%	71,476	71,476
2009	7	47,645	47,684	66%	24,867	24,887	34%	72,512	72,572
2009	8	48,321	48,405	66%	25,219	25,263	34%	73,540	73,668
2009	9	48,977	49,125	66%	25,562	25,639	34%	74,539	74,764
2009	10	49,618	49,845	66%	25,897	26,015	34%	75,515	75,860
2010	5	51,653	54,886	66%	26,958	28,646	34%	78,611	83,532
2010	6	51,699	55,606	66%	26,982	29,022	34%	78,681	84,628
2010	7	51,067	55,606	66%	26,653	29,022	34%	77,720	84,628
2010	8	50,385	55,606	66%	26,297	29,022	34%	76,682	84,628
2010	9	49,678	55,606	66%	25,927	29,022	34%	75,605	84,628
2010	10	48,970	55,606	66%	25,558	29,022	34%	74,528	84,628
2011-2018	5	44,549	55,606	66%	23,251	29,022	34%	67,799	84,628
2011-2018	6	44,485	55,606	66%	23,217	29,022	34%	67,702	84,628
2011-2018	7	44,485	55,606	66%	23,217	29,022	34%	67,702	84,628
2011-2018	8	44,485	55,606	66%	23,217	29,022	34%	67,702	84,628
2011-2018	9	44,485	55,606	66%	23,217	29,022	34%	67,702	84,628
2011-2018	10	44,485	55,606	66%	23,217	29,022	34%	67,702	84,628

Table 4-3

Commercial *Ex Ante* Cycling Regime Tons and Proportions

		30% Cycling			50% Cycling			Overall	
Year	Month	Net	Gross	Percent	Net	Gross	Percent	Net	Gross
2009	6	11,805	17,234	36%	21,399	31,239	64%	33,204	48,473
2009	7	12,113	17,683	36%	21,956	32,053	64%	34,069	49,736
2009	8	12,420	18,132	36%	22,513	32,866	64%	34,934	50,998
2009	9	12,728	18,581	36%	23,071	33,680	64%	35,798	52,260
2009	10	13,035	19,029	36%	23,628	34,494	64%	36,663	53,523
2010	5	15,187	22,171	36%	27,529	40,189	64%	42,717	62,360
2010	6	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2010	7	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2010	8	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2010	9	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2010	10	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2011-2018	5	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2011-2018	6	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2011-2018	7	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2011-2018	8	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2011-2018	9	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622
2011-2018	10	15,495	22,620	36%	28,087	41,002	64%	43,581	63,622

5. *Ex Post* Impact Results

This section presents the results from the impact evaluation for the 2008 Summer Saver Demand Response Program. Here we present a full set of kW per ton results for the peak day of 2008, October 1st. These results include program-level results and cycling regime-level results for the residential program and cycling regime-level results for the commercial program.

Because the commercial 30 percent cycling *ex post* impact estimate is not strictly speaking an *ex post* estimate, we do not combine it with the *ex post* impact estimate for the commercial 50 percent cycling group.

Table 5-1 and Table 5-2 provide the event characteristics for the residential and commercial programs. The event timing was the same for both programs. Sample counts and sample and program tons are, of course, unique to the program. Average daily temperature is the weighted average of premise-specific daily average temperature used for modeling purposes for that day. Because residential and commercial participants are distributed differently across the weather stations, these temperatures may not be the same between the residential and commercial samples.

Table 5-1
2008 Residential Summer Saver Event Characteristics

Date	Event Start	Event End	Duration	Cycled Group	Cycled Group Count	Comparison Group Count	Total Sample Count	Sample Tons	Program Tons	Average Daily Temperature, F.
10/01/2008	13:00	17:00	4	A	117	120	237	907	63,499	80.9
10/08/2008	13:00	17:00	4	B	121	116	237	907	63,499	78.6

Table 5-2
2008 Commercial Summer Saver Event Characteristics

Date	Event Start	Event End	Duration	Cycled Group	Cycled Group Count	Comparison Group Count	Total Sample Count	Sample Tons	Program Tons	Average Daily Temperature, F.
10/01/2008	13:00	17:00	4	A	110	105	215	3,533	36,085	80.9
10/08/2008	13:00	17:00	4	B	105	110	215	3,533	36,085	79.5

Table 5-3 through Table 5-12 present a full set of *ex post* impact estimates for the residential and commercial programs for the day of the system peak, October 1st. The event hours are the shaded rows, hours ending 14 through 17. Peak load occurred during hour ending 16. Along with the impact estimates, the tables provide the estimated reference loads and the observed loads during the events. The uncertainty adjusted load impact can be thought of as confidence intervals. The 10th and 90th percentiles provide an 80 percent confidence interval on the mean impact estimates.

Table 5-3

Residential kW per ton *Ex Post* Impacts, Tabular and Plot

October 1st, Day of System Peak, Combined 50 and 100 Percent Cycling Regimes

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	0.23	0.22	0.01	69.46	-0.05	-0.01	0.01	0.04	0.07
1-Oct	2	0.18	0.20	-0.02	68.68	-0.09	-0.05	-0.02	0.01	0.04
1-Oct	3	0.16	0.17	-0.01	67.30	-0.07	-0.03	-0.01	0.01	0.05
1-Oct	4	0.15	0.17	-0.01	66.71	-0.07	-0.04	-0.01	0.01	0.05
1-Oct	5	0.15	0.16	-0.01	67.36	-0.07	-0.03	-0.01	0.01	0.05
1-Oct	6	0.18	0.19	-0.01	68.19	-0.07	-0.04	-0.01	0.01	0.05
1-Oct	7	0.23	0.24	-0.01	74.31	-0.07	-0.03	-0.01	0.02	0.05
1-Oct	8	0.24	0.24	0.00	81.95	-0.06	-0.03	0.00	0.02	0.06
1-Oct	9	0.27	0.29	-0.02	88.28	-0.08	-0.05	-0.02	0.00	0.04
1-Oct	10	0.34	0.31	0.04	92.29	-0.02	0.01	0.04	0.06	0.09
1-Oct	11	0.36	0.37	-0.01	94.43	-0.05	-0.03	-0.01	0.01	0.04
1-Oct	12	0.43	0.44	0.00	94.46	-0.03	-0.01	0.00	0.01	0.02
1-Oct	13	0.48	0.50	-0.01	94.84	-0.04	-0.02	-0.01	0.00	0.01
1-Oct	14	0.56	0.47	0.09	93.92	0.02	0.06	0.09	0.12	0.16
1-Oct	15	0.59	0.48	0.12	93.95	0.04	0.09	0.12	0.15	0.20
1-Oct	16	0.63	0.49	0.14	90.66	0.05	0.10	0.14	0.17	0.22
1-Oct	17	0.66	0.46	0.20	86.60	0.12	0.17	0.20	0.24	0.29
1-Oct	18	0.66	0.68	-0.02	83.31	-0.10	-0.05	-0.02	0.02	0.07
1-Oct	19	0.65	0.72	-0.07	79.21	-0.16	-0.11	-0.07	-0.03	0.02
1-Oct	20	0.65	0.62	0.03	76.38	-0.06	0.00	0.03	0.07	0.13
1-Oct	21	0.60	0.52	0.08	73.75	0.00	0.04	0.08	0.11	0.16
1-Oct	22	0.49	0.46	0.03	71.93	-0.04	0.00	0.03	0.06	0.10
1-Oct	23	0.40	0.36	0.04	69.26	-0.03	0.01	0.04	0.07	0.11
1-Oct	24	0.32	0.27	0.05	67.69	-0.01	0.03	0.05	0.08	0.11
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		9.62	9.00	0.61	175.28	n/a	n/a	n/a	n/a	n/a

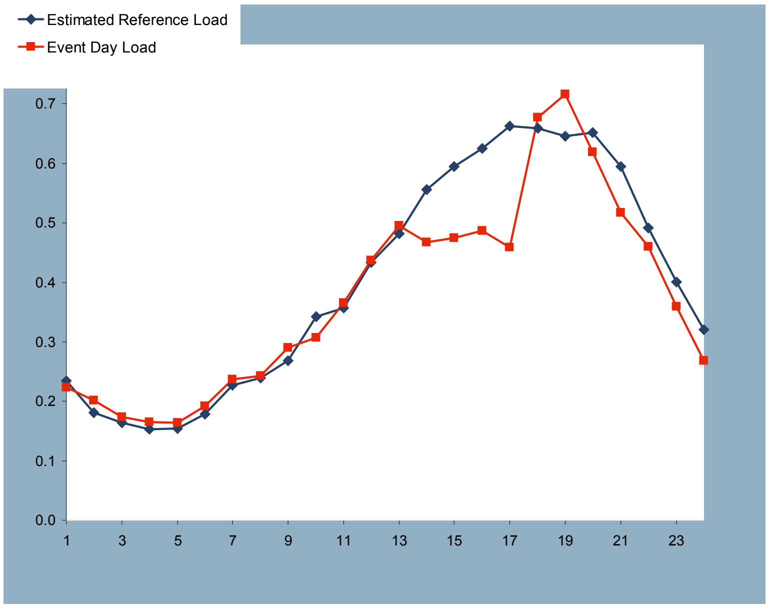


Table 5-4
Residential kW per ton *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, 50 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	0.26	0.22	0.03	69.46	-0.05	0.00	0.03	0.07	0.12
1-Oct	2	0.19	0.21	-0.02	68.68	-0.11	-0.06	-0.02	0.02	0.07
1-Oct	3	0.16	0.17	-0.01	67.30	-0.09	-0.04	-0.01	0.03	0.08
1-Oct	4	0.15	0.17	-0.01	66.71	-0.10	-0.05	-0.01	0.02	0.07
1-Oct	5	0.15	0.16	-0.01	67.36	-0.10	-0.05	-0.01	0.02	0.07
1-Oct	6	0.18	0.20	-0.02	68.19	-0.10	-0.05	-0.02	0.02	0.07
1-Oct	7	0.24	0.25	-0.02	74.31	-0.10	-0.05	-0.02	0.02	0.07
1-Oct	8	0.24	0.25	-0.02	81.95	-0.10	-0.05	-0.02	0.02	0.07
1-Oct	9	0.27	0.31	-0.04	88.28	-0.12	-0.07	-0.04	0.00	0.04
1-Oct	10	0.36	0.31	0.05	92.29	-0.03	0.02	0.05	0.08	0.13
1-Oct	11	0.36	0.39	-0.03	94.43	-0.09	-0.05	-0.03	0.00	0.04
1-Oct	12	0.46	0.47	0.00	94.46	-0.03	-0.02	0.00	0.01	0.03
1-Oct	13	0.49	0.51	-0.02	94.84	-0.05	-0.03	-0.02	0.00	0.02
1-Oct	14	0.58	0.50	0.07	93.92	-0.03	0.03	0.07	0.11	0.17
1-Oct	15	0.60	0.54	0.06	93.95	-0.05	0.01	0.06	0.11	0.17
1-Oct	16	0.65	0.56	0.10	90.66	-0.03	0.05	0.10	0.15	0.22
1-Oct	17	0.68	0.53	0.16	86.60	0.04	0.11	0.16	0.21	0.28
1-Oct	18	0.68	0.71	-0.03	83.31	-0.15	-0.08	-0.03	0.02	0.09
1-Oct	19	0.71	0.74	-0.03	79.21	-0.16	-0.08	-0.03	0.02	0.10
1-Oct	20	0.72	0.62	0.11	76.38	-0.03	0.05	0.11	0.16	0.24
1-Oct	21	0.65	0.51	0.14	73.75	0.03	0.09	0.14	0.19	0.25
1-Oct	22	0.51	0.46	0.05	71.93	-0.05	0.01	0.05	0.09	0.15
1-Oct	23	0.43	0.35	0.08	69.26	-0.02	0.04	0.08	0.12	0.17
1-Oct	24	0.35	0.27	0.07	67.69	-0.01	0.04	0.07	0.11	0.16
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		10.09	9.42	0.67	175.28	n/a	n/a	n/a	n/a	n/a

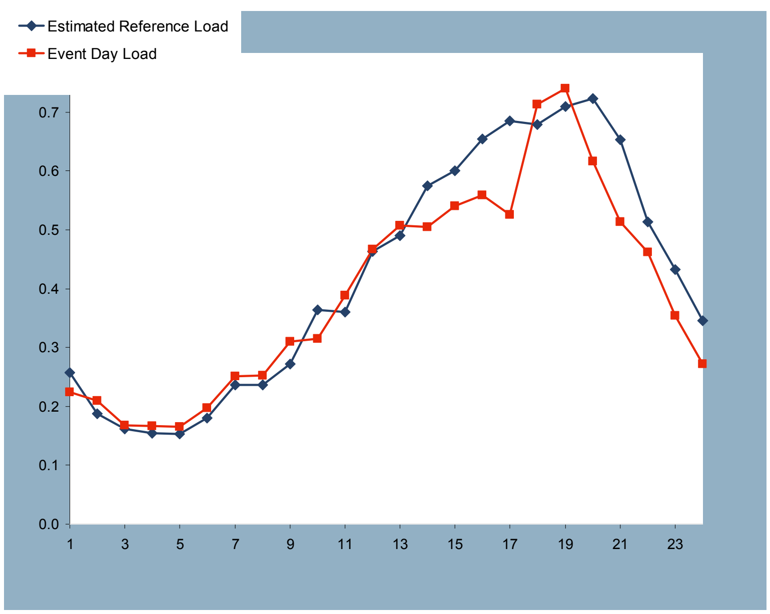


Table 5-5
Residential kW per ton *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, 100 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	0.19	0.22	-0.03	69.46	-0.09	-0.05	-0.03	0.00	0.03
1-Oct	2	0.17	0.19	-0.02	68.68	-0.08	-0.05	-0.02	0.01	0.04
1-Oct	3	0.17	0.19	-0.02	67.30	-0.08	-0.04	-0.02	0.01	0.04
1-Oct	4	0.15	0.16	-0.02	66.71	-0.08	-0.04	-0.02	0.01	0.05
1-Oct	5	0.16	0.16	-0.01	67.36	-0.07	-0.03	-0.01	0.02	0.06
1-Oct	6	0.18	0.18	-0.01	68.19	-0.07	-0.03	-0.01	0.02	0.06
1-Oct	7	0.21	0.21	0.00	74.31	-0.06	-0.02	0.00	0.03	0.07
1-Oct	8	0.24	0.22	0.02	81.95	-0.04	-0.01	0.02	0.04	0.08
1-Oct	9	0.26	0.25	0.01	88.28	-0.05	-0.02	0.01	0.03	0.07
1-Oct	10	0.30	0.29	0.01	92.29	-0.04	-0.01	0.01	0.03	0.06
1-Oct	11	0.35	0.32	0.03	94.43	-0.02	0.01	0.03	0.05	0.07
1-Oct	12	0.37	0.38	-0.01	94.46	-0.04	-0.02	-0.01	0.01	0.03
1-Oct	13	0.47	0.47	-0.01	94.84	-0.04	-0.02	-0.01	0.01	0.03
1-Oct	14	0.52	0.40	0.12	93.92	0.06	0.10	0.12	0.15	0.18
1-Oct	15	0.58	0.35	0.23	93.95	0.16	0.21	0.23	0.26	0.30
1-Oct	16	0.57	0.35	0.22	90.66	0.14	0.19	0.22	0.25	0.30
1-Oct	17	0.62	0.33	0.29	86.60	0.20	0.25	0.29	0.33	0.38
1-Oct	18	0.62	0.61	0.01	83.31	-0.08	-0.03	0.01	0.05	0.10
1-Oct	19	0.52	0.67	-0.15	79.21	-0.24	-0.19	-0.15	-0.11	-0.06
1-Oct	20	0.52	0.62	-0.11	76.38	-0.20	-0.14	-0.11	-0.07	-0.01
1-Oct	21	0.48	0.53	-0.04	73.75	-0.13	-0.08	-0.04	0.00	0.05
1-Oct	22	0.45	0.46	-0.01	71.93	-0.10	-0.05	-0.01	0.03	0.09
1-Oct	23	0.34	0.37	-0.03	69.26	-0.12	-0.07	-0.03	0.01	0.06
1-Oct	24	0.27	0.26	0.01	67.69	-0.06	-0.02	0.01	0.04	0.08
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		8.72	8.21	0.51	175.28	n/a	n/a	n/a	n/a	n/a

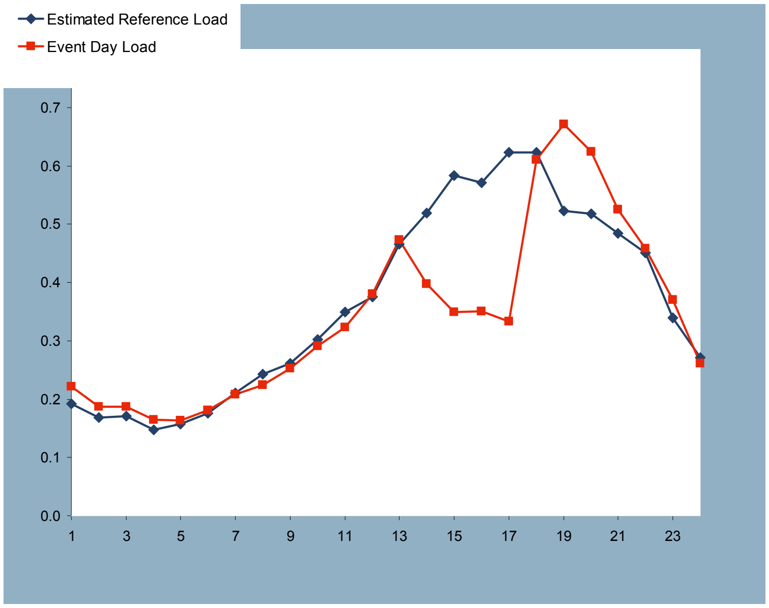


Table 5-6
Residential MW *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, Combined 50 and 100 Percent Cycling Regimes

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	14.89	14.19	0.71	69.46	-3.02	-0.82	0.71	2.23	4.43
1-Oct	2	11.50	12.82	-1.32	68.68	-5.45	-3.01	-1.32	0.36	2.80
1-Oct	3	10.44	11.06	-0.61	67.30	-4.38	-2.15	-0.61	0.93	3.15
1-Oct	4	9.68	10.51	-0.83	66.71	-4.63	-2.39	-0.83	0.73	2.97
1-Oct	5	9.79	10.44	-0.65	67.36	-4.47	-2.22	-0.65	0.91	3.16
1-Oct	6	11.34	12.17	-0.83	68.19	-4.65	-2.40	-0.83	0.73	2.98
1-Oct	7	14.43	15.01	-0.58	74.31	-4.51	-2.19	-0.58	1.03	3.35
1-Oct	8	15.16	15.42	-0.26	81.95	-4.12	-1.84	-0.26	1.33	3.61
1-Oct	9	17.02	18.46	-1.44	88.28	-5.13	-2.95	-1.44	0.07	2.25
1-Oct	10	21.77	19.48	2.29	92.29	-1.23	0.85	2.29	3.74	5.82
1-Oct	11	22.66	23.22	-0.57	94.43	-3.46	-1.75	-0.57	0.62	2.32
1-Oct	12	27.49	27.76	-0.27	94.46	-1.74	-0.87	-0.27	0.33	1.20
1-Oct	13	30.59	31.48	-0.88	94.84	-2.58	-1.58	-0.88	-0.19	0.82
1-Oct	14	35.29	29.69	5.60	93.92	1.24	3.81	5.60	7.38	9.95
1-Oct	15	37.77	30.17	7.60	93.95	2.66	5.58	7.60	9.62	12.54
1-Oct	16	39.71	30.94	8.78	90.66	3.37	6.56	8.78	10.99	14.18
1-Oct	17	42.12	29.17	12.95	86.60	7.48	10.71	12.95	15.19	18.42
1-Oct	18	41.88	43.05	-1.17	83.31	-6.56	-3.38	-1.17	1.04	4.23
1-Oct	19	41.00	45.50	-4.50	79.21	-10.31	-6.88	-4.50	-2.12	1.31
1-Oct	20	41.43	39.31	2.12	76.38	-3.82	-0.31	2.12	4.55	8.06
1-Oct	21	37.78	32.84	4.94	73.75	-0.21	2.83	4.94	7.05	10.09
1-Oct	22	31.26	29.25	2.01	71.93	-2.62	0.11	2.01	3.90	6.64
1-Oct	23	25.45	22.85	2.60	69.26	-1.85	0.78	2.60	4.43	7.06
1-Oct	24	20.32	17.01	3.31	67.69	-0.40	1.79	3.31	4.83	7.02
Date	Daily Summary	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		610.77	571.80	38.98	175.28	n/a	n/a	n/a	n/a	n/a

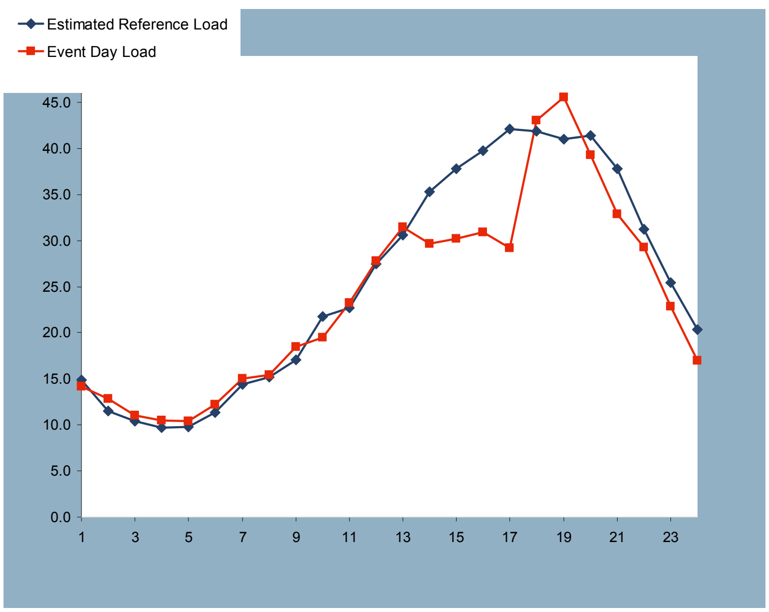


Table 5-7
Residential MW *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, 50 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	10.72	9.37	1.35	69.46	-2.14	-0.08	1.35	2.78	4.84
1-Oct	2	7.84	8.74	-0.89	68.68	-4.78	-2.48	-0.89	0.70	2.99
1-Oct	3	6.73	6.99	-0.26	67.30	-3.79	-1.70	-0.26	1.18	3.26
1-Oct	4	6.47	6.94	-0.47	66.71	-4.01	-1.92	-0.47	0.98	3.07
1-Oct	5	6.37	6.88	-0.51	67.36	-4.07	-1.97	-0.51	0.95	3.06
1-Oct	6	7.52	8.23	-0.71	68.19	-4.26	-2.16	-0.71	0.74	2.84
1-Oct	7	9.85	10.48	-0.63	74.31	-4.29	-2.13	-0.63	0.87	3.04
1-Oct	8	9.88	10.54	-0.66	81.95	-4.30	-2.15	-0.66	0.84	2.99
1-Oct	9	11.33	12.95	-1.62	88.28	-5.09	-3.04	-1.62	-0.20	1.85
1-Oct	10	15.19	13.14	2.04	92.29	-1.32	0.67	2.04	3.42	5.41
1-Oct	11	15.05	16.18	-1.13	94.43	-3.82	-2.23	-1.13	-0.03	1.56
1-Oct	12	19.33	19.47	-0.14	94.46	-1.42	-0.67	-0.14	0.38	1.14
1-Oct	13	20.47	21.18	-0.71	94.84	-2.24	-1.34	-0.71	-0.09	0.82
1-Oct	14	24.00	21.03	2.96	93.92	-1.18	1.26	2.96	4.66	7.11
1-Oct	15	25.06	22.56	2.51	93.95	-2.20	0.58	2.51	4.43	7.21
1-Oct	16	27.30	23.32	3.98	90.66	-1.14	1.89	3.98	6.07	9.10
1-Oct	17	28.56	21.91	6.65	86.60	1.54	4.56	6.65	8.75	11.77
1-Oct	18	28.32	29.75	-1.42	83.31	-6.44	-3.48	-1.42	0.63	3.60
1-Oct	19	29.62	30.87	-1.26	79.21	-6.71	-3.49	-1.26	0.97	4.19
1-Oct	20	30.15	25.72	4.44	76.38	-1.16	2.15	4.44	6.73	10.03
1-Oct	21	27.24	21.40	5.84	73.75	1.06	3.88	5.84	7.79	10.61
1-Oct	22	21.43	19.27	2.16	71.93	-1.96	0.48	2.16	3.85	6.29
1-Oct	23	18.07	14.77	3.29	69.26	-0.70	1.66	3.29	4.93	7.28
1-Oct	24	14.43	11.32	3.11	67.69	-0.31	1.71	3.11	4.50	6.52
Date	Daily Summary	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		420.92	393.01	27.92	175.28	n/a	n/a	n/a	n/a	n/a

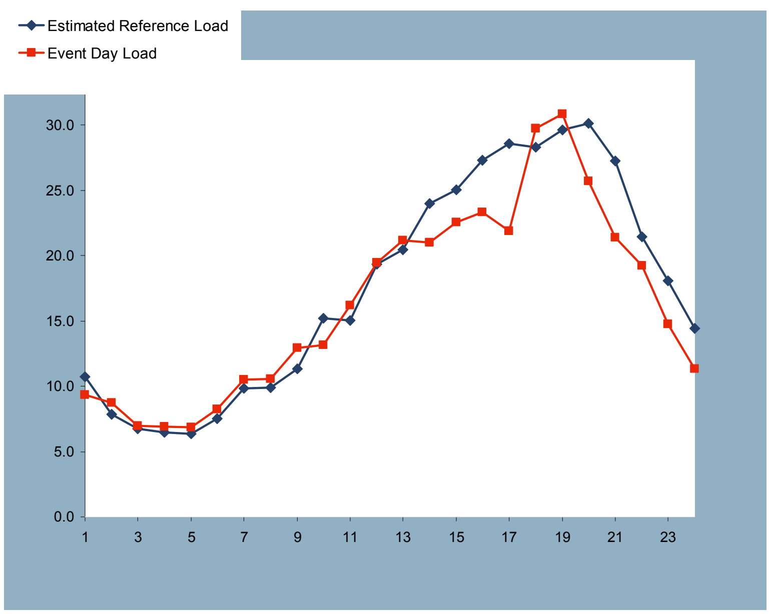


Table 5-8
Residential MW *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, 100 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	4.17	4.82	-0.65	69.46	-1.96	-1.18	-0.65	-0.11	0.67
1-Oct	2	3.65	4.09	-0.43	68.68	-1.80	-0.99	-0.43	0.13	0.94
1-Oct	3	3.72	4.07	-0.35	67.30	-1.67	-0.89	-0.35	0.19	0.97
1-Oct	4	3.22	3.58	-0.36	66.71	-1.75	-0.93	-0.36	0.21	1.03
1-Oct	5	3.41	3.56	-0.15	67.36	-1.51	-0.71	-0.15	0.41	1.21
1-Oct	6	3.82	3.94	-0.12	68.19	-1.54	-0.70	-0.12	0.45	1.29
1-Oct	7	4.58	4.53	0.05	74.31	-1.38	-0.54	0.05	0.63	1.47
1-Oct	8	5.28	4.88	0.40	81.95	-0.88	-0.13	0.40	0.92	1.68
1-Oct	9	5.69	5.51	0.18	88.28	-1.09	-0.34	0.18	0.70	1.45
1-Oct	10	6.59	6.33	0.25	92.29	-0.80	-0.18	0.25	0.68	1.30
1-Oct	11	7.61	7.04	0.57	94.43	-0.49	0.13	0.57	1.00	1.62
1-Oct	12	8.16	8.29	-0.13	94.46	-0.85	-0.43	-0.13	0.16	0.59
1-Oct	13	10.13	10.30	-0.17	94.84	-0.92	-0.48	-0.17	0.13	0.57
1-Oct	14	11.29	8.66	2.63	93.92	1.29	2.08	2.63	3.19	3.98
1-Oct	15	12.71	7.61	5.09	93.95	3.59	4.48	5.09	5.71	6.60
1-Oct	16	12.42	7.62	4.80	90.66	3.06	4.09	4.80	5.50	6.53
1-Oct	17	13.55	7.26	6.30	86.60	4.36	5.50	6.30	7.09	8.23
1-Oct	18	13.56	13.30	0.26	83.31	-1.72	-0.55	0.26	1.07	2.24
1-Oct	19	11.38	14.63	-3.24	79.21	-5.26	-4.07	-3.24	-2.42	-1.23
1-Oct	20	11.27	13.59	-2.32	76.38	-4.31	-3.13	-2.32	-1.50	-0.32
1-Oct	21	10.55	11.44	-0.89	73.75	-2.82	-1.68	-0.89	-0.11	1.03
1-Oct	22	9.82	9.98	-0.16	71.93	-2.27	-1.02	-0.16	0.71	1.95
1-Oct	23	7.38	8.07	-0.69	69.26	-2.68	-1.50	-0.69	0.13	1.30
1-Oct	24	5.89	5.69	0.20	67.69	-1.25	-0.39	0.20	0.80	1.66
Date	Daily Summary	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		189.85	178.79	11.06	175.28	n/a	n/a	n/a	n/a	n/a

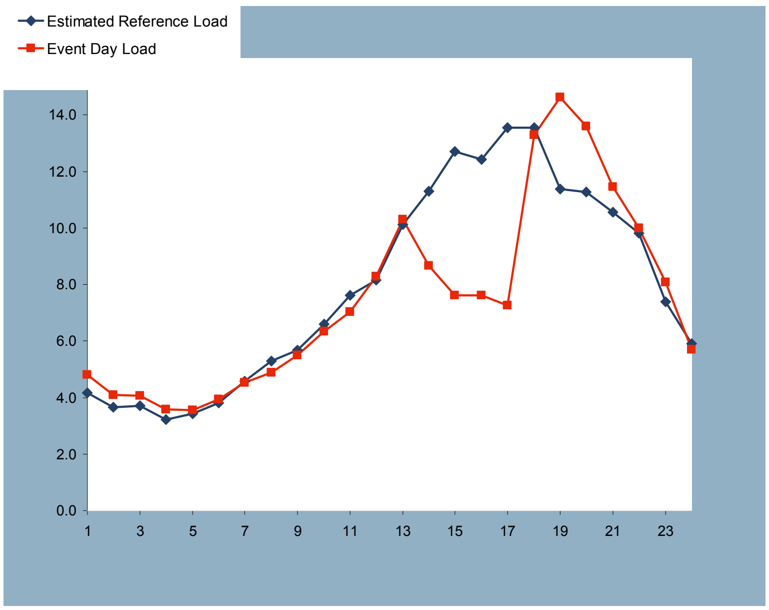


Table 5-9
Commercial kW per ton *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, 50 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	0.67	0.64	0.03	71.99	-0.06	-0.01	0.03	0.07	0.12
1-Oct	2	0.60	0.61	-0.02	71.48	-0.09	-0.05	-0.02	0.02	0.06
1-Oct	3	0.59	0.59	0.00	70.01	-0.08	-0.04	0.00	0.03	0.08
1-Oct	4	0.59	0.59	-0.01	69.05	-0.09	-0.04	-0.01	0.03	0.07
1-Oct	5	0.63	0.62	0.01	69.99	-0.08	-0.03	0.01	0.04	0.09
1-Oct	6	0.74	0.69	0.05	69.81	-0.04	0.01	0.05	0.09	0.15
1-Oct	7	0.83	0.80	0.03	76.45	-0.07	-0.01	0.03	0.07	0.13
1-Oct	8	0.96	1.03	-0.07	82.30	-0.13	-0.09	-0.07	-0.05	-0.01
1-Oct	9	1.20	1.30	-0.11	87.96	-0.16	-0.13	-0.11	-0.09	-0.06
1-Oct	10	1.42	1.50	-0.08	91.15	-0.12	-0.10	-0.08	-0.06	-0.03
1-Oct	11	1.61	1.66	-0.05	91.80	-0.09	-0.07	-0.05	-0.03	-0.01
1-Oct	12	1.69	1.70	-0.02	92.25	-0.04	-0.03	-0.02	-0.01	0.00
1-Oct	13	1.73	1.70	0.03	92.52	0.01	0.02	0.03	0.04	0.05
1-Oct	14	1.72	1.57	0.15	91.31	0.11	0.13	0.15	0.16	0.18
1-Oct	15	1.69	1.53	0.16	90.40	0.10	0.13	0.16	0.19	0.22
1-Oct	16	1.64	1.46	0.18	86.72	0.09	0.14	0.18	0.21	0.26
1-Oct	17	1.52	1.37	0.15	83.79	0.07	0.12	0.15	0.19	0.24
1-Oct	18	1.31	1.35	-0.04	80.47	-0.12	-0.07	-0.04	0.00	0.05
1-Oct	19	1.21	1.26	-0.05	77.72	-0.14	-0.09	-0.05	-0.01	0.05
1-Oct	20	1.23	1.21	0.02	75.75	-0.09	-0.03	0.02	0.06	0.12
1-Oct	21	1.11	1.07	0.04	74.28	-0.05	0.00	0.04	0.08	0.13
1-Oct	22	0.95	0.90	0.05	72.81	-0.04	0.01	0.05	0.08	0.13
1-Oct	23	0.83	0.77	0.05	71.21	-0.03	0.02	0.05	0.09	0.14
1-Oct	24	0.75	0.69	0.06	70.51	-0.02	0.03	0.06	0.09	0.14

Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		27.19	26.62	0.57	150.57	n/a	n/a	n/a	n/a	n/a

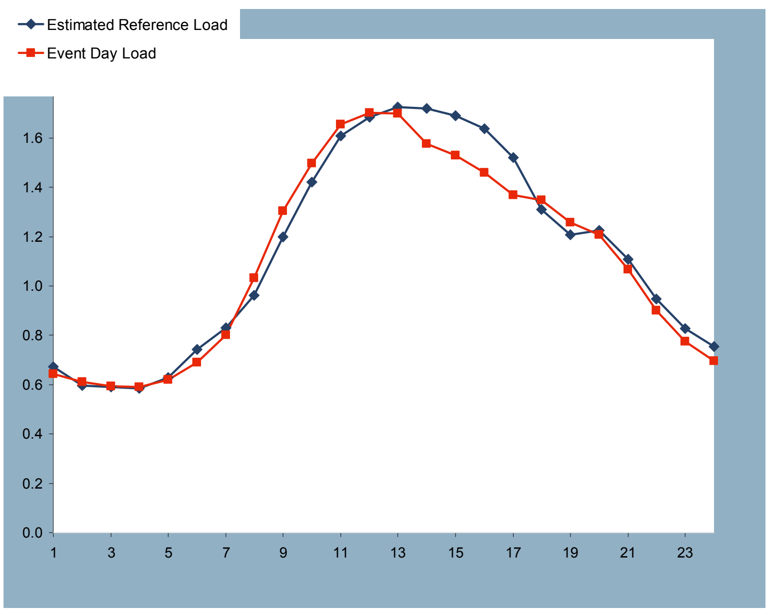


Table 5-10

Commercial kW per ton *Ex Post* Impacts, Tabular and Plot

October 1st, Day of System Peak, 30 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	0.66	0.66	0.00	72.09	0.00	0.00	0.00	0.00	0.00
1-Oct	2	0.63	0.63	0.00	71.51	0.00	0.00	0.00	0.00	0.00
1-Oct	3	0.61	0.61	0.00	70.10	0.00	0.00	0.00	0.00	0.00
1-Oct	4	0.61	0.61	0.00	68.98	0.00	0.00	0.00	0.00	0.00
1-Oct	5	0.62	0.62	0.00	70.08	0.00	0.00	0.00	0.00	0.00
1-Oct	6	0.71	0.71	0.00	69.82	0.00	0.00	0.00	0.00	0.00
1-Oct	7	0.84	0.84	0.00	77.18	0.00	0.00	0.00	0.00	0.00
1-Oct	8	1.01	1.01	0.00	82.93	0.00	0.00	0.00	0.00	0.00
1-Oct	9	1.24	1.24	0.00	88.52	-0.01	0.00	0.00	0.00	0.01
1-Oct	10	1.42	1.42	0.00	91.61	-0.01	0.00	0.00	0.00	0.01
1-Oct	11	1.58	1.58	0.00	92.10	-0.01	-0.01	0.00	0.01	0.01
1-Oct	12	1.68	1.68	0.00	92.53	-0.02	-0.01	0.00	0.01	0.02
1-Oct	13	1.71	1.71	0.00	92.74	-0.02	-0.01	0.00	0.01	0.02
1-Oct	14	1.74	1.64	0.10	91.66	0.08	0.09	0.10	0.10	0.11
1-Oct	15	1.74	1.64	0.10	90.68	0.08	0.09	0.10	0.10	0.11
1-Oct	16	1.67	1.58	0.10	86.90	0.08	0.09	0.10	0.10	0.12
1-Oct	17	1.56	1.48	0.09	83.90	0.07	0.08	0.09	0.09	0.10
1-Oct	18	1.35	1.37	0.00	80.26	-0.01	-0.01	0.00	0.01	0.01
1-Oct	19	1.21	1.24	0.00	77.40	-0.01	0.00	0.00	0.00	0.01
1-Oct	20	1.16	1.16	0.00	75.40	-0.01	0.00	0.00	0.00	0.01
1-Oct	21	1.09	1.09	0.00	73.99	-0.01	0.00	0.00	0.00	0.01
1-Oct	22	0.98	0.98	0.00	72.55	-0.01	0.00	0.00	0.00	0.01
1-Oct	23	0.85	0.85	0.00	70.96	-0.01	0.00	0.00	0.00	0.01
1-Oct	24	0.74	0.74	0.00	70.43	0.00	0.00	0.00	0.00	0.00

Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		27.40	27.07	0.38	153.80	n/a	n/a	n/a	n/a	n/a

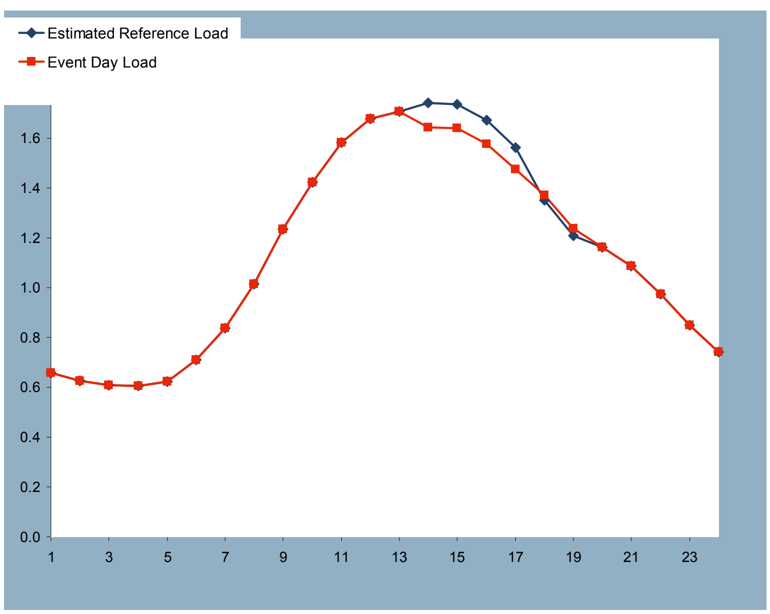


Table 5-11
Commercial MW *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, 50 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	15.64	14.97	0.67	71.99	-1.40	-0.18	0.67	1.52	2.74
1-Oct	2	13.85	14.22	-0.37	71.48	-2.20	-1.12	-0.37	0.38	1.46
1-Oct	3	13.75	13.82	-0.07	70.01	-1.92	-0.83	-0.07	0.68	1.78
1-Oct	4	13.62	13.74	-0.12	69.05	-1.98	-0.88	-0.12	0.63	1.73
1-Oct	5	14.60	14.39	0.20	69.99	-1.80	-0.62	0.20	1.02	2.20
1-Oct	6	17.24	16.02	1.22	69.81	-1.01	0.31	1.22	2.14	3.46
1-Oct	7	19.32	18.65	0.67	76.45	-1.64	-0.27	0.67	1.62	2.99
1-Oct	8	22.38	23.99	-1.61	82.30	-2.94	-2.15	-1.61	-1.06	-0.27
1-Oct	9	27.85	30.35	-2.50	87.96	-3.70	-2.99	-2.50	-2.01	-1.30
1-Oct	10	33.04	34.82	-1.78	91.15	-2.86	-2.22	-1.78	-1.33	-0.69
1-Oct	11	37.37	38.49	-1.12	91.80	-2.12	-1.53	-1.12	-0.71	-0.12
1-Oct	12	39.19	39.60	-0.40	92.25	-0.90	-0.61	-0.40	-0.20	0.10
1-Oct	13	40.15	39.49	0.66	92.52	0.14	0.45	0.66	0.87	1.18
1-Oct	14	40.00	36.62	3.38	91.31	2.50	3.02	3.38	3.75	4.27
1-Oct	15	39.31	35.60	3.71	90.40	2.22	3.10	3.71	4.32	5.20
1-Oct	16	38.11	33.96	4.15	86.72	2.20	3.35	4.15	4.95	6.11
1-Oct	17	35.33	31.80	3.53	83.79	1.53	2.71	3.53	4.34	5.52
1-Oct	18	30.48	31.32	-0.84	80.47	-2.83	-1.66	-0.84	-0.03	1.14
1-Oct	19	28.11	29.22	-1.10	77.72	-3.32	-2.01	-1.10	-0.19	1.12
1-Oct	20	28.50	28.10	0.39	75.75	-2.01	-0.59	0.39	1.37	2.79
1-Oct	21	25.75	24.84	0.92	74.28	-1.14	0.07	0.92	1.76	2.97
1-Oct	22	22.02	20.95	1.07	72.81	-0.86	0.28	1.07	1.85	2.99
1-Oct	23	19.23	18.00	1.22	71.21	-0.71	0.43	1.22	2.02	3.16
1-Oct	24	17.53	16.16	1.37	70.51	-0.52	0.60	1.37	2.15	3.27
Date	Daily Summary	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		632.36	619.10	13.26	150.57	n/a	n/a	n/a	n/a	n/a

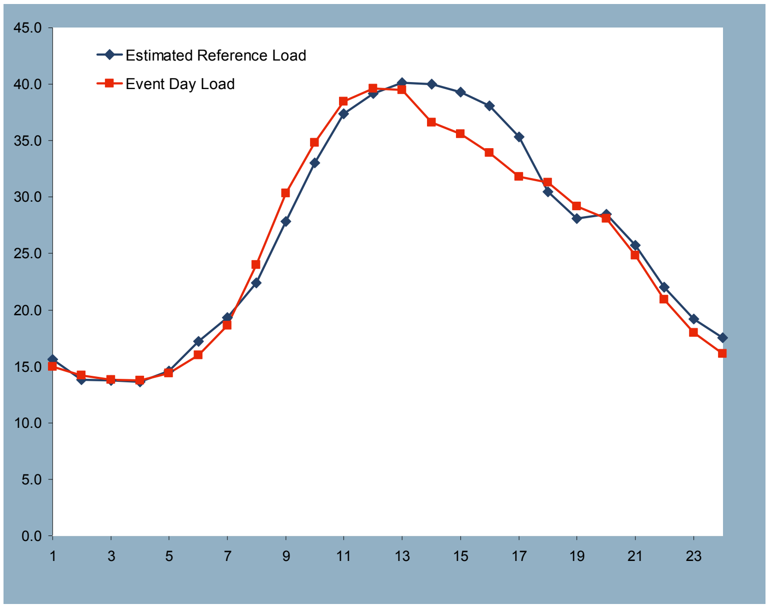
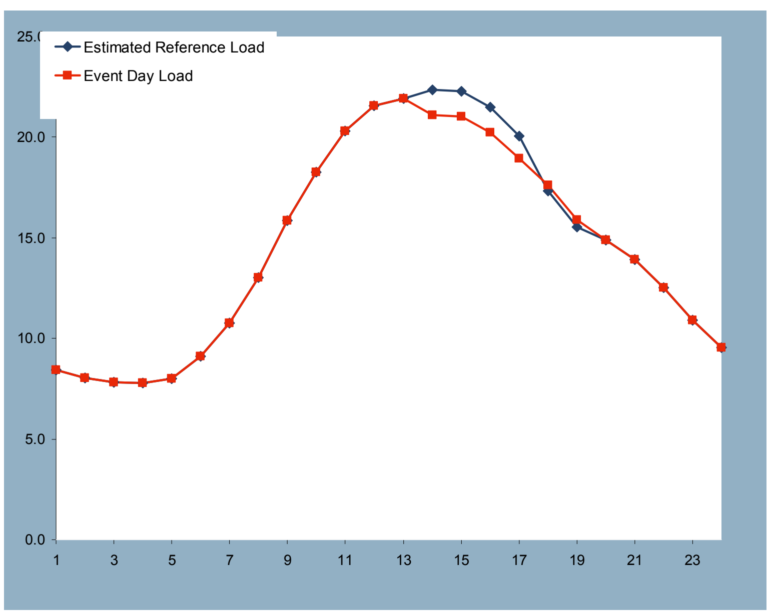


Table 5-12
Commercial MW *Ex Post* Impacts, Tabular and Plot
October 1st, Day of System Peak, 30 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct	1	8.44	8.44	0.00	72.09	-0.04	-0.02	0.00	0.02	0.04
1-Oct	2	8.03	8.03	0.00	71.51	-0.04	-0.02	0.00	0.02	0.04
1-Oct	3	7.80	7.80	0.00	70.10	-0.04	-0.02	0.00	0.02	0.04
1-Oct	4	7.77	7.77	0.00	68.98	-0.04	-0.02	0.00	0.02	0.04
1-Oct	5	7.99	7.99	0.00	70.08	-0.04	-0.02	0.00	0.02	0.04
1-Oct	6	9.10	9.10	0.00	69.82	-0.04	-0.02	0.00	0.02	0.04
1-Oct	7	10.75	10.75	0.00	77.18	-0.05	-0.02	0.00	0.02	0.05
1-Oct	8	13.02	13.02	0.00	82.93	-0.05	-0.02	0.00	0.02	0.05
1-Oct	9	15.86	15.86	0.00	88.52	-0.09	-0.04	0.00	0.04	0.09
1-Oct	10	18.27	18.27	0.00	91.61	-0.14	-0.06	0.00	0.06	0.14
1-Oct	11	20.30	20.30	0.00	92.10	-0.18	-0.07	0.00	0.07	0.18
1-Oct	12	21.54	21.54	0.00	92.53	-0.21	-0.08	0.00	0.08	0.21
1-Oct	13	21.91	21.91	0.00	92.74	-0.20	-0.08	0.00	0.08	0.20
1-Oct	14	22.33	21.10	1.23	91.66	1.02	1.15	1.23	1.32	1.44
1-Oct	15	22.29	21.04	1.25	90.68	1.03	1.16	1.25	1.34	1.47
1-Oct	16	21.47	20.22	1.25	86.90	1.02	1.16	1.25	1.34	1.48
1-Oct	17	20.06	18.94	1.12	83.90	0.91	1.04	1.12	1.21	1.34
1-Oct	18	17.32	17.60	0.00	80.26	-0.17	-0.07	0.00	0.07	0.17
1-Oct	19	15.52	15.88	0.00	77.40	-0.12	-0.05	0.00	0.05	0.12
1-Oct	20	14.90	14.90	0.00	75.40	-0.10	-0.04	0.00	0.04	0.10
1-Oct	21	13.93	13.93	0.00	73.99	-0.09	-0.04	0.00	0.04	0.09
1-Oct	22	12.51	12.51	0.00	72.55	-0.08	-0.03	0.00	0.03	0.08
1-Oct	23	10.91	10.91	0.00	70.96	-0.07	-0.03	0.00	0.03	0.07
1-Oct	24	9.53	9.53	0.00	70.43	-0.05	-0.02	0.00	0.02	0.05

Date	Daily Summary	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Oct		351.52	347.31	4.86	153.80	n/a	n/a	n/a	n/a	n/a



The residential program 50 percent and 100 percent cycling groups generated estimated impacts of 0.10 and 0.22 kW per ton, respectively, for hour ending 16. The overall residential impact estimate is 0.14 kW per ton. Impacts for all overall residential event hours are statistically significantly different than zero at the 80 percent confidence level.

Commercial programs 30 percent and 50 percent cycling groups generated estimated impacts of 0.10 and 0.18 kW per ton, respectively, for hour ending 16. We do not generate an overall impact for the commercial program. Impacts for all 50 percent cycling group event hours are statistically significantly different than zero at the 80 percent confidence level.

5.1 Comparison of 2007 and 2008 results

KEMA also evaluated the SDG&E's Summer Saver program for the 2007 cooling season[14]. The DR protocols were filed after that work was begun, but the basic goals of the DR protocols were incorporated into the evaluation. In addition, very similar methods were used to estimate *ex post* impacts for the 2007 and 2008 seasons. The results for the 2007 program provide a context within which to understand the 2008 impact results. This section compares the per-ton impact results estimated using premise-level data from 2007 and 2008.[15] Table 1-9 and Table 1-10 compare 50 percent cycling regime impacts for the residential and commercial programs. There was no commercial 30 percent cycling regime sample for either 2007 or 2008. The residential 100 percent cycling sample was relatively small in 2007 and was increased substantially for 2008.

[14] The 2007 Summer Saver Impact Evaluation report was not finalized and posted to calmac.org at the time of submission of this report.

[15] For the 2007 evaluation, the final residential impact results were developed using the end-use data. The end-use estimates exhibited a higher level of precision and the end-use modeling process included features we were unable to incorporate into the premise-level modeling effort at that time. For the 2008 evaluation, we are reporting final impact estimates for the residential program at the premise-level. See section 3.2.5 for a discussion of this decision.

Table 5-13
Residential per ton kW Impacts, Peak Days 2007 and 2008
50 Percent Cycling Regime

Hour	50 Percent Cycling Impact 2007	50 Percent Cycling Impact 2008	Daily Average Temperature 2007	Daily Average Temperature 2008
14	n/a	0.07	84.1	80.9
15	0.21	0.06		
16	0.39	0.10		
17	n/a	0.16		

Table 5-14
Commercial per ton kW Impacts, Peak Days 2007 and 2008
50 Percent Cycling Regime

Hour	50 Percent Cycling Impact 2007	50 Percent Cycling Impact 2008	Daily Average Temperature 2007	Daily Average Temperature 2008
14	n/a	0.15	80.8	80.9
15	0.21	0.16		
16	0.22	0.18		
17	n/a	0.15		

The system peak day impact estimates for 2008 are substantially lower than the impacts estimated for the 2007 system peak day, particular for the residential program. Because the weather was more mild and the 2008 system peak later in the year, we expected program impacts for 2008 to be lower than the 2007 impacts. The commercial program had a slight drop despite having almost identical weather. The residential program had a substantial drop, with a 3.2 F drop in daily average temperature.

The residential reduction in impacts goes beyond the magnitude of reduction expected for the lower temperature. Cooling usage levels in the pre-event hours dropped more precipitously than predicted by the 2008 cooling models indicate for a decline of 3.2 degrees, a drop of 50 percent compared to an expect drop of approximately 20 percent. This is evidence that a greater than expected number of residential customers already had their AC units turned off.

On the other hand, The 2007 peak day estimates derived from the premise level models were almost twice the size of any other day's impacts. This could be an artifact of a slight change in model structure. The 2007 premise-level estimates do not include the connected load constraint incorporated for the 2008 impact.

6. *Ex Ante* Impact Results

A strength of the modeling approach pursued for this evaluation is that the individual unit models can provide *ex ante* estimates for 50 percent straight cycling even if no events took place. Adaptive switch technology complicates *ex ante* estimation by making the range of potential impacts dependent on adaptive switch performance. Adaptive switch performance is a function of "learning days" and the proprietary adaptive algorithm, for which we have limited information. The *ex ante* modeling tool develops model-based adaptive estimates, by assuming the savings is equal to the duty cycle control percentage (50% or 33%) times the model's estimate of usage absent control. We hypothesize that the true adaptive switch impacts are bounded by this model-based adaptive impact estimate and the straight 50 percent cycling impact estimate and that a reasonable estimate can be developed by blending the two bounds in appropriate proportions.

In the absence of control events, the blending could be based on arbitrary percentage of the model-base adaptive impact estimate. For this evaluation we chose, instead, to leverage 2007 summer event impact results. Unlike the 2008 summer when only two events were called and only late in the cooling season, in 2007, eleven events were called across a range of temperature conditions. The comparison of *ex post* impacts and the two *ex ante* estimates (model-based adaptive and straight 50 percent cycling) allows for a data driven estimate of the blending parameter that can be applied to the *ex ante*s estimates based on the 2008 model.

The evaluation reports *ex ante* impact estimates for the Summer Saver Program consistent with requirement set out in the DR Protocols. The protocols require *ex ante* estimates for all feasible combinations of the following

- Six monthly peak event days and one average event day,
- 1-in2 and 1-in-10 weather conditions,
- Enrolled ton projections from 2009 through 2018,
- Per ton, Full program and net of overlapping programs.

Table 6-1

***Ex Ante* Tables Produced for Each Program (Commercial and Residential)**

Weather Year	Program Level or Cycling Regime	Population or per ton		Average Day	May Peak Day	June Peak Day	July Peak Day	August Peak Day	September Peak Day	October Peak Da
1-in-2 Weather	Program Level	Population no overlap	2009	x		x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	High Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	Low Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
1-in-10 Weather	Program Level	Population no overlap	2009	x		x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	High Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	Low Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x

The DR Protocols are not explicit regarding which views of the *ex ante* will be used for the purpose of planning. Here we produce, for the sake of example, the 1-in-2 peak average kW per ton *ex ante* impact estimates for commercial and residential programs. For the 2007 program SDG&E produced their own *ex ante* estimates.

Table 6-2
Residential kW per ton *Ex Ante* Impacts, Tabular and Plot
1-in-2 Weather, Average Day, Combined 50 and 100 Percent Cycling Regimes

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10	1	0.21	0.21	0.00	69.35	0.00	0.00	0.00	0.00	0.00
1-Jul-10	2	0.19	0.19	0.00	68.68	0.00	0.00	0.00	0.00	0.00
1-Jul-10	3	0.17	0.17	0.00	68.30	0.00	0.00	0.00	0.00	0.00
1-Jul-10	4	0.16	0.16	0.00	67.56	0.00	0.00	0.00	0.00	0.00
1-Jul-10	5	0.16	0.16	0.00	66.86	0.00	0.00	0.00	0.00	0.00
1-Jul-10	6	0.18	0.18	0.00	66.30	0.00	0.00	0.00	0.00	0.00
1-Jul-10	7	0.22	0.22	0.00	67.05	0.00	0.00	0.00	0.00	0.00
1-Jul-10	8	0.23	0.23	0.00	73.00	0.00	0.00	0.00	0.00	0.00
1-Jul-10	9	0.25	0.25	0.00	79.61	0.00	0.00	0.00	0.00	0.00
1-Jul-10	10	0.29	0.29	0.00	85.36	0.00	0.00	0.00	0.00	0.00
1-Jul-10	11	0.33	0.33	0.00	88.79	0.00	0.00	0.00	0.00	0.00
1-Jul-10	12	0.36	0.36	0.00	88.65	0.00	0.00	0.00	0.00	0.00
1-Jul-10	13	0.40	0.40	0.00	89.13	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	14	0.44	0.36	0.08	88.84	0.08	0.08	0.08	0.09	0.09
1-Jul-10	15	0.49	0.38	0.11	87.80	0.10	0.11	0.11	0.11	0.12
1-Jul-10	16	0.53	0.39	0.14	86.72	0.13	0.13	0.14	0.14	0.15
1-Jul-10	17	0.57	0.41	0.15	85.92	0.14	0.15	0.15	0.16	0.17
1-Jul-10	18	0.58	0.60	-0.02	83.33	-0.04	-0.03	-0.02	-0.02	-0.01
1-Jul-10	19	0.56	0.61	-0.06	79.65	-0.07	-0.06	-0.06	-0.05	-0.05
1-Jul-10	20	0.50	0.53	-0.03	75.86	-0.03	-0.03	-0.03	-0.02	-0.02
1-Jul-10	21	0.45	0.46	-0.01	73.57	-0.02	-0.01	-0.01	-0.01	0.00
1-Jul-10	22	0.41	0.41	0.00	71.97	-0.01	0.00	0.00	0.00	0.00
1-Jul-10	23	0.34	0.34	0.00	70.64	0.00	0.00	0.00	0.00	0.00
1-Jul-10	24	0.27	0.27	0.00	70.06	0.00	0.00	0.00	0.00	0.00
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10		8.31	7.94	0.36	119.66	n/a	n/a	n/a	n/a	n/a

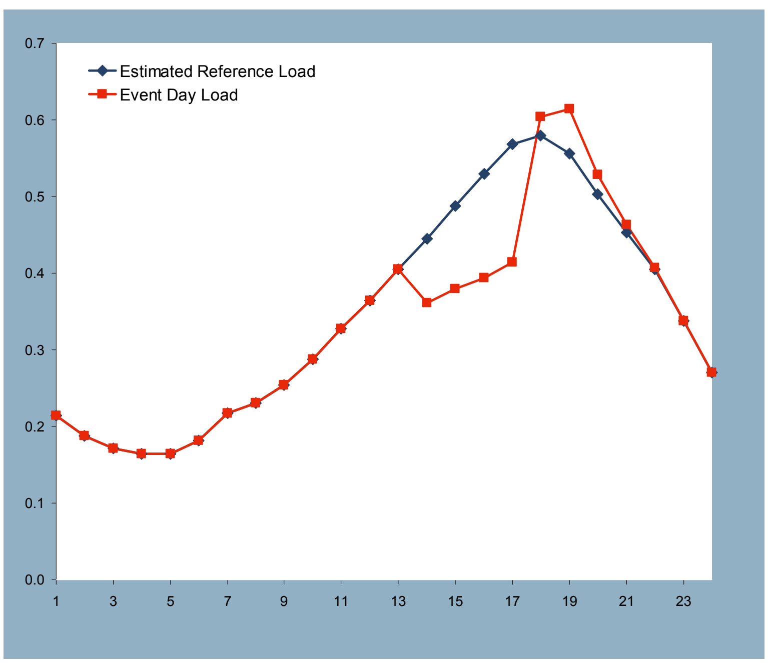
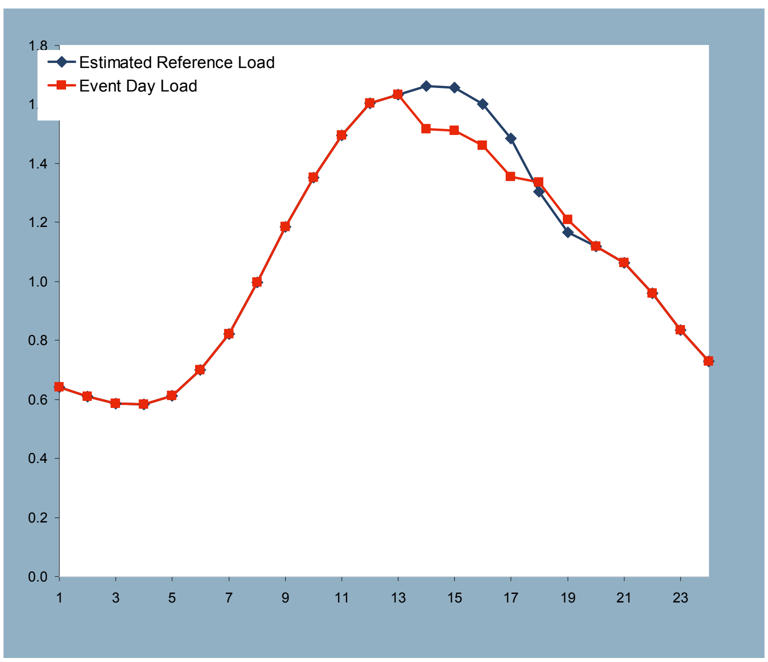


Table 6-3
Commercial kW per ton *Ex Ante* Impacts, Tabular and plot
1-in-2 Weather, Average Day, 50 Percent Cycling Regime

Date	Hour Ending	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10	1	0.64	0.64	0.00	70.18	0.00	0.00	0.00	0.00	0.00
1-Jul-10	2	0.61	0.61	0.00	69.78	0.00	0.00	0.00	0.00	0.00
1-Jul-10	3	0.59	0.59	0.00	69.52	0.00	0.00	0.00	0.00	0.00
1-Jul-10	4	0.58	0.58	0.00	68.96	0.00	0.00	0.00	0.00	0.00
1-Jul-10	5	0.61	0.61	0.00	68.32	0.00	0.00	0.00	0.00	0.00
1-Jul-10	6	0.70	0.70	0.00	67.80	0.00	0.00	0.00	0.00	0.00
1-Jul-10	7	0.82	0.82	0.00	68.51	0.00	0.00	0.00	0.00	0.00
1-Jul-10	8	1.00	1.00	0.00	72.57	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	9	1.19	1.19	0.00	77.65	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	10	1.35	1.35	0.00	82.04	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	11	1.49	1.49	0.00	85.08	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	12	1.61	1.61	0.00	85.66	-0.01	-0.01	0.00	0.01	0.01
1-Jul-10	13	1.63	1.63	0.00	85.59	-0.01	-0.01	0.00	0.01	0.01
1-Jul-10	14	1.66	1.52	0.15	85.41	0.13	0.14	0.15	0.15	0.16
1-Jul-10	15	1.66	1.51	0.15	84.61	0.13	0.14	0.15	0.15	0.16
1-Jul-10	16	1.60	1.46	0.14	83.86	0.13	0.13	0.14	0.15	0.16
1-Jul-10	17	1.49	1.36	0.13	83.32	0.12	0.12	0.13	0.13	0.14
1-Jul-10	18	1.30	1.34	-0.03	81.59	-0.04	-0.04	-0.03	-0.03	-0.02
1-Jul-10	19	1.17	1.21	-0.04	78.11	-0.05	-0.05	-0.04	-0.04	-0.03
1-Jul-10	20	1.12	1.12	0.00	74.83	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	21	1.06	1.06	0.00	72.91	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	22	0.96	0.96	0.00	71.92	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	23	0.84	0.84	0.00	71.13	-0.01	0.00	0.00	0.00	0.01
1-Jul-10	24	0.73	0.73	0.00	70.52	-0.01	0.00	0.00	0.00	0.01
Date	Daily Summary	Estimated Reference Load (kW)	Event Day Load (kW)	Estimated Load Impact (kW)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
1-Jul-10		26.40	25.92	0.49	87.92	n/a	n/a	n/a	n/a	n/a



6.1 Comparison of *Ex Post* and *Ex Ante* Estimates

Despite the relative mild and low variation temperatures in the 2008 cooling season the *ex ante* models based on the 2008 weather appears to do a reasonable job of estimating impacts across a range conditions. Figure 1-1 and Figure 1-2 compare results for the *ex ante* model with *ex post* results from 2007 for the residential and commercial 50 percent cycling groups. The figures plot hour ending 17 per ton kW with respect to daily average temperature.

Figure 6-1
Comparison of 2007 *Ex Post* with 2008 *Ex Ante*
Residential 50 Percent Cycle Impacts for Hour Ending 17

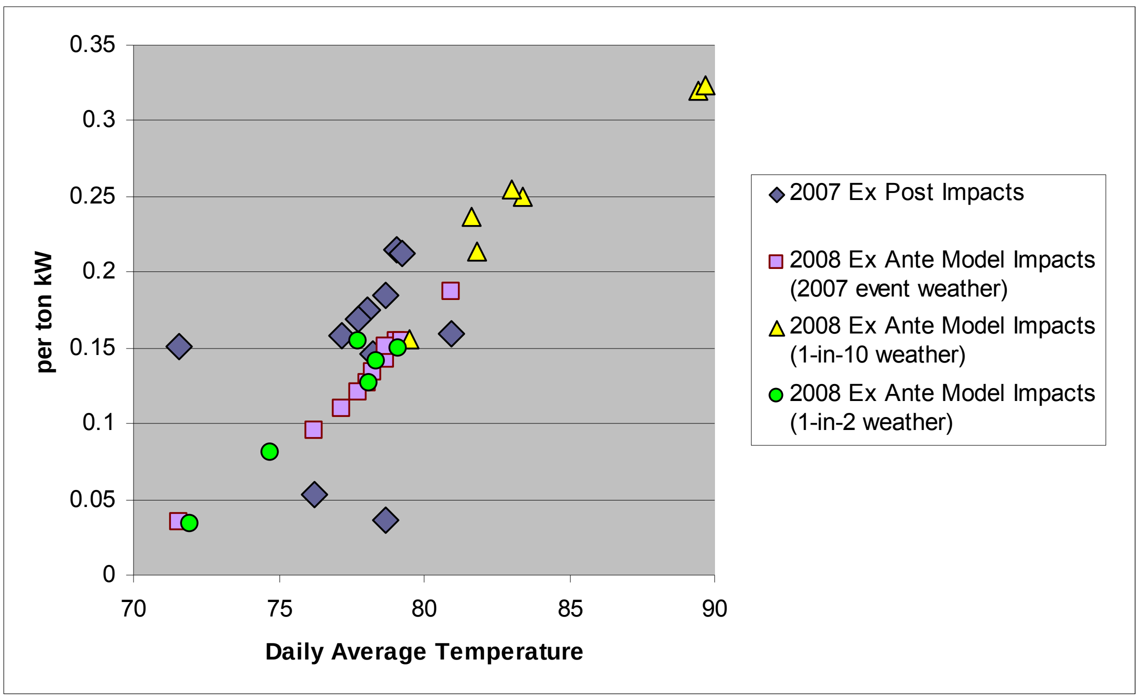
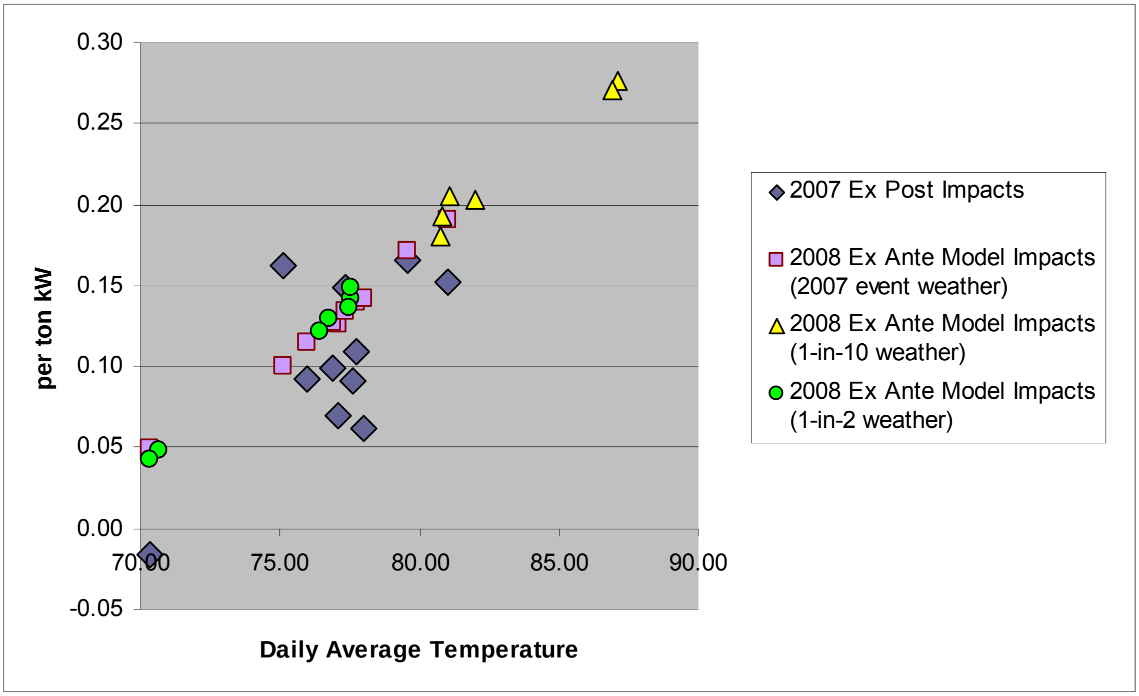


Figure 6-2
Comparison of 2007 *Ex Post* with 2008 *Ex Ante*
Commercial 50 Percent Cycle Impacts for Hour Ending 17



The figures plot the *ex post* impact results for the eleven events that took place in 2007. These are portrayed with dark blue diamonds. We estimated *ex ante* impacts with the 2008 ex ante model for those same eleven days using the 2007 event day weather as the input to the 2008 *ex ante* model. At every temperature for which there is an ex post result there is an ex ante result portrayed in a purple square. Finally, to give a fully picture of the 2008 ex ante model results, we include the 2008 ex ante model 1-in-2 and 1-in10 weather year estimates as well. These are included in green circles and yellow triangles, respectively.

We use 2007 *ex post* impacts for comparison because there were only two 2008 *ex post* events that were held in October and do not apper to be representative of typical behavior. These plots comparing to 2007 indicate two important points:

- The *ex post* impacts have a lot of variation
- *Ex ante* follow a trend line generally consistent with the scatter of the *ex post* results.

It's important to recognize that 2008 had very little hot weather and relatively little temperature variation over the whole season. As a result, it's difficult to estimate the models definitively, particularly for applications at higher temperatures such as 1 in 10. Moreover, customer behavior may have been different in 2008 as a result of the extended mild weather, compared to what would occur at similar temperatures in the middle of a hot summer. Despite this, the *ex ante* model appears to produce reasonable estimates relative to the 2007 *ex post* estimates.

In 2009 we hope to both continue to refine the models, and potentially to have hotter days that will better inform the models.

7. Statistical Measures Tables (Protocols 9 and 10)

This section presents the statistical measure tables required for Protocol 9 and 10. These tables are organized in a way that addresses the spirit of the two protocols while illustrating the strengths of the specific method used here.

The ex-post impact estimates include a premise-level adjustment. The adjustment is designed to improve the estimation accuracy during the event period. The adjustment also motivates the inclusion of Protocol 9 statistical measures as it represents a departure from the premise-level regression results. The event period adjustment comes at the cost of accuracy during hours outside of the event period. In all of the Protocol 9 statistics the focus should be on hours ending 14 through 17 which were the event hours for both 2008 events.

In recognition of the fact that the model is ultimately a regression based model, we include a distribution of premise-level R2s, as well.

7.1 Statistical Measures Equations (Protocol 9)

This analysis uses premise-level regression modeling adjusted with a same-day adjustment in a difference of difference framework utilizing a comparison group. Because of the adjustment applied to regression-based load estimates at the premise-level, regression-based diagnostics describe in the DR Protocols will not fully reflect the accuracy of premise-level load estimates. Protocol 9, designed with day-matching techniques in mind, offers a more flexible way of measuring load estimate accuracy using proxy days. The following sections provide the formulas used to calculate the Protocol 9 statistical measures.

The standard Protocol 9 statistical measures still underestimate the accuracy of the methodology employed here. The bias and variation resulting from the adjusted load model estimates should be similar across the controlled and comparison groups. In the difference of differences framework, systematic biases should cancel each other out at least partially increasing the accuracy of the final estimate. We provide Protocol 9 measures for bias separately by the two control groups. We then provide the analogous result for the difference between the two groups. These differenced biases measures reflect the bias experienced in the difference of differences framework.

7.1.1 Selection of Proxy Days

Proxy days are used to establish the accuracy of the impact estimation approach. In theory, the estimation approach ought to produce a reference load that equals observed load on non-event days. The error associated with estimating load on proxy days is the basis of the statistical measures reported here.

The DR protocols give some guidance as to how to select proxy days.[16] The most important directive is to select proxy days "as similar as possible" to the actual event days. SDG&E attempts to call an event on the day of the system peak. In the interest of developing a single criteria that would consistently select days resembling the day of the system peak, KEMA focused on peak period usage.

Five proxy days were selected based on premise-level usage, for residential and commercial sectors separately. Usage between the hours of 11 AM and 6 PM were summed across all sites in the sample. The six non-event, non-holiday weekdays with the greatest daily usage were chosen as proxy days, as shown in **Error! Reference source not found.** and **Error! Reference source not found.**. The selected days include the day immediately prior to the system peak day as well as at least one other day with a daily average temperature of a similar magnitude.

Table 7-1
Residential Proxy Days 2008

Date	Average Temperature	Sum of kW
6/20/2008	81	3,560.8
9/5/2008	75	3,418.9
9/4/2008	77	3,308.1
9/30/2008	78	3,303.8
6/23/2008	74	3,221.7

16 Identify a reasonable set of "proxy days" that occurred over a relevant time period. These "proxy days" are days on which the DR resource was not operated and which are as similar as possible to the actual days on which the DR resource was used. As many "proxy days" should be selected as possible, taking care to ensure that these days are indeed similar to the days on which the DR resource was used.

Table 7-2
Commercial Proxy Days 2008

Date	Average Temperature	Sum of kW
9/4/2008	75	44,058.7
9/30/2008	78	44,002.5
8/7/2008	76	43,380.5
10/2/2008	75	43,046.3
6/20/2008	78	42,700.8

7.1.2 Statistical Measure Equations

Protocol 9 provides equations for its statistical measures. We reproduce those equations here with clarifications that reflect the way the statistics were calculated for this report. A weight variable is included to make these equations as general as possible. This evaluation is performed under the assumption that the Summer Saver samples have been randomly selected from their populations. In this case, the weight will always equal one.

7.1.2.1 Average Error

The first statistic is the average error across customers and proxy days, for each hour of the day. With sample weights, the formula becomes:

$$\bar{e}_h = \frac{\sum_{j=1}^{n_{cust}} \sum_{p=1}^{n_{days}} \left(L_{jph} - \hat{L}_{jph}\right) \cdot w_j}{n_{cust} \cdot n_{days} \cdot \sum_{j=1}^{n_{cust}} w_j}$$

where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
L_{jph}	=	the actual load for the customer on the proxy day of interest for the hour of interest

$\hat{L}_{jph}$	=	the predicted load for the customer on the proxy day of interest for the hour of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
w_j	=	the sample weight for each unit or customer

7.1.2.2 Relative Average Error

Associated with the previous measure is the relative weighted average error for each hour, across customers and proxy days. It is calculated as the ratio of the weighted average error to the weighted average actual load that occurred in the specific hour. Its formula is given by:

$$r\overline{e}_h = \frac{\overline{e}_h}{\dfrac{\sum_{j=1}^{n_{cust}} \sum_{p=1}^{n_{days}} L_{jph} \cdot w_j}{n_{cust} \cdot n_{days} \cdot \sum_{j=1}^{n_{cust}} w_j}}$$

where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
$\overline{e}_h$	=	the average errors across customers and proxy days for the hour of interest
L_{jph}	=	the actual load for the customer on the proxy day of interest for the hour of interest
$\hat{L}_{jph}$	=	the predicted load for the customer on the proxy day of interest for the hour of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
w_j	=	the sample weight for each unit or customer

7.1.2.3 Median Error

The Protocol also requires the median error to be reported. A weighted median error is the error corresponding to the center of the distribution of error weights, when the error weights are arranged in order of magnitude. In case there is a tie between two weights, the simple average between them is used.

$$\tilde{e}_h = \begin{cases} e_{jph+1} & \text{if } \sum_{i=1}^{j} w_i < 50\% \cdot \sum_{i=1}^{n_{cust}} w_i < \sum_{i=1}^{j+1} w_i \\ \frac{1}{2}(e_{jph} + e_{jph+1}) & \text{if } \sum_{i=1}^{j} w_i = 50\% \cdot \sum_{i=1}^{n_{cust}} w_i \end{cases}$$

where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
e_{jph}	=	the prediction error, $L_{jph} - \hat{L}_{jph}$
L_{jph}	=	the actual load for the customer on the proxy day of interest for the hour of interest
$\hat{L}_{jph}$	=	the predicted load for the customer on the proxy day of interest for the hour of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
w_j	=	the sample weight for each unit or customer

7.1.2.4 Relative Median Error

A relative weighted median error can be calculated by dividing the weighted median error by the weighted median load for each hour of the day. It is calculated as:

$$r\tilde{e}_h = \frac{\tilde{e}_h}{\tilde{L}_h}$$

where:

h	=	the hour of the day
$\tilde{e}_h$	=	the median error across customers and proxy days for each hour of the entire day, as calculated above

$\tilde{L}_h$	=	the weighted median load for the customer on the proxy day of interest

7.1.2.5 Coefficient of Alienation

One way of evaluating how well a model performs is to measure how much variation is not accounted for by it. Protocol 9 demands the calculation of the Coefficient of Alienation, which measures the proportion of variation in load that is not explained by variation in the forecast load. Using sample weights, the coefficient is given by:

$$A = \sum_{j=1}^{n_{cust}} \sum_{p=1}^{n_{days}} \sum_{h=1}^{n_{hours}} \frac{(L_{jph} - \hat{L}_{jph})^2 \cdot w_j}{(L_{jph} - \bar{L}_{ph})^2} \cdot \frac{1}{\sum_{j=1}^{n_{cust}} w_j}$$

where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
L_{jph}	=	The actual load for the customer on the proxy of interest for the hour of interest
$\hat{L}_{jph}$	=	the predicted load for the customer on the proxy day of interest for the hour of interest
$\bar{L}_{ph}$	=	the average load on the proxy day of interest for the hour of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
n_{hours}	=	the total number of hours being observed on the proxy day
w_j	=	the sample weight for each unit or customer

7.1.2.6 Theil's U Statistic

To measure the predictive power of the model, the Protocol requires the calculation of Theil's *U* statistic[17]. Bound between 0 and 1, this statistic measures how better the model performs when compared to a simple prediction of no change. The closer the *U* statistic is to zero, the more accurate the model is. We report a sample-weighted Theil value that is calculated as follows:

$$U = \frac{\left[\dfrac{\sum_{p=1}^{n_{days}}\sum_{h=1}^{n_{hours}}(L_{jph}-\hat{L}_{jph})^2}{n_{days}\cdot n_{hours}}\right]^{\frac{1}{2}}}{\left[\dfrac{\sum_{p=1}^{n_{days}}\sum_{h=1}^{n_{hours}}L_{jph}^2}{n_{days}\cdot n_{hours}}\right]^{\frac{1}{2}}+\left[\dfrac{\sum_{p=1}^{n_{days}}\sum_{h=1}^{n_{hours}}\hat{L}_{jph}^2}{n_{days}\cdot n_{hours}}\right]^{\frac{1}{2}}}$$

where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
L_{jph}	=	the actual observed load for the period of interest
$\hat{L}_{jph}$	=	the predicted load for the period of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
n_{hours}	=	number of periods
w_j	=	the sample weight for each unit or customer

[17] The denominator of the Theil's U statistic describe in the DR protocols is a combination of estimated and actual load. We believe the intent of this version of the statistic was to normalize by the average level of the squared loads from the two sources. This would entail that the whole denominator is divided by two. For consistency, the Theil's U statistics presented in this report follow the DR protocol equations as they were published.

7.2 Statistical Measures Results

The average and median error tables are provided aggregated at the control group level because the impact estimates are a combination of impacts aggregated at the control group level. An additional table is included that combines the average and median errors as they would be combined in the difference of differences framework. The combined table illustrates the improvement in estimation accuracy that follows from the combination of comparison and controlled groups.

The magnitude of the estimation errors for the residential and commercial samples is similar. The errors are made relative with respect to premise load. For this reason, the relative error results for commercial look substantially better than the residential premises. The improvements resulting from the difference of differences framework are particularly striking in the residential errors. On average across the four hours, the relative average errors are more than halved.

Table 7-3
Residential Premise-Level Cycling Group A
Average and Median Errors (kW)

Hour	Count	Average Observed Load	Average Estimated Load	Average Error	Relative Average Error	Median Observed Load	Median Estimated Load	Median Error	Relative Median Error
1	530	0.76	0.93	-0.17	-23%	0.52	0.57	0.03	6%
2	530	0.67	0.87	-0.20	-30%	0.49	0.49	0.03	6%
3	530	0.62	0.82	-0.21	-34%	0.47	0.46	0.03	6%
4	530	0.59	0.80	-0.22	-37%	0.45	0.44	0.02	5%
5	530	0.57	0.81	-0.24	-43%	0.45	0.45	0.02	5%
6	530	0.65	0.88	-0.24	-37%	0.51	0.53	0.02	4%
7	530	0.76	1.00	-0.25	-32%	0.61	0.65	0.01	2%
8	530	0.84	1.05	-0.21	-26%	0.61	0.70	0.00	1%
9	530	0.94	1.13	-0.19	-20%	0.64	0.69	0.03	4%
10	530	1.04	1.21	-0.17	-16%	0.67	0.73	0.00	0%
11	530	1.11	1.28	-0.17	-15%	0.71	0.77	0.00	0%
12	530	1.29	1.36	-0.07	-5%	0.78	0.85	0.02	2%
13	530	1.44	1.44	0.00	0%	0.81	0.90	0.02	2%
14	530	1.63	1.53	0.09	6%	0.96	1.01	-0.01	-1%
15	530	1.77	1.63	0.14	8%	1.03	1.20	-0.01	-1%
16	530	1.98	1.76	0.22	11%	1.29	1.36	0.00	0%
17	530	2.17	1.86	0.30	14%	1.36	1.47	0.02	1%
18	530	2.16	1.92	0.23	11%	1.50	1.53	0.00	0%
19	530	2.03	1.87	0.16	8%	1.50	1.46	-0.02	-1%
20	530	1.87	1.73	0.14	7%	1.44	1.33	0.00	0%
21	530	1.64	1.62	0.02	1%	1.30	1.32	-0.03	-2%
22	530	1.49	1.49	0.00	0%	1.09	1.23	0.00	0%
23	530	1.28	1.28	0.00	0%	0.90	0.98	0.00	0%
24	530	1.00	1.10	-0.10	-10%	0.63	0.73	0.01	1%
Average	12,720	1.26	1.31	-0.05	-4%	0.75	0.87	0.01	1%

Table 7-4
Residential Premise-Level Cycling Group B
Average and Median Errors (kW)

Hour	Count	Average Observed Load	Average Estimated Load	Average Error	Relative Average Error	Median Observed Load	Median Estimated Load	Median Error	Relative Median Error
1	561	0.90	1.16	-0.27	-30%	0.62	0.69	0.00	-1%
2	561	0.78	1.07	-0.29	-38%	0.55	0.60	-0.01	-1%
3	561	0.71	1.03	-0.32	-45%	0.52	0.58	0.00	-1%
4	561	0.67	1.00	-0.33	-49%	0.52	0.57	0.01	2%
5	561	0.65	1.00	-0.35	-53%	0.50	0.58	0.00	-1%
6	561	0.68	1.03	-0.35	-51%	0.53	0.62	-0.01	-2%
7	561	0.85	1.17	-0.32	-37%	0.63	0.78	0.00	0%
8	561	0.94	1.26	-0.32	-34%	0.67	0.83	-0.02	-3%
9	561	1.03	1.33	-0.30	-29%	0.72	0.89	-0.01	-2%
10	561	1.18	1.45	-0.28	-24%	0.76	1.02	-0.01	-1%
11	561	1.40	1.60	-0.19	-14%	0.86	1.14	0.00	0%
12	561	1.49	1.68	-0.20	-13%	0.87	1.22	-0.01	-1%
13	561	1.75	1.83	-0.08	-4%	1.06	1.30	0.02	2%
14	561	2.10	1.98	0.12	6%	1.36	1.41	-0.01	-1%
15	561	2.38	2.11	0.27	11%	1.59	1.52	0.01	1%
16	561	2.60	2.25	0.36	14%	1.91	1.69	0.00	0%
17	561	2.74	2.37	0.37	13%	2.26	1.85	0.00	0%
18	561	2.75	2.38	0.36	13%	2.08	1.87	0.00	0%
19	561	2.55	2.34	0.21	8%	1.90	1.69	-0.01	0%
20	561	2.33	2.20	0.13	6%	1.79	1.69	-0.02	-1%
21	561	2.03	2.06	-0.03	-1%	1.61	1.65	-0.03	-2%
22	561	1.84	1.90	-0.07	-4%	1.40	1.54	0.00	0%
23	561	1.50	1.64	-0.14	-9%	1.05	1.22	0.00	0%
24	561	1.12	1.35	-0.23	-20%	0.75	0.91	-0.03	-3%
Average	13,464	1.54	1.63	-0.09	-6%	0.88	1.14	0.00	0%

Table 7-5
Residential Premise-Level Combined Cycling Group
Average and Median Errors (kW)

Hour	Average Error	Relative Average Error	Median Error	Relative Median Error
1	0.09	0.04	11%	4%
2	0.10	0.04	13%	5%
3	0.11	0.03	17%	5%
4	0.12	0.01	18%	2%
5	0.11	0.03	17%	4%
6	0.11	0.03	17%	5%
7	0.07	0.02	9%	2%
8	0.11	0.02	12%	3%
9	0.11	0.04	12%	4%
10	0.11	0.01	10%	1%
11	0.02	0.00	2%	0%
12	0.13	0.02	9%	2%
13	0.08	0.00	5%	0%
14	-0.03	0.00	-1%	0%
15	-0.13	-0.02	-6%	-1%
16	-0.14	0.00	-6%	0%
17	-0.07	0.02	-3%	1%
18	-0.13	0.00	-5%	0%
19	-0.05	-0.01	-2%	0%
20	0.00	0.02	0%	1%
21	0.04	0.00	2%	0%
22	0.07	0.00	4%	0%
23	0.13	0.00	10%	0%
24	0.13	0.03	12%	3%

Table 7-6
Residential Premise-Level Combined Cycling Group
Coefficient of Alienation and Theil's U (kW)

Period	Coefficient of Alienation	Theil's U
All Hours	0.534082804	0.286623
Event Hours	0.348076424	0.219503

Table 7-7
Commercial Premise-Level Cycling Group A
Average and Median Errors (kW)

Hour	Count	Average Observed Load	Average Estimated Load	Average Error	Relative Average Error	Median Observed Load	Median Estimated Load	Median Error	Relative Median Error
1	546	9.93	10.26	-0.33	-3%	5.21	5.56	-0.07	-1%
2	546	9.46	9.82	-0.37	-4%	5.03	5.30	-0.03	-1%
3	546	9.25	9.56	-0.31	-3%	5.04	5.33	-0.01	0%
4	546	9.24	9.55	-0.31	-3%	4.92	5.39	0.00	0%
5	546	9.55	9.83	-0.28	-3%	4.92	5.41	0.00	0%
6	546	10.76	11.09	-0.32	-3%	5.28	5.75	0.00	0%
7	546	12.72	12.92	-0.20	-2%	6.01	6.66	0.06	1%
8	546	15.79	15.49	0.30	2%	9.00	9.26	0.06	1%
9	546	18.78	18.50	0.27	1%	11.57	11.84	0.07	1%
10	546	21.71	21.10	0.61	3%	14.16	14.09	0.33	2%
11	546	23.98	23.32	0.66	3%	16.19	16.31	0.33	2%
12	546	25.21	24.69	0.51	2%	17.31	17.74	0.20	1%
13	546	25.32	25.04	0.29	1%	17.94	17.93	0.12	1%
14	546	25.51	25.48	0.04	0%	18.15	18.12	-0.07	0%
15	546	25.67	25.43	0.24	1%	18.24	18.19	-0.04	0%
16	546	24.53	24.57	-0.04	0%	17.13	17.52	-0.02	0%
17	546	22.83	23.10	-0.27	-1%	15.81	16.15	-0.07	0%
18	546	19.39	19.94	-0.56	-3%	12.21	13.52	-0.16	-1%
19	546	17.52	17.98	-0.46	-3%	10.18	11.57	-0.14	-1%
20	546	17.20	17.25	-0.05	0%	9.84	10.72	-0.10	-1%
21	546	16.23	16.29	-0.06	0%	8.26	9.42	-0.05	-1%
22	546	14.37	14.71	-0.34	-2%	7.33	8.24	-0.18	-2%
23	546	12.51	12.87	-0.36	-3%	6.24	6.69	-0.13	-2%
24	546	11.04	11.39	-0.35	-3%	5.64	6.14	-0.11	-2%
Average	13,104	17.02	17.09	-0.07	0%	9.45	10.32	0.00	0%

Table 7-8
Commercial Premise-Level Cycling Group B
Average and Median Errors (kW)

Hour	Count	Average Observed Load	Average Estimated Load	Average Error	Relative Average Error	Median Observed Load	Median Estimated Load	Median Error	Relative Median Error
1	522	11.26	11.70	-0.45	-4%	4.85	5.77	0.01	0%
2	522	10.33	11.10	-0.76	-7%	4.72	5.48	-0.01	0%
3	522	9.86	10.65	-0.79	-8%	4.67	5.34	-0.07	-1%
4	522	9.90	10.59	-0.70	-7%	4.72	5.33	-0.01	0%
5	522	10.60	11.22	-0.63	-6%	4.96	5.53	0.00	0%
6	522	12.12	12.69	-0.57	-5%	5.41	5.89	-0.02	0%
7	522	14.01	14.67	-0.66	-5%	7.30	7.84	-0.04	-1%
8	522	17.24	17.72	-0.47	-3%	10.55	10.81	0.00	0%
9	522	20.59	20.63	-0.04	0%	13.20	12.59	0.11	1%
10	522	23.73	23.29	0.44	2%	15.25	15.01	0.16	1%
11	522	26.03	25.51	0.52	2%	18.24	17.29	0.25	1%
12	522	28.14	27.64	0.50	2%	19.50	19.22	0.30	2%
13	522	28.34	28.09	0.25	1%	20.18	20.02	0.12	1%
14	522	28.76	28.68	0.08	0%	19.91	19.86	-0.01	0%
15	522	28.29	28.49	-0.20	-1%	18.98	19.69	0.01	0%
16	522	27.53	27.73	-0.20	-1%	18.70	19.14	0.00	0%
17	522	25.24	25.56	-0.32	-1%	18.19	18.00	-0.03	0%
18	522	22.46	22.95	-0.49	-2%	15.59	16.53	-0.14	-1%
19	522	20.35	20.57	-0.22	-1%	12.89	13.54	-0.01	0%
20	522	19.73	19.77	-0.04	0%	11.78	12.14	0.14	1%
21	522	18.81	19.05	-0.24	-1%	10.33	10.98	0.04	0%
22	522	17.15	17.40	-0.25	-1%	8.39	9.39	0.03	0%
23	522	14.83	15.21	-0.38	-3%	6.67	7.86	-0.02	0%
24	522	12.77	13.31	-0.53	-4%	5.88	6.48	0.02	0%
Average	12,528	19.09	19.34	-0.26	-1%	11.32	11.57	0.02	0%

Table 7-9
Commercial Premise-Level Combined Cycling Group
Average and Median Errors (kW)

Hour	Average Error	Relative Average Error	Median Error	Relative Median Error
1	0.11	-0.07	1%	-1%
2	0.40	-0.02	4%	0%
3	0.48	0.05	5%	1%
4	0.39	0.01	4%	0%
5	0.34	0.00	3%	0%
6	0.24	0.02	2%	0%
7	0.47	0.10	4%	1%
8	0.77	0.06	5%	0%
9	0.32	-0.05	2%	0%
10	0.16	0.17	1%	1%
11	0.14	0.08	1%	0%
12	0.02	-0.10	0%	0%
13	0.04	0.00	0%	0%
14	-0.05	-0.06	0%	0%
15	0.44	-0.05	2%	0%
16	0.16	-0.01	1%	0%
17	0.05	-0.04	0%	0%
18	-0.06	-0.02	0%	0%
19	-0.24	-0.13	-1%	-1%
20	-0.01	-0.24	0%	-1%
21	0.18	-0.09	1%	-1%
22	-0.09	-0.21	-1%	-1%
23	0.02	-0.11	0%	-1%
24	0.19	-0.13	2%	-1%

Table 7-10
Commercial Premise-Level Combined Cycling Group
Coefficient of Alienation and Theil's U (kW)

Period	Coefficient of Alienation	Theil's U
All Hours	0.047931332	0.08646
Event Hours	0.015358068	0.044717

7.2.1 Theil's U Statistic

Theil's U is a measure of variation. It's a relative measure of variance, scaled by the magnitude of the load, so is appropriate for comparison across units of different sizes. For the DR protocols, Theil's U is applied to individual premise data series for the selected proxy days. The distribution of Theil's U across the sample provides an indication of the level of estimation error on the proxy days.

Figure 7-1 and Figure 7-2 provide the distribution of Theil's U across the individual premises. For residential, the median value of distribution is 20 percent and the mean is 22 percent. The median Theil's U for commercial premises is 5%, whereas its mean is 7%. Note that lower values of Theil's U indicate better performance of the model.

Figure 7-1
Residential Distribution of Theil's U Statistic 2008

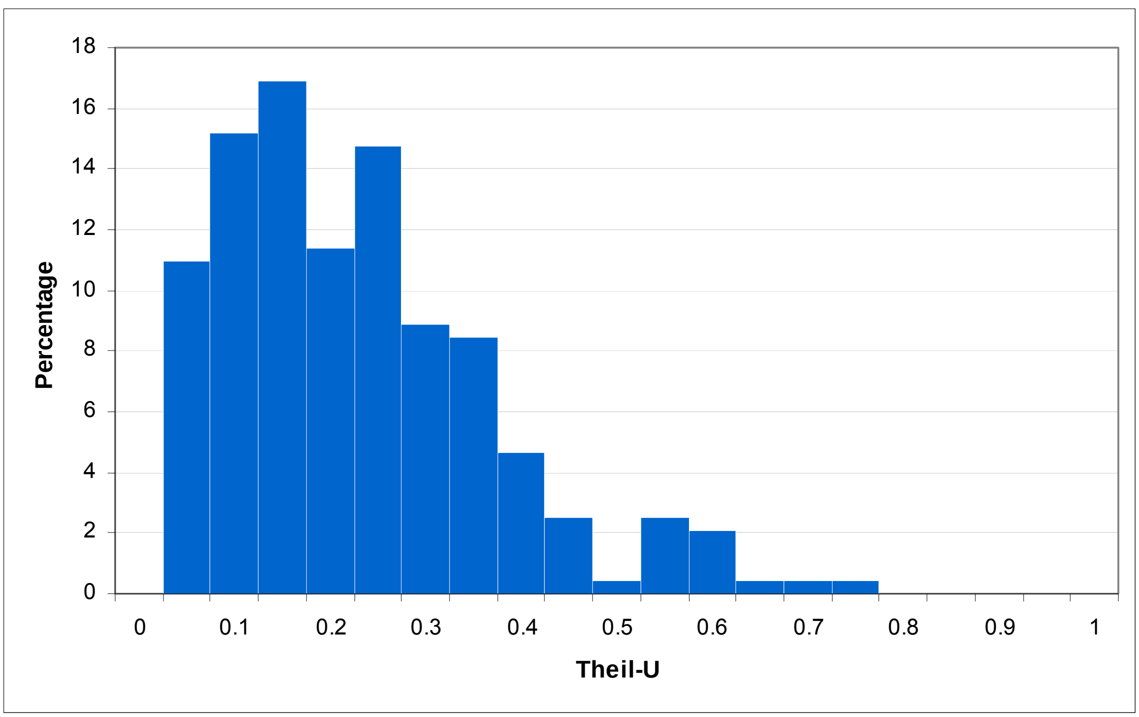
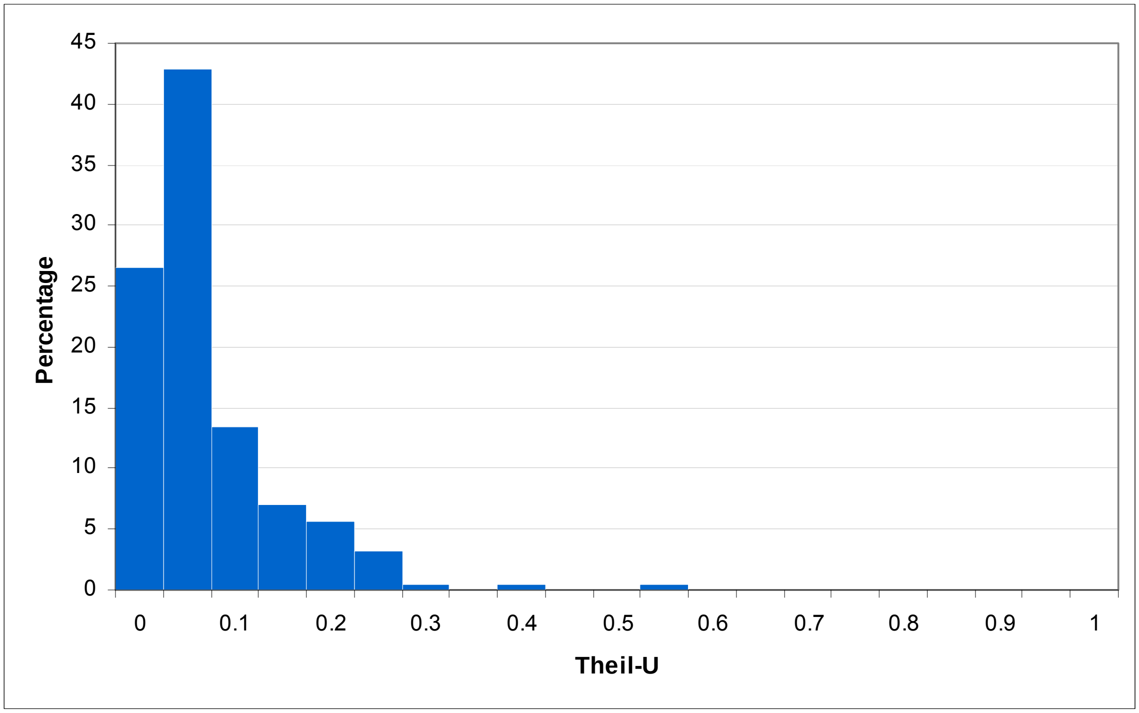


Figure 7-2
Commercial Distribution of Theil's U Statistic 2008



7.3 Tables prescribed by Protocol 10: Statistical Measures for Regression Based Methods

Protocol 10 requires a wide range of regression diagnostics to establish the accuracy of the regression(s) underlying the impact estimates. KEMA fits regression models separately to each participating premise non-event day data to estimate the premise's event-day reference load. The diagnostics from these many regressions are challenging to summarize.

Figure 7-3 shows that the cooling load model employed for this analysis accounted for more than 50 percent of the variation for 95 percent of the residential premises. The median adjusted R-squared for that sector is 0.77. In the case of commercial, presented in Figure 7-4, about 97 percent of the premises had an adjusted R-squared greater than 50 percent, with an overall median of 0.95.

Figure 7-3
Residential Distribution of Adjusted R-squared 2008

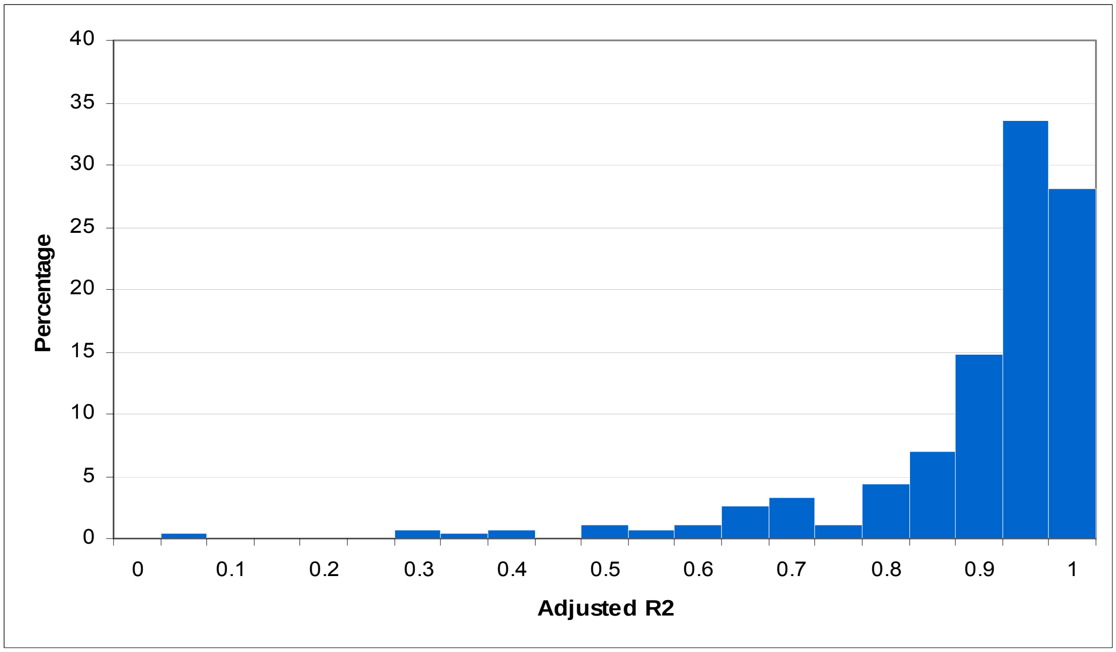
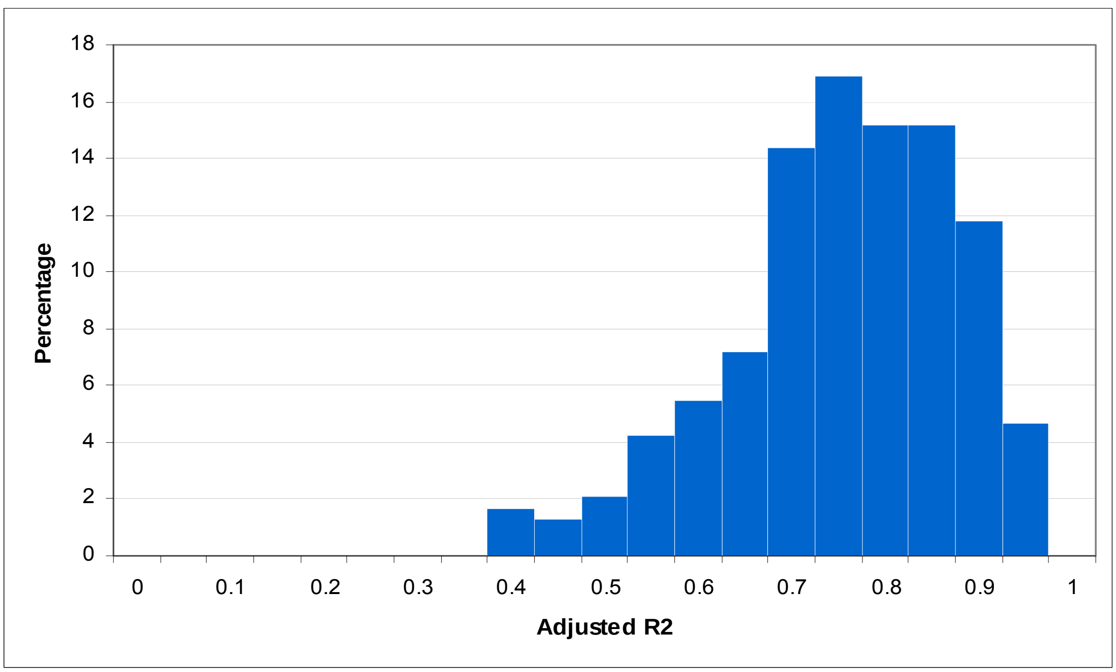


Figure 7-4
Commercial Distribution of Adjusted R-squared 2008



As previously explained, the regression results were the product of a selection process that tested several model specifications. Each alternative specification was estimated across a range of degree day bases in order to identify the optimal cooling degree base for each premise, according to an adjusted *F*-test statistic.

8. Conclusions

The 2008 Summer Saver impact evaluation provides both *ex post* and *ex ante* impact estimates for the residential and commercial Summer Saver programs. The *ex post* results are based on observed whole premise usage compared to modeled load and comparison group load in a difference of differences framework. With this framework, impacts are estimated from the difference between the estimated uncontrolled load and the observed load. Any systematic modeling error or unusual conditions affecting all units, unrelated to the control event, is adjusted for by subtracting the comparison group difference from the cycled group difference.

The *ex ante* results use the same premise-level cooling load models developed for the *ex post* estimates. Duty cycle analysis provides estimates of savings given the estimated cooling model and connected load. Calibration to observed *ex post* impacts provides an estimate of where the savings fall between the extremes of fixed non-adaptive control and perfect adaptive control.

Compared to 2007, the impact results for year 2008 are generally lower. Our investigation suggests that the driving force in this difference is the fact that the summer of 2008 was relatively mild in the territory covered by SDG&E. The system peak did not occur until October 1st and overall the temperatures were more moderate. In total, only two events were called in 2008, in contrast to twelve in 2007. Even on the peak day, the average temperature across customers was lower in the latter year than in the former, and so was the number of participants with any AC usage at all during that day in our sample.

The *ex ante* results are based on the models developed with interval data collected in 2008. In principle, the *ex ante* impact estimates are not constrained by the observed performance of the program in 2008. Enough cooling took place in the summer of 2008 to inform the cooling load model about the premise specific cooling characteristic. The initial, non-blended *ex ante* impact estimates accurately represent cooling usage despite the moderate temperatures in 2008. The inclusion of information from 2007 results to inform the blending of the two initial *ex ante* results

8.1 Recommendations

There are ways the evaluation of the Summer Saver program can be improved in the future:

- The SDG&E service territory is characterized by highly variable weather. The M&V sample populations are geo-coded for appropriate matching with weather stations. If the program population were similarly geo-coded and matched with weather stations, aggregation could take into account the relative frequency of weather stations in the population. This would improve the accuracy of both *ex post* and *ex ante* impact estimates.

- Many of the adaptive control devices on the market have a data storage capability; that is, the device can record observed and expected unit duty cycles for some period of time. Downloading this data from the control devices and incorporating it into the analysis could improve the analysis in a number of ways:
    - Confirmation of expected unit duty cycle;
    - Confirmation of duty cycle reduction; and
    - Improved understanding of when the algorithm defaults to straight 50 percent cycling.
- The DR protocol framework, with its focus on representative weather days, is conducive to more complex models and/or models with a wider range of explanatory variables. Strong cooling load models provide the bridge between *ex post* and *ex ante* results.
- With the coming availability of AMI data for all program participants, evaluation of direct load control programs will likely increasingly rely on whole premise data. At the present time, the availability of end use data should be leveraged to improve the accuracy of whole premise cooling load models. The new commercial end use sample for 2009 should provide this opportunity for the commercial program.

Appendix A – Impact Tools for *Ex Post* and *Ex Ante* Estimates

Because of the variety of factors influencing *ex post* and *ex ante* impact estimates, it is fundamental to analyze them under different scenarios. Unfortunately, the number of possible combinations increases exponentially as more levels of analysis are introduced. For example, for our *ex ante* estimates, more than 500 tables were generated. Merely providing information in the traditional form of a list of tables can be inconvenient, if not confusing, for the reader.

To facilitate the communication of our results we provide a visualization tool that allows the user to choose what level of analysis he or she wants to examine. The tool will dynamically build a table with the impact variables, in the format prescribed by the DR Protocols. Furthermore, it will plot the observed and reference load for the particular period chosen.

Some explanation is in order. First, a few options are not available for certain levels of analysis, even though they are displayed in the drop-down menus. For example, in *ex ante* no population level table can be generated for May Peak 2009 because the projections for program tonnage start in June 2009. For *ex post*, the only invalid case is commercial at the program level, since we decided not to estimate overall impacts for that sector. For *ex ante*, the full list of valid options is presented in Table A-1.

Second, the Impact Tool for *ex ante* results reads from a large number of records, which can cause Excel to become unresponsive for a few seconds. This should not pose any problems for modern computers, but in case one needs to check many different options at a time, this delay can become frustrating. In this case, we recommend the user to disable the automatic recalculation of all cells, which is on by default.

To turn off automatic calculation in Excel, the user needs to click on **Tools** and choose **Options**. Under the tab **Calculation**, one must change the option to **Manual** and click OK. This last step is illustrated in. Figure A-1 Once this change is made, the user can make the desired choices in the main tab without waiting for the updates; the table and plot will be reconstructed when the shortcut key F9 is pressed.

Finally, it is worth reiterating that to serve as a baseline comparison with actual values we included data for the curtailed group from the two event days in 2008 in the *ex ante* calculations. These event days can also be accessed from the Impact Tool, but note that the year type must be set to Event Day.

We hope that our Impact Tool can meet its goal of simplifying understanding of the impact evaluation. We plan to further improve the tool in next rounds.

Table A-1
List of Options in the *Ex Ante* Impact Tool

Weather Year	Program Level or Cycling Regime	Population or per ton		Average Day	May Peak Day	June Peak Day	July Peak Day	August Peak Day	September Peak Day	October Peak Da
1-in-2 Weather	Program Level	Population no overlap	2009	x		x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	High Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	Low Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
1-in-10 Weather	Program Level	Population no overlap	2009	x		x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	High Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x
	Low Cycling	Population no overlap	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Population	2009	x	x	x	x	x	x	x
			2010	x	x	x	x	x	x	x
			2011-2018	x	x	x	x	x	x	x
		Per Ton		x	x	x	x	x	x	x

Figure A-1
Disabling Automatic Calculation of Cells in Excel 2003