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Prepared by:
RLW Analytics

Prepared for:
PJM Load Analysis Subcommittee
&
Charles Goldman
Lawrence Berkeley National Laboratory

Environmental Energy Technologies Division

April 2007

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Executive Summary

Background

During 2005 and 2006, the PJM Interconnection (PJM) Load Analysis Subcommittee (LAS) examined ways to reduce the costs and improve the effectiveness of its existing measurement and verification (M&V) protocols for Direct Load Control (DLC) programs.[1] The current M&V protocol requires that a PURPA-compliant Load Research study be conducted every five years for each Load-Serving Entity (LSE). The current M&V protocol is expensive to implement and administer particularly for mature load control programs, some of which are marginally cost-effective. There was growing evidence that some LSEs were mothballing or dropping[2] their DLC programs in lieu of incurring the expense associated with the M&V.

This project had several objectives: (1) examine the potential for developing deemed savings estimates acceptable to PJM for legacy air conditioning and water heating DLC programs, and (2) explore the development of a collaborative, regional, consensus-based approach for conducting monitoring and verification of load reductions for emerging load management technologies for customers that do not have interval metering capability.

Approach

The deemed savings estimates presented in this study are based on historical end-use metered data available across several jurisdictions. Air conditioning end-use metered data were received from Baltimore Gas and Electric (BGE), FirstEnergy (FE), and Public Service Electric and Gas (PSE&G). Water heating end-use metered data were provided by Baltimore Gas and Electric. Duty cycle models were constructed to examine a wide range of potential switch cycling strategies (27%, 43%, 50%, 67%, 75%, 87% and 100%).[3] Customer segmentation based on air conditioning size (e.g., connected load or seasonal usage) can also be accommodated with the model set. Next, the estimates of the customer's demand saving were mapped to their appropriate weather stations. Finally, regression analysis was conducted to predict the demand savings estimates from weighted temperature humidity indices. The demand savings predictions were tabularized for use by the participating utilities.

Air Conditioning Direct Load Control: Deemed Savings Results

Table 1 presents a sample of the predictive capability of the model and shows the predicted deemed savings for various cycling strategies at varying weighted temperature humidity (THI) combinations from 60^{o}F to 88^{o}F for the 15 minute time period that ends at 5PM. At a THI of 84^{o}F, the demand reduction estimate ranges from a low of 0.37 kW

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[1] PJM Manual 19: Load Data Systems

[2] Only Baltimore Gas and Electric maintains an active load research sample on their air conditioning and water heating direct load control programs for the purpose of reporting to PJM.

[3] Using the regional models developed in this project, the project team can run any duty cycle strategy desired by project contributors including those strategies that employ an adaptive algorithm associated with newer, smarter switches.

for the 27% cycling strategy to a high of 2.06 kW at 100% cycling. The 50% cycling strategy yields an estimate of 0.80 kW. Similar summary tables are available for every 15-minute period throughout the day. Starting at a WTHI of 80°F the savings estimates are available for every 0.1°F increments. Table 2 presents the savings between 84°F and 85°F for the period ending at 5 PM.

Table 1 Deemed Savings Estimates for A/C Load Control at 15-minute period ending 5pm

	Predicted Savings at 5pm For Various Duty Cycle Strategies						
WTHI	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
70.0	0.02	0.04	0.06	0.06	0.09	0.18	0.30
71.0	0.02	0.04	0.06	0.13	0.19	0.28	0.43
72.0	0.02	0.04	0.06	0.21	0.28	0.38	0.55
73.0	0.02	0.09	0.13	0.29	0.37	0.48	0.68
74.0	0.05	0.15	0.19	0.37	0.46	0.58	0.80
75.0	0.09	0.20	0.25	0.45	0.55	0.68	0.93
76.0	0.12	0.25	0.31	0.53	0.65	0.78	1.06
77.0	0.15	0.30	0.37	0.61	0.74	0.87	1.18
78.0	0.18	0.35	0.43	0.68	0.83	0.97	1.31
79.0	0.21	0.40	0.50	0.76	0.92	1.07	1.43
80.0	0.24	0.45	0.56	0.84	1.01	1.17	1.56
81.0	0.27	0.51	0.62	0.92	1.10	1.27	1.68
82.0	0.30	0.56	0.68	1.00	1.20	1.37	1.81
83.0	0.34	0.61	0.74	1.08	1.29	1.47	1.93
84.0	0.37	0.66	0.80	1.16	1.38	1.57	2.06
85.0	0.40	0.71	0.87	1.23	1.47	1.67	2.19
86.0	0.43	0.76	0.93	1.31	1.56	1.77	2.31
87.0	0.46	0.81	0.99	1.39	1.65	1.87	2.44

Table 2 Deemed Savings Estimates for A/C Load Control between 84°F and 85°F at 5pm

	Predicted Savings at 5pm For Various Duty Cycle Strategies						
WTHI	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
84.0	0.37	0.66	0.80	1.16	1.38	1.57	2.06
84.1	0.37	0.66	0.81	1.16	1.39	1.58	2.07
84.2	0.37	0.67	0.82	1.17	1.40	1.59	2.08
84.3	0.38	0.67	0.82	1.18	1.41	1.60	2.10
84.4	0.38	0.68	0.83	1.19	1.42	1.61	2.11
84.5	0.38	0.68	0.83	1.20	1.43	1.62	2.12
84.6	0.39	0.69	0.84	1.20	1.43	1.63	2.13
84.7	0.39	0.70	0.85	1.21	1.44	1.64	2.15
84.8	0.39	0.70	0.85	1.22	1.45	1.65	2.16
84.9	0.40	0.71	0.86	1.23	1.46	1.66	2.17
85.0	0.40	0.71	0.87	1.23	1.47	1.67	2.19

Should the participating utility have the ability to differentiate their population of participating customers by size of air conditioner (i.e., based on either connected load or seasonal energy use), then alternative tables can be applied to generate more customized estimates of a/c load control savings for each utility. The models and analytical methods can support the development of any stratification based on these two variables. Current tables have been constructed for seasonal air conditioning use greater or less than 1,600 kWh and for air conditioning connected load greater or less than 3.5kW.

Table 3 shows the same 15-minute ending 5pm period for WTHI in the range between 70^{o}F and 87^{o}F and including separate estimates by air conditioning (A/C) energy usage stratum. For customers with a seasonal air conditioning use over 1,600 kWh, the estimated demand savings at a WTHI of 84^{o}F ranges from a low of 0.21 kW for the 27% cycling strategy to 1.34 kW for the 100% cycling strategy. For large users (i.e., those with a seasonal use greater than or equal to 1,600 kWh), the demand savings range from a low of 0.48 kW for the 27% cycling strategy to 2.61 kW for the 100% cycling strategy. To develop a specific estimate, the utility simply selects the WTHI for the appropriate hour and creates a weighted average for the appropriate cycling strategy.

Table 3 Predicted A/C Load Control Reduction by Seasonal A/C Use

	Predicted Savings at 5pm For Various Duty Cycle Strategies													
	Stratum 1 AC Usage < 1,600 kWh							Stratum 2 AC Usage > 1,600 kWh						
WTHI	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
70.0	0.01	0.02	0.03	0.04	0.06	0.04	0.05	0.03	0.06	0.05	0.18	0.25	0.39	0.63
71.0	0.01	0.02	0.03	0.04	0.06	0.04	0.14	0.03	0.06	0.12	0.27	0.36	0.51	0.77
72.0	0.01	0.02	0.03	0.04	0.06	0.12	0.23	0.03	0.12	0.19	0.37	0.47	0.63	0.91
73.0	0.01	0.02	0.03	0.09	0.13	0.19	0.33	0.06	0.18	0.26	0.47	0.58	0.74	1.05
74.0	0.01	0.05	0.07	0.15	0.20	0.27	0.42	0.10	0.25	0.33	0.56	0.69	0.86	1.19
75.0	0.03	0.08	0.11	0.21	0.27	0.34	0.51	0.14	0.31	0.40	0.66	0.81	0.98	1.33
76.0	0.05	0.12	0.15	0.27	0.33	0.42	0.60	0.18	0.37	0.47	0.76	0.92	1.09	1.48
77.0	0.07	0.15	0.19	0.33	0.40	0.49	0.69	0.22	0.43	0.54	0.85	1.03	1.21	1.62
78.0	0.09	0.18	0.23	0.38	0.47	0.57	0.79	0.26	0.50	0.61	0.95	1.14	1.33	1.76
79.0	0.11	0.22	0.27	0.44	0.54	0.64	0.88	0.29	0.56	0.68	1.04	1.25	1.44	1.90
80.0	0.13	0.25	0.31	0.50	0.61	0.72	0.97	0.33	0.62	0.75	1.14	1.36	1.56	2.04
81.0	0.15	0.28	0.35	0.56	0.68	0.79	1.06	0.37	0.69	0.82	1.24	1.47	1.68	2.18
82.0	0.17	0.32	0.40	0.62	0.75	0.87	1.15	0.41	0.75	0.89	1.33	1.59	1.80	2.32
83.0	0.19	0.35	0.44	0.67	0.82	0.94	1.25	0.45	0.81	0.96	1.43	1.70	1.91	2.46
84.0	0.21	0.38	0.48	0.73	0.89	1.02	1.34	0.48	0.87	1.03	1.53	1.81	2.03	2.61
84.1	0.22	0.39	0.48	0.74	0.90	1.03	1.35	0.49	0.88	1.04	1.54	1.82	2.04	2.62
84.2	0.22	0.39	0.49	0.74	0.90	1.03	1.36	0.49	0.89	1.05	1.55	1.83	2.05	2.63
84.3	0.22	0.40	0.49	0.75	0.91	1.04	1.37	0.50	0.89	1.06	1.56	1.84	2.06	2.65
84.4	0.22	0.40	0.49	0.76	0.92	1.05	1.37	0.50	0.90	1.06	1.56	1.85	2.08	2.66
84.5	0.22	0.40	0.50	0.76	0.93	1.06	1.38	0.50	0.91	1.07	1.57	1.86	2.09	2.68
84.6	0.23	0.41	0.50	0.77	0.93	1.06	1.39	0.51	0.91	1.08	1.58	1.88	2.10	2.69
84.7	0.23	0.41	0.51	0.77	0.94	1.07	1.40	0.51	0.92	1.08	1.59	1.89	2.11	2.70
84.8	0.23	0.41	0.51	0.78	0.95	1.08	1.41	0.52	0.92	1.09	1.60	1.90	2.12	2.72
84.9	0.23	0.42	0.51	0.78	0.95	1.09	1.42	0.52	0.93	1.10	1.61	1.91	2.13	2.73
85.0	0.23	0.42	0.52	0.79	0.96	1.09	1.43	0.52	0.94	1.10	1.62	1.92	2.15	2.75
86.0	0.25	0.45	0.56	0.85	1.03	1.17	1.52	0.56	1.00	1.18	1.72	2.03	2.26	2.89
87.0	0.27	0.49	0.60	0.91	1.10	1.24	1.61	0.60	1.06	1.25	1.82	2.14	2.38	3.03

To demonstrate the approach, BGE provided 2006 monthly billing data for their entire population of program participants (~220,000 customers). These data were used to develop a model for estimating the air conditioning use of each customer. Next, we calculated the number of participants above and below 1,600 kWh of estimated air conditioning for the June-September 2006 period. Approximately 76% of the current program participants were estimated to have air conditioning usage greater than 1,600 kWh with the remaining 24% using less. Applying the weights to the 84^{o}F estimate presented in Table 3 yields a load reduction estimate of 0.90 kW for the hour ending 5pm for BGE's population of DLC customers.

Similarly, Table 4 presents the predicted reduction by connected air conditioning load. For this analysis, we utilized two strata: connected demand less than 3.5 kW and greater than or equal to 3.5 kW. For the 15-minute period ending at 5pm at a THI of 84^{o}F, the predicted demand reduction associated with the smaller air conditioning units ranged from a low of 0.32 kW for the 27% cycling strategy to a high of 1.86 kW for 100% cycling. For the larger air conditioners, the savings are estimated to range from a low of 0.59 kW for the 27% cycling to 2.93 kW for 100% cycling. For comparison, the aggregate results from Table 1 were 0.80 kW for 50% cycling to 2.06 kW for 100% cycling. If the utility tracks the connected demand of their program participants then this data can be used to develop a unique estimate. To do this, the utility simply selects the WTHI for the appropriate hour and cycling strategy and creates a weighted average based on the number of units above and below a connected demand of 3.5 kW.

Table 4 Predicted A/C Load Control Reduction by Connected kW

	Predicted Savings at 5pm For Various Duty Cycle Strategies													
	Stratum 1 AC Connected Demand < 3.5 kW							**Stratum 2 AC Connected Demand > 3.5 kW**						
WTHI	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
70.0	0.02	0.04	0.05	0.05	0.08	0.16	0.28	0.04	0.08	0.07	0.10	0.20	0.27	0.49
71.0	0.02	0.04	0.05	0.12	0.17	0.25	0.39	0.04	0.08	0.07	0.22	0.33	0.41	0.67
72.0	0.02	0.04	0.05	0.19	0.25	0.34	0.50	0.04	0.08	0.16	0.34	0.46	0.56	0.84
73.0	0.02	0.08	0.11	0.26	0.33	0.43	0.61	0.04	0.16	0.25	0.45	0.59	0.71	1.02
74.0	0.05	0.13	0.16	0.33	0.41	0.52	0.73	0.09	0.24	0.34	0.57	0.72	0.85	1.19
75.0	0.07	0.17	0.22	0.40	0.49	0.61	0.84	0.14	0.32	0.42	0.69	0.85	1.00	1.36
76.0	0.10	0.22	0.27	0.47	0.58	0.70	0.95	0.19	0.40	0.51	0.81	0.98	1.15	1.54
77.0	0.13	0.26	0.33	0.54	0.66	0.79	1.07	0.24	0.48	0.60	0.92	1.11	1.29	1.71
78.0	0.16	0.31	0.38	0.61	0.74	0.88	1.18	0.29	0.56	0.69	1.04	1.24	1.44	1.89
79.0	0.18	0.35	0.43	0.68	0.82	0.96	1.29	0.34	0.64	0.78	1.16	1.37	1.58	2.06
80.0	0.21	0.40	0.49	0.75	0.91	1.05	1.41	0.39	0.72	0.86	1.28	1.50	1.73	2.23
81.0	0.24	0.44	0.54	0.82	0.99	1.14	1.52	0.44	0.80	0.95	1.39	1.63	1.88	2.41
82.0	0.26	0.49	0.60	0.89	1.07	1.23	1.63	0.49	0.88	1.04	1.51	1.75	2.02	2.58
83.0	0.29	0.53	0.65	0.96	1.15	1.32	1.75	0.54	0.96	1.13	1.63	1.88	2.17	2.76
84.0	0.32	0.58	0.71	1.03	1.23	1.41	1.86	0.59	1.04	1.21	1.75	2.01	2.32	2.93
84.1	0.32	0.58	0.71	1.04	1.24	1.42	1.87	0.60	1.05	1.22	1.76	2.03	2.33	2.95
84.2	0.32	0.59	0.72	1.04	1.25	1.43	1.88	0.60	1.06	1.23	1.77	2.04	2.35	2.96
84.3	0.33	0.59	0.72	1.05	1.26	1.44	1.89	0.61	1.07	1.24	1.78	2.05	2.36	2.98
84.4	0.33	0.59	0.73	1.06	1.27	1.45	1.91	0.61	1.07	1.25	1.79	2.07	2.37	3.00
84.5	0.33	0.60	0.73	1.06	1.28	1.46	1.92	0.62	1.08	1.26	1.80	2.08	2.39	3.02
84.6	0.34	0.60	0.74	1.07	1.28	1.47	1.93	0.62	1.09	1.27	1.82	2.09	2.40	3.03
84.7	0.34	0.61	0.74	1.08	1.29	1.48	1.94	0.63	1.10	1.28	1.83	2.10	2.42	3.05
84.8	0.34	0.61	0.75	1.09	1.30	1.48	1.95	0.63	1.11	1.29	1.84	2.12	2.43	3.07
84.9	0.34	0.62	0.76	1.09	1.31	1.49	1.96	0.64	1.11	1.29	1.85	2.13	2.45	3.09
85.0	0.35	0.62	0.76	1.10	1.32	1.50	1.97	0.64	1.12	1.30	1.86	2.14	2.46	3.10
86.0	0.37	0.67	0.82	1.17	1.40	1.59	2.09	0.69	1.20	1.39	1.98	2.27	2.61	3.28
87.0	0.40	0.71	0.87	1.24	1.48	1.68	2.20	0.74	1.28	1.48	2.10	2.40	2.76	3.45

Water Heating Load Control: Deemed Savings Results

A similar duty cycle analysis was conducted for customers with direct load control of their water heaters. Table 5 summarizes the findings for the 100% cycling strategy, with average load reduction results differentiated by season (i.e., spring/fall, summer and winter) and day type (i.e., weekday or weekend) for selected hour ending time periods. For the summer weekday period at hour ending 4pm, the demand savings are estimated to be 0.24 kW. Similarly, for the winter weekday at hour ending 7am, the water heating demand savings are estimated to be 0.64 kW.

Table 5 Water Heating Load Control: Deemed Savings Estimates

		Selected Time Periods															
Season	DayType	6am	7am	8am	9am	10am	11am	12N	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm
Spring/Fall	Weekday	0.28	0.56	0.76	0.56	0.44	0.40	0.36	0.32	0.32	0.28	0.28	0.32	0.40	0.48	0.52	0.52
Spring/Fall	Weekend	0.12	0.24	0.44	0.56	0.64	0.62	0.60	0.52	0.48	0.44	0.40	0.44	0.44	0.48	0.52	0.52
Summer	Weekday	0.24	0.44	0.56	0.44	0.36	0.32	0.28	0.28	0.24	0.24	0.24	0.28	0.32	0.36	0.40	0.40
Summer	Weekend	0.12	0.20	0.36	0.48	0.48	0.48	0.48	0.40	0.40	0.36	0.32	0.36	0.36	0.40	0.40	0.40
Winter	Weekday	0.32	0.64	0.84	0.72	0.56	0.48	0.44	0.44	0.40	0.36	0.32	0.40	0.48	0.60	0.64	0.60
Winter	Weekend	0.16	0.28	0.48	0.68	0.80	0.84	0.72	0.68	0.60	0.56	0.52	0.56	0.56	0.64	0.64	0.60

Figure 1 summarizes the time-temperature matrix created for average weekday water heating savings for selected time periods: the 15-minutes ending 7am, 8am, 9am, 5pm, 6pm and 7pm. As shown, the savings estimates decrease with increasing WTHI. These relationships were used to generate tables for each 15-minute period throughout the day and are summarized in Appendix J.

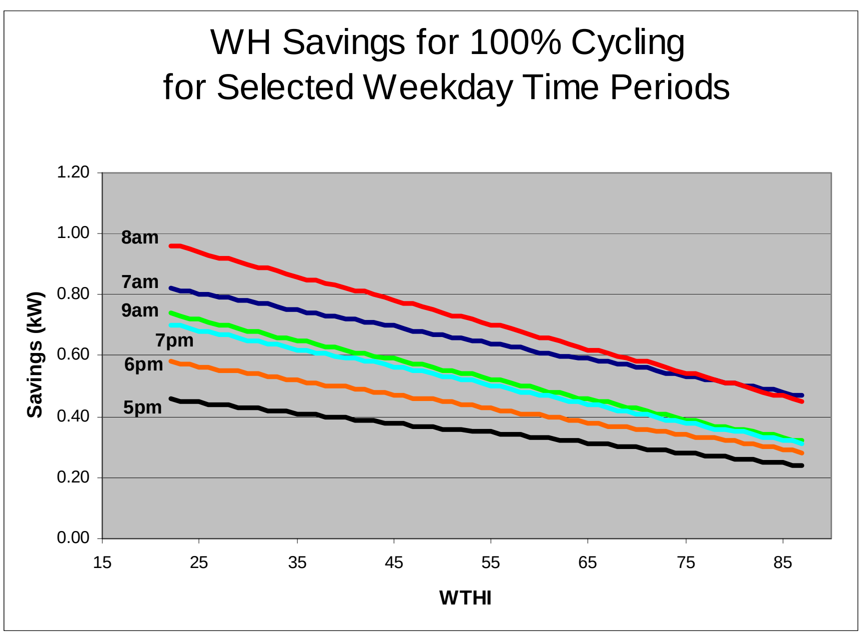

Figure 1 Water Heater Control Savings for 100% Cycling: Selected Time Periods.

Future Studies

As utilities in the PJM market footprint (see Figure 2) explore new demand response initiatives, consideration should be given to conducting regional M&V studies that effectively pool the resources of the participating utilities. The PJM market footprint is quite large (stretching from the Eastern seaboard to the western part of Illinois) with significant diversity in weather and customer household characteristics.

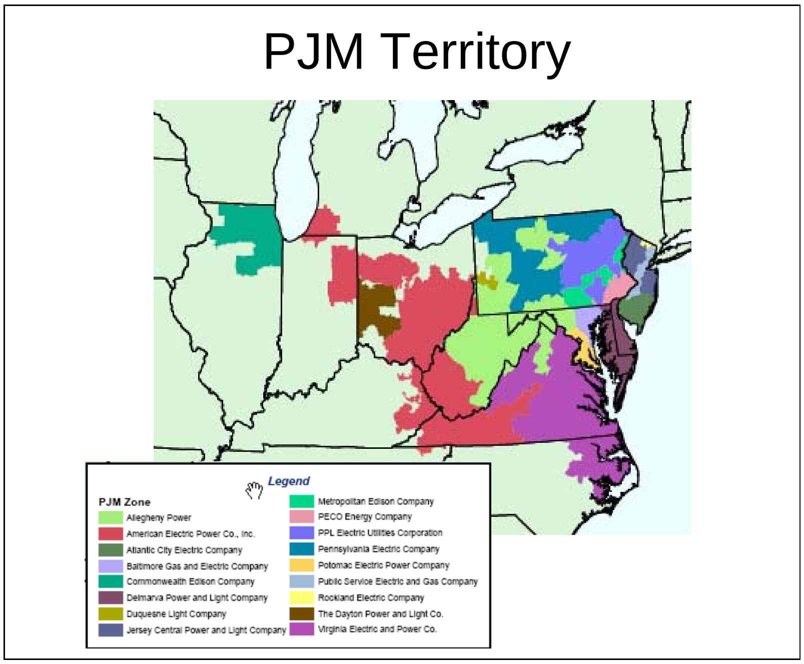

Figure 2 PJM Service Territory

We recommend a regional stratification for future studies that estimate load reductions from residential load management with sufficient sample points to meet some minimum precision criterion, e.g., 90% confidence ±20% precision, within the region. The utilities should be allowed to pool the data across the PJM footprint to improve the estimate. The specific utility would be allowed to use either unique load reduction estimates for their specific service territory, i.e., PJM zone, or the load reduction estimate from the pooled result. The key to any combined analysis is collecting consistent data across the various project components. The data elements to be included in a regional study should be clearly specified and should, at a minimum, include the following:

- End-use metered data on at least a 15-minute basis for the affected appliance;
- Total load metered data on at least an hourly basis for each residence in the end-use metered sample. Depending on the cost of data collection[4], consideration should be given to a larger total load sample of participants following a nested sampling strategy;

[4] AMI is making data collection at the whole premise level very affordable for large samples.

- Whole house consumption billing data[5] to use as an analytical link with the respective population billing systems;
- Spot wattage measurements;
- Regional weather data including at a minimum, hourly dry-bulb, hourly wet-bulb readings.

Other supporting information may prove beneficial including billing data on the population of program participants, demographic data on a large sample of program participants, and demographic data on the monitored sample.

The final deemed savings estimates should take advantage of the wealth of data collected by the contributing utilities while reflecting the unique characteristics of the specific service territory.

Operability Studies

We also recommend that each utility be required to conduct periodic operability studies, using a common sampling, testing and reporting methodology. Initially, we recommend that each utility select a simple random sample of 250 program participants and determine the operability of the control switch(s) at each sample home.[6] The testing protocol should verify both signal reception and switch operation, and identify the underlying causes of the problems that are encountered. The utility should report the overall failure rate and the appropriate net-to-gross ratio to be used to adjust the gross savings impact.

The utility-specific operability study should be conducted at least every five years, but may be conducted more frequently if a utility believes it has taken steps to mitigate its operability problems and wishes to use an improved net-to-gross ratio.

If a utility has been able to demonstrate a net-to-gross ratio of 90% or higher, then it is still required to conduct operability studies every five years, but a reduced sample size can be used. In this case the recommended sample is 100 homes.[7] If the reduced study yields an estimated net-to-gross ratio less than 90%, then we recommend that a full sample of 250 homes be tested as soon as practical and that the larger sample size be used in subsequent studies until the utility has again demonstrated a net-to-gross ratio of 90% or higher.[8]

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[5] Whole premise billing information was unavailable for some of the participants included in the current analysis. This required the project team to make necessary assumptions in order to combine the data from the three service territories. Some of the concerns raised by this approach are alleviated in the stratum level analysis.

[6] A sample of 250 will give an error bound of at most ±0.05 at the 90% level of confidence for the net to gross ratio. If a tighter error bound is desired then a larger sample will be agreed to and selected.

[7] If the net to gross ratio is 0.90 or larger, a sample of 100 will give an error bound of at most ±0.05 at the 90% level of confidence for the true net to gross ratio.

[8] Our recommendations have been informed by ISO 2859-1:1999(E), "Sampling Procedures for Inspection by Attributes" which is the current version of ANSI/ASQC Z1.4.

As an initial starting point, we recommend that the utilities use the **minimum** of their last estimate or 50%. This will provide a starting point for utilities that have not conducted an operability study in the past. Here again, the utilities should be required to initiate an operability study prior to their next submittal or face a further write-down of 10% per year until the operability study is completed.

1 Introduction

During 2005 and 2006, the PJM's Load Analysis Subcommittee (LAS) examined ways to reduce the costs and improve the effectiveness of its existing measurement and verification (M&V) protocols for Direct Load Control (DLC) programs.[9] The current protocol, a PURPA-compliant Load Research approach conducted every five years for each Load-Serving Entity (LSE), is expensive to implement and administer particularly for mature load control programs, many of which are marginally cost-effective. There was growing evidence that some LSEs were considering mothballing or dropping their DLC programs rather than incur the expense associated with the M&V.[10]

There was a consensus that the current DLC M&V protocol is analytic over-kill considering that the per-active-participant load impacts for DLC programs with static technologies have not significantly changed over time. Almost all the recent downward change in reported net per-unit load impacts has come from de-rating due to failed switches and poor radio coverage. To examine this issue further, Lawrence Berkeley National Laboratory (LBNL) contracted with *RLW Analytics* (*RLW*).

This project had several objectives: (1) to examine the potential for developing deemed savings estimates acceptable to PJM for legacy air conditioning and water heating DLC programs, and (2) to explore the development of a collaborative, regional, consensus-based approach for conducting monitoring and verification of load reductions for emerging load management technologies for customers that do not have interval metering capability.

1.1 Current PJM M&V Requirements

The current PJM M&V requirements are presented in the PJM Manual 19: Load Data Systems in Attachment B: Direct Load Control Load Research Guidelines:

- **Study Design:** DLC load research studies will be designed to achieve a minimum accuracy of 90% confidence with 10% error.
- **Failure Rate:** Per-participant impacts must reflect the average impact of all active participants (i.e., net impacts), including those with inoperable switches or switches not receiving the control signal.
- **Study Detail:** Load research studies must present estimated per-participant impacts in a matrix which details average impacts on non-holiday weekdays by hour for the hours ending 1pm through 8pm (PJM Eastern Region) or 8am through 9pm (PJM Western Region), and by weather condition (over a range of local conditions under which it can reasonably be expected that the program will be implemented). Separate matrices are required by program and PJM zone.

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[9] PJM Manual 19:Load Data Systems

[10] Only Baltimore Gas and Electric maintains an active load research sample on their air conditioning and water heating direct load control programs for the purpose of reporting to PJM.

1.2 Project Background

RLW attended a subgroup meeting of the Load Research Working Group (LRWG) on July 28, 2005. The LSEs represented included Public Service Electric and Gas (PSE&G), Baltimore Gas and Electric (BGE), GPU Energy (GPU), and Potomac Electric Power Company (PEPCO). The purpose of the meeting was to introduce *RLW* to the staffs of the LSEs and discuss the scope of the initial feasibility study (see Appendix A for meeting minutes).

Prior to attending the meeting, *RLW* staff reviewed each of the 2001 load impact evaluation studies conducted by the LSEs and the 2002 evaluation conducted by BGE:

- Public Service Electric and Gas (PSE&G): Final Report, 2001 Direct Load Control Evaluation, March 7, 2002, prepared by Xenergy Inc.
- Baltimore Gas and Electric (BGE): Evaluation of the Load Impacts of the Residential Air Conditioner Recycling Program, Summer 2002, prepared by BGE staff.
- Baltimore Gas and Electric (BGE): Evaluation of the Load Impacts of the Residential Air Conditioner Recycling Program, Summer 2001, prepared by BGE staff.
- GPU Energy (GPU): GPU Energy's Power Plus Savers Residential Air Conditioning Cycling Load Control Program, Final Evaluation Report, April 2002, prepared by Quantum Consulting Inc.
- Potomac Electric Power Company (PEPCO): 2001 Load Impact Evaluation of PEPCO's Direct Load Control Active Load Management Programs, March 2002, prepared by Dr. Marvin Horowitz of Demand Research.

In addition, pertinent sections of PJM Manual 19: Load Data System were reviewed. The project team also received and reviewed a report from Conectiv Power Delivery entitled "Direct Load Control Deductions in the Delmarva Zone", Summer 2001, Load Research, Planning Finance and Regulation Department, prepared by Quantum Consulting, Inc.

The purpose of the historical review was not to critique past efforts but to provide a basic understanding of the approaches used by each LSE, establishing a common basis for discussing future impact evaluation strategies and directions.

A second meeting was held on Tuesday, August 30, 2005 in Wilmington, Delaware and focused on a review of results of a feasibility study prepared by LBNL and RLW (see Appendix B for meeting minutes).[11]

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[11] LBNL and RLW 2005. "Rethinking M&V Protocols for DLC Programs in the PJM Region, Feasibility Study for AC Direct Load Control Evaluation," September.

2 Feasibility Study: Overview of Findings

In this section, we provide an overview of the key findings from the initial LBNL/RLW feasibility study.

The prior review of utility evaluations of their DLC programs suggested that the performance of these legacy programs is more strongly affected by operational problems than by changes in the gross savings. In particular, two categories of operational problems seem to be important – signal reception and the operability of the switch itself. Both of these operational problems are likely to vary from one utility to another. For example, the coverage of the signal depends on the particular communication system of each utility. Problems with operability of the switch itself are often created when an older air conditioner is repaired or replaced by a newer one and the switch is not reconnected. Again, the extent of this problem will vary from utility to utility depending on the measures taken by the utility to identify and replace inoperable switches.

The gross savings per unit may also vary from one utility to another and are affected by the size and efficiency of the air conditioner. Those utilities that have emphasized the importance of correctly sizing air conditioners rather than over-sizing them can expect greater gross savings per unit. However, our initial review of the utility evaluation studies suggests that there may be less variation in gross savings from utility to utility and from year to year than the differences in operational problems (see Appendix C for summary of the gross savings analysis).

This reinforces the appropriateness of the current M&V policy of differentiating the analysis of operational problems from the analysis of gross savings. To the extent that utility-specific assessment of gross savings is required, it might be best to standardize the methodology from one utility to another so that the findings can be directly compared. Standardizing methods of estimating overall operability problems should also be considered.

2.1 Recommended Alternative M&V Approach

The approaches taken by the four LSEs present an array of alternative M&V strategies. To summarize, three of the four LSEs used end-use metered and one used whole facility load data. While separate projects are possible, LBNL/RLW believe that pooling the efforts of the four LSEs into some form of regional study would be more cost-effective than conducting four separate studies.

We considered using a nested sampling approach;[12] this approach is often used to cost effectively estimate end-use metered loads. However, we rejected this approach since the M&V study is not directed at estimating the total air conditioning load of the participants but at the impacts available across a broad range of time and temperatures. Similarly, while effective in a test/control environment, we rejected whole premise metering in

[12] A nested sample would use a small subset of end-use metering points with a larger and cheaper whole facility metering sample to construct the analysis framework.

favor of the end-use metering, duty cycle approach. We believe it advisable to focus on the duty cycle approach since this method focuses on the fundamental determinants of gross savings – connected load and natural duty cycle – and since this method is insensitive to the number of actual control days and the temperature conditions on these control days.

As such, we would recommend a data collection and analysis strategy with the objective of constructing a single time-temperature matrix. The project would be conducted across the various service territories of the LSEs with "similar" programs and program control strategies. We envision a sample design that is informed by the historical data and one that uses an optimal allocation based on the LSE's contribution to the overall resource among the group of participating utilities.

The proposed approach would allow for individual estimates to be developed for each LSE in one of two fashions and tested against the pooled approach. One strategy would calculate the estimate using just the data indigenous to the LSE. Another approach would be to map **all** of the available data into a post-stratification strategy in order to develop LSE specific weights. The various analysis results could be contrasted and compared by LSE. If additional information is available about the populations, e.g., number of AC units, then it may be possible to use this data to help inform the analysis.

2.2 Summary

The feasibility study recommended conducting a cross jurisdiction analysis of the historical end-use metering data as a ***proof of concept***. We believe the insight afforded from the analysis will be extremely valuable for informing the design of a system-wide study to meet the upcoming PJM M&V requirement for utilities with DLC programs. The analysis will test several evaluation strategies including a post-stratification analysis to the respective zones and a common analysis weighted by the program participants in each zone. We propose using the results of the supplemental analysis to address the litany of issues brought up in the context of this feasibility study.

For future new initiatives, we recommended designing and implementing a single end-use metering study directed at developing the time-temperature matrices required by PJM Manual 19, i.e., time-temperature matrices by PJM zone.

The remainder of this report presents the results of the cross-jurisdictional proof-of-concept analysis conducted during the summer of 2006 (see Appendix D for scope of work).

3 Deemed Savings for Air Conditioning Cycling Programs

A memorandum of understanding and scope of work for conducting the proof-of-concept analysis was finalized in June 2006 (see Appendix D). The following parties were participants in the project.

1) Allegheny Electric Cooperative
2) Baltimore, Gas and Electric (BGE)
3) First Energy (FE)
4) Lawrence Berkeley National Laboratory (LBNL)
5) Buckeye Power
6) Southern Maryland Electric Cooperative
7) Old Dominion Electric Cooperative
8) Pepco Holdings, Inc. (PHI)
9) Public Service Electric and Gas (PSE&G);

3.1 Project Purpose and Objective

The purpose of the project was to eliminate or reduce the need for sponsoring expensive load research for legacy residential air conditioner and water heater direct load control programs. If the "deemed results" from such a regional model is accepted by PJM, it will reduce both the financial barriers and the complexity of operating and participating in the PJM Load Response programs.

The project's stated objective was to develop a statistical model-based alternative to the current Measurement and Verification (M&V) requirements[13] placed by PJM on direct load control program eligibility for Active Load Management capacity credits.[14]

3.2 Scope and Eligibility

The scope of the project was limited to legacy residential air conditioner and water heater load cycling programs and was not to be extended to new programs invoking new enabling technology like "roll-up" thermostats.

Program eligibility was extended to any entity interested in owning or operating residential direct load control technology in the PJM region.

3.3 Project Description

This project develops a regional model, based primarily on previous end-use load research data gathered by three PJM-East electric distribution utilities (BGE, JCP&L, and PSE&G), that is capable of serving as a basis for the development of regression-based, time-temperature/humidity estimates of load impacts for direct load control programs on a zonal basis.

[13] PJM's Active Load Management M&V requirement requires that a load research study be conducted every five years to measure the attributable to direct load control load impacts. The specific input required by PJM is a time-temperature - humidity calculation of load impacts for each direct load control program. For more details see PJM Manual 19.
[14] The resulting estimates can also be used to determine program energy reduction benefits.

3.4 Results

This section details the substantive results of the proof-of-concept analysis.

3.4.1 Data Used in the Analysis

<u>Interval Load Data</u>

The analysis contained in this section relies on end-use metered data from three participating utilities. First Energy (FE) and Public Service Electric and Gas (PSEG) provided end-use metered air conditioning data, while Baltimore Gas and Electric (BGE) provided both water heater and air conditioning data. The First Energy data was from their Jersey Central Power and Light (JCPL) service territory. A fourth participating utility, Potomac Electric Power (PEPCO) provided summary impact data on air conditioning and water heating.

Table 6 recapitulates the source data used for the analysis. Since PEPCO data was not at the individual customer level, it was not used. PSEG data was aggregated to the 15 minutes interval level so that there would be a common basis for the analysis.

Table 6 Summary of Source Data

Company	End Use	Units of Measure	Interval	Start Date	End Date	Number of Sample Points	Number of Intervals
BGE	Water Heating	kWh	15 mins	1/1/2001	12/31/2005	82	120,772
BGE	Air Conditioning	kWh	15 mins	6/1/2001	9/30/2005	110	55,632
PSEG	Air Conditioning	KW	2 Mins	7/11/2001	10/11/2001	85	2,991,700
JCPL	Air Conditioning	KW	15 mins	1/1/2001	12/31/2001	77	120,772

In the analysis we began by calculating the 99th percentile of observed demands for each sample point. The individual customer's 99th percentile of observed demands was used as a proxy for the equipment's "spot watts", or the maximum amount of load that the customer had available for the interruption. Figure 3 shows a comparison of the cumulative distributions of the spot watts of each sample. The distribution of sample customers from each utility is similar, albeit the First Energy sample tended to be larger.

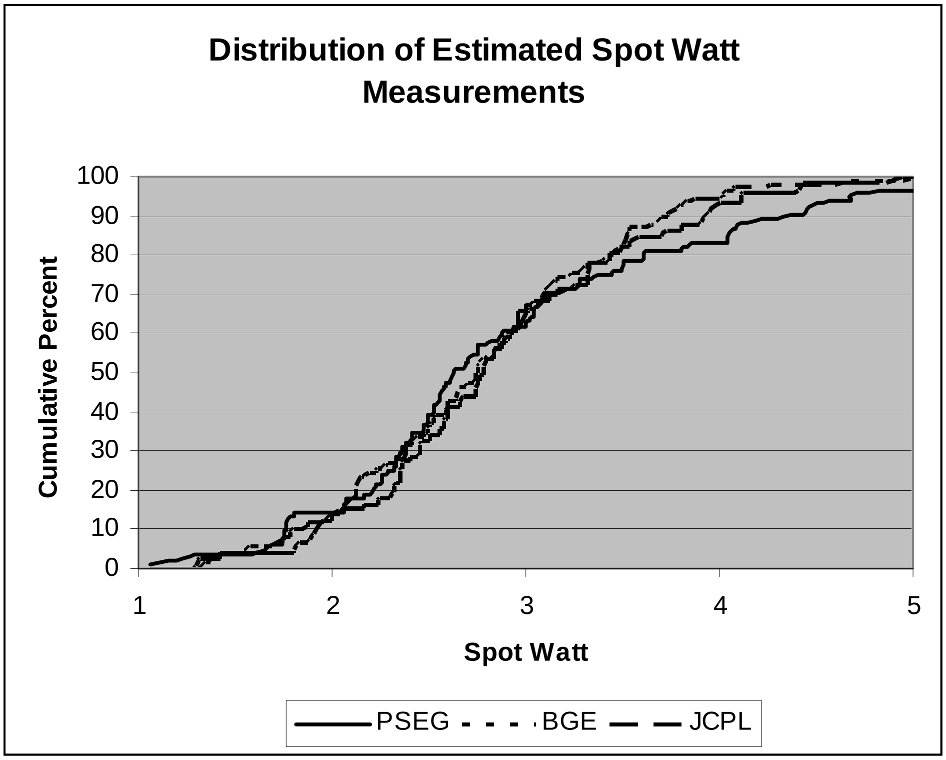

Figure 3 Cumulative Distribution of Air Conditioning Spot Watts by Company

<u>Weather Data</u>
The final piece of data needed for the analysis was weather data. The analysis was performed using a weighted temperature-humidity index (THI). The THI was defined as:

$$THI_{L,t} = 17.5 + .55^* \ DB_{L,t} + .2^* \ WB_{L,t}$$

Where:

$THI_{L,t}$ = The temperature-humidity index for location L for time t
$DB_{L,t}$ = The dry bulb temperature for location L for time t
$WB_{L,t}$ = The wet bulb temperature for location L for time t

For WTHI, the current day's THI gets a weight of 10, the previous day's THI gets a weight of 3, and the weight for two days ago is 1.

Unique locations were used as the temperature basis for each Company. Baltimore-Washington was used for BGE; Philadelphia was used for PSE&G, and JCP&L.

3.4.2 Duty Cycle Discussion

In order to model the load relief that can be expected at any time-temperature combination, we utilize the duty cycle model. Using the duty cycle model does not depend on having event calls. However, the duty cycle approach does require special handling of event day interruptions. For this application, the event days were omitted from the analysis (see Appendix E for a complete listing of event days).

Figure 4 illustrates the duty cycle model and shows the kW load of an air conditioner at various temperatures. From temperature a to temperature b, there is no demand for air conditioning. From temperature b to temperature d, the uncontrolled air conditioning load increases with the temperature until it reaches full output. At any temperature higher than d, the uncontrolled unit is fully loaded. In short, the segmented line abde represents the load curve for the uncontrolled unit.

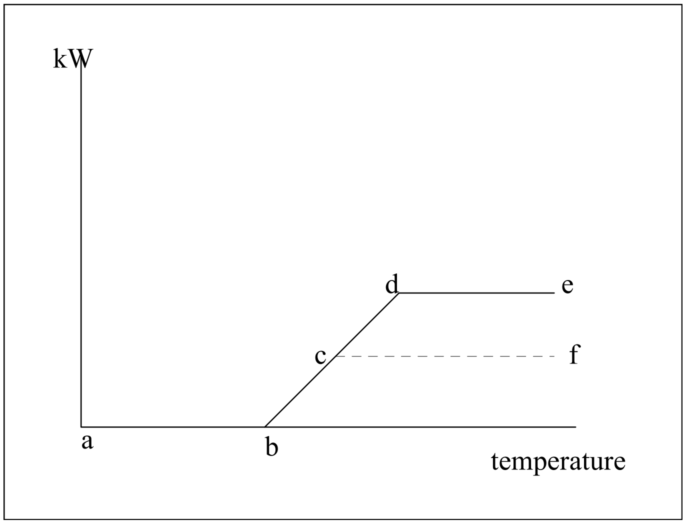

Figure 4 The Duty Cycle Model for Estimating Load Control Impacts

Now consider a 50% cycling strategy. Under this strategy, the load curve for the unit is lowered to the segmented line abcf. Therefore, above temperature d, the impact is 50% of the full load. Below temperature c, there is no impact. Between c and d there is a partial impact.

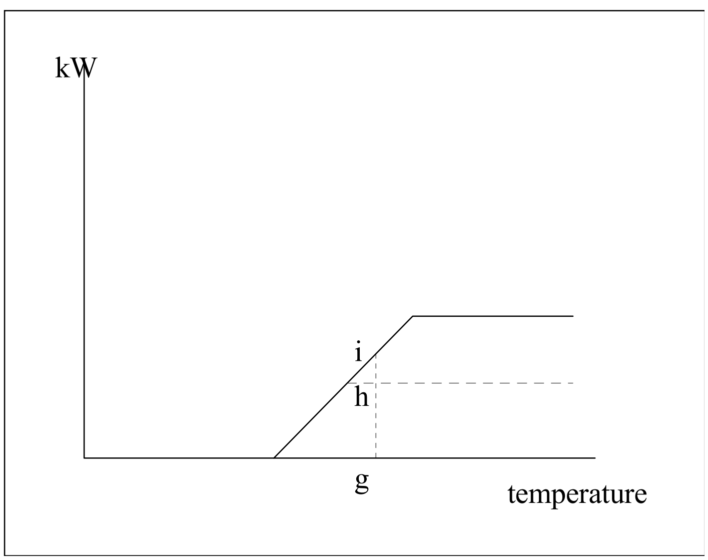

Figure 5 Duty Cycle Model for Estimating Load Impacts (Cont)

Figure 5 illustrates the partial impact. At temperature g, if the air conditioning unit were uncontrolled, its demand would be i. At this temperature, it is operating at only a fraction of its full load, e.g., 70%. In other words, the unit is operating at a 70% duty cycle. Under control, its demand is reduced to point h, which is 50% of full load. Therefore the savings is 70% - 50% or 20% of full load. At a higher temperature the savings would be greater, e.g., if the unit was operating at a 90% duty cycle, the savings of a 50% cycling strategy would be 40% of its full load.

The preceding analysis shows that the impact of a cycling strategy on a particular hour depends on the duty cycle of the units in that hour. The greater the duty cycle of the controlled units, the greater the impact. In particular, full potential impact is only achieved for units that are fully loaded, i.e., would have been operating with a 100% duty cycle.

Returning to Figure 4, the impact of ***any cycling strategy*** can be predicted by determining the points b and d for each participant. Point b is the lowest temperature for which air conditioning is required. Point d is determined by two parameters: the full kW load of the unit and the lowest temperature at which the unit reaches full load. To summarize, under the duty-cycle model, the impact of any cycling strategy can be predicted by determining the following three parameters for each participant:

- The lowest temperature for which air conditioning is required,
- The full kW load of the AC unit, and
- The lowest temperature at which the unit reaches full load.

The duty cycle analysis will result in the expected impacts at the individual customer level for any selected cycling strategy (e.g. 50%, 53%, etc., up to 100%).

3.4.3 Duty Cycle Application

In this evaluation, savings were calculated to simulate 27%, 43%, 50%, 66.7%, 75% and 100% cycling strategies. The possible savings were defined as:

$$Savings_{c,s,d,t} = Max(0, demand_{c,d,t} - spotwatt_c * (1-CS))$$

Where:

$Savings_{c,s,d,t}$ = Estimated Savings for customer c, using cycling strategy s, on date d, during time of day period t

$demand_{c,d,t}$ = Demand for customer c on date d during time period of day period t

$spotwatt_c$ = Estimated spot watts for customer c. (Spot watts were not available for all the sites; in these cases, spot watts were estimated by assuming that the spot watt rating was equal to the 99^{th} percentile of observed demands for the customer.)

CS = Cycling strategy (27%, 43%, 50%, 66.7%, 75%, 83% and 100%), and

t = Time of day period. There were 96 time of day periods, one for each 15 minute period from 12:15 AM to 12:00 M.

For the air conditioning analysis, savings for each customer was calculated for each date for each 15 minute period under each strategy. The time periods were matched to the appropriate weather stations.

Under each cycling strategy, the average savings were calculated by time of day, for each WTHI that was observed during that time of day period. The average savings for each WTHI during each time of day period were calculated as follows:

$$Average\,Savings_{g,w,s,t} = \sum_{c=1}^{n_w} \sum_{d_w} \frac{\text{Savings}_{\text{g,c,s,d,t}}}{(n_{g,w} + d_w)}$$

Where:

Average $\text{Savings}_{g,w,s,t}$ = Average savings group g when the WTHI was w, under strategy s during time of day period t,
$\text{Savings}_{g,w,s,t}$ = Individual customer savings in group g when the WTHI was w for strategy s during time of day period t,
$n_{g,w}$ = number of customers in group g when WTHI was w during time of day period t,
d_w = the days with WTHI w during time period t.

To model the relationship between savings and WTHI, for each group, for time period for each cycling strategy, a regression model was estimated. The models had the form of:

$$\text{Average Savings}_{g,,w,s,t} = \beta_0 + \beta_1 * DH_{t,sp} + \varepsilon$$

Where:

Average $\text{Savings}_{g,s,t}$ = Average savings, for group g, strategy s at time of day period t
$DH_{t,sp}$ = Degree hours for time of day period t based on WTHI and set point sp.

The degree hours are calculated as: $DH_{t,s\,p}$= Max(of $WTHI_t$-sp_t,0)
Where:

$WTHI_t$ = Weighted THI for time of day period t,
sp_t = set point for time t. For this analysis, the set points examined ranged from 60^0 to 85^0,
ε = the error term.

The model estimated slope term, β_1, can be interpreted as the incremental savings per degree of WTHI, beginning at the set point WTHI.

To optimize the models, a family of set points was examined for each unique strategy and time of day period. The family of set points was examined to avoid presupposing a set point of when air conditioning usage begins.

The set points ranged from 60^0 to 85^0, incremented by 1^0. The model that provided the best fit (i.e., minimized the residual mean squared error) was chosen as the optimal model and used in the prediction of savings.

Models were developed for all customers in aggregate, and for three subgroups. The subgroups included spot watt strata (greater than or less than 3.5 kW), annual air conditioning consumption (greater than or less than or equal to 1,600 kWh), and by utility. For each strategy, for each subgroup group, 96 models (one for each time of day period) were chosen to estimate the savings for the range of WTHI.

Using the optimal models, the predicted average savings was estimated for each time of day period for each of the WTHI between 70°F to 87°F. The estimated savings for each WTHI during each time of day period were calculated as follows:

$$EstimatedSavings_{w,t} = b_{0,t} + b_{1,t} * (Max(w_t - sp_t, 0)$$

Where:

Estimated $Savings_{w,t,}$ = the estimate of savings at WTHI 'w' during time of day period t,
$b_{0,t}$,$b_{1,t}$ = The estimated coefficients for time of day period t,
w_t = WTHI during time of day period t, (The WTHI ranged from 70°F to 87°F.)
sp_t = The optimal set point for time of day period t.

3.4.4 Analysis Summary

Table 7 shows the distribution of the annual air conditioning usage by PJM region. Figure 6 illustrates the cumulative distribution of energy usage. The table and figure shows that the analysis is dominated by BGE, with data from 456 summers. FE (JCP&L) and BGE have very similar distributions. PSEG has slightly less air conditioning usage that the other two utilities. However, it can be generally concluded that the distribution of annual air conditioning usage for each utility is similar.

Table 7 Distribution of Annual Air Conditioning Usage

Quantile	JCPL	BGE	PSEG	Aggregate
n	**145**	**456**	**85**	**686**
Max	7,309	7,676	5,243	7,676
99%	6,563	5,160	5,243	5,429
95%	4,147	3,722	3,500	3,780
90%	2,898	3,039	2,289	2,933
Q3	2,069	2,298	1,686	2,155
Mean	1,629	1,764	1,351	1,684
Median	1,381	1,582	1,117	1,497
Q1	693	1,016	703	914
10%	261	639	417	543
5%	96	483	348	337
1%	-	118	18	18
Min	-	0	18	-

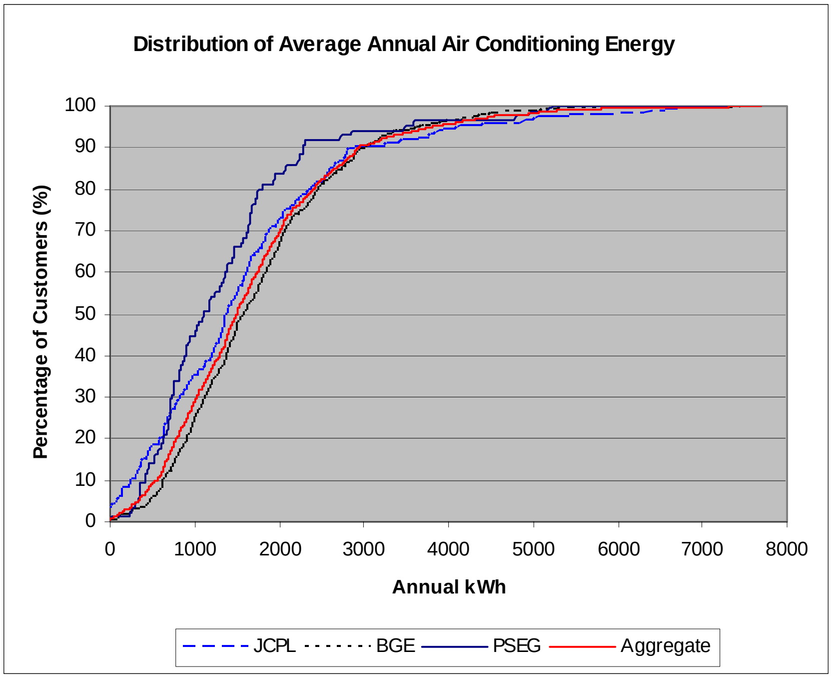

Figure 6 Distribution of Average Air Conditioning Usage

Table 8 Distribution of Possible Air Conditioning Savings under Various Strategies

	50% Cycling					66.7% Cycling			
Quantile	**JCPL**	**BGE**	**PSEG**	**Aggregate**	**Quantile**	**JCPL**	**BGE**	**PSEG**	**Aggregate**
n	**145**	**456**	**85**		**n**	**145**	**456**	**85**	
Max	2,360	2,246	1,966	2,360	**Max**	3,904	3,916	2,962	3,916
99%	2,141	1,685	1,966	1,836	**99%**	3,560	2,718	2,962	2,893
95%	1,058	1,146	926	1,068	**95%**	1,854	1,918	1,632	1,851
90%	833	793	621	793	**90%**	1,512	1,317	1,011	1,327
Q3	496	418	433	440	**Q3**	868	844	743	848
Mean	378	325	336	337	**Mean**	704	637	588	645
Median	238	212	241	227	**Median**	533	463	465	483
Q1	112	77	118	88	**Q1**	262	235	244	242
10%	33	32	46	33	**10%**	91	116	115	114
5%	7	18	29	19	**5%**	37	71	100	66
1%	-	3	8	1	**1%**	-	22	11	10
Min	-	-	8	-	**Min**	-	-	11	-
	75% Cycling					100% Cycling			
Quantile	**JCPL**	**BGE**	**PSEG**	**Aggregate**	**Quantile**	**JCPL**	**BGE**	**PSEG**	**Aggregate**
n	**145**	**456**	**85**		**n**	**145**	**456**	**85**	
Max	4,695	4,775	3,441	4,775	**Max**	7,309	7,676	5,243	7,676
99%	4,273	3,246	3,441	3,441	**99%**	6,563	5,160	5,243	5,429
95%	2,377	2,253	2,009	2,260	**95%**	4,147	3,722	3,500	3,780
90%	1,809	1,665	1,349	1,667	**90%**	2,898	3,039	2,289	2,933
Q3	1,144	1,136	936	1,111	**Q3**	2,069	2,298	1,686	2,155
Mean	896	848	743	845	**Mean**	1,629	1,764	1,351	1,684
Median	714	687	615	687	**Median**	1,381	1,582	1,117	1,497
Q1	340	372	337	357	**Q1**	693	1,016	703	914
10%	118	209	179	186	**10%**	261	639	417	543
5%	48	138	142	118	**5%**	96	483	348	337
1%	-	52	13	13	**1%**	-	118	18	18
Min	-	-	13	-	**Min**	-	0	18	-

Table 8 show the annual energy savings under the various cycling strategies. The data presented in Table 8 and Figure 7 are just theoretical and assumes that the air conditioning control is conducted every single day of the summer season, a highly improbable operational scenario. Figure 7 shows similar cumulative theoretical distributions of potential energy savings under the various cycling strategies for each utility.

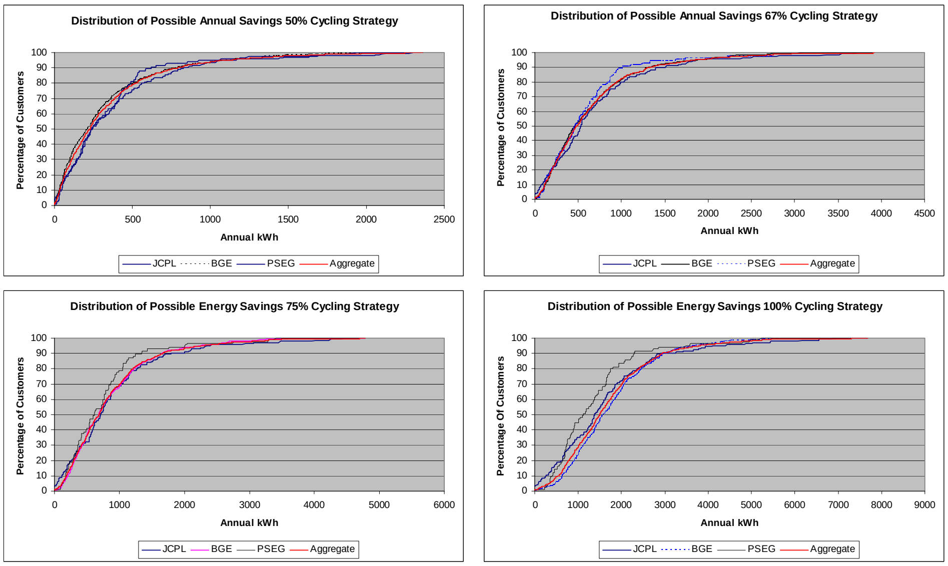

Figure 7 Cumulative Distributions of Energy Savings Under Various Cycling Strategies

The BGE data provided was based on a stratified sample. The stratification variable was whole house usage. Table 9 shows a comparison by strata of the distribution of air conditioning usage, including the mean and weighted average of the distribution points. This table shows that there is a difference in the distribution of the strata. The simple average of the distribution points is slightly greater than the weighted average.

Table 9 Distribution of BGE Annual Air conditioning Usage, By Strata

Quantile	S1	S2	SRS	Weighted
n	248	208	456	456
Max	5,429	7,676	7,676	6,088
99%	3,808	5,284	5,160	4,241
95%	2,885	4,315	3,722	3,305
90%	2,425	3,651	3,039	2,784
Q3	1,879	2,723	2,298	2,127
Mean	1,428	2,164	1,764	1,644
Median	1,343	2,018	1,582	1,541
Q1	839	1,400	1,016	1,003
10%	558	930	639	667
5%	353	751	483	469
1%	87	481	118	202
Min	0	129	0	38

Unfortunately, JCPL and PSEG did not provide information to map their sample points into the BGE sample design. In addition, the annual air conditioning usage, and the sample design usage were not well correlated. Accordingly, the JCPL and the PSEG information could not be disaggregated using this method.

Although the simple average shows a slight upward bias, the authors concluded that the bias was not material, when weighed against the potential loss of the JCPL and PSEG sample data. Accordingly, the analysis was based on unweighted results from the contributing utilities. To help alleviate any concern regarding the approach, alternatives were conducted that stratified the analysis by air conditioning connected demand and air conditioning seasonal energy use. The utilities could elect to apply these alternative estimates to specific segments of their populations to more uniquely reflect the actual characteristics of their service territories. Of course, this requires information to be available on the connected load through program records or estimated[15] for the seasonal air conditioning use using customer billing information for the respective populations. An example of this analysis was completed using billing data from BGE and is reported in a later section of this report.

The next step in the process was to merge the savings data with the WTHI data. Based on this information the average savings was calculated, by time period, by WTHI. For each time period, a model was developed to predict the savings for a given WTHI.

For each cycling strategy, 96 models were developed, one for each 15 minute period during the day. An optimal "set point" temperature for each model was chosen. Table 10 shows the average optimal set points and the R-squared statistics from the models. The average set point decreases as the cycling strategy increases and there is a high correlation between WTHI and potential energy savings.

Table 10 Average Optimal Set Points and R-Squared Statistics

	Set Point				R-Squared			
Cycling Strategy	**50%**	**67%**	**75%**	**100%**	**50%**	**67%**	**75%**	**100%**
Minimum	67	66	66	64	86%	89%	90%	94%
Mean	72	70	69	67	96%	97%	97%	98%
Median	71	70	69	66	96%	97%	97%	98%
Maximum	74	73	72	70	99%	99%	99%	99%

Figure 8 shows the optimal set points by the time of day, which reflects the temperature at which demand savings begin. Interesting, for each cycling strategy, the optimal set points follow a uniform pattern, i.e., a drop in the early morning hours and rise in the mid mornings. In addition, the set points dip in the early evening. Interestingly, the set points generally decrease as the cycling strategy increases.

[15] The authors believe that the air conditioning seasonal energy use can be effectively estimated for sizing the populations through a PRISM type analysis.

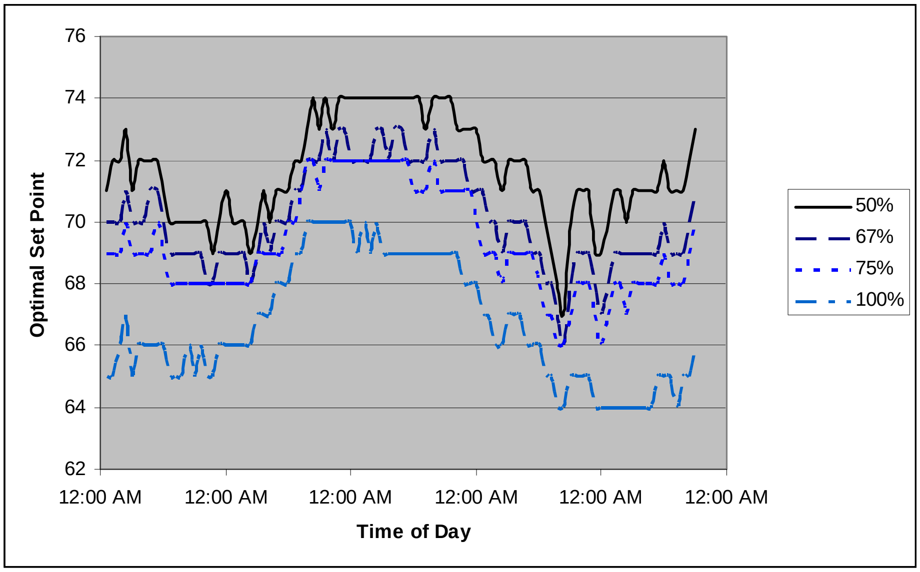

Figure 8 Optimal Set Points by Time of Day

To verify the aggregate models, for each time period, separate models were developed for each utility (i.e., PJM zone), and compared to the aggregate values. Figure 9 shows the modeled savings for a 50% cycling strategy, by utility. The expected savings for BGE and PSEG are consistent with the aggregate modeled savings. JCPL modeled savings shows a weaker reaction to WTHI than the other utilities. This pattern is consistent across all cycling strategies.

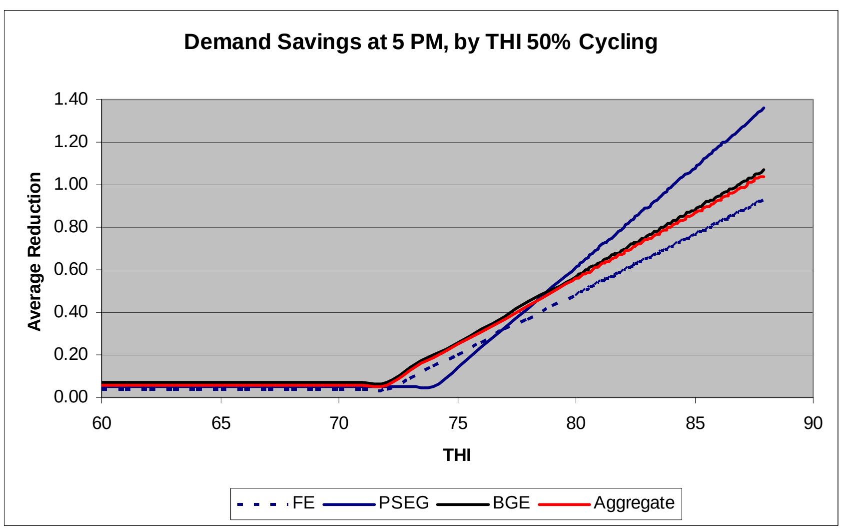

Figure 9 Modeled Savings by THI for 50% Cycling at 5PM

Tables were prepared for each of the 96 time periods, i.e., 12:15 AM through 12:00 Midnight, for each cycling strategy. An example of the tables is shown in Table 11. The full set of tables is contained in an Excel spreadsheet that accompanies this report. Sample tables for selected times are provided in Appendix F**.**

Table 11 Example of Actual and Modeled Results Table, for each A/C Cycling Strategy at 5 PM

	Predicted Savings at 5pm For Various Duty Cycle Strategies						
WTHI	27%	43%	50%	67%	75%	83%	100%
70.0	0.02	0.04	0.06	0.06	0.09	0.18	0.30
71.0	0.02	0.04	0.06	0.13	0.19	0.28	0.43
72.0	0.02	0.04	0.06	0.21	0.28	0.38	0.55
73.0	0.02	0.09	0.13	0.29	0.37	0.48	0.68
74.0	0.05	0.15	0.19	0.37	0.46	0.58	0.80
75.0	0.09	0.20	0.25	0.45	0.55	0.68	0.93
76.0	0.12	0.25	0.31	0.53	0.65	0.78	1.06
77.0	0.15	0.30	0.37	0.61	0.74	0.87	1.18
78.0	0.18	0.35	0.43	0.68	0.83	0.97	1.31
79.0	0.21	0.40	0.50	0.76	0.92	1.07	1.43
80.0	0.24	0.45	0.56	0.84	1.01	1.17	1.56
81.0	0.27	0.51	0.62	0.92	1.10	1.27	1.68
82.0	0.30	0.56	0.68	1.00	1.20	1.37	1.81
83.0	0.34	0.61	0.74	1.08	1.29	1.47	1.93
84.0	0.37	0.66	0.80	1.16	1.38	1.57	2.06
84.1	0.37	0.66	0.81	1.16	1.39	1.58	2.07
84.2	0.37	0.67	0.82	1.17	1.40	1.59	2.08
84.3	0.38	0.67	0.82	1.18	1.41	1.60	2.10
84.4	0.38	0.68	0.83	1.19	1.42	1.61	2.11
84.5	0.38	0.68	0.83	1.20	1.43	1.62	2.12
84.6	0.39	0.69	0.84	1.20	1.43	1.63	2.13
84.7	0.39	0.70	0.85	1.21	1.44	1.64	2.15
84.8	0.39	0.70	0.85	1.22	1.45	1.65	2.16
84.9	0.40	0.71	0.86	1.23	1.46	1.66	2.17
85.0	0.40	0.71	0.87	1.23	1.47	1.67	2.19
86.0	0.43	0.76	0.93	1.31	1.56	1.77	2.31
87.0	0.46	0.81	0.99	1.39	1.65	1.87	2.44

The average savings per customer can be derived by applying the zonal temperatures for a specific time period. Figure 10 displays the THI calculated for two weather stations in the PJM footprint: Baltimore/Washington and Philadelphia. The THI for the Philadelphia zone was the highest throughout the period; the impacts per customer, under the various scenarios are also the greatest for this zone.

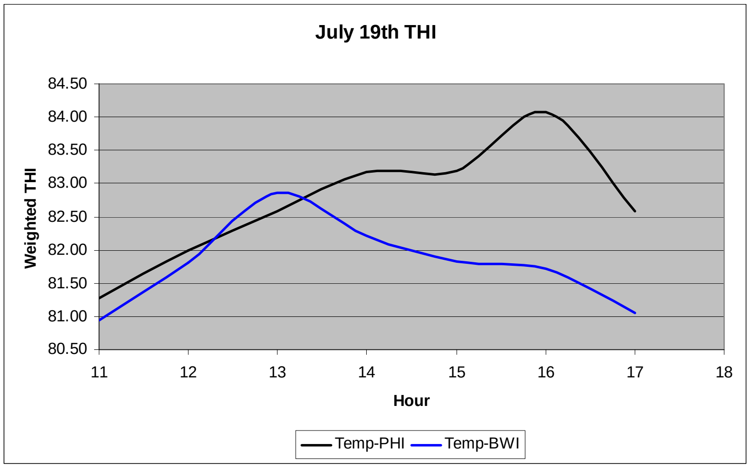

Figure 10 July 19th Temperature Data for Philadelphia and Baltimore/Washington zones

Figure 11 shows the results for a simulated event occurring on July 19^{th} from 11 Am to 4 PM. The savings per customer rise throughout the period under each cycling strategy. The maximum impact was estimated to be 1.90 kW at 4 PM under the 100% cycling strategy in the Philadelphia zone. The THI at this time for this zone was 84^0F. We can use weather data for other parts of the PJM territory to estimate the demand impact associated with these legacy DLC programs.

Given the models developed, the project team can run any duty cycle strategy desired by the project contributors *including strategies that employ an adaptive algorithm associated with newer, smarter switches.* In addition, any segmentation based on air conditioning size, e.g., connected load or seasonal usage, can be accommodated within the model set. These are explored in more detail in the next section.

3.4.5 Deemed Savings by Strata

The authors felt it important to provide information that allows the contributing utilities to apply unique estimates to different portions of their direct load control populations. This allows the estimates to be "customized" to the unique characteristics of the contributing utility's population of DLC participants. This requires that the number of participants by air conditioner size be available or estimated from program tracking data or that seasonal air conditioning use be estimated from customer billing data.[16] The same basic strategy discussed above was employed, however the analysis was conducted based on the seasonal air conditioning use, i.e., customer above and below 1600 kWh, and estimated connected demand, i.e., a threshold of 3.5 kW was used for this stratification. The models and analytical methods can support any cut points desired by the participating utilities.

Table 12 presents an example of the results of the analysis by seasonal air conditioning use and shows estimated savings by cycling strategy for various levels of WTHI.[17] The table presents the savings for customers with less than 1600 kWh of seasonal air conditioning use and the savings for customers with more than 1600 kWh of seasonal air conditioning use. At a WTHI of 84^oF and cycling strategy of 50%, the estimated savings are 0.48 kW for the low energy use stratum and 1.03 kW for the high energy use stratum. From Table 11, we see that the aggregate average savings were estimated at 0.80 kW. These tables will allow each participating utility to generate a customized estimate for use in reporting the appropriate savings to PJM. The full set of tables is contained in an Excel spreadsheet that accompanies this report. Sample tables for selected times are provided in Appendix G.

[16] The authors believe that a Princeton Scorekeeping Methodology (PRISM) can be effectively employed to estimate the number of participants by seasonal air conditioning use.
[17] Seasonal use defined as June through September.

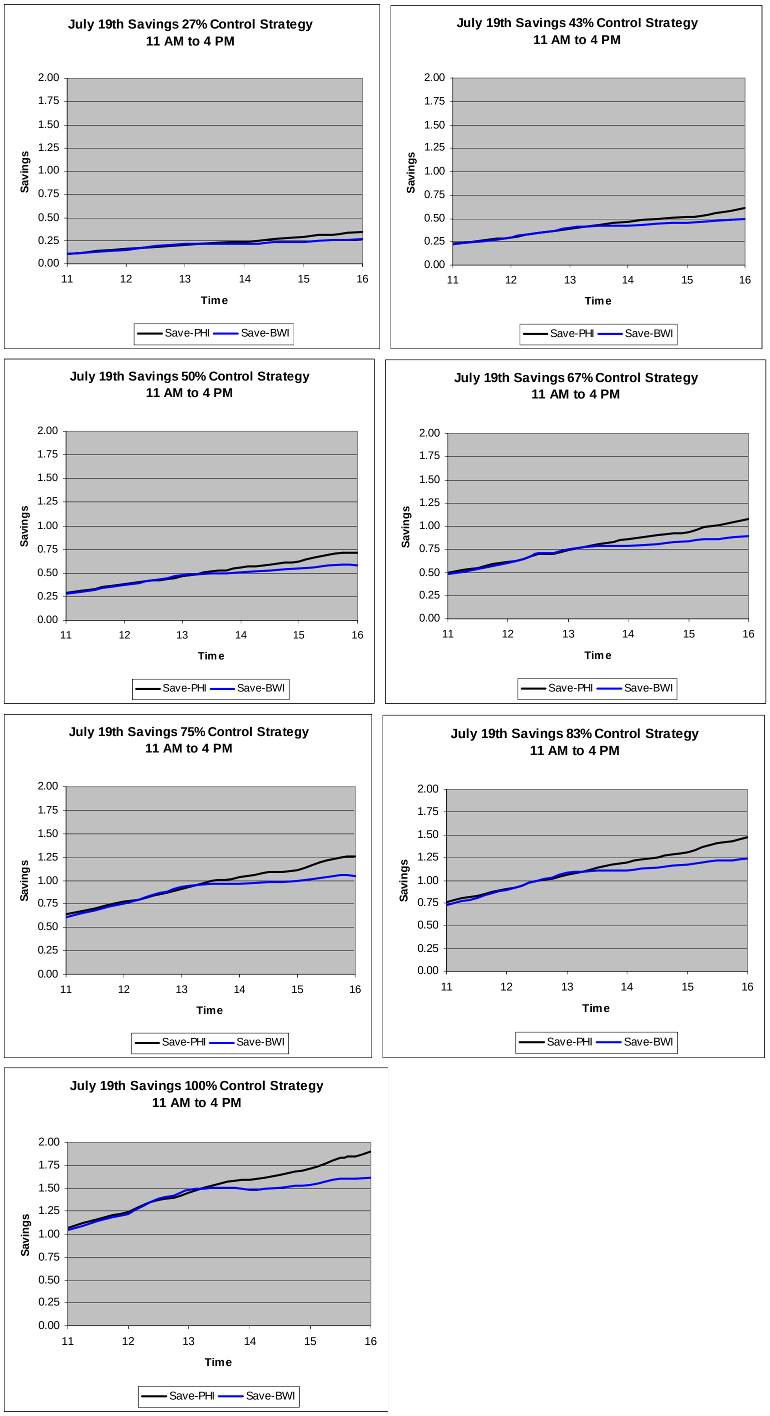

Figure 11 Example of Savings, By Zone under Various Cycling Strategies

Table 12 A/C Load Control Savings by Energy Stratum 15-Min Ending 5pm

	Predicted Savings at 5pm For Various Duty Cycle Strategies													
	Stratum 1 AC Usage < 1,600 kWh							Stratum 2 AC Usage > 1,600 kWh						
WTHI	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
70.0	0.01	0.02	0.03	0.04	0.06	0.04	0.05	0.03	0.06	0.05	0.18	0.25	0.39	0.63
71.0	0.01	0.02	0.03	0.04	0.06	0.04	0.14	0.03	0.06	0.12	0.27	0.36	0.51	0.77
72.0	0.01	0.02	0.03	0.04	0.06	0.12	0.23	0.03	0.12	0.19	0.37	0.47	0.63	0.91
73.0	0.01	0.02	0.03	0.09	0.13	0.19	0.33	0.06	0.18	0.26	0.47	0.58	0.74	1.05
74.0	0.01	0.05	0.07	0.15	0.20	0.27	0.42	0.10	0.25	0.33	0.56	0.69	0.86	1.19
75.0	0.03	0.08	0.11	0.21	0.27	0.34	0.51	0.14	0.31	0.40	0.66	0.81	0.98	1.33
76.0	0.05	0.12	0.15	0.27	0.33	0.42	0.60	0.18	0.37	0.47	0.76	0.92	1.09	1.48
77.0	0.07	0.15	0.19	0.33	0.40	0.49	0.69	0.22	0.43	0.54	0.85	1.03	1.21	1.62
78.0	0.09	0.18	0.23	0.38	0.47	0.57	0.79	0.26	0.50	0.61	0.95	1.14	1.33	1.76
79.0	0.11	0.22	0.27	0.44	0.54	0.64	0.88	0.29	0.56	0.68	1.04	1.25	1.44	1.90
80.0	0.13	0.25	0.31	0.50	0.61	0.72	0.97	0.33	0.62	0.75	1.14	1.36	1.56	2.04
81.0	0.15	0.28	0.35	0.56	0.68	0.79	1.06	0.37	0.69	0.82	1.24	1.47	1.68	2.18
82.0	0.17	0.32	0.40	0.62	0.75	0.87	1.15	0.41	0.75	0.89	1.33	1.59	1.80	2.32
83.0	0.19	0.35	0.44	0.67	0.82	0.94	1.25	0.45	0.81	0.96	1.43	1.70	1.91	2.46
84.0	0.21	0.38	0.48	0.73	0.89	1.02	1.34	0.48	0.87	1.03	1.53	1.81	2.03	2.61
84.1	0.22	0.39	0.48	0.74	0.90	1.03	1.35	0.49	0.88	1.04	1.54	1.82	2.04	2.62
84.2	0.22	0.39	0.49	0.74	0.90	1.03	1.36	0.49	0.89	1.05	1.55	1.83	2.05	2.63
84.3	0.22	0.40	0.49	0.75	0.91	1.04	1.37	0.50	0.89	1.06	1.56	1.84	2.06	2.65
84.4	0.22	0.40	0.49	0.76	0.92	1.05	1.37	0.50	0.90	1.06	1.56	1.85	2.08	2.66
84.5	0.22	0.40	0.50	0.76	0.93	1.06	1.38	0.50	0.91	1.07	1.57	1.86	2.09	2.68
84.6	0.23	0.41	0.50	0.77	0.93	1.06	1.39	0.51	0.91	1.08	1.58	1.88	2.10	2.69
84.7	0.23	0.41	0.51	0.77	0.94	1.07	1.40	0.51	0.92	1.08	1.59	1.89	2.11	2.70
84.8	0.23	0.41	0.51	0.78	0.95	1.08	1.41	0.52	0.92	1.09	1.60	1.90	2.12	2.72
84.9	0.23	0.42	0.51	0.78	0.95	1.09	1.42	0.52	0.93	1.10	1.61	1.91	2.13	2.73
85.0	0.23	0.42	0.52	0.79	0.96	1.09	1.43	0.52	0.94	1.10	1.62	1.92	2.15	2.75
86.0	0.25	0.45	0.56	0.85	1.03	1.17	1.52	0.56	1.00	1.18	1.72	2.03	2.26	2.89
87.0	0.27	0.49	0.60	0.91	1.10	1.24	1.61	0.60	1.06	1.25	1.82	2.14	2.38	3.03

Table 12 presents an example of the results of the analysis by connected air conditioning load. The table presents the estimated savings by cycling strategy for various levels of WTHI for customers with connected load less than 3.5 kW or equal to and greater than 3.5 kW. At a WTHI of 84^{o}F and cycling strategy of 50%, the estimated savings are 0.71 kW for the low connected load stratum and 1.21 kW for the high connected load stratum. From Table 11 we see that the aggregate average savings were estimated at 0.80 kW. These tables will allow each participating utility to generate a customized estimate for use in reporting the appropriate savings to PJM. The full set of tables is contained in an Excel spreadsheet that accompanies this report. Sample tables for selected times are provided in Appendix H.

Table 13 Savings by Connected Load Stratum 15-Min Ending 5pm.

	Predicted Savings at 5pm For Various Duty Cycle Strategies													
	Stratum 1 AC Connected Demand < 3.5 kW							Stratum 2 AC Connected Demand > 3.5 kW						
WTHI	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
70.0	0.02	0.04	0.05	0.05	0.08	0.16	0.28	0.04	0.08	0.07	0.10	0.20	0.27	0.49
71.0	0.02	0.04	0.05	0.12	0.17	0.25	0.39	0.04	0.08	0.07	0.22	0.33	0.41	0.67
72.0	0.02	0.04	0.05	0.19	0.25	0.34	0.50	0.04	0.08	0.16	0.34	0.46	0.56	0.84
73.0	0.02	0.08	0.11	0.26	0.33	0.43	0.61	0.04	0.16	0.25	0.45	0.59	0.71	1.02
74.0	0.05	0.13	0.16	0.33	0.41	0.52	0.73	0.09	0.24	0.34	0.57	0.72	0.85	1.19
75.0	0.07	0.17	0.22	0.40	0.49	0.61	0.84	0.14	0.32	0.42	0.69	0.85	1.00	1.36
76.0	0.10	0.22	0.27	0.47	0.58	0.70	0.95	0.19	0.40	0.51	0.81	0.98	1.15	1.54
77.0	0.13	0.26	0.33	0.54	0.66	0.79	1.07	0.24	0.48	0.60	0.92	1.11	1.29	1.71
78.0	0.16	0.31	0.38	0.61	0.74	0.88	1.18	0.29	0.56	0.69	1.04	1.24	1.44	1.89
79.0	0.18	0.35	0.43	0.68	0.82	0.96	1.29	0.34	0.64	0.78	1.16	1.37	1.58	2.06
80.0	0.21	0.40	0.49	0.75	0.91	1.05	1.41	0.39	0.72	0.86	1.28	1.50	1.73	2.23
81.0	0.24	0.44	0.54	0.82	0.99	1.14	1.52	0.44	0.80	0.95	1.39	1.63	1.88	2.41
82.0	0.26	0.49	0.60	0.89	1.07	1.23	1.63	0.49	0.88	1.04	1.51	1.75	2.02	2.58
83.0	0.29	0.53	0.65	0.96	1.15	1.32	1.75	0.54	0.96	1.13	1.63	1.88	2.17	2.76
84.0	0.32	0.58	0.71	1.03	1.23	1.41	1.86	0.59	1.04	1.21	1.75	2.01	2.32	2.93
84.1	0.32	0.58	0.71	1.04	1.24	1.42	1.87	0.60	1.05	1.22	1.76	2.03	2.33	2.95
84.2	0.32	0.59	0.72	1.04	1.25	1.43	1.88	0.60	1.06	1.23	1.77	2.04	2.35	2.96
84.3	0.33	0.59	0.72	1.05	1.26	1.44	1.89	0.61	1.07	1.24	1.78	2.05	2.36	2.98
84.4	0.33	0.59	0.73	1.06	1.27	1.45	1.91	0.61	1.07	1.25	1.79	2.07	2.37	3.00
84.5	0.33	0.60	0.73	1.06	1.28	1.46	1.92	0.62	1.08	1.26	1.80	2.08	2.39	3.02
84.6	0.34	0.60	0.74	1.07	1.28	1.47	1.93	0.62	1.09	1.27	1.82	2.09	2.40	3.03
84.7	0.34	0.61	0.74	1.08	1.29	1.48	1.94	0.63	1.10	1.28	1.83	2.10	2.42	3.05
84.8	0.34	0.61	0.75	1.09	1.30	1.48	1.95	0.63	1.11	1.29	1.84	2.12	2.43	3.07
84.9	0.34	0.62	0.76	1.09	1.31	1.49	1.96	0.64	1.11	1.29	1.85	2.13	2.45	3.09
85.0	0.35	0.62	0.76	1.10	1.32	1.50	1.97	0.64	1.12	1.30	1.86	2.14	2.46	3.10
86.0	0.37	0.67	0.82	1.17	1.40	1.59	2.09	0.69	1.20	1.39	1.98	2.27	2.61	3.28
87.0	0.40	0.71	0.87	1.24	1.48	1.68	2.20	0.74	1.28	1.48	2.10	2.40	2.76	3.45

4 Deemed Savings Estimates for Water Heating Load Control

In the feasibility study, the project team prepared a technical memorandum on pooling water heating load control estimates (see Appendix H). The memorandum was based on a review of work performed by several utilities: Potomac Electric, Baltimore Gas and Electric and Conectiv.

Table 14 presents a summary of the historical water heating load control estimates for the three utilities for the period from hour ending 1pm to hour ending 8pm. The estimates are fairly stable with the exception of the Conectiv estimates, which tended to be somewhat higher than the estimates derived by the other two utilities.

Table 14 Summary of Historical WH Load Control Estimates

Hour		BGE			
Ending	PEPCO	1998	2001	2002	Conectiv
1pm	0.26	0.27	0.26	0.25	0.35
2pm	0.23	0.28	0.23	0.20	0.33
3pm	0.20	0.26	0.22	0.20	0.31
4pm	0.21	0.25	0.20	0.19	0.34
5pm	0.23	0.26	0.23	0.24	0.39
6pm	0.32	0.30	0.31	0.29	0.43
7pm	0.35	0.36	0.35	0.30	0.42
8pm	0.31	0.41	0.37	0.34	0.40
Average	0.27	0.30	0.27	0.25	0.37

In this section, we use five years of historical end-use metering data available for a sample of Baltimore Gas and Electric (BGE) customers to develop “deemed savings” estimates following a duty cycle strategy. BGE was the only utility with detailed end-use metering data available for analysis.

Similar to the air conditioning analysis, we derive the maximum demand for each water heater contained in the sample. The individual customer’s maximum demand was used as a proxy for the equipment’s “spot watts”, or the maximum amount of load that the customer had available to interrupt. Figure 12 shows a comparison of the cumulative distribution of the spot watts for BGE customers in the sample.

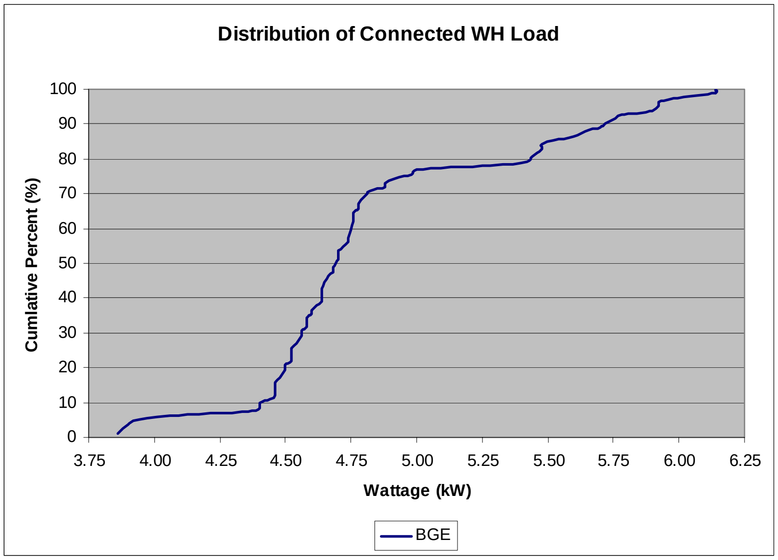

Figure 12 Cumulative Distribution of Water Heater Spot Watts

Electric water heaters come in a wide variety of configurations and often have an upper and lower element with an interlock that prevents the two elements from operating simultaneously. The element configuration can run the gambit from 750 watt to 6,000 watt rating. A very typical configuration is a 4,500 watt upper and lower element. This is evidenced by the vast majority of the customer loads falling in this range (see Figure 12).

For this project, the potential savings were calculated to simulate a 50%, 66.7%, 75% and 100% cycling strategy. The potential savings were defined as:

$$Savings_{c,S,t} = Max(0, Demand_{c,t} - Spotwatt_c * (1-CS))$$

Where:

$Savings_{c,S,t}$ = Estimated Savings for customer c, using cycling strategy S, at time t,
$Demand_{c,t}$ = Demand for customer c during time period t,
$Spotwatt_c$ = Spot watts for customer c,
CS = Cycling strategy (50%, 66.7%, 75% and 100%).

For the water heating analysis, the savings was calculated for each customer for each 15 minute period under the various cycling strategies. Since, the water heater demand is not terribly weather sensitive, the overall average demands were calculated by time of day.

4.1 Analysis Approach

Figure 13 illustrates the cumulative distribution of energy usage and presents a table with the distribution statistics for annual water heating use. The table and figure shows that the analysis is based on data from 319 annual periods. The median annual water heating energy use is estimated to be 2,986 kWh with a mean annual use of 2,828 kWh.

Quantile	
n	**319**
Max	7,522
99%	6,886
95%	5,536
90%	4,919
Q3	3,726
Mean	2,828
Median	2,986
Q1	2,062
10%	1,291
5%	972
1%	731
Min	663

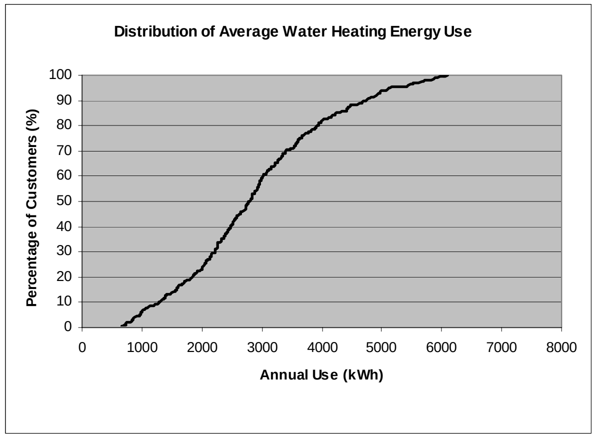

Figure 13 Distribution of Average Water Heating Usage

Table 15 shows the *potential upper bound* of annual energy savings under the various cycling strategies. Please note that the data presented in Table 15 are just theoretical and assumes that the water heating control is conducted every single day of the summer season without regard to any payback, a highly improbable operational scenario. Figure 13 shows the cumulative distributions of possible energy savings under the various cycling strategies. Please note the data in Table 15 assumes that the water heater is controlled every day in the year.

Table 15 Technical Upper Limit of Water Heater Load Control Savings under Various Cycling Strategies

Percentile	50% Cycling BGE	67% Cycling BGE	75% Cycling BGE	100% Cycling BGE
n	**319**	**319**	**319**	**319**
Max	2,254	3,581	4,298	7,522
99%	1,883	3,121	3,776	6,886
95%	1,348	2,295	2,866	5,536
90%	1,156	1,996	2,461	4,919
Q3	736	1,390	1,790	3,726
Mean	539	1,022	1,376	2,986
Median	437	864	1,221	2,828
Q1	234	531	803	2,062
10%	96	242	419	1,291
5%	52	182	303	972
1%	19	122	250	731
Min	-	33	72	663

4.2 Analysis Summary

The average 15-minute savings by strategy are illustrated in Figure 11 and presented in Table 16 and Table 17. The average savings associated with the 15-minute ending period 7am is estimated to be 0.59 kW for the 100% cycling approach. For the 15-minute period ending 7pm this estimate is 0.50 kW.

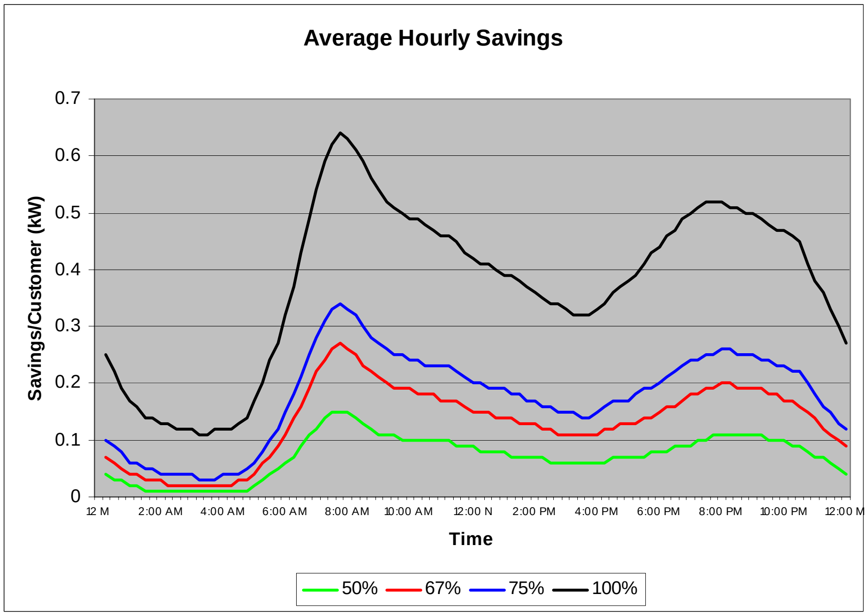

Figure 14 Water Heating Load Control Savings, By Cycling Strategy

Table 16 Average Water Heater Control Savings by Time Period and Cycling Strategy

		Cycling Strategy			
Period	**Time**	**50%**	**67%**	**75%**	**100%**
1	**12:15 AM**	0.04	0.07	0.10	0.25
2	**12:30 AM**	0.03	0.06	0.09	0.22
3	**12:45 AM**	0.03	0.05	0.08	0.19
4	**1:00 AM**	0.02	0.04	0.06	0.17
5	**1:15 AM**	0.02	0.04	0.06	0.16
6	**1:30 AM**	0.01	0.03	0.05	0.14
7	**1:45 AM**	0.01	0.03	0.05	0.14
8	**2:00 AM**	0.01	0.03	0.04	0.13
9	**2:15 AM**	0.01	0.02	0.04	0.13
10	**2:30 AM**	0.01	0.02	0.04	0.12
11	**2:45 AM**	0.01	0.02	0.04	0.12
12	**3:00 AM**	0.01	0.02	0.04	0.12
13	**3:15 AM**	0.01	0.02	0.03	0.11
14	**3:30 AM**	0.01	0.02	0.03	0.11
15	**3:45 AM**	0.01	0.02	0.03	0.12
16	**4:00 AM**	0.01	0.02	0.04	0.12
17	**4:15 AM**	0.01	0.02	0.04	0.12
18	**4:30 AM**	0.01	0.03	0.04	0.13
19	**4:45 AM**	0.01	0.03	0.05	0.14
20	**5:00 AM**	0.02	0.04	0.06	0.17
21	**5:15 AM**	0.03	0.06	0.08	0.20
22	**5:30 AM**	0.04	0.07	0.10	0.24
23	**5:45 AM**	0.05	0.09	0.12	0.27
24	**6:00 AM**	0.06	0.11	0.15	0.32
25	**6:15 AM**	0.07	0.14	0.18	0.37
26	**6:30 AM**	0.09	0.16	0.21	0.43
27	**6:45 AM**	0.11	0.19	0.25	0.49
28	**7:00 AM**	0.12	0.22	0.28	0.54
29	**7:15 AM**	0.14	0.24	0.31	0.59
30	**7:30 AM**	0.15	0.26	0.33	0.62
31	**7:45 AM**	0.15	0.27	0.34	0.64
32	**8:00 AM**	0.15	0.26	0.33	0.63
33	**8:15 AM**	0.14	0.25	0.32	0.61
34	**8:30 AM**	0.13	0.23	0.30	0.59
35	**8:45 AM**	0.12	0.22	0.28	0.56
36	**9:00 AM**	0.11	0.21	0.27	0.54
37	**9:15 AM**	0.11	0.20	0.26	0.52
38	**9:30 AM**	0.11	0.19	0.25	0.51
39	**9:45 AM**	0.10	0.19	0.25	0.50
40	**10:00 AM**	0.10	0.19	0.24	0.49
41	**10:15 AM**	0.10	0.18	0.24	0.49
42	**10:30 AM**	0.10	0.18	0.23	0.48
43	**10:45 AM**	0.10	0.18	0.23	0.47
44	**11:00 AM**	0.10	0.17	0.23	0.46
45	**11:15 AM**	0.10	0.17	0.23	0.46
46	**11:30 AM**	0.09	0.17	0.22	0.45
47	**11:45 AM**	0.09	0.16	0.21	0.43
48	**12:00 N**	0.09	0.15	0.20	0.42

Table 17 Average Water Heating Load Control Savings by Time Period and Cycling Strategy (cont)

		Cycling Strategy			
Period	**Time**	**50%**	**67%**	**75%**	**100%**
49	12:15 PM	0.08	0.15	0.20	0.41
50	12:30 PM	0.08	0.15	0.19	0.41
51	12:45 PM	0.08	0.14	0.19	0.40
52	1:00 PM	0.08	0.14	0.19	0.39
53	1:15 PM	0.07	0.14	0.18	0.39
54	1:30 PM	0.07	0.13	0.18	0.38
55	1:45 PM	0.07	0.13	0.17	0.37
56	2:00 PM	0.07	0.13	0.17	0.36
57	2:15 PM	0.07	0.12	0.16	0.35
58	2:30 PM	0.06	0.12	0.16	0.34
59	2:45 PM	0.06	0.11	0.15	0.34
60	3:00 PM	0.06	0.11	0.15	0.33
61	3:15 PM	0.06	0.11	0.15	0.32
62	3:30 PM	0.06	0.11	0.14	0.32
63	3:45 PM	0.06	0.11	0.14	0.32
64	4:00 PM	0.06	0.11	0.15	0.33
65	4:15 PM	0.06	0.12	0.16	0.34
66	4:30 PM	0.07	0.12	0.17	0.36
67	4:45 PM	0.07	0.13	0.17	0.37
68	5:00 PM	0.07	0.13	0.17	0.38
69	5:15 PM	0.07	0.13	0.18	0.39
70	5:30 PM	0.07	0.14	0.19	0.41
71	5:45 PM	0.08	0.14	0.19	0.43
72	6:00 PM	0.08	0.15	0.20	0.44
73	6:15 PM	0.08	0.16	0.21	0.46
74	6:30 PM	0.09	0.16	0.22	0.47
75	6:45 PM	0.09	0.17	0.23	0.49
76	7:00 PM	0.09	0.18	0.24	0.50
77	7:15 PM	0.10	0.18	0.24	0.51
78	7:30 PM	0.10	0.19	0.25	0.52
79	7:45 PM	0.11	0.19	0.25	0.52
80	8:00 PM	0.11	0.20	0.26	0.52
81	8:15 PM	0.11	0.20	0.26	0.51
82	8:30 PM	0.11	0.19	0.25	0.51
83	8:45 PM	0.11	0.19	0.25	0.50
84	9:00 PM	0.11	0.19	0.25	0.50
85	9:15 PM	0.11	0.19	0.24	0.49
86	9:30 PM	0.10	0.18	0.24	0.48
87	9:45 PM	0.10	0.18	0.23	0.47
88	10:00 PM	0.10	0.17	0.23	0.47
89	10:15 PM	0.09	0.17	0.22	0.46
90	10:30 PM	0.09	0.16	0.22	0.45
91	10:45 PM	0.08	0.15	0.20	0.41
92	11:00 PM	0.07	0.14	0.18	0.38
93	11:15 PM	0.07	0.12	0.16	0.36
94	11:30 PM	0.06	0.11	0.15	0.33
95	11:45 PM	0.05	0.10	0.13	0.30
96	12:00 M	0.04	0.09	0.12	0.27

4.3 100% Cycling

Typically, a 100% cycling strategy is employed with water heating controls since most water heaters have a tank with sufficient capacity to last several hours during control. In these next sections we will examine the issue of time sensitivity, seasonal sensitivity and weekday/weekend sensitivity.

4.3.1 Time Sensitivity

Figure 15 presents the demand savings duration curves associated with 100% cycling for the following weekday periods:

- Hour ending 8am;
- Hour ending 5pm; and
- Hour ending 7pm.

In this figure we have selected the average weekday demand for the annual period. The average demand in kW is displayed on the y-axis and the percentage of time the load is at or below the specified demand level on the x-axis. For example, if we examine the hour ending 8am profile we see that the load is at or below 0.72 kW for 50% of all weekdays. If we look at the 80th percentile, we can estimate that the savings are at or above 0.92 kW 20% of the time or if we examine the 80th percentile we see that the savings are at or above 0.52 kW 80% of the time. Table 18 presented selected distribution statistics for selected hour ending periods.

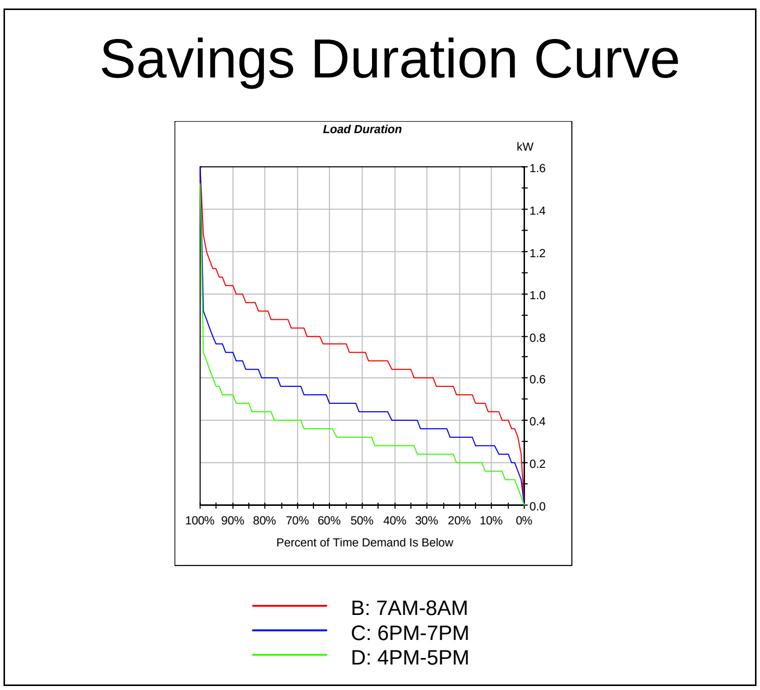

Figure 15 Water Heater Load Control Savings Duration Curve for Selected Hours (100% Cycling)

Table 18 Water Heating Load Control Savings Duration Curve for Selected Hours (100% Cycling)

	Hour Ending								
Percentile (Bin)	7am	8am	9am	2pm	3pm	4pm	5pm	6pm	7pm
1st (0.00-1.00%)	0.16	0.24	0.20	0.08	0.04	0.04	0.04	0.08	0.12
10th (9.00-10.00%)	0.32	0.44	0.32	0.16	0.16	0.12	0.16	0.20	0.28
25th (24.00-25.00%)	0.40	0.56	0.44	0.20	0.20	0.20	0.24	0.28	0.36
50th (49.00-50.00%)	0.52	0.72	0.56	0.32	0.28	0.28	0.32	0.36	0.44
75th (74.00-75.00%)	0.68	0.88	0.72	0.40	0.36	0.36	0.40	0.48	0.56
90th (89.00-90.00%)	0.84	1.04	0.88	0.52	0.48	0.44	0.52	0.60	0.72
95th (94.00-95.00%)	0.92	1.12	1.00	0.60	0.52	0.52	0.56	0.68	0.76
99th (98.00-99.00%)	1.12	1.28	1.20	0.76	0.68	0.68	0.72	0.84	0.92

4.3.2 Seasonal Sensitivity

There is some inherent seasonality associated with the water heating load. Figure 16 demonstrates the seasonal nature of the load for BGE customers in our sample. The lowest levels of load are in the summer with the highest loads in the winter. The Spring/Fall acts as a transition period.

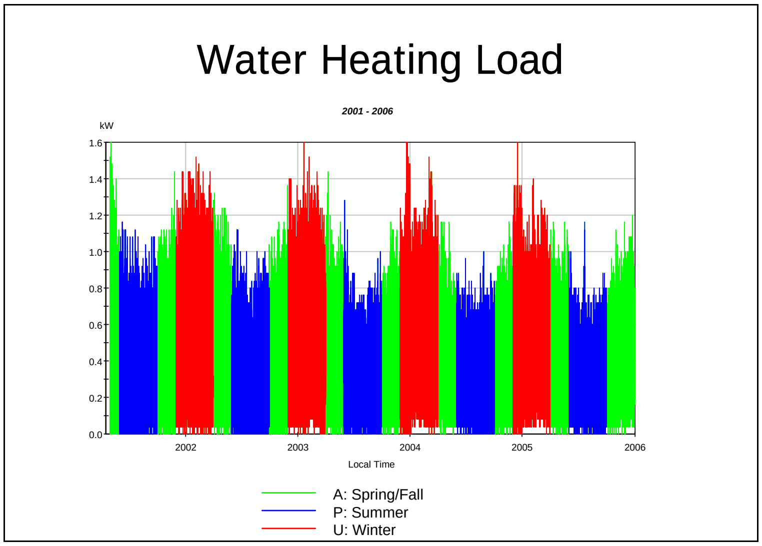

Figure 16 Seasonal Sensitivity of Water Heating Loads

To reflect this seasonality, we examined the 100% cycling load response by season. Selected distribution statistics for the water heating load, i.e., (anticipated savings under 100% cycling) are presented in Table 19, Table 20, and Table 21. The distribution statistics are presented for each hour. For example, the median load relief expected at hour ending 7am is 0.48 kW in the Spring/Fall, 0.36 kW in the summer and 0.52 kW in the winter. This assumes a signal reception rate of 100%.

Table 19 Spring Fall Average Water Heating Demand Distribution

				Percentiles						
Season	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
SPRFAL	1	2,316	0.20	0.04	0.08	0.12	0.20	0.24	0.32	0.36
SPRFAL	2	2,316	0.13	0.04	0.04	0.08	0.12	0.16	0.24	0.24
SPRFAL	3	2,300	0.12	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SPRFAL	4	2,316	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SPRFAL	5	2,316	0.13	0.04	0.04	0.08	0.12	0.16	0.24	0.28
SPRFAL	6	2,316	0.26	0.08	0.08	0.16	0.24	0.36	0.44	0.48
SPRFAL	7	2,313	0.49	0.12	0.20	0.28	0.48	0.64	0.80	0.88
SPRFAL	8	2,315	0.66	0.28	0.36	0.48	0.68	0.80	0.96	1.04
SPRFAL	9	2,315	0.59	0.32	0.36	0.44	0.56	0.72	0.84	0.92
SPRFAL	10	2,316	0.51	0.24	0.28	0.36	0.48	0.64	0.76	0.84
SPRFAL	11	2,316	0.47	0.20	0.24	0.32	0.44	0.60	0.72	0.84
SPRFAL	12	2,319	0.43	0.16	0.24	0.28	0.40	0.52	0.68	0.76
SPRFAL	13	2,319	0.40	0.16	0.20	0.28	0.36	0.48	0.64	0.72
SPRFAL	14	2,315	0.37	0.16	0.20	0.24	0.36	0.48	0.60	0.68
SPRFAL	15	2,314	0.34	0.12	0.16	0.24	0.32	0.44	0.52	0.60
SPRFAL	16	2,312	0.31	0.12	0.16	0.20	0.28	0.40	0.52	0.56
SPRFAL	17	2,312	0.36	0.16	0.20	0.24	0.36	0.44	0.56	0.64
SPRFAL	18	2,311	0.41	0.20	0.24	0.32	0.40	0.48	0.60	0.68
SPRFAL	19	2,311	0.47	0.24	0.28	0.36	0.48	0.56	0.68	0.72
SPRFAL	20	2,313	0.52	0.28	0.32	0.40	0.52	0.60	0.72	0.80
SPRFAL	21	2,314	0.52	0.28	0.32	0.40	0.52	0.60	0.72	0.80
SPRFAL	22	2,316	0.49	0.24	0.28	0.36	0.48	0.60	0.68	0.76
SPRFAL	23	2,318	0.43	0.20	0.24	0.32	0.40	0.52	0.64	0.68
SPRFAL	24	2,319	0.32	0.12	0.16	0.24	0.32	0.40	0.48	0.52

Table 20 Summer Average Water Heating Demand Distribution

				Percentiles						
Season	Hour	Obs	Mean	5th	10th	25th	Median	75th	90th	95th
SUMMER	1	2,440	0.17	0.04	0.08	0.12	0.16	0.20	0.28	0.32
SUMMER	2	2,440	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SUMMER	3	2,440	0.09	0.00	0.04	0.04	0.08	0.12	0.16	0.20
SUMMER	4	2,440	0.09	0.00	0.04	0.04	0.08	0.12	0.16	0.20
SUMMER	5	2,440	0.10	0.02	0.04	0.08	0.08	0.12	0.20	0.20
SUMMER	6	2,440	0.22	0.04	0.08	0.12	0.20	0.28	0.36	0.40
SUMMER	7	2,440	0.38	0.12	0.16	0.24	0.36	0.52	0.64	0.68
SUMMER	8	2,440	0.52	0.24	0.28	0.40	0.52	0.64	0.76	0.84
SUMMER	9	2,440	0.46	0.24	0.28	0.36	0.44	0.56	0.64	0.72
SUMMER	10	2,440	0.41	0.20	0.24	0.32	0.40	0.48	0.60	0.68
SUMMER	11	2,435	0.39	0.16	0.20	0.28	0.36	0.48	0.60	0.64
SUMMER	12	2,401	0.36	0.16	0.20	0.24	0.32	0.44	0.56	0.64
SUMMER	13	2,377	0.33	0.12	0.16	0.24	0.32	0.40	0.52	0.60
SUMMER	14	2,343	0.31	0.12	0.16	0.20	0.28	0.40	0.48	0.56
SUMMER	15	2,312	0.28	0.12	0.12	0.20	0.28	0.36	0.44	0.52
SUMMER	16	2,305	0.27	0.08	0.12	0.20	0.24	0.32	0.40	0.48
SUMMER	17	2,288	0.30	0.12	0.16	0.20	0.28	0.36	0.44	0.48
SUMMER	18	2,292	0.33	0.16	0.20	0.24	0.32	0.40	0.48	0.52
SUMMER	19	2,316	0.38	0.20	0.24	0.28	0.36	0.44	0.56	0.60
SUMMER	20	2,325	0.41	0.20	0.24	0.32	0.40	0.48	0.60	0.64
SUMMER	21	2,360	0.43	0.20	0.24	0.32	0.40	0.52	0.60	0.68
SUMMER	22	2,392	0.42	0.20	0.24	0.32	0.40	0.52	0.60	0.68
SUMMER	23	2,429	0.38	0.16	0.20	0.28	0.36	0.48	0.56	0.64
SUMMER	24	2,440	0.28	0.12	0.16	0.20	0.28	0.36	0.40	0.48

Table 21 Winter Average Water Heating Demand Distribution

				Percentiles						
Season	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
WINTER	1	2,064	0.27	0.08	0.12	0.20	0.28	0.36	0.44	0.48
WINTER	2	2,064	0.18	0.04	0.08	0.12	0.16	0.24	0.32	0.36
WINTER	3	2,064	0.16	0.04	0.08	0.12	0.16	0.20	0.28	0.32
WINTER	4	2,064	0.15	0.04	0.08	0.12	0.16	0.20	0.24	0.28
WINTER	5	2,064	0.18	0.04	0.08	0.12	0.16	0.24	0.28	0.32
WINTER	6	2,064	0.30	0.08	0.12	0.20	0.28	0.40	0.48	0.56
WINTER	7	2,064	0.53	0.16	0.20	0.32	0.52	0.72	0.88	0.96
WINTER	8	2,063	0.74	0.28	0.36	0.52	0.76	0.96	1.08	1.20
WINTER	9	2,064	0.73	0.40	0.48	0.60	0.72	0.84	1.00	1.08
WINTER	10	2,063	0.65	0.32	0.40	0.52	0.64	0.80	0.92	1.04
WINTER	11	2,064	0.61	0.28	0.32	0.44	0.56	0.76	0.96	1.04
WINTER	12	2,058	0.57	0.24	0.32	0.40	0.52	0.72	0.88	1.00
WINTER	13	2,064	0.52	0.20	0.28	0.36	0.48	0.64	0.84	0.92
WINTER	14	2,064	0.47	0.20	0.24	0.32	0.44	0.60	0.72	0.80
WINTER	15	2,064	0.43	0.16	0.20	0.28	0.40	0.56	0.68	0.80
WINTER	16	2,064	0.40	0.16	0.20	0.28	0.40	0.52	0.64	0.76
WINTER	17	2,064	0.45	0.20	0.24	0.32	0.44	0.56	0.68	0.76
WINTER	18	2,059	0.52	0.28	0.32	0.40	0.52	0.60	0.72	0.80
WINTER	19	2,060	0.61	0.32	0.40	0.48	0.60	0.72	0.84	0.88
WINTER	20	2,060	0.65	0.36	0.40	0.52	0.64	0.76	0.88	1.00
WINTER	21	2,062	0.60	0.32	0.36	0.48	0.60	0.72	0.84	0.92
WINTER	22	2,061	0.54	0.28	0.32	0.44	0.52	0.64	0.76	0.84
WINTER	23	2,064	0.50	0.24	0.32	0.40	0.48	0.60	0.72	0.80
WINTER	24	2,064	0.38	0.16	0.20	0.28	0.36	0.48	0.56	0.64

4.3.3 Seasonal and Weekday/Weekend Sensitivity

Figure 17 examines hour ending 7am by distinguishing between weekdays and weekends and summer and winter. Clearly, the savings estimates differ by season and average weekday versus weekend. Table 22, Table 23, and Table 24 summarizes the water heater savings distributions for the 100% cycling strategy.

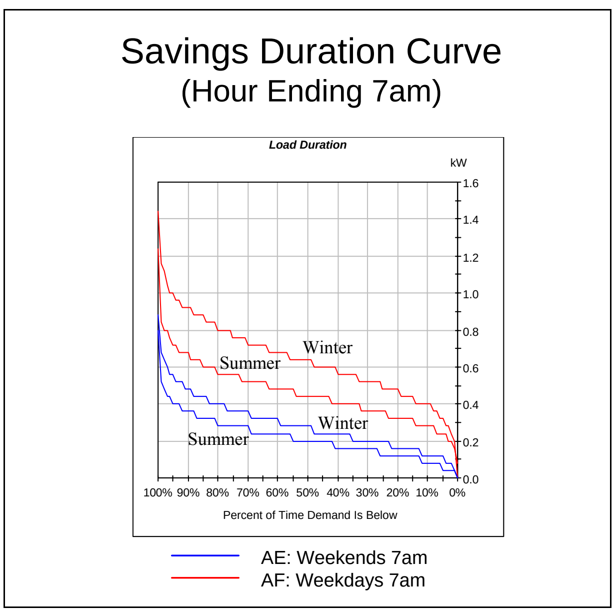

Figure 17 Water Heating Load Control Savings Duration Curve (7am)

Table 22 Spring/Fall Average Weekday/Weekend Water Heating Savings Distribution

				Percentiles							
Season	Type	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
SPRFAL	Weekday	1	1,660	0.19	0.04	0.08	0.12	0.16	0.24	0.32	0.36
SPRFAL	Weekday	2	1,660	0.13	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SPRFAL	Weekday	3	1,660	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SPRFAL	Weekday	4	1,660	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.20
SPRFAL	Weekday	5	1,660	0.14	0.04	0.04	0.08	0.12	0.20	0.24	0.28
SPRFAL	Weekday	6	1,660	0.31	0.12	0.16	0.24	0.28	0.40	0.48	0.52
SPRFAL	Weekday	7	1,657	0.58	0.28	0.36	0.44	0.56	0.72	0.84	0.92
SPRFAL	Weekday	8	1,659	0.74	0.44	0.52	0.60	0.76	0.88	1.00	1.04
SPRFAL	Weekday	9	1,659	0.59	0.32	0.36	0.44	0.56	0.72	0.84	0.92
SPRFAL	Weekday	10	1,660	0.46	0.24	0.28	0.36	0.44	0.56	0.68	0.74
SPRFAL	Weekday	11	1,660	0.40	0.20	0.24	0.28	0.40	0.48	0.60	0.68
SPRFAL	Weekday	12	1,663	0.36	0.16	0.20	0.28	0.36	0.44	0.56	0.64
SPRFAL	Weekday	13	1,663	0.34	0.12	0.16	0.24	0.32	0.40	0.52	0.60
SPRFAL	Weekday	14	1,659	0.32	0.12	0.16	0.24	0.32	0.40	0.48	0.56
SPRFAL	Weekday	15	1,658	0.29	0.12	0.16	0.20	0.28	0.36	0.44	0.52
SPRFAL	Weekday	16	1,656	0.27	0.12	0.12	0.20	0.28	0.36	0.44	0.48
SPRFAL	Weekday	17	1,656	0.32	0.16	0.16	0.24	0.32	0.40	0.48	0.52
SPRFAL	Weekday	18	1,655	0.39	0.20	0.24	0.28	0.40	0.48	0.56	0.64
SPRFAL	Weekday	19	1,655	0.47	0.24	0.28	0.36	0.48	0.56	0.64	0.72
SPRFAL	Weekday	20	1,657	0.52	0.28	0.32	0.40	0.52	0.60	0.72	0.80
SPRFAL	Weekday	21	1,658	0.51	0.28	0.32	0.40	0.52	0.60	0.72	0.80
SPRFAL	Weekday	22	1,660	0.49	0.24	0.28	0.36	0.48	0.60	0.72	0.76
SPRFAL	Weekday	23	1,662	0.44	0.20	0.24	0.32	0.44	0.52	0.64	0.68
SPRFAL	Weekday	24	1,663	0.31	0.12	0.16	0.20	0.28	0.40	0.48	0.52
Season	Type	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
SPRFAL	Weekend	1	656	0.23	0.08	0.12	0.16	0.24	0.28	0.36	0.40
SPRFAL	Weekend	2	656	0.15	0.04	0.04	0.08	0.16	0.20	0.24	0.28
SPRFAL	Weekend	3	640	0.13	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SPRFAL	Weekend	4	656	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SPRFAL	Weekend	5	656	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SPRFAL	Weekend	6	656	0.13	0.04	0.04	0.08	0.12	0.16	0.24	0.28
SPRFAL	Weekend	7	656	0.24	0.08	0.12	0.16	0.24	0.32	0.40	0.44
SPRFAL	Weekend	8	656	0.44	0.20	0.24	0.32	0.44	0.52	0.64	0.72
SPRFAL	Weekend	9	656	0.59	0.36	0.40	0.48	0.56	0.68	0.80	0.88
SPRFAL	Weekend	10	656	0.64	0.36	0.40	0.52	0.64	0.76	0.88	0.96
SPRFAL	Weekend	11	656	0.64	0.40	0.44	0.52	0.62	0.76	0.88	0.96
SPRFAL	Weekend	12	656	0.59	0.32	0.40	0.48	0.60	0.68	0.80	0.88
SPRFAL	Weekend	13	656	0.54	0.28	0.36	0.44	0.52	0.64	0.76	0.84
SPRFAL	Weekend	14	656	0.49	0.28	0.32	0.40	0.48	0.60	0.68	0.76
SPRFAL	Weekend	15	656	0.45	0.24	0.28	0.36	0.44	0.52	0.64	0.68
SPRFAL	Weekend	16	656	0.41	0.20	0.24	0.32	0.40	0.52	0.60	0.68
SPRFAL	Weekend	17	656	0.45	0.24	0.28	0.36	0.44	0.56	0.64	0.72
SPRFAL	Weekend	18	656	0.47	0.24	0.28	0.36	0.44	0.56	0.64	0.72
SPRFAL	Weekend	19	656	0.48	0.24	0.32	0.40	0.48	0.56	0.68	0.76
SPRFAL	Weekend	20	656	0.52	0.28	0.32	0.40	0.52	0.64	0.72	0.80
SPRFAL	Weekend	21	656	0.52	0.28	0.32	0.40	0.52	0.64	0.72	0.80
SPRFAL	Weekend	22	656	0.48	0.24	0.28	0.36	0.46	0.56	0.68	0.76
SPRFAL	Weekend	23	656	0.41	0.20	0.24	0.32	0.40	0.52	0.60	0.68
SPRFAL	Weekend	24	656	0.33	0.16	0.20	0.24	0.32	0.40	0.48	0.56

Table 23 Summer Average Weekday/Weekend Water Heating Savings Distribution

				Percentiles							
Season	Type	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
SUMMER	Weekday	1	1,724	0.16	0.04	0.08	0.12	0.16	0.20	0.28	0.32
SUMMER	Weekday	2	1,724	0.11	0.04	0.04	0.08	0.08	0.12	0.20	0.20
SUMMER	Weekday	3	1,724	0.09	0.00	0.04	0.04	0.08	0.12	0.16	0.20
SUMMER	Weekday	4	1,724	0.09	0.00	0.04	0.04	0.08	0.12	0.16	0.16
SUMMER	Weekday	5	1,724	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SUMMER	Weekday	6	1,724	0.26	0.12	0.12	0.20	0.24	0.32	0.40	0.44
SUMMER	Weekday	7	1,724	0.45	0.24	0.28	0.36	0.44	0.56	0.64	0.72
SUMMER	Weekday	8	1,724	0.58	0.32	0.40	0.48	0.56	0.68	0.80	0.88
SUMMER	Weekday	9	1,724	0.45	0.24	0.28	0.36	0.44	0.52	0.64	0.72
SUMMER	Weekday	10	1,724	0.37	0.20	0.24	0.28	0.36	0.44	0.52	0.60
SUMMER	Weekday	11	1,719	0.34	0.16	0.20	0.24	0.32	0.40	0.52	0.56
SUMMER	Weekday	12	1,685	0.31	0.12	0.16	0.24	0.28	0.36	0.48	0.52
SUMMER	Weekday	13	1,661	0.28	0.12	0.16	0.20	0.28	0.36	0.44	0.48
SUMMER	Weekday	14	1,627	0.26	0.12	0.12	0.20	0.24	0.32	0.40	0.44
SUMMER	Weekday	15	1,596	0.24	0.08	0.12	0.16	0.24	0.32	0.36	0.44
SUMMER	Weekday	16	1,589	0.23	0.08	0.12	0.16	0.24	0.28	0.36	0.40
SUMMER	Weekday	17	1,572	0.27	0.12	0.16	0.20	0.28	0.32	0.40	0.44
SUMMER	Weekday	18	1,576	0.32	0.16	0.20	0.24	0.32	0.40	0.48	0.52
SUMMER	Weekday	19	1,600	0.38	0.20	0.24	0.28	0.36	0.44	0.52	0.60
SUMMER	Weekday	20	1,609	0.41	0.20	0.24	0.32	0.40	0.48	0.56	0.60
SUMMER	Weekday	21	1,644	0.43	0.20	0.24	0.32	0.40	0.52	0.60	0.68
SUMMER	Weekday	22	1,676	0.42	0.24	0.24	0.32	0.40	0.52	0.60	0.68
SUMMER	Weekday	23	1,713	0.38	0.16	0.24	0.28	0.36	0.48	0.56	0.64
SUMMER	Weekday	24	1,724	0.27	0.12	0.16	0.20	0.28	0.32	0.40	0.44
Season	Type	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
SUMMER	Weekend	1	716	0.19	0.08	0.08	0.12	0.16	0.24	0.28	0.36
SUMMER	Weekend	2	716	0.13	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SUMMER	Weekend	3	716	0.10	0.00	0.04	0.04	0.08	0.12	0.16	0.20
SUMMER	Weekend	4	716	0.09	0.00	0.04	0.04	0.08	0.12	0.16	0.20
SUMMER	Weekend	5	716	0.09	0.00	0.04	0.04	0.08	0.12	0.16	0.20
SUMMER	Weekend	6	716	0.11	0.04	0.04	0.08	0.12	0.16	0.20	0.24
SUMMER	Weekend	7	716	0.22	0.04	0.08	0.12	0.20	0.28	0.36	0.40
SUMMER	Weekend	8	716	0.37	0.16	0.20	0.28	0.36	0.44	0.52	0.60
SUMMER	Weekend	9	716	0.48	0.28	0.32	0.36	0.48	0.56	0.68	0.72
SUMMER	Weekend	10	716	0.50	0.28	0.32	0.40	0.48	0.60	0.72	0.80
SUMMER	Weekend	11	716	0.49	0.24	0.32	0.36	0.48	0.56	0.68	0.80
SUMMER	Weekend	12	716	0.47	0.24	0.28	0.36	0.48	0.56	0.64	0.68
SUMMER	Weekend	13	716	0.43	0.24	0.28	0.32	0.40	0.52	0.60	0.68
SUMMER	Weekend	14	716	0.41	0.20	0.24	0.32	0.40	0.48	0.60	0.64
SUMMER	Weekend	15	716	0.37	0.20	0.24	0.28	0.36	0.44	0.52	0.60
SUMMER	Weekend	16	716	0.34	0.16	0.20	0.24	0.32	0.40	0.52	0.56
SUMMER	Weekend	17	716	0.36	0.16	0.20	0.28	0.36	0.44	0.52	0.56
SUMMER	Weekend	18	716	0.36	0.20	0.24	0.28	0.36	0.44	0.52	0.56
SUMMER	Weekend	19	716	0.38	0.20	0.24	0.28	0.40	0.48	0.56	0.60
SUMMER	Weekend	20	716	0.41	0.20	0.24	0.32	0.40	0.52	0.60	0.64
SUMMER	Weekend	21	716	0.43	0.20	0.24	0.32	0.40	0.52	0.64	0.72
SUMMER	Weekend	22	716	0.41	0.20	0.24	0.32	0.40	0.48	0.60	0.68
SUMMER	Weekend	23	716	0.38	0.16	0.20	0.28	0.36	0.48	0.56	0.64
SUMMER	Weekend	24	716	0.28	0.12	0.16	0.20	0.28	0.36	0.44	0.48

Table 24 Winter Average Weekday/Weekend Water Heating Savings Distribution

				Percentiles							
Season	Type	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
WINTER	Weekday	1	1,448	0.26	0.08	0.12	0.16	0.24	0.32	0.40	0.48
WINTER	Weekday	2	1,448	0.17	0.04	0.08	0.12	0.16	0.20	0.28	0.32
WINTER	Weekday	3	1,448	0.16	0.04	0.08	0.12	0.16	0.20	0.24	0.28
WINTER	Weekday	4	1,448	0.15	0.04	0.04	0.12	0.16	0.20	0.24	0.28
WINTER	Weekday	5	1,448	0.19	0.08	0.08	0.12	0.20	0.24	0.32	0.36
WINTER	Weekday	6	1,448	0.35	0.16	0.20	0.28	0.32	0.44	0.52	0.60
WINTER	Weekday	7	1,448	0.63	0.28	0.36	0.48	0.64	0.76	0.92	1.00
WINTER	Weekday	8	1,447	0.85	0.40	0.52	0.72	0.84	1.00	1.16	1.20
WINTER	Weekday	9	1,448	0.74	0.40	0.48	0.60	0.72	0.88	1.04	1.12
WINTER	Weekday	10	1,448	0.59	0.28	0.36	0.48	0.56	0.72	0.84	0.92
WINTER	Weekday	11	1,448	0.51	0.24	0.28	0.40	0.48	0.62	0.76	0.84
WINTER	Weekday	12	1,442	0.48	0.24	0.28	0.36	0.44	0.60	0.72	0.84
WINTER	Weekday	13	1,448	0.44	0.20	0.24	0.32	0.44	0.56	0.68	0.76
WINTER	Weekday	14	1,448	0.41	0.16	0.24	0.28	0.40	0.52	0.64	0.68
WINTER	Weekday	15	1,448	0.37	0.16	0.20	0.28	0.36	0.46	0.56	0.64
WINTER	Weekday	16	1,448	0.35	0.12	0.16	0.24	0.32	0.44	0.56	0.64
WINTER	Weekday	17	1,448	0.41	0.16	0.24	0.32	0.40	0.48	0.60	0.68
WINTER	Weekday	18	1,443	0.49	0.24	0.28	0.40	0.48	0.60	0.68	0.80
WINTER	Weekday	19	1,444	0.60	0.32	0.40	0.48	0.60	0.72	0.80	0.88
WINTER	Weekday	20	1,444	0.65	0.36	0.40	0.52	0.64	0.76	0.88	0.96
WINTER	Weekday	21	1,446	0.60	0.28	0.36	0.48	0.60	0.72	0.84	0.92
WINTER	Weekday	22	1,445	0.55	0.28	0.36	0.44	0.56	0.64	0.76	0.80
WINTER	Weekday	23	1,448	0.51	0.24	0.32	0.40	0.52	0.60	0.72	0.80
WINTER	Weekday	24	1,448	0.37	0.16	0.20	0.28	0.36	0.48	0.56	0.64
Season	Type	Hour	n	Mean	5th	10th	25th	Median	75th	90th	95th
WINTER	Weekend	1	616	0.30	0.12	0.12	0.20	0.28	0.36	0.48	0.52
WINTER	Weekend	2	616	0.21	0.08	0.08	0.16	0.20	0.28	0.36	0.40
WINTER	Weekend	3	616	0.17	0.04	0.08	0.12	0.16	0.24	0.28	0.32
WINTER	Weekend	4	616	0.15	0.04	0.08	0.12	0.16	0.20	0.24	0.28
WINTER	Weekend	5	616	0.15	0.04	0.04	0.08	0.16	0.20	0.24	0.28
WINTER	Weekend	6	616	0.18	0.04	0.08	0.12	0.16	0.24	0.28	0.32
WINTER	Weekend	7	616	0.28	0.08	0.12	0.20	0.28	0.36	0.48	0.56
WINTER	Weekend	8	616	0.50	0.20	0.28	0.36	0.48	0.64	0.76	0.84
WINTER	Weekend	9	616	0.69	0.40	0.44	0.56	0.68	0.80	0.96	1.04
WINTER	Weekend	10	615	0.82	0.48	0.56	0.68	0.80	0.96	1.08	1.20
WINTER	Weekend	11	616	0.83	0.48	0.56	0.68	0.84	0.96	1.12	1.20
WINTER	Weekend	12	616	0.76	0.48	0.52	0.64	0.72	0.88	1.04	1.12
WINTER	Weekend	13	616	0.71	0.44	0.48	0.60	0.68	0.84	0.96	1.04
WINTER	Weekend	14	616	0.62	0.36	0.40	0.50	0.60	0.76	0.84	0.92
WINTER	Weekend	15	616	0.58	0.28	0.36	0.44	0.56	0.68	0.84	0.92
WINTER	Weekend	16	616	0.52	0.24	0.28	0.40	0.52	0.64	0.76	0.84
WINTER	Weekend	17	616	0.57	0.28	0.36	0.44	0.56	0.68	0.80	0.88
WINTER	Weekend	18	616	0.59	0.36	0.40	0.48	0.56	0.68	0.80	0.88
WINTER	Weekend	19	616	0.63	0.32	0.40	0.52	0.64	0.76	0.84	0.92
WINTER	Weekend	20	616	0.66	0.36	0.44	0.56	0.64	0.76	0.88	1.00
WINTER	Weekend	21	616	0.60	0.36	0.40	0.48	0.60	0.72	0.84	0.92
WINTER	Weekend	22	616	0.53	0.28	0.32	0.40	0.52	0.64	0.76	0.84
WINTER	Weekend	23	616	0.48	0.24	0.28	0.38	0.48	0.56	0.68	0.76
WINTER	Weekend	24	616	0.39	0.16	0.24	0.28	0.40	0.48	0.56	0.64

From a daily operational perspective, the median savings estimates extracted and highlighted in Table 25 would be appropriate. However, if the program is run more based on extreme system conditions, then these conditions are often associated with extreme temperatures. Therefore, we have assembled a time-temperature matrix for estimating the savings.

Table 25 Water Heating Savings Estimates by Season and Day Type

Season	DayType	Selected Time Periods - Median															
		6am	7am	8am	9am	10am	11am	12N	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm
Spring/Fall	Weekday	0.28	0.56	0.76	0.56	0.44	0.40	0.36	0.32	0.32	0.28	0.28	0.32	0.40	0.48	0.52	0.52
Spring/Fall	Weekend	0.12	0.24	0.44	0.56	0.64	0.62	0.60	0.52	0.48	0.44	0.40	0.44	0.44	0.48	0.52	0.52
Summer	Weekday	0.24	0.44	0.56	0.44	0.36	0.32	0.28	0.28	0.24	0.24	0.24	0.28	0.32	0.36	0.40	0.40
Summer	Weekend	0.12	0.20	0.36	0.48	0.48	0.48	0.48	0.40	0.40	0.36	0.32	0.36	0.36	0.40	0.40	0.40
Winter	Weekday	0.32	0.64	0.84	0.72	0.56	0.48	0.44	0.44	0.40	0.36	0.32	0.40	0.48	0.60	0.64	0.60
Winter	Weekend	0.16	0.28	0.48	0.68	0.80	0.84	0.72	0.68	0.60	0.56	0.52	0.56	0.56	0.64	0.64	0.60

The time temperature relationships for selected hours during weekdays are presented in Figure 18, which clearly shows a decreasing level of savings by each of the selected time periods as the WTHI goes from cold to hot. Relationships were developed for each 15-minute period throughout the day and tabularized similar to the AC findings. Table 31 summarizes the savings estimates for 100% cycling for selected time periods. Alternative cycling strategies were run and are documented with the tables presented to PJM.

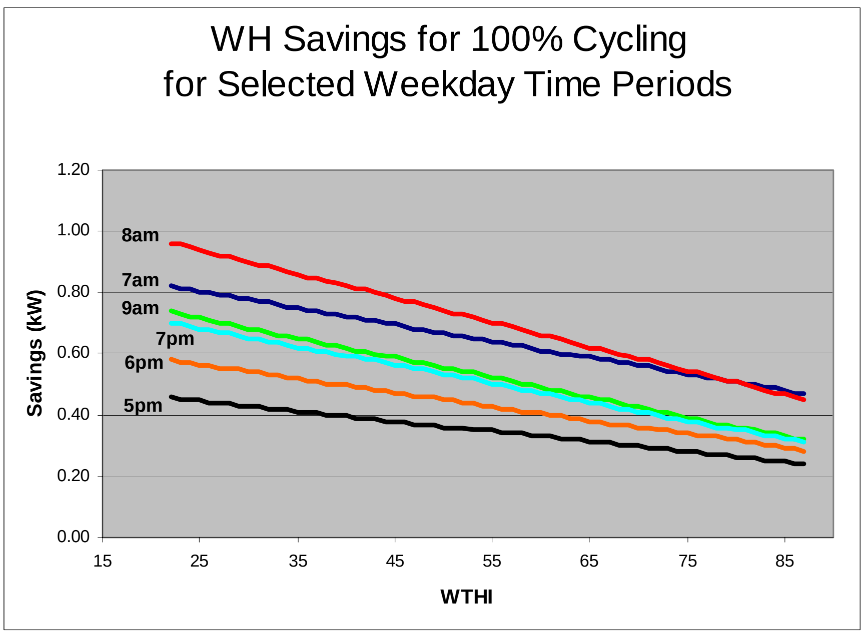

Figure 18 Water Heating Savings for 100% Cycling for Selected Weekday Time Periods

Table 26 Water Heating Savings by WTHI Temperature Bin

WTHI	7am	8am	9am	10am	11am	Noon	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm
22	0.82	0.96	0.74	0.58	0.54	0.50	0.46	0.43	0.42	0.40	0.46	0.58	0.70	0.70	0.56
23	0.81	0.96	0.73	0.57	0.53	0.50	0.46	0.43	0.41	0.40	0.45	0.57	0.70	0.69	0.56
24	0.81	0.95	0.72	0.57	0.53	0.49	0.46	0.43	0.41	0.40	0.45	0.57	0.69	0.69	0.56
25	0.80	0.94	0.72	0.57	0.53	0.49	0.45	0.42	0.41	0.39	0.45	0.56	0.68	0.68	0.56
26	0.80	0.93	0.71	0.56	0.52	0.48	0.45	0.42	0.40	0.39	0.44	0.56	0.68	0.67	0.55
27	0.79	0.92	0.70	0.56	0.52	0.48	0.45	0.42	0.40	0.39	0.44	0.55	0.67	0.67	0.55
28	0.79	0.92	0.70	0.55	0.51	0.48	0.44	0.41	0.40	0.38	0.44	0.55	0.67	0.66	0.55
29	0.78	0.91	0.69	0.55	0.51	0.47	0.44	0.41	0.39	0.38	0.43	0.55	0.66	0.66	0.55
30	0.78	0.90	0.68	0.54	0.51	0.47	0.44	0.41	0.39	0.38	0.43	0.54	0.65	0.65	0.54
31	0.77	0.89	0.68	0.54	0.50	0.46	0.43	0.40	0.39	0.37	0.43	0.54	0.65	0.65	0.54
32	0.77	0.89	0.67	0.54	0.50	0.46	0.43	0.40	0.38	0.37	0.42	0.53	0.64	0.64	0.54
33	0.76	0.88	0.66	0.53	0.49	0.46	0.43	0.40	0.38	0.37	0.42	0.53	0.64	0.64	0.54
34	0.75	0.87	0.66	0.53	0.49	0.45	0.42	0.39	0.38	0.37	0.42	0.52	0.63	0.63	0.53
35	0.75	0.86	0.65	0.52	0.49	0.45	0.42	0.39	0.37	0.36	0.41	0.52	0.62	0.63	0.53
36	0.74	0.85	0.65	0.52	0.48	0.44	0.41	0.39	0.37	0.36	0.41	0.51	0.62	0.62	0.53
37	0.74	0.85	0.64	0.51	0.48	0.44	0.41	0.38	0.36	0.36	0.41	0.51	0.61	0.61	0.53
38	0.73	0.84	0.63	0.51	0.47	0.44	0.41	0.38	0.36	0.35	0.40	0.50	0.61	0.61	0.52
39	0.73	0.83	0.63	0.51	0.47	0.43	0.40	0.38	0.36	0.35	0.40	0.50	0.60	0.60	0.52
40	0.72	0.82	0.62	0.50	0.47	0.43	0.40	0.37	0.35	0.35	0.40	0.50	0.59	0.60	0.52
41	0.72	0.81	0.61	0.50	0.46	0.42	0.40	0.37	0.35	0.35	0.39	0.49	0.59	0.59	0.52
42	0.71	0.81	0.61	0.49	0.46	0.42	0.39	0.37	0.35	0.34	0.39	0.49	0.58	0.59	0.51
43	0.71	0.80	0.60	0.49	0.45	0.42	0.39	0.36	0.34	0.34	0.39	0.48	0.58	0.58	0.51
44	0.70	0.79	0.59	0.49	0.45	0.41	0.39	0.36	0.34	0.34	0.38	0.48	0.57	0.58	0.51
45	0.70	0.78	0.59	0.48	0.45	0.41	0.38	0.36	0.34	0.33	0.38	0.47	0.56	0.57	0.51
46	0.69	0.77	0.58	0.48	0.44	0.40	0.38	0.36	0.33	0.33	0.38	0.47	0.56	0.57	0.50
47	0.68	0.77	0.57	0.47	0.44	0.40	0.38	0.35	0.33	0.33	0.37	0.46	0.55	0.56	0.50
48	0.68	0.76	0.57	0.47	0.44	0.40	0.37	0.35	0.33	0.33	0.37	0.46	0.55	0.55	0.50
49	0.67	0.75	0.56	0.46	0.43	0.39	0.37	0.35	0.32	0.32	0.37	0.46	0.54	0.55	0.50
50	0.67	0.74	0.55	0.46	0.43	0.39	0.37	0.34	0.32	0.32	0.36	0.45	0.53	0.54	0.49
51	0.66	0.73	0.55	0.46	0.42	0.38	0.36	0.34	0.32	0.32	0.36	0.45	0.53	0.54	0.49
52	0.66	0.73	0.54	0.45	0.42	0.38	0.36	0.34	0.31	0.31	0.36	0.44	0.52	0.53	0.49
53	0.65	0.72	0.54	0.45	0.42	0.38	0.35	0.33	0.31	0.31	0.35	0.44	0.52	0.53	0.49
54	0.65	0.71	0.53	0.44	0.41	0.37	0.35	0.33	0.31	0.31	0.35	0.43	0.51	0.52	0.48
55	0.64	0.70	0.52	0.44	0.41	0.37	0.35	0.33	0.30	0.31	0.35	0.43	0.50	0.52	0.48
56	0.64	0.70	0.52	0.43	0.40	0.36	0.34	0.32	0.30	0.30	0.34	0.42	0.50	0.51	0.48
57	0.63	0.69	0.51	0.43	0.40	0.36	0.34	0.32	0.30	0.30	0.34	0.42	0.49	0.51	0.48
58	0.63	0.68	0.50	0.43	0.40	0.36	0.34	0.32	0.29	0.30	0.34	0.41	0.48	0.50	0.47
59	0.62	0.67	0.50	0.42	0.39	0.35	0.33	0.31	0.29	0.29	0.33	0.41	0.48	0.49	0.47
60	0.61	0.66	0.49	0.42	0.39	0.35	0.33	0.31	0.29	0.29	0.33	0.41	0.47	0.49	0.47
61	0.61	0.66	0.48	0.41	0.38	0.34	0.33	0.31	0.28	0.29	0.33	0.40	0.47	0.48	0.47
62	0.60	0.65	0.48	0.41	0.38	0.34	0.32	0.30	0.28	0.28	0.32	0.40	0.46	0.48	0.46
63	0.60	0.64	0.47	0.40	0.38	0.34	0.32	0.30	0.28	0.28	0.32	0.39	0.45	0.47	0.46
64	0.59	0.63	0.46	0.40	0.37	0.33	0.32	0.30	0.27	0.28	0.32	0.39	0.45	0.47	0.46
65	0.59	0.62	0.46	0.40	0.37	0.33	0.31	0.29	0.27	0.28	0.31	0.38	0.44	0.46	0.46
66	0.58	0.62	0.45	0.39	0.36	0.32	0.31	0.29	0.27	0.27	0.31	0.38	0.44	0.46	0.45
67	0.58	0.61	0.45	0.39	0.36	0.32	0.31	0.29	0.26	0.27	0.31	0.37	0.43	0.45	0.45
68	0.57	0.60	0.44	0.38	0.36	0.32	0.30	0.28	0.26	0.27	0.30	0.37	0.42	0.44	0.45
69	0.57	0.59	0.43	0.38	0.35	0.31	0.30	0.28	0.25	0.26	0.30	0.37	0.42	0.44	0.45
70	0.56	0.58	0.43	0.37	0.35	0.31	0.29	0.28	0.25	0.26	0.30	0.36	0.41	0.43	0.44
71	0.56	0.58	0.42	0.37	0.35	0.30	0.29	0.27	0.25	0.26	0.29	0.36	0.41	0.43	0.44
72	0.55	0.57	0.41	0.37	0.34	0.30	0.29	0.27	0.24	0.26	0.29	0.35	0.40	0.42	0.44
73	0.54	0.56	0.41	0.36	0.34	0.30	0.28	0.27	0.24	0.25	0.29	0.35	0.39	0.42	0.43
74	0.54	0.55	0.40	0.36	0.33	0.29	0.28	0.26	0.24	0.25	0.28	0.34	0.39	0.41	0.43
75	0.53	0.54	0.39	0.35	0.33	0.29	0.28	0.26	0.23	0.25	0.28	0.34	0.38	0.41	0.43
76	0.53	0.54	0.39	0.35	0.33	0.28	0.27	0.26	0.23	0.24	0.28	0.33	0.38	0.40	0.43
77	0.52	0.53	0.38	0.34	0.32	0.28	0.27	0.25	0.23	0.24	0.27	0.33	0.37	0.40	0.42
78	0.52	0.52	0.37	0.34	0.32	0.28	0.27	0.25	0.22	0.24	0.27	0.33	0.36	0.39	0.42
79	0.51	0.51	0.37	0.34	0.31	0.27	0.26	0.25	0.22	0.24	0.27	0.32	0.36	0.38	0.42
80	0.51	0.51	0.36	0.33	0.31	0.27	0.26	0.24	0.22	0.23	0.26	0.32	0.35	0.38	0.42
81	0.50	0.50	0.36	0.33	0.31	0.26	0.26	0.24	0.21	0.23	0.26	0.31	0.35	0.37	0.41
82	0.50	0.49	0.35	0.32	0.30	0.26	0.25	0.24	0.21	0.23	0.26	0.31	0.34	0.37	0.41
83	0.49	0.48	0.34	0.32	0.30	0.26	0.25	0.23	0.21	0.22	0.25	0.30	0.33	0.36	0.41
84	0.49	0.47	0.34	0.31	0.29	0.25	0.25	0.23	0.20	0.22	0.25	0.30	0.33	0.36	0.41
85	0.48	0.47	0.33	0.31	0.29	0.25	0.24	0.23	0.20	0.22	0.25	0.29	0.32	0.35	0.40
86	0.47	0.46	0.32	0.31	0.29	0.24	0.24	0.22	0.20	0.22	0.24	0.29	0.32	0.35	0.40
87	0.47	0.45	0.32	0.30	0.28	0.24	0.23	0.22	0.19	0.21	0.24	0.28	0.31	0.34	0.40

5 Future Studies

5.1 Cooperative Projects

As utilities in the PJM market footprint explore new demand response initiatives consideration should be given to conducting regional studies that effectively pool the resources of the participating utilities. Figure 19 presents a map of the PJM territory. The figure shows a territory that stretches from the eastern seaboard to the western part of Illinois. We recommend a regional stratification for future studies that estimate load reductions from residential load management with sufficient sample points to meet some minimum precision criterion, e.g., 90% confidence ±20% precision. Sufficient data should be assembled to allow the pooled metering results to be directly applied to the various service territories. For any end-use metered data collected this would include the whole house consumption information[18] to use as an analytical link with the respective population billing systems. We believe that the final estimate should take advantage of the wealth of data collected by the contributing utilities while reflecting the unique characteristics of the specific service territory.

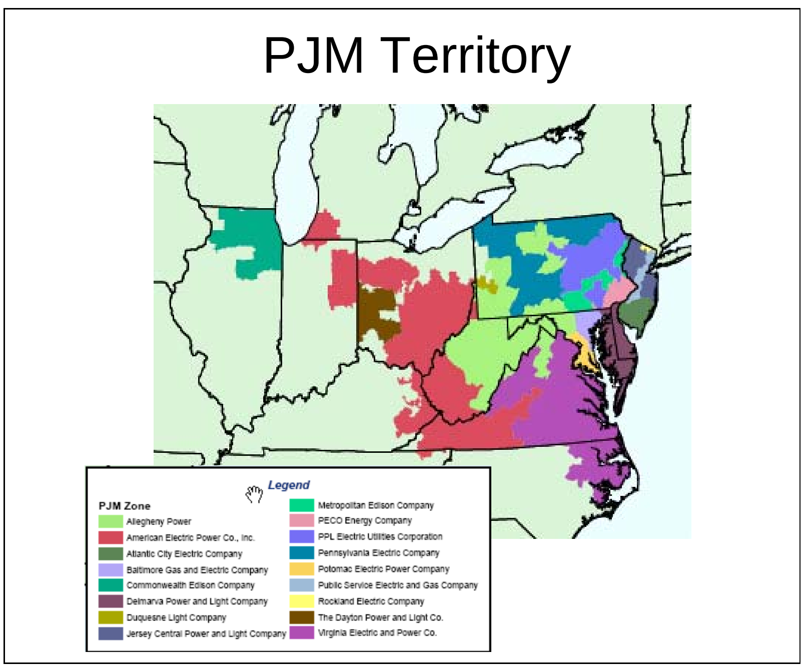

Figure 19 PJM Service Territory

5.2 Operability Studies

In reviewing the prior evaluation studies of direct load control, we noted that the two utilities that had conducted operability studies in 2001 did find significant operability problems. We recommend that each utility be required to conduct periodic operability studies, using a common sampling, testing and reporting methodology. Initially, we

[18] Whole premise billing information was unavailable for some of the participants included in the current analysis. This required the project team to make necessary assumptions in order to combine the data from the three service territories. Some of the concerns raised by this approach are alleviated in the stratum level analysis.

recommend that each utility select a simple random sample of 250 program participants and determine the operability of the switch(s) at each sample home.[19] The testing protocol should verify both signal reception and switch operation, and identify the underlying causes of the problems that are encountered. The utility should report the overall failure rate and the appropriate net-to-gross ratio to be used to adjust the gross impact.

The utility-specific operability study should be conducted at least every five years, but may be conducted more frequently if a utility believes it has taken steps to mitigate its operability problems and wishes to use an improved net-to-gross ratio. For 2007, the utility must submit their latest operability study for use in calculating net load impacts. In the absence of an operability study conducted in the last five years, the utility may elect to use an initial operability ratio of 50%. If an operability study has not been conducted in the last five years then a new operability study must be completed by the 2008 submittal.

If a utility has been able to demonstrate a net-to-gross ratio of 90% or higher then it is still required to conduct operability studies at least every five years, but a reduced sample size can be used. In this case the recommended sample is 100 homes.[20] If the reduced study yields an estimated net-to-gross ratio less than 90%, then we recommend that a full sample of 250 homes be tested as soon as practical and that the larger sample size be used in subsequent studies until the utility has again demonstrated a net to gross ratio of 90% or higher.[21]

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[19] A sample of 250 will give an error bound of at most ±0.05 at the 90% level of confidence for the net to gross ratio. If a tighter error bound is desired then a larger sample will be agreed to and selected.

[20] If the net to gross ratio is 0.90 or larger, a sample of 100 will give an error bound of at most ±0.05 at the 90% level of confidence for the true net to gross ratio.

[21] Our recommendations have been informed by ISO 2859-1:1999(E), “Sampling Procedures for Inspection by Attributes” which is the current version of ANSI/ASQC Z1.4.

Appendix A: Load Research Working Group EDC Subgroup Meeting Summary

Date: 7/28/2005
Location: Baltimore, MD

A meeting of a subgroup of the recently-formed Load Research Working Group was held on July 28, 2005 in the PHI offices in downtown Baltimore. The subgroup comprised representatives from the four EDCs who reported EWH and AC load impact estimates to PJM in 2002-2003.

Table 27 LRWG Meeting Attendees: July 28, 2005

Name	Position	Organization	Contact Information
Chris Siebens	DR Program Manager	JCP&L	csiebens@gpu.com
John Reynolds	Sr. Engineer	PJM Interconnection	reynolj@pjm.com
Grayson Heffner	Consultant	LBNL	gcheffner@lbl.gov
Mike Prendergast	Mgr- Demand Analysis	PSE&G	Michael.prendergast@pseg.com
Greg Urbin	Program Mgr	BG&E	Gregory.M.Urbin@bge.com
Mary M. Straub	Load Research Specialist	BG&E	Mary.m.straub@bge.com
Chuck Goldman	Program Manager	LBNL	cagoldman@lbl.gov
Curt Puckett	Vice-President	RLW Analytics	Curt.puckett@rlw.com
Steve Sunderhauf	Manager-Pgm Evaluation	PHI	slsunderhauf@pepco.com

Meeting Purpose

The purpose of the meeting was to:

- Discuss and agree a joint plan for meeting the PJM ALM reporting requirements for 2006-2007 and beyond, which John Reynolds can take forward to the LAS and eventually the Operations Committee;
- Discuss the value and feasibility of estimating a PJM East regional model for estimating DLC impacts. Such a regional model would require load data contributions from all four EDCs, and could be done for air conditioners only or for both electric water heaters and air conditioners.

Review of LRWG Work to date

Since the June 23 LRWG kick-off meeting the following progress has been made:

- The Working Group and PJM Staff now agree that load impacts from existing AC and WH DLC programs are static and not subject to change even over long periods; therefore, even a quinquennial requirement for a load research study to re-estimate DLC load impacts may be unnecessary and too costly relative to program benefits.

- PJM staff agreed to propose to LAS and the Planning and Operations Committees a one-year delay in the 2006-2007 quinquennial requirement for load impact estimation, with the understanding that this time would be used to explore and develop new, cost-savings approaches to DLC M&V.
- John Reynolds reported that the Planning Committee at its July 28 meeting approved a suspension of the current load research rules for one year only, only the LRWG can complete its work.
- The EDCs holding load data from 2001-2002 have agreed to study whether a pooled approach to performing load impact estimation in the future, for both existing and new programs, is feasible and economical.
- As a first step the EDCs agreed to share with LBNL detailed information on their 2001-2002 studies.
- LBNL has retained RLW Associates as a load research statistical consultant, at no cost to PJM or the EDCs, to review the various study approaches and impact estimation methods and perform a feasibility study of EDC load data pooling for purposes of meeting PJM's DLC M&V requirements.

Strawman Plan for Meeting the 2006-2007 PJM M&V Requirements

Any changes in ALM M&V requirements, including delays in the M&V reporting schedule, must be approved by PJM stakeholders (i.e., the Load Analysis Subcommittee and the Planning and Markets Committees). LBNL put forward the following strawman plan that PJM Staff could present to these committees in order to gain stakeholder support:

- PJM and stakeholders approve a one-year delay in the quinquennial load impact re-estimation requirement (from 2006-2007 to 2007-2008).
- Each EDC participating in the ALM DLC program proceeds with their switch operability/availability surveys in 2006 per usual.
- All four EDCs reporting DLC load impact estimates in 2001 collaborate in a load data pooling effort resulting in formulation of a PJM Eastern Region-wide model for estimating load impacts of air conditioners and water heaters.
- Based on confidence gained in pooling of data and regional models for estimating DLC load impacts, the EDCs would jointly propose a pooled approach to future load research on DLC impacts of both existing and new programs, including the possibility of fielding a single load research sample across the region rather than individual EDC load research samples.
- Any proposed changes to the load research rules would be available for stakeholder consideration in 2006.

RLW **Discussion of Statistical Issues Associated with Pooled M&V Approach for PJM East EDCs**

Curt Puckett of RLW Associates described the role of RLW in supporting the LREG efforts. RLW will provide input into the statistical and practical challenges associated with the different levels of M&V cooperation between the PJM East EDCs. RLW will produce a feasibility study of pooling of existing data for purposes of developing a region-wide load impact estimation model. Assuming the nature of the individual EDC sample design and data holdings is conducive to pooling the data, RLW will draft a Work Plan for developing simplified DLC M&V procedures, included pooling of EDC resources, for 2007-2008 and beyond.

Curt went on to describe some of the challenges to a pooled M&V approach, including:

- Standardizing data associated with differing programs, time periods, cycling strategies, event days, and weather;
- Accommodating data taken at the whole-house vs. end-use level and at different intervals;
- Statistical weighting, ratio estimation techniques, or model specification needed to reflect and adjust for changing population pools, housing characteristics, end-use behavior and appliance characteristics.
- Samples stratified using different variables and with different number of strata and strata thresholds.

Curt described his initial review of the load impact estimation methods taken by the four EDCs, which comprise two generic approaches as follows:

- Duty-cycle modeling with pooled data to develop time-temperature matrices for various duty-cycle strategies. This approach is amenable to data pooling because it would be possible to use all available end-use metering data regardless of LSE, time period or frequency of data collection. The output of the EDC-specific models or a region-wide version would be a time-temperature (or THI) matrix as required by PJM.
- Regression-based event-day approach using pooled data. The event-day model could operate on total facility load data using a customer base line (CBL) or matched day strategy. Using this approach to develop a pooled model would have the advantage of drawing from a large sample of same-day data from across the EDCs and would still yield a time-temperature matrix of probable impacts.

Curt’s initial conclusion is that a pooled approach is very promising, both for developing a regional model based on previous data collected and for developing load research strategies in the future. His likely recommendation will be to investigate strategies that combine both the duty-cycle and regression based approaches and see whether it is possible to leverage the end-use data together with the whole house data to develop improved estimates. Such a model specification will likely need additional variables to account for differences by PJM zone and program design.

Discussion

During and after the presentation of the LRWG work to date, the straw-man plan, and statistical issues associated with pooled approaches to M&V, the EDC participants made the following comments and suggestions:

- The consideration of pooled approaches and regional model estimation should definitely extend to include EWH as well as AC direct control, even though only two EDCs (BGE and PEPCO) have large EWH programs.

- Similarly, the possibility of considering all participants in similar programs as part of a single PJM East regional population for which one sample could be drawn should logically apply to not only existing but new programs. This would serve the objective of lowering the barriers to entry of new technologies and program designs.
- In developing and submitting plans for the 2006 switch operability survey it would be useful to adopt and share with PJM some standard guidelines for the switch survey design. Each EDC would then be free to me or exceed these minimum guidelines. It was agreed that the objective of the operability survey is to determine what fraction of the total program population has operable switches. Inspection of operability is at EDC discretion, and may include visual inspection only or use of hand-held transmitters or other devices.
- The possibility of a single operability sample drawn across all the EDCs was discussed. Although the idea of a pooled sample has merit, the individual characteristics and distinctive history of each program, including signal transmission coverage issues, mitigate against trying such an approach for next year.
- In performing its scope of work RLW should separately study the feasibility of and develop a work plan for the AC and EWH programs.
- BGE pointed out that the benefit to them of a pooled approach is likely less than for PSE&G and JCP&L. This is because BGE has a standing load research sample from which they collect and analyze data on an ongoing basis. However, BGE is supportive of the concept, especially if it could be extended to commercial load control programs and residential EWH programs.
- PEPCO asked how widely the results of a regional model for estimating EWH and AC DLC impacts would be shared. This is a threshold issue for agreeing to support such an effort, as EDCs would need to be reassured that such an effort and product would not result in competitive disadvantage for them or their parent companies. This is likely an issue that should be taken to the LWG and LAS.
- RLW indicated that they would not require actual load data for the initial feasibility study and work plan development. LBNL raised the issue of data confidentiality with the utilities as an issue that may have to be addressed depending on the work-plan.

Outcomes and Next Steps

The EDCs participating in the meeting endorsed the feasibility study and work plan development, although, it was made clear that no commitments were being made in terms of funding any actual pooled regional model estimation work at this time. RLW and LBNL will perform the feasibility study and, if results warrant, work plan development in time for the next meeting of the LRWG in late August. The study and work plan will be circulated to the EDC subgroup (and PJM) for comment before being sent to the full LRWG. The EDCs also expressed thanks for LBL support to development by RLW of some simple survey guidelines for next year’s switch operability survey. RLW will develop these guidelines and circulate them within a week, again to the EDCs and PJM for comment first. In anticipation of a positive result of the feasibility study, the EDCs agreed to locate and ready their 2001-2002 load data for use. The EDCs also agreed to work with LBL and RLW to finish gathering the detailed documentation on their sample designs and data specifications, per the Annex to this Meeting Summary. The next meeting of the full LRWG was rescheduled for Aug. 30 from 10 am to noon in Wilmington. PJM will take care of the announcement and arrangements.

Outcomes
Agree on a proposed 2006-2007 M&V approach to take to LAS and Operations Committee in September

Commission (with LBL funding) a feasibility study & work plan for pooling M&V data for purposes of developing a region-wide load impact model
Agree to share load data from 2002 should a pooled approach be found feasible & economical

Submit plans for 2006 switch availability surveys

Consider pooling resources for other M&V tasks

A second meeting of the Load Research Working Group was scheduled for August 25 to allow discussion of the proposed M&V protocols as well as other issues related to load research collaboration and cooperation.

<table>
<tr><th></th><th>JCP&L/GPU/FirstEnergy Air Conditioner Load Control Program</th><th>PEPCO KiloWatchers Club and Plus Program</th><th>PSE&G's Cool Customer Program</th><th>BG&E's Residential Rider 5</th></tr>
<tr><td>Date Channels</td><td>Recorder # 1: Whole House
Recorder # 2: AC Compressor</td><td>AC Program: Whole house
WH Program: End-use data loggers</td><td>Forthcoming</td><td>AC Program: Compressor Load
WH Program: EWH load</td></tr>
<tr><td>Data Collection Intervals</td><td>15 minute</td><td>15 minute</td><td>Forthcoming</td><td>15 minute</td></tr>
<tr><td>Load Impact Study Contractor</td><td>Quantum Consulting</td><td>Demand Research (Dr. Marvin Horowitz/Johns Hopkins Univ, President)</td><td>Kema/Xenergy</td><td>In house</td></tr>
<tr><td>Sample Stratification – Air Conditioner Studies</td><td>Stratified Random Sample with 4 strata, based on total kWh usage in July-August billing cycled 1999</td><td>510 points spread amongst 3 separate sub-populations: DC, Montgomery County, PG County. Other details forthcoming.</td><td>Forthcoming</td><td>88 useable data points stratified into two equal-sized cells based on monthly energy use August 1999. Threshold: ≤1717 kWh ≥
<table><tr><td></td><td>≤1717 kWh</td><td>≥1717 kWh</td></tr><tr><td>Pop.</td><td>184000</td><td>76335</td></tr><tr><td>Sample</td><td>TBD</td><td>TBD</td></tr></table></td></tr>
<tr><td>Sample Stratification – Water Heater Studies</td><td>N/A</td><td>60 points in a Simple Random Sample, no jurisdictional split</td><td>N/A</td><td>Sample size: 52 useable data points in a four-way strata by TOU vs. non-TOU and greater than or less than a monthly energy use in August 1999 of 1592 kWh
<table><tr><td>Strata 1</td><td></td><td>≤1592</td><td>≥1592</td></tr><tr><td>Non-TOU</td><td>Pop.</td><td>34476</td><td>14755</td></tr><tr><td></td><td>Sample</td><td>25</td><td>18</td></tr><tr><td>TOU</td><td>Pop.</td><td>12744</td><td>10146</td></tr><tr><td></td><td>Sample</td><td>10</td><td>12</td></tr></table></td></tr>
<tr><td>Load Control Strategy</td><td>AC: 15 min out of every half hour</td><td>AC: 13 min per half hour for 6 hrs (Club)c
100% Load shed for up to 6 hours (Plus)

WH: 100% Load shed up to 6 hours</td><td>Forthcoming</td><td>AC: 15 min per half hour

WH: 100% load shed</td></tr>
<tr><td>Availability of population data</td><td>With some difficulty</td><td>With some difficulty</td><td></td><td>With some difficulty</td></tr>
<tr><td>Availability of demographic data</td><td># of AC units: NO
AC Tonnage: YES
Household size (ft^1): NO</td><td># of AC units: NO
AC Tonnage: NO
Household size (ft^1): NO
EWH size (gal): YES</td><td>Forthcoming</td><td># of AC units: YES
AC Tonnage: NO
Household size (ft^1): NO
EWH size (gal): NO</td></tr>
</table>

Annex: Comparison of Load Research Sample Designs & Load Data Specification

Appendix B: Load Research Working Group Meeting Summary

Date: 8/30/2005
Location: Wilmington, DE

A meeting of the Load Research Working Group was held on August 30, 2005 at the Spencer Hotel in downtown, Wilmington, Delaware. Table 33 lists the individuals in attendance and their affiliation.

Table 28 LRWG Meeting Attendees: August 30, 2005

Name	Company Name
At the Meeting In Person	
Blume, Craig	UGI Utilities, Inc.
Heffner, Grayson	Lawrence Berkeley Laboratory
Lowe, Will	Potomac Electric Power
Miyaji, Wendell	Comverge
Prendergast, Michael	Public Service Electric and Gas
Puckett, Curt	RLW Analytics
Puryear, Erin	Old Dominion Electric Cooperative
Reynolds, John	PJM Interconnection
Slivika, John	PJM Interconnection
On Conference Call In Line	
	American Electric Power
Bertochhi, John	Jersey Central Power and Light
Chintapalli, Raj	Customized Energy Solutions
Goldman, Chuck	Lawrence Berkeley Laboratory
Icart, Eric	Public Service Commision of Maryland
Kogut, George	Consolidated Edison of New York
Nowicki, Linda	New Jersey Board of Public Utilities
Siebens, Chris	Jersey Central Power and Light
Straub, Mary	Baltimore Gas and Electric

Meeting Purpose

The primary purpose of the meeting was to review the work completed to date by the LBNL team on the feasibility of a pooled approach to Active Load Management/Direct Load Control (ALM/DLC) measurement & verification (M&V).

Meeting Notes

John Reynolds, PJM, welcomed everyone to the meeting and initiated the introductions. Grayson Heffner then reviewed the agenda and the steps leading up to the development of the feasibility study, i.e. the June 23, 2005 kick-off meeting establishing the LRWG within the Load Analysis Subcommittee, and an August 28, 2005 meeting of the four PJM LSEs with 2001/2002 ALM/DLC M&V results. Grayson noted recent action by PJM's Operations Committee granting a one year delay in the quinquennial[22] requirement for load impact estimation on direct load control programs. There was some discussion among the participants regarding the exact meaning of the delay. There was general agreement that results for the 2006 commitment could be deferred until at least 2007.

[22] Every five years.

Grayson reiterated that the goal of the feasibility study was to be forward looking and explore opportunities to pool resources and data to reduce M&V costs across the PJM region. Further he described the project's objective as "work with the various stakeholders to explore and develop a collaborative, consensus based approach to meeting future M&V requirements." At this point, Grayson turned the meeting over to Curt Puckett.

Curt Puckett, of *RLW Analytics* (which has been funded by LBNL) then presented the feasibility study (both the study itself and the summary presentation are available on the PJM website). In general, the consensus was that the differences that existed were not significant enough to prevent a pooled analysis to be completed and a cross zonal study to be developed.

The conclusions of the feasibility study were summarized as follows:

- Program impacts appear to be more strongly affected by operational issues over time than by changes in gross savings/household;
- Current M&V policy of differentiating the analysis of operational performance from the analysis of gross savings is appropriate;
- A simple re-analysis of the historical data may not satisfy PJM's Manual 19 requirements as currently written;
- A DLC M&V study that cuts across the entire PJM footprint is feasible and should be considered as an alternative to continued LSE-specific load research studies; and
- Standardized methods for data collection, analysis and PJM reporting should be pursued.

This portion of the program was closed by describing the results of two additional tasks assigned during the last subgroup meeting, i.e., the development of a straw man work plan for the execution of the recommendations of the project, and the development of a protocol for conducting future operability studies.

The presentation was followed by a general discussion. John Reynolds began by summarizing the alternatives for M&V of these legacy type programs. A low cost solution to the M&V challenge would deal with pooling the historical data to develop a single estimate. At the far end of the cost spectrum was having each LSE implement a new indigenous study. A middle ground might be a cross zonal sample and a pooled estimate.

There was some general discussion regarding these alternatives. The discussion focused on the value of fielding a new load research sample given that these legacy programs were in their declining years and new, innovative technology e.g., "smart" thermostats, was already being discussed by each of the LSEs as future replacement programs. The general conclusion was that it was probably not necessary to conduct another "new" field study but that there were some merits in attempting to pool the available historical data into a combined, region-wide estimation model.

A reanalysis of the historical data was described as a crucial step in the straw man work plan and could reasonably be completed by the end of 2005. The reanalysis would be a useful test of the proposed analysis strategy and would allow the group to reach common ground on a number of the ancillary issues surrounding future projects. Further, if at the conclusion of the reanalysis agreement could be reached to accept the results as a "deemed" savings estimate, then the "new" field study could possibly be cancelled. If the reanalysis failed to yield a reliable estimate then the "new" field study could be launched with data collection slated for as early as the summer 2006. There was some discussion regarding whether or not there was a need to have the results in this relatively short time frame. John Reynolds pointed out that the LRWG needed to report their conclusions to the LAS by the end of the year.

The reanalysis would require several pieces of data from the LSEs including:

- Individual interval load data,
- Corresponding weather data,
- Historical billing consumption data, i.e., July and August use, for the interval load customers used for post-stratification,
- Population tracking data for the current program participants, and
- Billing consumption data, preferably 13-months of use, for the current program participants.

A straw poll was taken to see how difficult securing the requested data would be. Each of the utilities responded that with the exception of the historical July and August billing data that most of the other data should be readily available. Other LSEs in attendance were polled regarding the availability of data. No other data were identified; however, John Reynolds indicated that he would send a solicitation to those LSEs in the PJM area that might have additional data.

Chuck Goldman, LBNL, discussed the issues of confidentiality and disclosure indicating that this could be a potential stumbling block for a project with such a short initial launch. None of the LSEs seemed to view this as much of an issue. Further, Chuck indicated a willingness by LBNL to join the LSEs in financially supporting the pooled model estimation work, provided that LBNL would have the option to publish the results. Grayson Heffner indicated that a separate discussion would need to be held with the LSE subgroup to discuss contractual and procurement issues. There was some general discussion on the willingness of the LSEs to contribute financial resources to the pooled model estimation effort. It was suggested that a pooled model could be completed for less than $100,000. The LSEs seemed receptive to supporting the effort, as long as the cost was modest.

The meeting concluded with a summary of next steps and action items by Grayson Heffner:

- *RLW* would revise and complete the feasibility study based on the discussion at today's meeting;

- *RLW* would develop a schedule and cost estimate to perform the work outlined as the reanalysis component of the Work Plan included as Appendix A of the feasibility study (see above);
- LBNL to prepare a letter memo regarding disclosure and confidentiality arrangements for this effort;
- PJM Staff to poll whether other LSEs would like to join the core group of four utilities with either data offerings or resources to support the second phase work;
- A subgroup comprising the four utilities plus any other interested LSEs to meet and arrange all the details for the follow-on effort;
- This subgroup would then advise the work itself; and
- The next full meeting of the LRWG would be after the regional model has been estimated and results available for review and presentation to the LAS.

Appendix C: Comparison of LSE A/C DLC Evaluation Results

A supplemental task associated with this project is to perform statistical tests on the estimates to identify whether or not the estimates of A/C cycling load reductions are statistically different among the utilities that conducted studies during 2001-2002. Table 34, has selected estimates and the associated standard errors.

Table 29 Reported impacts with standard error estimates

	Demand Reduction (kW) for Hour Ending							
	PSE&G[1]	GPU[1,2]	BGE	Conectiv[3]	PEPCO-DC[4]	PEPCO-DC[4]	PEPCO-MD[4]	PEPCO-MD[4]
WTHI	50%	50%	50%	50%	100%	43%	100%	43%
1pm @ 84	1.19	0.87	0.61	0.60	1.21	0.58	1.46	0.84
Std Error	0.0693	0.1362	0.0688	0.0284	0.0948	0.0523	0.1258	0.0650
5pm @ 84	1.24	0.83	0.92	0.70	1.56	0.86	2.07	1.07
Std Error	0.0693	0.1362	0.0457	0.0243	0.0948	0.0523	0.1258	0.0650

[1] The 1pm estimate is from the 1pm-2pm bin and the 5pm estimate is from the 5pm-6pm bin

[2] The estimate and standard error for "extreme" temperature days analysis

[3] Results from "severe" day analysis

[4] No standard error estimate was provided so the design precision of 10% was assumed

In the PEPCO report, the contractor reported a range of relative precision estimates for hour ending 5pm. The reported range was from ±8.5% to ±26%. For this comparative analysis among utility DLC programs, we elected to use ±10%, the design precision, as a proxy for the PEPCO estimates. For GPU, relative precision estimates were provided by day type, i.e., extreme, hot, etc. We elected to use the achieved relative precision for hour ending 1pm on the extreme temperature day as the precision proxy. This estimate was ±27%.

Table 30 T-Test Results (43% and 50% Cycling)

	Demand Reduction (kW) for Hour Ending 1pm					
x_2	PSE&G	GPU	BGE	Conectiv	PEPCO-DC	PEPCO-MD
WTHI/Cycling	50%	50%	50%	50%	43%	43%
84	1.19	0.87	0.61	0.60	0.58	0.84
Std Error	0.0666	0.1428	0.0457	0.0284	0.0353	0.0510
	T-Test Values (Ho: x1-x2=0 Reject if |Tc| > 2.576)					
x_1		**Do Not Reject**	**Reject**			
PSE&G		2.03	7.18	8.16	8.10	4.19
GPU			1.73	1.85	1.97	0.20
BGE				0.19	0.52	3.34
Conectiv					0.44	4.10
PEPCO-DC (43%)						4.18
	Demand Reduction (kW) for Hour Ending 5pm					
x_2	PSE&G	GPU	BGE	Conectiv	PEPCO-DC	PEPCO-MD
WTHI/Cycling	50%	50%	50%	50%	43%	43%
84	1.24	0.83	0.92	0.70	0.86	1.07
Std Error	0.0693	0.1362	0.0457	0.0243	0.0523	0.0650
	T-Test Values (Ho: x1-x2=0 Reject if |Tc| > 2.576)					
x_1	**Do Not Reject**	**Reject**				
PSE&G		2.68	3.85	7.35	4.38	1.79
GPU			0.63	0.94	0.21	1.59
BGE				4.25	0.86	1.89
Conectiv					2.78	5.33
PEPCO-DC (43%)						2.52

For the statistical comparison, a series of T-Tests were used to compare the individual couplets. The results of the T-Test are presented in Table 30 for the 43% and 50% cycling programs and in Table 31 for the 100% cycling programs. The results are mixed. Couplets where the null hypothesis was rejected are displayed as green shaded boxes. For the 50% and 43% cycling programs, the null hypothesis was rejected for the PSE&G estimate when compared to all but the PEPCO-MD estimate.

Table 31 T-Test Results (100% Cycling)

Demand Reduction (kW) for Hour Ending 1pm		
x_2	PEPCO-DC	PEPCO-MD
WTHI	100%	100%
84	1.21	1.46
Std Error	0.0733	0.0887
T-Test Values (Ho: x1-x2=0 Reject if |Tc| > 2.576)		
x_1		**Do Not Reject**
PEPCO-DC (100%)		2.21
Demand Reduction (kW) for Hour Ending 5pm		
x_2	PEPCO-DC	PEPCO-MD
WTHI	100%	100%
84	1.56	2.07
Std Error	0.0948	0.1258
T-Test Values (Ho: x1-x2=0 Reject if |Tc| > 2.576)		
x_1		**Reject**
PEPCO-DC (100%)		3.24

Since the gross savings were significantly different between many of the programs, one might conclude that the programs cannot be pooled in future impact evaluations. However, we believe this is *not* the only defensible conclusion. The results may reflect differences in the approach to the prior evaluation from utility to utility rather than differences in the gross savings themselves. If this is the case, then the differences may be reduced by using a common analysis approach across all the programs. To shed further light on the advisability of a pooled or common approach, it may be desirable to re-analyze the prior data using a common analytical approach.

Appendix D: Project Work Plan

Introduction and Background

Load research data from several air conditioner and water heater load control programs operating in the PJM East region will be pooled together and analyzed by Contractor in an effort to develop a regional load impact model suitable for use as an alternative M&V protocol for non-metered active load management programs. After conducting this analysis, Contractor will report back to the PLM Load Analysis Subcommittee on whether this approach is a suitable replacement for large-scale load research programs fielded at five year intervals.

Subcontractor Task and Deliverables

The overall study effort comprises seven tasks:

<u>Task 1: Transfer of data</u>
Contractor will work with utilities to transfer data, including transfer of the interval end-use or premise load data for each load research sample point together with the respective participant population data, including current monthly billing data, load curtailment schedules, and associated weather data for each historical year. The Contractor will work with each utility contributing data to specify data protocols and transfer media.

<u>Task 2: Data review and screening</u>
Contractor will review and screen data including examining each individual interval load site during control days to identify whether or not the end-use was being effectively controlled. During the data review process, contractor will identify selected screening criterion, which will be documented for potential use in future program evaluations. Contractor will also estimate each participant's maximum air conditioning demand for use in the duty cycle analysis.

<u>Task 3: Duty Cycle Analysis</u>
Contractor will conduct duty cycle analysis, including establishing individual "natural" duty cycles for each end-use metering participant. The participant's natural duty cycle will be used to estimate the amount of load that can be curtailed given at least three duty cycle strategies, i.e., 43%, 50% and 100%. Contractor will develop a "deemed" savings estimate for air conditioning cycling and electric water heating programs.

<u>Task 4: Time-temperature regression analysis</u>
Contractor will conduct a time-temperature regression analysis, including formulation of a time-temperature matrix relating the load available for each of the duty cycle strategies to different weighted temperature-humidity indices.

<u>Task 5: Aggregate research and analysis</u>
Contractor will conduct aggregate research and analysis, including aggregate analysis of PJM area results and comparison with area (zone) specific information. The objective of

this task is to develop a regression equation that can be used by zone to calculate deemed savings for the reporting of gross AC-DLC savings to PJM.

Task 6: Technical Reports
Contractor will prepare technical memo for the PJM Load Research Working Group, Load Analysis Subcommittee that documents the analytic approach and summarizes estimates of deemed savings for regional legacy A/C programs given cycling strategy and temperature parameters and WH curtailment program.

Working with Lawrence Berkeley National Laboratory (LBNL), Contractor will prepare technical report that documents analytic methods, presents results of the pooled load impact analysis, and summarizes key findings.

Task 7: Project management
Contractor will manage project, coordinate with project sponsors and funders, and participate in meetings of the PJM Load Research Working Group (as necessary). Contractor will also prepare periodic briefings as needed to the Load Analysis Subcommittee on project progress, interim and final results.

Deliverables

The Contractor will prepare the following deliverables:

- Project memorandum on data transfer, data quality following data review and screening (June 2006);
- Technical memo to Load Analysis Subcommittee of PJM Load Research Working Group that describes and summarizes estimates of deemed savings for regional legacy A/C programs given cycling strategy and temperature parameters and WH curtailment program (August 2006)
- Draft and Final Technical Report (with LBNL) that describes approach, analytic methods, results, key findings, including implications for other utilities and ISOs that want to improve M&V for mass market DR programs (Draft Report; Aug 2006; Final Report Sept 2006).

Appendix E: Event Day History

The following tables present the event day history for the various utilities.

Table 32 First Energy Event Dates and Times

Number	Date	Hour Start	Hour Stop	Duration
1	06/13/01	16:00	18:00	2:00
2	06/20/01	15:00	18:00	3:00
3	06/27/01	15:00	19:00	4:00
4	06/28/01	15:00	18:30	3:30
5	07/10/01	15:00	16:00	1:00
6	07/24/01	14:00	17:00	3:00
7	07/25/01	15:00	18:00	3:00
8	08/02/01	14:00	17:00	3:00
9	08/06/01	14:00	18:00	4:00
10	08/07/01	14:00	18:00	4:00
11	08/09/01	12:00	18:30	6:30
12	08/10/01	11:00	18:00	7:00
13	06/27/01	15:00	19:00	4:00
14	06/28/01	15:00	21:30	6:30
15	08/09/01	12:00	20:00	8:00
1	06/24/02	14:00	17:00	3:00
2	06/25/02	14:00	18:00	4:00
3	06/26/02	13:00	18:00	5:00
4	06/27/02	13:00	18:00	5:00
5	07/01/02	15:00	18:00	3:00
6	07/02/02	13:00	17:00	4:00
7	07/03/02	12:00	15:00	3:00
8	07/03/02	15:01	18:00	2:59
9	07/17/02	15:00	19:00	4:00
10	07/18/02	13:00	18:00	5:00
11	07/19/02	14:00	18:00	4:00
12	07/22/02	13:00	18:00	5:00
13	07/23/02	14:00	17:00	3:00
14	07/29/02	13:00	19:00	6:00
15	07/30/00	12:00	18:00	6:00
16	07/31/02	15:00	18:00	3:00
17	08/01/02	15:00	17:00	2:00
18	08/13/02	16:00	18:00	2:00
19	08/14/02	16:00	18:00	2:00
20	08/15/02	16:00	18:00	2:00
21	08/19/02	12:25	20:00	7:35

Table 33 PSE&G Event Dates and Times

Date	Start	Stop	Duration
07/25/01	13:00	18:02	5:02
08/07/01	14:00	18:42	4:42
08/08/01	12:12	18:45	6:33
08/09/01	12:42	19:15	6:33
08/10/01	12:12	14:56	2:44

Table 34 BGE AC Cycling Event Dates and Times

Number	Date	Start	End	Duration
1	4-May-01	2:05 PM	5:35 PM	3 Hrs 30 Min
2	10-May-01	12:58 PM	7:00 PM	6 Hrs 2 Min
3	13-Jun-01	12:30 PM	6:30 PM	6 Hrs 0 Min
4	20-Jun-01	12:30 PM	6:30 PM	6 Hrs 0 Min
5	28-Jun-01	12:30 PM	6:30 PM	6 Hrs 0 Min
6	29-Jun-01	12:30 PM	6:30 PM	6 Hrs 0 Min
7	10-Jul-01	1:45 PM	4:45 PM	3 Hrs 0 Min
8	17-Jul-01	12:00 PM	5:00 PM	5 Hrs 0 Min
9	24-Jul-01	1:50 PM	7:00 PM	5 Hrs 10 Min
10	25-Jul-01	1:00 PM	5:25 PM	4 Hrs 25 Min
11	6-Aug-01	2:40 PM	8:00 PM	5 Hrs 20 Min
12	7-Aug-01	2:36 PM	3:13 PM	0 Hrs 37 Min
13	8-Aug-01	11:05 AM	7:00 PM	7 Hrs 55 Min
14	9-Aug-01	12:00 PM	8:00 PM	8 Hrs 0 Min
15	10-Aug-01	12:00 PM	4:00 PM	4 Hrs 0 Min
16	31-Aug-01	2:34 PM	3:28 PM	0 Hrs 54 Min
Number	Date	Start	End	Duration
1	6-Jun-02	11:32 AM	3:15 PM	3 Hrs 43 Min
2	25-Jun-02	1:53 PM	6:00 PM	4 Hrs 7 Min
3	26-Jun-02	1:20 PM	4:55 PM	3 Hrs 35 Min
4	2-Jul-02	5:15 PM	7:00 PM	1 Hrs 45 Min
5	3-Jul-02	10:20 AM	6:00 PM	7 Hrs 40 Min
6	9-Jul-02	2:52 PM	5:26 PM	2 Hrs 34 Min
7	17-Jul-02	4:20 PM	6:18 PM	1 Hrs 58 Min
8	19-Jul-02	2:35 PM	3:03 PM	0 Hrs 28 Min
9	22-Jul-02	1:00 PM	7:00 PM	6 Hrs 0 Min
10	23-Jul-02	12:26 PM	6:15 PM	5 Hrs 49 Min
11	29-Jul-02	2:28 PM	6:00 PM	3 Hrs 32 Min
12	2-Aug-02	1:27 PM	7:00 PM	5 Hrs 33 Min
13	3-Aug-02	2:56 PM	4:26 PM	1 Hrs 30 Min
14	4-Aug-02	3:00 PM	7:00 PM	4 Hrs 0 Min
15	12-Aug-02	4:16 PM	5:36 PM	1 Hrs 20 Min
16	13-Aug-02	1:03 PM	5:25 PM	4 Hrs 22 Min
17	14-Aug-02	12:48 PM	5:34 PM	4 Hrs 46 Min
18	19-Aug-02	1:09 PM	5:46 PM	4 Hrs 37 Min
19	22-Aug-02	7:00 PM	8:00 PM	1 Hrs 0 Min
20	3-Oct-02	1:12 PM	2:00 PM	0 Hrs 48 Min
Number	Date	Start	End	Duration
1	12-Jun-03	3:19 PM	5:09 PM	1 Hrs 50 Min
2	26-Jun-03	5:26 PM	6:14 PM	0 Hrs 48 Min
3	6-Jul-03	4:25 PM	6:40 PM	2 Hrs 15 Min
4	21-Jul-03	1:07 PM	6:25 PM	5 Hrs 18 Min
5	14-Aug-03	4:00 PM	8:14 PM	4 Hrs 14 Min
6	15-Aug-03	12:03 PM	6:14 PM	6 Hrs 11 Min
7	21-Aug-03	5:00 PM	8:14 PM	3 Hrs 14 Min
8	22-Aug-03	12:00 PM	4:00 PM	4 Hrs 0 Min
9	26-Aug-03	11:45 AM	4:15 PM	4 Hrs 30 Min

Table 35 BGE AC Cycling Event Dates and Times (cont)

Number	Date	Start	End	Duration
1	29-Jul-04	1:00 PM	6:00 PM	5 Hrs 0 Min
2	3-Aug-04	3:00 PM	8:00 PM	5 Hrs 0 Min
3	4-Aug-04	2:00 PM	6:00 PM	4 Hrs 0 Min
4	10-Aug-04	12:00 PM	5:00 PM	5 Hrs 0 Min
5	20-Aug-04	12:00 PM	6:00 PM	6 Hrs 0 Min
6	24-Aug-04	2:00 PM	7:00 PM	5 Hrs 0 Min
Number	Date	Start	End	Duration
1	6-Jun-05	2:26 PM	7:00 PM	4 Hrs 34 Min
2	7-Jun-05	5:55 PM	7:00 PM	1 Hrs 5 Min
3	8-Jun-05	1:00 PM	7:00 PM	6 Hrs 0 Min
4	13-Jun-05	2:00 PM	8:00 PM	6 Hrs 0 Min
5	14-Jun-05	1:30 PM	9:00 PM	7 Hrs 30 Min
6	28-Jun-05	1:50 PM	6:15 PM	4 Hrs 25 Min
7	12-Jul-05	12:20 PM	3:20 PM	3 Hrs 0 Min
8	13-Jul-05	2:47 PM	5:35 PM	2 Hrs 48 Min
9	14-Jul-05	3:50 PM	6:03 PM	2 Hrs 13 Min
10	15-Jul-05	2:15 PM	4:40 PM	2 Hrs 25 Min
11	18-Jul-05	12:03 PM	4:00 PM	3 Hrs 57 Min
11	18-Jul-05	5:30 PM	6:45 PM	1 Hrs 15 Min
12	19-Jul-05	10:50 AM	4:00 PM	5 Hrs 10 Min
12	19-Jul-05	5:28 PM	6:55 PM	1 Hrs 27 Min
13	20-Jul-05	11:40 AM	7:00 PM	7 Hrs 20 Min
14	21-Jul-05	12:38 PM	4:00 PM	3 Hrs 22 Min
14	21-Jul-05	4:54 PM	6:29 PM	1 Hrs 35 Min
15	25-Jul-05	11:04 AM	3:45 PM	4 Hrs 41 Min
15	25-Jul-05	6:10 PM	7:45 PM	1 Hrs 35 Min
16	26-Jul-05	10:44 AM	3:46 PM	5 Hrs 2 Min
16	26-Jul-05	6:10 PM	7:40 PM	1 Hrs 30 Min
17	27-Jul-05	10:40 AM	6:10 PM	7 Hrs 30 Min
17	27-Jul-05	6:10 PM	6:50 PM	0 Hrs 40 Min
18	1-Aug-05	3:09 PM	6:25 PM	3 Hrs 16 Min
19	2-Aug-05	12:25 PM	7:55 PM	7 Hrs 30 Min
20	3-Aug-05	12:40 PM	8:22 PM	7 Hrs 42 Min
21	4-Aug-05	12:50 PM	6:47 PM	5 Hrs 57 Min
22	5-Aug-05	12:25 PM	5:31 PM	5 Hrs 6 Min
23	11-Aug-05	12:45 PM	7:20 PM	6 Hrs 35 Min
24	12-Aug-05	12:15 PM	6:55 PM	6 Hrs 40 Min
25	15-Aug-05	12:00 PM	6:41 PM	6 Hrs 41 Min
26	22-Aug-05	1:32 PM	6:03 PM	4 Hrs 31 Min
27	23-Aug-05	2:40 PM	6:47 PM	4 Hrs 7 Min
28	29-Aug-05	1:10 PM	6:51 PM	5 Hrs 41 Min
29	30-Aug-05	12:30 PM	6:45 PM	6 Hrs 15 Min
30	31-Aug-05	11:00 AM	5:30 PM	6 Hrs 30 Min
31	2-Sep-05	12:36 PM	6:22 PM	5 Hrs 46 Min
32	13-Sep-05	2:57 PM	6:25 PM	3 Hrs 28 Min
33	14-Sep-05	3:23 PM	6:00 PM	2 Hrs 37 Min
34	15-Sep-05	1:10 PM	6:15 PM	5 Hrs 5 Min
35	16-Sep-05	11:34 AM	5:59 PM	6 Hrs 25 Min
36	19-Sep-05	2:43 PM	5:53 PM	3 Hrs 10 Min
37	21-Sep-05	3:28 PM	6:22 PM	2 Hrs 54 Min
38	22-Sep-05	2:30 PM	5:36 PM	3 Hrs 6 Min
39	23-Sep-05	12:27 PM	5:45 PM	5 Hrs 18 Min

Appendix F: Deemed Savings Estimates for A/C Cycling Combined Results

This appendix contains the detail tables for selected 15 minute time periods for the AC Cycling savings estimates in aggregate.

Table 36 Deemed AC Cycling Savings 15-minutes ending 1:00pm

Time Of Day	WTHI	Predicted Savings For Various Duty Cycle Strategies						
		27%	43%	50%	67%	75%	83%	100%
1:00 PM	70	0.02	0.03	0.03	0.04	0.07	0.06	0.13
	71	0.02	0.03	0.03	0.04	0.07	0.06	0.13
	72	0.02	0.03	0.03	0.04	0.07	0.14	0.25
	73	0.02	0.03	0.03	0.11	0.15	0.23	0.36
	74	0.02	0.03	0.08	0.17	0.23	0.32	0.47
	75	0.02	0.07	0.12	0.24	0.31	0.40	0.59
	76	0.04	0.12	0.17	0.31	0.39	0.49	0.70
	77	0.07	0.16	0.21	0.37	0.47	0.58	0.82
	78	0.09	0.20	0.26	0.44	0.54	0.66	0.93
	79	0.12	0.24	0.30	0.50	0.62	0.75	1.04
	80	0.14	0.28	0.35	0.57	0.70	0.83	1.16
	81	0.17	0.32	0.39	0.63	0.78	0.92	1.27
	82	0.19	0.36	0.44	0.70	0.86	1.01	1.38
	83	0.22	0.40	0.49	0.76	0.94	1.09	1.50
	84	0.24	0.45	0.53	0.83	1.02	1.18	1.61
	84.1	0.24	0.45	0.54	0.84	1.03	1.19	1.62
	84.2	0.25	0.45	0.54	0.84	1.03	1.20	1.64
	84.3	0.25	0.46	0.54	0.85	1.04	1.20	1.65
	84.4	0.25	0.46	0.55	0.86	1.05	1.21	1.66
	84.5	0.25	0.47	0.55	0.86	1.06	1.22	1.67
	84.6	0.25	0.47	0.56	0.87	1.07	1.23	1.68
	84.7	0.26	0.47	0.56	0.88	1.07	1.24	1.69
	84.8	0.26	0.48	0.57	0.88	1.08	1.25	1.70
	84.9	0.26	0.48	0.57	0.89	1.09	1.26	1.72
	85	0.26	0.49	0.58	0.90	1.10	1.27	1.73
	85.1	0.27	0.49	0.58	0.90	1.11	1.27	1.74
	85.2	0.27	0.49	0.59	0.91	1.11	1.28	1.75
	85.3	0.27	0.50	0.59	0.92	1.12	1.29	1.76
	85.4	0.27	0.50	0.59	0.92	1.13	1.30	1.77
	85.5	0.28	0.51	0.60	0.93	1.14	1.31	1.78
	85.6	0.28	0.51	0.60	0.93	1.14	1.32	1.79
	85.7	0.28	0.52	0.61	0.94	1.15	1.33	1.81
	85.8	0.28	0.52	0.61	0.95	1.16	1.33	1.82
	85.9	0.29	0.52	0.62	0.95	1.17	1.34	1.83
	86	0.29	0.53	0.62	0.96	1.18	1.35	1.84
	87	0.31	0.57	0.67	1.03	1.26	1.44	1.95

Table 37 Deemed AC Cycling Savings 15-minutes ending 2:00pm

Time Of Day	WTHI	Predicted Savings For Various Duty Cycle Strategies						
		27%	43%	50%	67%	75%	83%	100%
2:00 PM	**70**	0.01	0.04	0.03	0.05	0.09	0.07	0.09
	71	0.01	0.04	0.03	0.05	0.09	0.07	0.20
	72	0.01	0.04	0.03	0.05	0.09	0.16	0.32
	73	0.01	0.04	0.03	0.12	0.17	0.26	0.43
	74	0.01	0.04	0.09	0.20	0.26	0.35	0.55
	75	0.04	0.09	0.14	0.27	0.34	0.44	0.66
	76	0.06	0.13	0.19	0.34	0.43	0.54	0.77
	77	0.09	0.18	0.24	0.41	0.51	0.63	0.89
	78	0.11	0.22	0.29	0.48	0.60	0.72	1.00
	79	0.14	0.27	0.34	0.56	0.68	0.81	1.12
	80	0.16	0.32	0.39	0.63	0.77	0.91	1.23
	81	0.19	0.36	0.44	0.70	0.85	1.00	1.34
	82	0.21	0.41	0.50	0.77	0.94	1.09	1.46
	83	0.24	0.46	0.55	0.84	1.03	1.19	1.57
	84	0.26	0.50	0.60	0.92	1.11	1.28	1.68
	84.1	0.26	0.51	0.60	0.92	1.12	1.29	1.70
	84.2	0.27	0.51	0.61	0.93	1.13	1.30	1.71
	84.3	0.27	0.52	0.61	0.94	1.14	1.31	1.72
	84.4	0.27	0.52	0.62	0.94	1.15	1.32	1.73
	84.5	0.27	0.53	0.62	0.95	1.15	1.33	1.74
	84.6	0.28	0.53	0.63	0.96	1.16	1.34	1.75
	84.7	0.28	0.53	0.63	0.97	1.17	1.34	1.76
	84.8	0.28	0.54	0.64	0.97	1.18	1.35	1.78
	84.9	0.28	0.54	0.64	0.98	1.19	1.36	1.79
	85	0.29	0.55	0.65	0.99	1.20	1.37	1.80
	85.1	0.29	0.55	0.65	1.00	1.21	1.38	1.81
	85.2	0.29	0.56	0.66	1.00	1.21	1.39	1.82
	85.3	0.29	0.56	0.66	1.01	1.22	1.40	1.83
	85.4	0.30	0.57	0.67	1.02	1.23	1.41	1.84
	85.5	0.30	0.57	0.67	1.02	1.24	1.42	1.86
	85.6	0.30	0.58	0.68	1.03	1.25	1.43	1.87
	85.7	0.30	0.58	0.68	1.04	1.26	1.44	1.88
	85.8	0.31	0.59	0.69	1.05	1.26	1.45	1.89
	85.9	0.31	0.59	0.69	1.05	1.27	1.46	1.90
	86	0.31	0.60	0.70	1.06	1.28	1.47	1.91
	87	0.34	0.64	0.75	1.13	1.37	1.56	2.03

Table 38 Deemed AC Cycling Savings 15-minutes ending 3:00pm

Time Of Day	WTHI	Predicted Savings For Various Duty Cycle Strategies						
		27%	43%	50%	67%	75%	83%	100%
3:00 PM	70	0.03	0.05	0.04	0.07	0.05	0.09	0.11
	71	0.03	0.05	0.04	0.07	0.05	0.09	0.23
	72	0.03	0.05	0.04	0.07	0.14	0.19	0.35
	73	0.03	0.05	0.04	0.14	0.23	0.29	0.47
	74	0.03	0.05	0.10	0.22	0.31	0.39	0.59
	75	0.03	0.10	0.16	0.30	0.40	0.49	0.72
	76	0.06	0.15	0.21	0.38	0.49	0.59	0.84
	77	0.09	0.20	0.27	0.46	0.58	0.69	0.96
	78	0.12	0.26	0.33	0.54	0.66	0.79	1.08
	79	0.15	0.31	0.39	0.62	0.75	0.89	1.20
	80	0.19	0.36	0.44	0.69	0.84	0.99	1.32
	81	0.22	0.41	0.50	0.77	0.92	1.09	1.44
	82	0.25	0.46	0.56	0.85	1.01	1.19	1.56
	83	0.28	0.51	0.61	0.93	1.10	1.29	1.68
	84	0.31	0.57	0.67	1.01	1.18	1.39	1.81
	84.1	0.32	0.57	0.67	1.02	1.19	1.40	1.82
	84.2	0.32	0.58	0.68	1.02	1.20	1.41	1.83
	84.3	0.32	0.58	0.69	1.03	1.21	1.42	1.84
	84.4	0.33	0.59	0.69	1.04	1.22	1.43	1.85
	84.5	0.33	0.59	0.70	1.05	1.23	1.44	1.87
	84.6	0.33	0.60	0.70	1.05	1.24	1.45	1.88
	84.7	0.34	0.60	0.71	1.06	1.24	1.46	1.89
	84.8	0.34	0.61	0.71	1.07	1.25	1.47	1.90
	84.9	0.34	0.61	0.72	1.08	1.26	1.48	1.91
	85	0.35	0.62	0.73	1.09	1.27	1.49	1.93
	85.1	0.35	0.62	0.73	1.09	1.28	1.50	1.94
	85.2	0.35	0.63	0.74	1.10	1.29	1.51	1.95
	85.3	0.36	0.63	0.74	1.11	1.30	1.52	1.96
	85.4	0.36	0.64	0.75	1.12	1.31	1.53	1.98
	85.5	0.36	0.64	0.75	1.13	1.31	1.54	1.99
	85.6	0.37	0.65	0.76	1.13	1.32	1.55	2.00
	85.7	0.37	0.65	0.77	1.14	1.33	1.56	2.01
	85.8	0.37	0.66	0.77	1.15	1.34	1.57	2.02
	85.9	0.38	0.66	0.78	1.16	1.35	1.58	2.04
	86	0.38	0.67	0.78	1.16	1.36	1.59	2.05
	87	0.41	0.72	0.84	1.24	1.45	1.69	2.17

Table 39 Deemed AC Cycling Savings 15-minutes ending 4:00pm

Time Of Day	WTHI	Predicted Savings For Various Duty Cycle Strategies						
		27%	43%	50%	67%	75%	83%	100%
4:00 PM	**70**	0.02	0.05	0.04	0.06	0.05	0.08	0.23
	71	0.02	0.05	0.04	0.06	0.13	0.18	0.34
	72	0.02	0.05	0.04	0.14	0.22	0.28	0.46
	73	0.02	0.05	0.10	0.22	0.30	0.38	0.58
	74	0.02	0.10	0.15	0.29	0.39	0.48	0.70
	75	0.05	0.15	0.21	0.37	0.48	0.57	0.82
	76	0.09	0.20	0.26	0.45	0.56	0.67	0.94
	77	0.12	0.25	0.32	0.52	0.65	0.77	1.06
	78	0.15	0.30	0.38	0.60	0.73	0.87	1.18
	79	0.18	0.35	0.43	0.68	0.82	0.97	1.30
	80	0.21	0.40	0.49	0.76	0.91	1.07	1.42
	81	0.24	0.45	0.54	0.83	0.99	1.16	1.53
	82	0.27	0.50	0.60	0.91	1.08	1.26	1.65
	83	0.31	0.55	0.66	0.99	1.17	1.36	1.77
	84	0.34	0.60	0.71	1.07	1.25	1.46	1.89
	84.1	0.34	0.61	0.72	1.07	1.26	1.47	1.90
	84.2	0.34	0.61	0.72	1.08	1.27	1.48	1.91
	84.3	0.35	0.62	0.73	1.09	1.28	1.49	1.93
	84.4	0.35	0.62	0.73	1.10	1.29	1.50	1.94
	84.5	0.35	0.63	0.74	1.11	1.29	1.51	1.95
	84.6	0.36	0.63	0.75	1.11	1.30	1.52	1.96
	84.7	0.36	0.64	0.75	1.12	1.31	1.53	1.97
	84.8	0.36	0.64	0.76	1.13	1.32	1.54	1.99
	84.9	0.36	0.65	0.76	1.14	1.33	1.55	2.00
	85	0.37	0.65	0.77	1.14	1.34	1.56	2.01
	85.1	0.37	0.66	0.77	1.15	1.35	1.57	2.02
	85.2	0.37	0.66	0.78	1.16	1.35	1.58	2.03
	85.3	0.38	0.67	0.79	1.17	1.36	1.59	2.05
	85.4	0.38	0.67	0.79	1.18	1.37	1.60	2.06
	85.5	0.38	0.68	0.80	1.18	1.38	1.61	2.07
	85.6	0.39	0.68	0.80	1.19	1.39	1.62	2.08
	85.7	0.39	0.69	0.81	1.20	1.40	1.63	2.09
	85.8	0.39	0.69	0.81	1.21	1.41	1.64	2.11
	85.9	0.40	0.70	0.82	1.21	1.41	1.65	2.12
	86	0.40	0.70	0.82	1.22	1.42	1.66	2.13
	87	0.43	0.75	0.88	1.30	1.51	1.76	2.25

Table 40 Deemed AC Cycling Savings 15-minutes ending 5:00pm

Time Of Day	WTHI	Predicted Savings For Various Duty Cycle Strategies						
		27%	43%	50%	67%	75%	83%	100%
5:00 PM	70	0.02	0.04	0.06	0.06	0.09	0.18	0.30
	71	0.02	0.04	0.06	0.13	0.19	0.28	0.43
	72	0.02	0.04	0.06	0.21	0.28	0.38	0.55
	73	0.02	0.09	0.13	0.29	0.37	0.48	0.68
	74	0.05	0.15	0.19	0.37	0.46	0.58	0.80
	75	0.09	0.20	0.25	0.45	0.55	0.68	0.93
	76	0.12	0.25	0.31	0.53	0.65	0.78	1.06
	77	0.15	0.30	0.37	0.61	0.74	0.87	1.18
	78	0.18	0.35	0.43	0.68	0.83	0.97	1.31
	79	0.21	0.40	0.50	0.76	0.92	1.07	1.43
	80	0.24	0.45	0.56	0.84	1.01	1.17	1.56
	81	0.27	0.51	0.62	0.92	1.10	1.27	1.68
	82	0.30	0.56	0.68	1.00	1.20	1.37	1.81
	83	0.34	0.61	0.74	1.08	1.29	1.47	1.93
	84	0.37	0.66	0.80	1.16	1.38	1.57	2.06
	84.1	0.37	0.66	0.81	1.16	1.39	1.58	2.07
	84.2	0.37	0.67	0.82	1.17	1.40	1.59	2.08
	84.3	0.38	0.67	0.82	1.18	1.41	1.60	2.10
	84.4	0.38	0.68	0.83	1.19	1.42	1.61	2.11
	84.5	0.38	0.68	0.83	1.20	1.43	1.62	2.12
	84.6	0.39	0.69	0.84	1.20	1.43	1.63	2.13
	84.7	0.39	0.70	0.85	1.21	1.44	1.64	2.15
	84.8	0.39	0.70	0.85	1.22	1.45	1.65	2.16
	84.9	0.40	0.71	0.86	1.23	1.46	1.66	2.17
	85	0.40	0.71	0.87	1.23	1.47	1.67	2.19
	85.1	0.40	0.72	0.87	1.24	1.48	1.68	2.20
	85.2	0.41	0.72	0.88	1.25	1.49	1.69	2.21
	85.3	0.41	0.73	0.88	1.26	1.50	1.70	2.22
	85.4	0.41	0.73	0.89	1.27	1.51	1.71	2.24
	85.5	0.41	0.74	0.90	1.27	1.52	1.72	2.25
	85.6	0.42	0.74	0.90	1.28	1.53	1.73	2.26
	85.7	0.42	0.75	0.91	1.29	1.54	1.74	2.27
	85.8	0.42	0.75	0.91	1.30	1.54	1.75	2.29
	85.9	0.43	0.76	0.92	1.31	1.55	1.76	2.30
	86	0.43	0.76	0.93	1.31	1.56	1.77	2.31
	87	0.46	0.81	0.99	1.39	1.65	1.87	2.44

Table 41 Deemed AC Cycling Savings 15-minutes ending 6:00pm

Time Of Day	WTHI	Predicted Savings For Various Duty Cycle Strategies						
		27%	43%	50%	67%	75%	83%	100%
6:00 PM	70	0.02	0.04	0.06	0.13	0.18	0.27	0.45
	71	0.02	0.04	0.06	0.20	0.27	0.36	0.57
	72	0.02	0.09	0.12	0.28	0.36	0.46	0.68
	73	0.05	0.14	0.18	0.36	0.45	0.56	0.80
	74	0.08	0.19	0.24	0.43	0.54	0.66	0.92
	75	0.11	0.24	0.30	0.51	0.63	0.76	1.04
	76	0.14	0.29	0.36	0.59	0.72	0.85	1.16
	77	0.17	0.34	0.42	0.66	0.81	0.95	1.28
	78	0.20	0.38	0.48	0.74	0.90	1.05	1.40
	79	0.23	0.43	0.53	0.82	0.99	1.15	1.52
	80	0.26	0.48	0.59	0.90	1.08	1.25	1.64
	81	0.29	0.53	0.65	0.97	1.17	1.34	1.76
	82	0.32	0.58	0.71	1.05	1.26	1.44	1.88
	83	0.35	0.63	0.77	1.13	1.35	1.54	1.99
	84	0.38	0.68	0.83	1.20	1.44	1.64	2.11
	84.1	0.38	0.69	0.84	1.21	1.45	1.65	2.13
	84.2	0.38	0.69	0.84	1.22	1.46	1.66	2.14
	84.3	0.39	0.70	0.85	1.23	1.46	1.67	2.15
	84.4	0.39	0.70	0.86	1.23	1.47	1.68	2.16
	84.5	0.39	0.71	0.86	1.24	1.48	1.69	2.17
	84.6	0.39	0.71	0.87	1.25	1.49	1.70	2.18
	84.7	0.40	0.72	0.87	1.26	1.50	1.71	2.20
	84.8	0.40	0.72	0.88	1.26	1.51	1.72	2.21
	84.9	0.40	0.72	0.89	1.27	1.52	1.73	2.22
	85	0.41	0.73	0.89	1.28	1.53	1.74	2.23
	85.1	0.41	0.73	0.90	1.29	1.54	1.75	2.24
	85.2	0.41	0.74	0.90	1.29	1.55	1.76	2.26
	85.3	0.42	0.74	0.91	1.30	1.55	1.76	2.27
	85.4	0.42	0.75	0.92	1.31	1.56	1.77	2.28
	85.5	0.42	0.75	0.92	1.32	1.57	1.78	2.29
	85.6	0.42	0.76	0.93	1.33	1.58	1.79	2.30
	85.7	0.43	0.76	0.93	1.33	1.59	1.80	2.32
	85.8	0.43	0.77	0.94	1.34	1.60	1.81	2.33
	85.9	0.43	0.77	0.95	1.35	1.61	1.82	2.34
	86	0.44	0.78	0.95	1.36	1.62	1.83	2.35
	87	0.47	0.83	1.01	1.43	1.71	1.93	2.47

Table 42 Deemed AC Cycling Savings 15-minutes ending 7:00pm

Time Of Day	WTHI	Predicted Savings For Various Duty Cycle Strategies						
		27%	43%	50%	67%	75%	83%	100%
7:00 PM	70	0.02	0.03	0.08	0.19	0.25	0.34	0.54
	71	0.02	0.08	0.13	0.26	0.33	0.43	0.65
	72	0.04	0.12	0.18	0.33	0.42	0.53	0.77
	73	0.07	0.17	0.23	0.40	0.50	0.62	0.88
	74	0.09	0.21	0.28	0.47	0.58	0.71	0.99
	75	0.12	0.25	0.33	0.54	0.67	0.80	1.11
	76	0.14	0.30	0.38	0.61	0.75	0.89	1.22
	77	0.17	0.34	0.43	0.68	0.84	0.99	1.33
	78	0.20	0.39	0.48	0.75	0.92	1.08	1.45
	79	0.22	0.43	0.53	0.82	1.00	1.17	1.56
	80	0.25	0.47	0.58	0.89	1.09	1.26	1.67
	81	0.27	0.52	0.62	0.97	1.17	1.35	1.79
	82	0.30	0.56	0.67	1.04	1.25	1.45	1.90
	83	0.32	0.61	0.72	1.11	1.34	1.54	2.01
	84	0.35	0.65	0.77	1.18	1.42	1.63	2.13
	84.1	0.35	0.65	0.78	1.18	1.43	1.64	2.14
	84.2	0.35	0.66	0.78	1.19	1.44	1.65	2.15
	84.3	0.36	0.66	0.79	1.20	1.45	1.66	2.16
	84.4	0.36	0.67	0.79	1.21	1.46	1.67	2.17
	84.5	0.36	0.67	0.80	1.21	1.46	1.68	2.18
	84.6	0.36	0.68	0.80	1.22	1.47	1.69	2.19
	84.7	0.37	0.68	0.81	1.23	1.48	1.70	2.21
	84.8	0.37	0.69	0.81	1.23	1.49	1.70	2.22
	84.9	0.37	0.69	0.82	1.24	1.50	1.71	2.23
	85	0.37	0.69	0.82	1.25	1.51	1.72	2.24
	85.1	0.38	0.70	0.83	1.26	1.51	1.73	2.25
	85.2	0.38	0.70	0.83	1.26	1.52	1.74	2.26
	85.3	0.38	0.71	0.84	1.27	1.53	1.75	2.27
	85.4	0.38	0.71	0.84	1.28	1.54	1.76	2.28
	85.5	0.39	0.72	0.85	1.28	1.55	1.77	2.30
	85.6	0.39	0.72	0.85	1.29	1.56	1.78	2.31
	85.7	0.39	0.73	0.86	1.30	1.56	1.79	2.32
	85.8	0.40	0.73	0.86	1.31	1.57	1.80	2.33
	85.9	0.40	0.73	0.87	1.31	1.58	1.81	2.34
	86	0.40	0.74	0.87	1.32	1.59	1.82	2.35
	87	0.43	0.78	0.92	1.39	1.67	1.91	2.47

Appendix G: Deemed Savings Estimates for A/C Cycling By Seasonal A/C Use

This appendix contains the detail tables by 15 minute time period for the AC Cycling savings estimates by seasonal air conditioning usage.

Table 43 Deemed AC Cycling Savings by Energy Stratum for 15-Minutes Ending 1:00pm

		Predicted Savings for Duty Cycle Strategies AC Use < 1600 kWh							Predicted Savings for Duty Cycle Strategies AC Use > 1600 kWh						
Day	**WTHI**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
1:00 PM	**70**	0.01	0.01	0.02	0.03	0.04	0.03	0.07	0.02	0.05	0.04	0.06	0.10	0.09	0.25
	71	0.01	0.01	0.02	0.03	0.04	0.03	0.07	0.02	0.05	0.04	0.06	0.10	0.19	0.38
	72	0.01	0.01	0.02	0.03	0.04	0.03	0.07	0.02	0.05	0.04	0.14	0.20	0.30	0.51
	73	0.01	0.01	0.02	0.03	0.04	0.03	0.07	0.02	0.05	0.10	0.23	0.30	0.41	0.65
	74	0.01	0.01	0.02	0.03	0.04	0.09	0.16	0.02	0.10	0.15	0.31	0.40	0.52	0.78
	75	0.01	0.01	0.02	0.07	0.10	0.15	0.24	0.05	0.15	0.21	0.39	0.50	0.63	0.92
	76	0.01	0.04	0.05	0.11	0.15	0.21	0.33	0.08	0.20	0.27	0.47	0.59	0.73	1.05
	77	0.02	0.06	0.08	0.16	0.21	0.27	0.41	0.11	0.25	0.33	0.56	0.69	0.84	1.18
	78	0.04	0.08	0.11	0.20	0.26	0.34	0.49	0.14	0.30	0.39	0.64	0.79	0.95	1.32
	79	0.05	0.11	0.14	0.25	0.32	0.40	0.58	0.17	0.36	0.45	0.72	0.89	1.06	1.45
	80	0.06	0.13	0.17	0.29	0.37	0.46	0.66	0.20	0.41	0.50	0.81	0.99	1.17	1.58
	81	0.08	0.15	0.20	0.34	0.43	0.52	0.75	0.24	0.46	0.56	0.89	1.09	1.28	1.72
	82	0.09	0.18	0.23	0.38	0.49	0.58	0.83	0.27	0.51	0.62	0.97	1.19	1.38	1.85
	83	0.11	0.20	0.26	0.43	0.54	0.64	0.91	0.30	0.56	0.68	1.06	1.29	1.49	1.98
	84	0.12	0.22	0.29	0.47	0.60	0.70	1.00	0.33	0.61	0.74	1.14	1.39	1.60	2.12
	84.1	0.12	0.23	0.29	0.48	0.60	0.70	1.01	0.33	0.62	0.74	1.15	1.39	1.61	2.13
	84.2	0.12	0.23	0.29	0.48	0.61	0.71	1.01	0.33	0.62	0.75	1.16	1.40	1.62	2.14
	84.3	0.12	0.23	0.30	0.49	0.61	0.72	1.02	0.34	0.63	0.75	1.16	1.41	1.63	2.16
	84.4	0.12	0.23	0.30	0.49	0.62	0.72	1.03	0.34	0.63	0.76	1.17	1.42	1.64	2.17
	84.5	0.13	0.24	0.30	0.49	0.63	0.73	1.04	0.34	0.64	0.77	1.18	1.43	1.65	2.18
	84.6	0.13	0.24	0.31	0.50	0.63	0.73	1.05	0.35	0.65	0.77	1.19	1.44	1.67	2.20
	84.7	0.13	0.24	0.31	0.50	0.64	0.74	1.06	0.35	0.65	0.78	1.20	1.45	1.68	2.21
	84.8	0.13	0.24	0.31	0.51	0.64	0.75	1.06	0.35	0.66	0.78	1.21	1.46	1.69	2.22
	84.9	0.13	0.25	0.32	0.51	0.65	0.75	1.07	0.36	0.66	0.79	1.21	1.47	1.70	2.24
	85	0.13	0.25	0.32	0.52	0.65	0.76	1.08	0.36	0.67	0.79	1.22	1.48	1.71	2.25
	85.1	0.13	0.25	0.32	0.52	0.66	0.76	1.09	0.36	0.67	0.80	1.23	1.49	1.72	2.26
	85.2	0.14	0.25	0.32	0.53	0.66	0.77	1.10	0.36	0.68	0.81	1.24	1.50	1.73	2.28
	85.3	0.14	0.26	0.33	0.53	0.67	0.78	1.11	0.37	0.68	0.81	1.25	1.51	1.74	2.29
	85.4	0.14	0.26	0.33	0.53	0.68	0.78	1.11	0.37	0.69	0.82	1.25	1.52	1.75	2.30
	85.5	0.14	0.26	0.33	0.54	0.68	0.79	1.12	0.37	0.69	0.82	1.26	1.53	1.76	2.32
	85.6	0.14	0.26	0.34	0.54	0.69	0.79	1.13	0.38	0.70	0.83	1.27	1.54	1.77	2.33
	85.7	0.14	0.27	0.34	0.55	0.69	0.80	1.14	0.38	0.70	0.84	1.28	1.55	1.78	2.34
	85.8	0.14	0.27	0.34	0.55	0.70	0.81	1.15	0.38	0.71	0.84	1.29	1.56	1.80	2.36
	85.9	0.15	0.27	0.35	0.56	0.70	0.81	1.16	0.39	0.71	0.85	1.30	1.57	1.81	2.37
	86	0.15	0.27	0.35	0.56	0.71	0.82	1.16	0.39	0.72	0.85	1.30	1.58	1.82	2.38
	87	0.16	0.30	0.38	0.61	0.76	0.88	1.25	0.42	0.77	0.91	1.39	1.68	1.93	2.52

Table 44 Deemed AC Cycling Savings by Energy Stratum for 15-Minutes Ending 2:00pm

		Predicted Savings for Duty Cycle Strategies AC Use < 1600 kWh							Predicted Savings for Duty Cycle Strategies AC Use > 1600 kWh						
Day	**WTHI**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
2:00 PM	**70**	-	0.02	0.01	0.03	0.05	0.04	0.09	0.02	0.05	0.04	0.07	0.12	0.11	0.29
	71	-	0.02	0.01	0.03	0.05	0.04	0.09	0.02	0.05	0.04	0.07	0.12	0.22	0.43
	72	-	0.02	0.01	0.03	0.05	0.04	0.09	0.02	0.05	0.04	0.16	0.23	0.34	0.57
	73	-	0.02	0.01	0.03	0.05	0.04	0.09	0.02	0.05	0.11	0.25	0.33	0.45	0.71
	74	-	0.02	0.01	0.03	0.05	0.11	0.18	0.02	0.11	0.17	0.34	0.44	0.57	0.85
	75	-	0.02	0.04	0.08	0.11	0.18	0.27	0.06	0.17	0.24	0.43	0.54	0.68	0.99
	76	0.02	0.04	0.07	0.13	0.17	0.24	0.36	0.09	0.22	0.30	0.52	0.65	0.80	1.12
	77	0.03	0.07	0.10	0.18	0.24	0.31	0.45	0.13	0.28	0.37	0.61	0.76	0.91	1.26
	78	0.05	0.10	0.13	0.23	0.30	0.38	0.54	0.16	0.34	0.43	0.70	0.86	1.03	1.40
	79	0.06	0.13	0.17	0.29	0.36	0.44	0.63	0.20	0.40	0.50	0.79	0.97	1.14	1.54
	80	0.08	0.15	0.20	0.34	0.42	0.51	0.72	0.23	0.45	0.56	0.88	1.07	1.26	1.68
	81	0.09	0.18	0.23	0.39	0.49	0.58	0.82	0.27	0.51	0.62	0.97	1.18	1.37	1.82
	82	0.11	0.21	0.26	0.44	0.55	0.65	0.91	0.30	0.57	0.69	1.06	1.28	1.49	1.96
	83	0.12	0.24	0.29	0.49	0.61	0.71	1.00	0.34	0.63	0.75	1.15	1.39	1.60	2.10
	84	0.13	0.27	0.32	0.54	0.67	0.78	1.09	0.37	0.69	0.82	1.24	1.49	1.72	2.24
	84.1	0.14	0.27	0.32	0.54	0.68	0.79	1.10	0.38	0.69	0.82	1.25	1.51	1.73	2.26
	84.2	0.14	0.27	0.33	0.55	0.68	0.79	1.11	0.38	0.70	0.83	1.26	1.52	1.74	2.27
	84.3	0.14	0.27	0.33	0.55	0.69	0.80	1.11	0.38	0.70	0.84	1.27	1.53	1.75	2.28
	84.4	0.14	0.28	0.33	0.56	0.70	0.81	1.12	0.39	0.71	0.84	1.28	1.54	1.76	2.30
	84.5	0.14	0.28	0.34	0.56	0.70	0.81	1.13	0.39	0.71	0.85	1.29	1.55	1.77	2.31
	84.6	0.14	0.28	0.34	0.57	0.71	0.82	1.14	0.39	0.72	0.86	1.30	1.56	1.79	2.33
	84.7	0.14	0.29	0.34	0.58	0.72	0.83	1.15	0.40	0.73	0.86	1.31	1.57	1.80	2.34
	84.8	0.15	0.29	0.35	0.58	0.72	0.83	1.16	0.40	0.73	0.87	1.31	1.58	1.81	2.35
	84.9	0.15	0.29	0.35	0.59	0.73	0.84	1.17	0.40	0.74	0.88	1.32	1.59	1.82	2.37
	85	0.15	0.29	0.35	0.59	0.73	0.85	1.18	0.41	0.74	0.88	1.33	1.60	1.83	2.38
	85.1	0.15	0.30	0.36	0.60	0.74	0.85	1.19	0.41	0.75	0.89	1.34	1.61	1.84	2.39
	85.2	0.15	0.30	0.36	0.60	0.75	0.86	1.20	0.41	0.75	0.90	1.35	1.62	1.86	2.41
	85.3	0.15	0.30	0.36	0.61	0.75	0.87	1.21	0.42	0.76	0.90	1.36	1.63	1.87	2.42
	85.4	0.15	0.30	0.36	0.61	0.76	0.87	1.21	0.42	0.77	0.91	1.37	1.64	1.88	2.44
	85.5	0.16	0.31	0.37	0.62	0.77	0.88	1.22	0.42	0.77	0.91	1.38	1.65	1.89	2.45
	85.6	0.16	0.31	0.37	0.62	0.77	0.89	1.23	0.43	0.78	0.92	1.39	1.66	1.90	2.46
	85.7	0.16	0.31	0.37	0.63	0.78	0.89	1.24	0.43	0.78	0.93	1.40	1.67	1.91	2.48
	85.8	0.16	0.32	0.38	0.63	0.78	0.90	1.25	0.44	0.79	0.93	1.40	1.68	1.92	2.49
	85.9	0.16	0.32	0.38	0.64	0.79	0.91	1.26	0.44	0.79	0.94	1.41	1.70	1.94	2.51
	86	0.16	0.32	0.38	0.64	0.80	0.91	1.27	0.44	0.80	0.95	1.42	1.71	1.95	2.52
	87	0.18	0.35	0.41	0.69	0.86	0.98	1.36	0.48	0.86	1.01	1.51	1.81	2.06	2.66

Table 45 Deemed AC Cycling Savings by Energy Stratum for 15-Minutes Ending 3:00pm

		Predicted Savings for Duty Cycle Strategies AC Use < 1600 kWh							Predicted Savings for Duty Cycle Strategies AC Use > 1600 kWh						
Day	**WTHI**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
3:00 PM	**70**	0.01	0.02	0.03	0.04	0.06	0.05	0.05	0.03	0.04	0.06	0.04	0.09	0.14	0.33
	71	0.01	0.02	0.03	0.04	0.06	0.05	0.05	0.03	0.04	0.06	0.13	0.19	0.26	0.48
	72	0.01	0.02	0.03	0.04	0.06	0.05	0.05	0.03	0.04	0.06	0.22	0.30	0.38	0.63
	73	0.01	0.02	0.03	0.04	0.06	0.05	0.15	0.03	0.10	0.13	0.32	0.41	0.50	0.77
	74	0.01	0.02	0.03	0.04	0.06	0.12	0.24	0.03	0.16	0.20	0.41	0.51	0.62	0.92
	75	0.01	0.02	0.03	0.09	0.13	0.20	0.33	0.07	0.21	0.27	0.50	0.62	0.75	1.06
	76	0.01	0.05	0.07	0.15	0.20	0.27	0.42	0.11	0.27	0.34	0.59	0.73	0.87	1.21
	77	0.03	0.08	0.11	0.21	0.26	0.34	0.51	0.15	0.33	0.41	0.68	0.83	0.99	1.35
	78	0.05	0.12	0.15	0.27	0.33	0.42	0.60	0.19	0.39	0.48	0.78	0.94	1.11	1.50
	79	0.07	0.15	0.19	0.32	0.40	0.49	0.69	0.23	0.45	0.55	0.87	1.05	1.23	1.65
	80	0.09	0.18	0.23	0.38	0.47	0.57	0.78	0.27	0.51	0.62	0.96	1.16	1.36	1.79
	81	0.11	0.21	0.27	0.44	0.54	0.64	0.88	0.30	0.57	0.69	1.05	1.26	1.48	1.94
	82	0.13	0.25	0.31	0.49	0.61	0.71	0.97	0.34	0.62	0.77	1.14	1.37	1.60	2.08
	83	0.15	0.28	0.35	0.55	0.68	0.79	1.06	0.38	0.68	0.84	1.23	1.48	1.72	2.23
	84	0.17	0.31	0.39	0.61	0.75	0.86	1.15	0.42	0.74	0.91	1.33	1.58	1.84	2.37
	84.1	0.17	0.31	0.39	0.61	0.75	0.87	1.16	0.42	0.75	0.91	1.34	1.59	1.85	2.39
	84.2	0.18	0.32	0.40	0.62	0.76	0.88	1.17	0.43	0.75	0.92	1.34	1.61	1.87	2.40
	84.3	0.18	0.32	0.40	0.62	0.77	0.88	1.18	0.43	0.76	0.93	1.35	1.62	1.88	2.42
	84.4	0.18	0.32	0.40	0.63	0.77	0.89	1.19	0.44	0.76	0.93	1.36	1.63	1.89	2.43
	84.5	0.18	0.33	0.41	0.64	0.78	0.90	1.20	0.44	0.77	0.94	1.37	1.64	1.90	2.45
	84.6	0.18	0.33	0.41	0.64	0.79	0.91	1.20	0.44	0.78	0.95	1.38	1.65	1.92	2.46
	84.7	0.19	0.33	0.42	0.65	0.80	0.91	1.21	0.45	0.78	0.96	1.39	1.66	1.93	2.48
	84.8	0.19	0.34	0.42	0.65	0.80	0.92	1.22	0.45	0.79	0.96	1.40	1.67	1.94	2.49
	84.9	0.19	0.34	0.43	0.66	0.81	0.93	1.23	0.46	0.79	0.97	1.41	1.68	1.95	2.51
	85	0.19	0.34	0.43	0.66	0.82	0.94	1.24	0.46	0.80	0.98	1.42	1.69	1.96	2.52
	85.1	0.19	0.35	0.43	0.67	0.82	0.94	1.25	0.46	0.81	0.98	1.43	1.70	1.98	2.54
	85.2	0.20	0.35	0.44	0.68	0.83	0.95	1.26	0.47	0.81	0.99	1.44	1.71	1.99	2.55
	85.3	0.20	0.35	0.44	0.68	0.84	0.96	1.27	0.47	0.82	1.00	1.45	1.72	2.00	2.56
	85.4	0.20	0.36	0.45	0.69	0.84	0.97	1.28	0.47	0.82	1.00	1.45	1.73	2.01	2.58
	85.5	0.20	0.36	0.45	0.69	0.85	0.97	1.29	0.48	0.83	1.01	1.46	1.74	2.02	2.59
	85.6	0.20	0.36	0.45	0.70	0.86	0.98	1.30	0.48	0.84	1.02	1.47	1.76	2.04	2.61
	85.7	0.21	0.37	0.46	0.70	0.86	0.99	1.30	0.49	0.84	1.03	1.48	1.77	2.05	2.62
	85.8	0.21	0.37	0.46	0.71	0.87	0.99	1.31	0.49	0.85	1.03	1.49	1.78	2.06	2.64
	85.9	0.21	0.37	0.47	0.72	0.88	1.00	1.32	0.49	0.85	1.04	1.50	1.79	2.07	2.65
	86	0.21	0.38	0.47	0.72	0.89	1.01	1.33	0.50	0.86	1.05	1.51	1.80	2.09	2.67
	87	0.23	0.41	0.51	0.78	0.95	1.08	1.42	0.54	0.92	1.12	1.60	1.91	2.21	2.81

Table 46 Deemed AC Cycling Savings by Energy Stratum for 15-Minutes Ending 4:00pm

		Predicted Savings for Duty Cycle Strategies AC Use < 1600 kWh							Predicted Savings for Duty Cycle Strategies AC Use > 1600 kWh						
Day	WTHI	27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
4:00 PM	70	0.01	0.02	0.03	0.04	0.03	0.05	0.05	0.03	0.03	0.05	0.09	0.18	0.25	0.51
	71	0.01	0.02	0.03	0.04	0.03	0.05	0.05	0.03	0.03	0.05	0.18	0.29	0.37	0.65
	72	0.01	0.02	0.03	0.04	0.03	0.05	0.14	0.03	0.09	0.12	0.28	0.40	0.49	0.79
	73	0.01	0.02	0.03	0.04	0.09	0.12	0.23	0.03	0.15	0.19	0.37	0.50	0.61	0.92
	74	0.01	0.02	0.03	0.09	0.15	0.19	0.32	0.07	0.20	0.26	0.47	0.61	0.73	1.06
	75	0.01	0.05	0.06	0.15	0.21	0.26	0.41	0.10	0.26	0.33	0.57	0.71	0.85	1.20
	76	0.03	0.08	0.10	0.20	0.27	0.33	0.50	0.14	0.32	0.40	0.66	0.82	0.97	1.34
	77	0.05	0.11	0.14	0.26	0.33	0.41	0.59	0.18	0.38	0.47	0.76	0.93	1.09	1.48
	78	0.07	0.14	0.18	0.31	0.40	0.48	0.68	0.22	0.44	0.54	0.85	1.03	1.21	1.62
	79	0.09	0.18	0.22	0.37	0.46	0.55	0.77	0.26	0.50	0.61	0.95	1.14	1.33	1.76
	80	0.11	0.21	0.26	0.42	0.52	0.62	0.85	0.30	0.56	0.68	1.04	1.24	1.45	1.89
	81	0.13	0.24	0.30	0.48	0.58	0.69	0.94	0.33	0.62	0.75	1.14	1.35	1.57	2.03
	82	0.15	0.27	0.34	0.53	0.64	0.77	1.03	0.37	0.67	0.82	1.24	1.45	1.69	2.17
	83	0.17	0.30	0.38	0.59	0.70	0.84	1.12	0.41	0.73	0.89	1.33	1.56	1.81	2.31
	84	0.18	0.33	0.42	0.65	0.76	0.91	1.21	0.45	0.79	0.96	1.43	1.67	1.93	2.45
	84.1	0.19	0.34	0.42	0.65	0.77	0.92	1.22	0.45	0.80	0.97	1.44	1.68	1.94	2.46
	84.2	0.19	0.34	0.42	0.66	0.78	0.92	1.23	0.46	0.80	0.98	1.45	1.69	1.95	2.48
	84.3	0.19	0.34	0.43	0.66	0.78	0.93	1.24	0.46	0.81	0.98	1.46	1.70	1.97	2.49
	84.4	0.19	0.35	0.43	0.67	0.79	0.94	1.25	0.46	0.81	0.99	1.47	1.71	1.98	2.50
	84.5	0.19	0.35	0.44	0.67	0.80	0.95	1.26	0.47	0.82	1.00	1.48	1.72	1.99	2.52
	84.6	0.20	0.35	0.44	0.68	0.80	0.95	1.27	0.47	0.83	1.01	1.48	1.73	2.00	2.53
	84.7	0.20	0.36	0.44	0.68	0.81	0.96	1.27	0.48	0.83	1.01	1.49	1.74	2.01	2.55
	84.8	0.20	0.36	0.45	0.69	0.81	0.97	1.28	0.48	0.84	1.02	1.50	1.75	2.03	2.56
	84.9	0.20	0.36	0.45	0.69	0.82	0.98	1.29	0.48	0.84	1.03	1.51	1.76	2.04	2.57
	85	0.20	0.37	0.46	0.70	0.83	0.98	1.30	0.49	0.85	1.03	1.52	1.77	2.05	2.59
	85.1	0.21	0.37	0.46	0.71	0.83	0.99	1.31	0.49	0.86	1.04	1.53	1.78	2.06	2.60
	85.2	0.21	0.37	0.46	0.71	0.84	1.00	1.32	0.50	0.86	1.05	1.54	1.79	2.07	2.62
	85.3	0.21	0.38	0.47	0.72	0.84	1.00	1.33	0.50	0.87	1.05	1.55	1.80	2.09	2.63
	85.4	0.21	0.38	0.47	0.72	0.85	1.01	1.34	0.50	0.87	1.06	1.56	1.81	2.10	2.64
	85.5	0.21	0.38	0.47	0.73	0.86	1.02	1.35	0.51	0.88	1.07	1.57	1.82	2.11	2.66
	85.6	0.22	0.39	0.48	0.73	0.86	1.03	1.35	0.51	0.89	1.08	1.58	1.84	2.12	2.67
	85.7	0.22	0.39	0.48	0.74	0.87	1.03	1.36	0.51	0.89	1.08	1.59	1.85	2.13	2.68
	85.8	0.22	0.39	0.49	0.74	0.88	1.04	1.37	0.52	0.90	1.09	1.60	1.86	2.15	2.70
	85.9	0.22	0.39	0.49	0.75	0.88	1.05	1.38	0.52	0.90	1.10	1.61	1.87	2.16	2.71
	86	0.22	0.40	0.49	0.76	0.89	1.05	1.39	0.53	0.91	1.10	1.62	1.88	2.17	2.73
	87	0.24	0.43	0.53	0.81	0.95	1.13	1.48	0.56	0.97	1.17	1.71	1.98	2.29	2.86

Table 47 Deemed AC Cycling Savings by Energy Stratum for 15-Minutes Ending 5:00pm

		Predicted Savings for Duty Cycle Strategies AC Use < 1600 kWh							Predicted Savings for Duty Cycle Strategies AC Use > 1600 kWh						
Day	WTHI	27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
5:00 PM	70	0.01	0.02	0.03	0.04	0.06	0.04	0.05	0.03	0.06	0.05	0.18	0.25	0.39	0.63
	71	0.01	0.02	0.03	0.04	0.06	0.04	0.14	0.03	0.06	0.12	0.27	0.36	0.51	0.77
	72	0.01	0.02	0.03	0.04	0.06	0.12	0.23	0.03	0.12	0.19	0.37	0.47	0.63	0.91
	73	0.01	0.02	0.03	0.09	0.13	0.19	0.33	0.06	0.18	0.26	0.47	0.58	0.74	1.05
	74	0.01	0.05	0.07	0.15	0.20	0.27	0.42	0.10	0.25	0.33	0.56	0.69	0.86	1.19
	75	0.03	0.08	0.11	0.21	0.27	0.34	0.51	0.14	0.31	0.40	0.66	0.81	0.98	1.33
	76	0.05	0.12	0.15	0.27	0.33	0.42	0.60	0.18	0.37	0.47	0.76	0.92	1.09	1.48
	77	0.07	0.15	0.19	0.33	0.40	0.49	0.69	0.22	0.43	0.54	0.85	1.03	1.21	1.62
	78	0.09	0.18	0.23	0.38	0.47	0.57	0.79	0.26	0.50	0.61	0.95	1.14	1.33	1.76
	79	0.11	0.22	0.27	0.44	0.54	0.64	0.88	0.29	0.56	0.68	1.04	1.25	1.44	1.90
	80	0.13	0.25	0.31	0.50	0.61	0.72	0.97	0.33	0.62	0.75	1.14	1.36	1.56	2.04
	81	0.15	0.28	0.35	0.56	0.68	0.79	1.06	0.37	0.69	0.82	1.24	1.47	1.68	2.18
	82	0.17	0.32	0.40	0.62	0.75	0.87	1.15	0.41	0.75	0.89	1.33	1.59	1.80	2.32
	83	0.19	0.35	0.44	0.67	0.82	0.94	1.25	0.45	0.81	0.96	1.43	1.70	1.91	2.46
	84	0.21	0.38	0.48	0.73	0.89	1.02	1.34	0.48	0.87	1.03	1.53	1.81	2.03	2.61
	84.1	0.22	0.39	0.48	0.74	0.90	1.03	1.35	0.49	0.88	1.04	1.54	1.82	2.04	2.62
	84.2	0.22	0.39	0.49	0.74	0.90	1.03	1.36	0.49	0.89	1.05	1.55	1.83	2.05	2.63
	84.3	0.22	0.40	0.49	0.75	0.91	1.04	1.37	0.50	0.89	1.06	1.56	1.84	2.06	2.65
	84.4	0.22	0.40	0.49	0.76	0.92	1.05	1.37	0.50	0.90	1.06	1.56	1.85	2.08	2.66
	84.5	0.22	0.40	0.50	0.76	0.93	1.06	1.38	0.50	0.91	1.07	1.57	1.86	2.09	2.68
	84.6	0.23	0.41	0.50	0.77	0.93	1.06	1.39	0.51	0.91	1.08	1.58	1.88	2.10	2.69
	84.7	0.23	0.41	0.51	0.77	0.94	1.07	1.40	0.51	0.92	1.08	1.59	1.89	2.11	2.70
	84.8	0.23	0.41	0.51	0.78	0.95	1.08	1.41	0.52	0.92	1.09	1.60	1.90	2.12	2.72
	84.9	0.23	0.42	0.51	0.78	0.95	1.09	1.42	0.52	0.93	1.10	1.61	1.91	2.13	2.73
	85	0.23	0.42	0.52	0.79	0.96	1.09	1.43	0.52	0.94	1.10	1.62	1.92	2.15	2.75
	85.1	0.24	0.42	0.52	0.80	0.97	1.10	1.44	0.53	0.94	1.11	1.63	1.93	2.16	2.76
	85.2	0.24	0.43	0.53	0.80	0.97	1.11	1.45	0.53	0.95	1.12	1.64	1.94	2.17	2.77
	85.3	0.24	0.43	0.53	0.81	0.98	1.12	1.46	0.53	0.96	1.13	1.65	1.95	2.18	2.79
	85.4	0.24	0.43	0.54	0.81	0.99	1.12	1.47	0.54	0.96	1.13	1.66	1.96	2.19	2.80
	85.5	0.24	0.44	0.54	0.82	1.00	1.13	1.48	0.54	0.97	1.14	1.67	1.98	2.20	2.82
	85.6	0.25	0.44	0.54	0.83	1.00	1.14	1.49	0.55	0.97	1.15	1.68	1.99	2.22	2.83
	85.7	0.25	0.44	0.55	0.83	1.01	1.15	1.49	0.55	0.98	1.15	1.69	2.00	2.23	2.85
	85.8	0.25	0.45	0.55	0.84	1.02	1.15	1.50	0.55	0.99	1.16	1.70	2.01	2.24	2.86
	85.9	0.25	0.45	0.56	0.84	1.02	1.16	1.51	0.56	0.99	1.17	1.71	2.02	2.25	2.87
	86	0.25	0.45	0.56	0.85	1.03	1.17	1.52	0.56	1.00	1.18	1.72	2.03	2.26	2.89
	87	0.27	0.49	0.60	0.91	1.10	1.24	1.61	0.60	1.06	1.25	1.82	2.14	2.38	3.03

Table 48 Deemed AC Cycling Savings by Energy Stratum for 15-Minutes Ending 6:00pm

		Predicted Savings for Duty Cycle Strategies AC Use < 1600 kWh							Predicted Savings for Duty Cycle Strategies AC Use > 1600 kWh						
Day	**WTHI**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
6:00 PM	**70**	0.01	0.01	0.02	0.03	0.02	0.04	0.14	0.02	0.05	0.11	0.26	0.37	0.49	0.74
	71	0.01	0.01	0.02	0.03	0.09	0.12	0.23	0.02	0.11	0.18	0.35	0.48	0.60	0.88
	72	0.01	0.01	0.02	0.09	0.15	0.19	0.32	0.06	0.17	0.24	0.45	0.58	0.72	1.02
	73	0.01	0.05	0.06	0.15	0.22	0.27	0.42	0.09	0.23	0.31	0.54	0.69	0.83	1.16
	74	0.03	0.08	0.10	0.21	0.28	0.34	0.51	0.13	0.29	0.38	0.63	0.79	0.95	1.30
	75	0.05	0.11	0.15	0.26	0.34	0.42	0.60	0.17	0.35	0.45	0.73	0.89	1.06	1.44
	76	0.07	0.15	0.19	0.32	0.41	0.49	0.69	0.20	0.41	0.52	0.82	1.00	1.18	1.58
	77	0.09	0.18	0.23	0.38	0.47	0.57	0.78	0.24	0.47	0.58	0.92	1.10	1.29	1.72
	78	0.11	0.21	0.27	0.44	0.54	0.64	0.87	0.27	0.53	0.65	1.01	1.21	1.41	1.86
	79	0.13	0.25	0.31	0.50	0.60	0.72	0.97	0.31	0.59	0.72	1.10	1.31	1.52	2.00
	80	0.15	0.28	0.35	0.55	0.66	0.79	1.06	0.35	0.65	0.79	1.20	1.42	1.64	2.14
	81	0.17	0.31	0.39	0.61	0.73	0.87	1.15	0.38	0.71	0.86	1.29	1.52	1.75	2.28
	82	0.19	0.35	0.43	0.67	0.79	0.94	1.24	0.42	0.77	0.92	1.38	1.63	1.87	2.42
	83	0.21	0.38	0.47	0.73	0.86	1.01	1.33	0.45	0.83	0.99	1.48	1.73	1.98	2.56
	84	0.23	0.41	0.51	0.78	0.92	1.09	1.43	0.49	0.89	1.06	1.57	1.84	2.10	2.70
	84.1	0.23	0.42	0.52	0.79	0.93	1.10	1.44	0.49	0.90	1.07	1.58	1.85	2.11	2.71
	84.2	0.23	0.42	0.52	0.80	0.93	1.10	1.44	0.50	0.91	1.07	1.59	1.86	2.12	2.73
	84.3	0.24	0.42	0.52	0.80	0.94	1.11	1.45	0.50	0.91	1.08	1.60	1.87	2.13	2.74
	84.4	0.24	0.43	0.53	0.81	0.95	1.12	1.46	0.50	0.92	1.09	1.61	1.88	2.15	2.76
	84.5	0.24	0.43	0.53	0.81	0.95	1.13	1.47	0.51	0.92	1.09	1.62	1.89	2.16	2.77
	84.6	0.24	0.43	0.54	0.82	0.96	1.13	1.48	0.51	0.93	1.10	1.63	1.90	2.17	2.78
	84.7	0.24	0.44	0.54	0.82	0.97	1.14	1.49	0.51	0.94	1.11	1.64	1.91	2.18	2.80
	84.8	0.25	0.44	0.54	0.83	0.97	1.15	1.50	0.52	0.94	1.11	1.65	1.92	2.19	2.81
	84.9	0.25	0.44	0.55	0.84	0.98	1.16	1.51	0.52	0.95	1.12	1.66	1.93	2.20	2.83
	85	0.25	0.45	0.55	0.84	0.99	1.16	1.52	0.53	0.95	1.13	1.67	1.94	2.22	2.84
	85.1	0.25	0.45	0.56	0.85	0.99	1.17	1.53	0.53	0.96	1.13	1.67	1.95	2.23	2.85
	85.2	0.25	0.45	0.56	0.85	1.00	1.18	1.54	0.53	0.97	1.14	1.68	1.96	2.24	2.87
	85.3	0.26	0.45	0.56	0.86	1.00	1.19	1.55	0.54	0.97	1.15	1.69	1.97	2.25	2.88
	85.4	0.26	0.46	0.57	0.86	1.01	1.19	1.56	0.54	0.98	1.15	1.70	1.98	2.26	2.89
	85.5	0.26	0.46	0.57	0.87	1.02	1.20	1.56	0.54	0.98	1.16	1.71	1.99	2.27	2.91
	85.6	0.26	0.46	0.58	0.88	1.02	1.21	1.57	0.55	0.99	1.17	1.72	2.00	2.28	2.92
	85.7	0.26	0.47	0.58	0.88	1.03	1.22	1.58	0.55	1.00	1.18	1.73	2.01	2.30	2.94
	85.8	0.27	0.47	0.58	0.89	1.04	1.22	1.59	0.55	1.00	1.18	1.74	2.02	2.31	2.95
	85.9	0.27	0.47	0.59	0.89	1.04	1.23	1.60	0.56	1.01	1.19	1.75	2.03	2.32	2.96
	86	0.27	0.48	0.59	0.90	1.05	1.24	1.61	0.56	1.01	1.20	1.76	2.05	2.33	2.98
	87	0.29	0.51	0.63	0.96	1.11	1.31	1.70	0.60	1.07	1.26	1.85	2.15	2.45	3.12

Table 49 Deemed AC Cycling Savings by Energy Stratum for 15-Minutes Ending 7:00pm

		Predicted Savings for Duty Cycle Strategies AC Use < 1600 kWh							Predicted Savings for Duty Cycle Strategies AC Use > 1600 kWh						
Day	**WTHI**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**	**27%**	**43%**	**50%**	**67%**	**75%**	**83%**	**100%**
7:00 PM	**70**	0.01	0.02	0.02	0.03	0.05	0.10	0.18	0.02	0.10	0.14	0.33	0.45	0.57	0.84
	71	0.01	0.02	0.02	0.08	0.11	0.17	0.27	0.05	0.15	0.20	0.41	0.54	0.68	0.98
	72	0.01	0.02	0.06	0.13	0.18	0.25	0.37	0.08	0.21	0.27	0.50	0.64	0.78	1.11
	73	0.01	0.06	0.09	0.19	0.24	0.32	0.46	0.11	0.26	0.33	0.59	0.74	0.89	1.24
	74	0.03	0.09	0.13	0.24	0.31	0.39	0.56	0.14	0.32	0.40	0.67	0.84	1.00	1.38
	75	0.05	0.12	0.16	0.29	0.37	0.46	0.65	0.17	0.37	0.46	0.76	0.93	1.11	1.51
	76	0.07	0.15	0.20	0.35	0.43	0.53	0.75	0.21	0.42	0.53	0.85	1.03	1.22	1.64
	77	0.09	0.19	0.24	0.40	0.50	0.60	0.84	0.24	0.48	0.59	0.93	1.13	1.32	1.77
	78	0.11	0.22	0.27	0.45	0.56	0.67	0.94	0.27	0.53	0.66	1.02	1.22	1.43	1.91
	79	0.13	0.25	0.31	0.51	0.63	0.74	1.03	0.30	0.58	0.72	1.11	1.32	1.54	2.04
	80	0.15	0.28	0.35	0.56	0.69	0.81	1.13	0.33	0.64	0.79	1.19	1.42	1.65	2.17
	81	0.17	0.32	0.38	0.61	0.76	0.88	1.22	0.36	0.69	0.85	1.28	1.52	1.76	2.31
	82	0.19	0.35	0.42	0.67	0.82	0.96	1.31	0.39	0.75	0.92	1.37	1.61	1.86	2.44
	83	0.21	0.38	0.45	0.72	0.89	1.03	1.41	0.42	0.80	0.99	1.45	1.71	1.97	2.57
	84	0.22	0.41	0.49	0.77	0.95	1.10	1.50	0.45	0.85	1.05	1.54	1.81	2.08	2.71
	84.1	0.23	0.42	0.49	0.78	0.96	1.11	1.51	0.46	0.86	1.06	1.55	1.82	2.09	2.72
	84.2	0.23	0.42	0.50	0.78	0.97	1.11	1.52	0.46	0.86	1.06	1.56	1.83	2.10	2.73
	84.3	0.23	0.42	0.50	0.79	0.97	1.12	1.53	0.46	0.87	1.07	1.56	1.84	2.11	2.75
	84.4	0.23	0.43	0.50	0.79	0.98	1.13	1.54	0.47	0.88	1.08	1.57	1.85	2.12	2.76
	84.5	0.23	0.43	0.51	0.80	0.99	1.13	1.55	0.47	0.88	1.08	1.58	1.86	2.13	2.77
	84.6	0.24	0.43	0.51	0.80	0.99	1.14	1.56	0.47	0.89	1.09	1.59	1.87	2.15	2.79
	84.7	0.24	0.44	0.52	0.81	1.00	1.15	1.57	0.47	0.89	1.10	1.60	1.88	2.16	2.80
	84.8	0.24	0.44	0.52	0.82	1.01	1.15	1.58	0.48	0.90	1.10	1.61	1.89	2.17	2.81
	84.9	0.24	0.44	0.52	0.82	1.01	1.16	1.59	0.48	0.90	1.11	1.62	1.89	2.18	2.83
	85	0.24	0.45	0.53	0.83	1.02	1.17	1.60	0.48	0.91	1.12	1.63	1.90	2.19	2.84
	85.1	0.25	0.45	0.53	0.83	1.02	1.18	1.61	0.49	0.91	1.12	1.63	1.91	2.20	2.85
	85.2	0.25	0.45	0.53	0.84	1.03	1.18	1.62	0.49	0.92	1.13	1.64	1.92	2.21	2.87
	85.3	0.25	0.46	0.54	0.84	1.04	1.19	1.63	0.49	0.92	1.14	1.65	1.93	2.22	2.88
	85.4	0.25	0.46	0.54	0.85	1.04	1.20	1.64	0.50	0.93	1.14	1.66	1.94	2.23	2.89
	85.5	0.25	0.46	0.54	0.85	1.05	1.20	1.65	0.50	0.93	1.15	1.67	1.95	2.24	2.91
	85.6	0.26	0.46	0.55	0.86	1.06	1.21	1.66	0.50	0.94	1.16	1.68	1.96	2.25	2.92
	85.7	0.26	0.47	0.55	0.86	1.06	1.22	1.66	0.51	0.95	1.16	1.69	1.97	2.26	2.93
	85.8	0.26	0.47	0.56	0.87	1.07	1.23	1.67	0.51	0.95	1.17	1.69	1.98	2.28	2.95
	85.9	0.26	0.47	0.56	0.87	1.08	1.23	1.68	0.51	0.96	1.17	1.70	1.99	2.29	2.96
	86	0.26	0.48	0.56	0.88	1.08	1.24	1.69	0.51	0.96	1.18	1.71	2.00	2.30	2.97
	87	0.28	0.51	0.60	0.93	1.15	1.31	1.79	0.55	1.02	1.25	1.80	2.10	2.40	3.10

Appendix H: Deemed Savings Estimates for A/C Cycling by Demand Strata

This appendix contains the detail tables by 15 minute time period for the AC Cycling savings estimates by connected demand.

Table 50 Deemed AC Cycling Savings by Connected kW for 15-Minutes Ending 1:00pm

Time Of Day	WTHI	Predicted Savings by Duty Cycle Strategies AC Demand < 3.5 kW							Predicted Savings by Duty Cycle Strategies AC Demand > 3.5 kW						
		27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
1:00 PM	**70**	0.01	0.03	0.04	0.04	0.06	0.05	0.12	0.02	0.04	0.05	0.07	0.04	0.07	0.07
	71	0.01	0.03	0.04	0.04	0.06	0.05	0.12	0.02	0.04	0.05	0.07	0.04	0.07	0.24
	72	0.01	0.03	0.04	0.04	0.06	0.13	0.22	0.02	0.04	0.05	0.07	0.16	0.21	0.41
	73	0.01	0.03	0.04	0.09	0.13	0.20	0.32	0.02	0.04	0.05	0.18	0.28	0.35	0.58
	74	0.01	0.03	0.04	0.15	0.20	0.28	0.42	0.02	0.10	0.14	0.29	0.41	0.49	0.75
	75	0.01	0.06	0.08	0.21	0.27	0.35	0.52	0.06	0.17	0.22	0.40	0.53	0.63	0.92
	76	0.03	0.10	0.12	0.26	0.34	0.43	0.62	0.10	0.24	0.30	0.51	0.65	0.77	1.09
	77	0.05	0.13	0.17	0.32	0.40	0.50	0.72	0.14	0.31	0.38	0.62	0.77	0.91	1.26
	78	0.07	0.16	0.21	0.37	0.47	0.58	0.82	0.18	0.37	0.46	0.73	0.89	1.05	1.43
	79	0.09	0.20	0.25	0.43	0.54	0.65	0.92	0.22	0.44	0.54	0.84	1.01	1.19	1.59
	80	0.11	0.23	0.29	0.49	0.61	0.73	1.02	0.27	0.51	0.62	0.95	1.13	1.33	1.76
	81	0.13	0.27	0.34	0.54	0.68	0.80	1.12	0.31	0.57	0.70	1.06	1.25	1.47	1.93
	82	0.15	0.30	0.38	0.60	0.74	0.88	1.22	0.35	0.64	0.79	1.17	1.37	1.61	2.10
	83	0.17	0.33	0.42	0.65	0.81	0.95	1.32	0.39	0.71	0.87	1.28	1.49	1.75	2.27
	84	0.19	0.37	0.46	0.71	0.88	1.03	1.42	0.43	0.78	0.95	1.39	1.62	1.89	2.44
	84.1	0.20	0.37	0.47	0.72	0.89	1.04	1.43	0.43	0.78	0.96	1.40	1.63	1.90	2.46
	84.2	0.20	0.37	0.47	0.72	0.89	1.04	1.44	0.44	0.79	0.96	1.41	1.64	1.92	2.48
	84.3	0.20	0.38	0.48	0.73	0.90	1.05	1.45	0.44	0.80	0.97	1.43	1.65	1.93	2.49
	84.4	0.20	0.38	0.48	0.73	0.91	1.06	1.46	0.45	0.80	0.98	1.44	1.66	1.94	2.51
	84.5	0.20	0.38	0.48	0.74	0.91	1.07	1.47	0.45	0.81	0.99	1.45	1.68	1.96	2.53
	84.6	0.21	0.39	0.49	0.74	0.92	1.07	1.48	0.45	0.82	1.00	1.46	1.69	1.97	2.55
	84.7	0.21	0.39	0.49	0.75	0.93	1.08	1.49	0.46	0.82	1.00	1.47	1.70	1.99	2.56
	84.8	0.21	0.39	0.50	0.75	0.94	1.09	1.50	0.46	0.83	1.01	1.48	1.71	2.00	2.58
	84.9	0.21	0.40	0.50	0.76	0.94	1.09	1.51	0.47	0.84	1.02	1.49	1.72	2.01	2.60
	85	0.21	0.40	0.51	0.77	0.95	1.10	1.52	0.47	0.84	1.03	1.50	1.74	2.03	2.61
	85.1	0.22	0.40	0.51	0.77	0.96	1.11	1.53	0.48	0.85	1.04	1.51	1.75	2.04	2.63
	85.2	0.22	0.41	0.51	0.78	0.96	1.12	1.54	0.48	0.86	1.05	1.52	1.76	2.06	2.65
	85.3	0.22	0.41	0.52	0.78	0.97	1.12	1.55	0.48	0.86	1.05	1.54	1.77	2.07	2.66
	85.4	0.22	0.41	0.52	0.79	0.98	1.13	1.56	0.49	0.87	1.06	1.55	1.79	2.08	2.68
	85.5	0.22	0.42	0.53	0.79	0.98	1.14	1.57	0.49	0.88	1.07	1.56	1.80	2.10	2.70
	85.6	0.23	0.42	0.53	0.80	0.99	1.15	1.58	0.50	0.89	1.08	1.57	1.81	2.11	2.72
	85.7	0.23	0.43	0.53	0.81	1.00	1.15	1.59	0.50	0.89	1.09	1.58	1.82	2.13	2.73
	85.8	0.23	0.43	0.54	0.81	1.00	1.16	1.60	0.50	0.90	1.09	1.59	1.83	2.14	2.75
	85.9	0.23	0.43	0.54	0.82	1.01	1.17	1.61	0.51	0.91	1.10	1.60	1.85	2.15	2.77
	86	0.24	0.44	0.55	0.82	1.02	1.18	1.62	0.51	0.91	1.11	1.61	1.86	2.17	2.78
	87	0.26	0.47	0.59	0.88	1.08	1.25	1.72	0.55	0.98	1.19	1.72	1.98	2.31	2.95

Table 51 Deemed AC Cycling Savings by Connected kW for 15-Minutes Ending 2:00pm

Time Of Day	WTHI	Predicted Savings by Duty Cycle Strategies AC Demand < 3.5 kW							Predicted Savings by Duty Cycle Strategies AC Demand > 3.5 kW						
		27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
2:00 PM	**70**	0.02	0.03	0.05	0.04	0.07	0.06	0.15	0.02	0.05	0.07	0.09	0.07	0.11	0.12
	71	0.02	0.03	0.05	0.04	0.07	0.06	0.15	0.02	0.05	0.07	0.09	0.07	0.11	0.29
	72	0.02	0.03	0.05	0.04	0.07	0.15	0.25	0.02	0.05	0.07	0.09	0.19	0.25	0.46
	73	0.02	0.03	0.05	0.11	0.15	0.23	0.36	0.02	0.05	0.07	0.21	0.32	0.40	0.64
	74	0.02	0.03	0.05	0.17	0.22	0.31	0.47	0.02	0.12	0.15	0.32	0.45	0.54	0.81
	75	0.02	0.07	0.09	0.23	0.30	0.39	0.57	0.07	0.19	0.24	0.44	0.57	0.68	0.98
	76	0.04	0.11	0.14	0.30	0.37	0.47	0.68	0.11	0.26	0.33	0.55	0.70	0.83	1.15
	77	0.06	0.15	0.19	0.36	0.45	0.56	0.78	0.16	0.33	0.41	0.67	0.82	0.97	1.33
	78	0.09	0.19	0.24	0.42	0.52	0.64	0.89	0.20	0.40	0.50	0.78	0.95	1.11	1.50
	79	0.11	0.23	0.29	0.48	0.60	0.72	1.00	0.25	0.47	0.58	0.90	1.07	1.26	1.67
	80	0.13	0.27	0.34	0.55	0.67	0.80	1.10	0.29	0.55	0.67	1.01	1.20	1.40	1.85
	81	0.16	0.31	0.38	0.61	0.75	0.88	1.21	0.33	0.62	0.75	1.12	1.32	1.54	2.02
	82	0.18	0.35	0.43	0.67	0.82	0.97	1.32	0.38	0.69	0.84	1.24	1.45	1.69	2.19
	83	0.20	0.39	0.48	0.73	0.90	1.05	1.42	0.42	0.76	0.92	1.35	1.58	1.83	2.36
	84	0.23	0.42	0.53	0.80	0.97	1.13	1.53	0.47	0.83	1.01	1.47	1.70	1.98	2.54
	84.1	0.23	0.43	0.53	0.80	0.98	1.14	1.54	0.47	0.84	1.02	1.48	1.71	1.99	2.55
	84.2	0.23	0.43	0.54	0.81	0.99	1.15	1.55	0.48	0.84	1.02	1.49	1.73	2.00	2.57
	84.3	0.24	0.44	0.54	0.82	1.00	1.15	1.56	0.48	0.85	1.03	1.50	1.74	2.02	2.59
	84.4	0.24	0.44	0.55	0.82	1.00	1.16	1.57	0.48	0.86	1.04	1.51	1.75	2.03	2.61
	84.5	0.24	0.44	0.55	0.83	1.01	1.17	1.58	0.49	0.87	1.05	1.53	1.76	2.05	2.62
	84.6	0.24	0.45	0.56	0.83	1.02	1.18	1.59	0.49	0.87	1.06	1.54	1.78	2.06	2.64
	84.7	0.24	0.45	0.56	0.84	1.03	1.19	1.60	0.50	0.88	1.07	1.55	1.79	2.08	2.66
	84.8	0.25	0.46	0.57	0.85	1.03	1.19	1.62	0.50	0.89	1.07	1.56	1.80	2.09	2.68
	84.9	0.25	0.46	0.57	0.85	1.04	1.20	1.63	0.51	0.89	1.08	1.57	1.81	2.11	2.69
	85	0.25	0.46	0.58	0.86	1.05	1.21	1.64	0.51	0.90	1.09	1.58	1.83	2.12	2.71
	85.1	0.25	0.47	0.58	0.87	1.06	1.22	1.65	0.52	0.91	1.10	1.59	1.84	2.13	2.73
	85.2	0.26	0.47	0.59	0.87	1.06	1.23	1.66	0.52	0.92	1.11	1.61	1.85	2.15	2.74
	85.3	0.26	0.48	0.59	0.88	1.07	1.24	1.67	0.52	0.92	1.12	1.62	1.87	2.16	2.76
	85.4	0.26	0.48	0.60	0.88	1.08	1.24	1.68	0.53	0.93	1.13	1.63	1.88	2.18	2.78
	85.5	0.26	0.48	0.60	0.89	1.09	1.25	1.69	0.53	0.94	1.13	1.64	1.89	2.19	2.80
	85.6	0.27	0.49	0.61	0.90	1.09	1.26	1.70	0.54	0.94	1.14	1.65	1.90	2.21	2.81
	85.7	0.27	0.49	0.61	0.90	1.10	1.27	1.71	0.54	0.95	1.15	1.66	1.92	2.22	2.83
	85.8	0.27	0.50	0.62	0.91	1.11	1.28	1.72	0.55	0.96	1.16	1.67	1.93	2.23	2.85
	85.9	0.27	0.50	0.62	0.92	1.12	1.28	1.73	0.55	0.97	1.17	1.69	1.94	2.25	2.87
	86	0.28	0.50	0.63	0.92	1.12	1.29	1.74	0.56	0.97	1.18	1.70	1.95	2.26	2.88
	87	0.30	0.54	0.67	0.98	1.20	1.37	1.85	0.60	1.04	1.26	1.81	2.08	2.41	3.06

Table 52 Deemed AC Cycling Savings by Connected kW for 15-Minutes Ending 3:00pm

Time Of Day	WTHI	Predicted Savings by Duty Cycle Strategies AC Demand < 3.5 kW							Predicted Savings by Duty Cycle Strategies AC Demand > 3.5 kW						
		27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
3:00 PM	70	0.02	0.04	0.04	0.05	0.04	0.08	0.10	0.03	0.06	0.05	0.06	0.10	0.06	0.17
	71	0.02	0.04	0.04	0.05	0.04	0.08	0.21	0.03	0.06	0.05	0.06	0.10	0.20	0.34
	72	0.02	0.04	0.04	0.05	0.12	0.16	0.32	0.03	0.06	0.05	0.17	0.23	0.34	0.52
	73	0.02	0.04	0.04	0.12	0.20	0.25	0.43	0.03	0.06	0.13	0.28	0.36	0.49	0.70
	74	0.02	0.04	0.08	0.19	0.28	0.34	0.53	0.03	0.14	0.21	0.40	0.49	0.63	0.88
	75	0.02	0.08	0.13	0.26	0.35	0.43	0.64	0.08	0.21	0.30	0.51	0.62	0.77	1.05
	76	0.05	0.13	0.18	0.33	0.43	0.52	0.75	0.13	0.29	0.38	0.62	0.75	0.91	1.23
	77	0.08	0.17	0.23	0.40	0.51	0.61	0.86	0.18	0.37	0.47	0.73	0.88	1.05	1.41
	78	0.10	0.22	0.28	0.47	0.59	0.70	0.97	0.22	0.44	0.55	0.85	1.02	1.19	1.59
	79	0.13	0.26	0.33	0.54	0.66	0.79	1.08	0.27	0.52	0.63	0.96	1.15	1.33	1.76
	80	0.16	0.31	0.38	0.61	0.74	0.88	1.19	0.32	0.59	0.72	1.07	1.28	1.48	1.94
	81	0.19	0.35	0.43	0.68	0.82	0.97	1.30	0.37	0.67	0.80	1.19	1.41	1.62	2.12
	82	0.21	0.40	0.48	0.75	0.90	1.06	1.41	0.42	0.75	0.88	1.30	1.54	1.76	2.30
	83	0.24	0.44	0.53	0.82	0.97	1.15	1.51	0.46	0.82	0.97	1.41	1.67	1.90	2.47
	84	0.27	0.49	0.58	0.89	1.05	1.24	1.62	0.51	0.90	1.05	1.52	1.80	2.04	2.65
	84.1	0.27	0.49	0.58	0.90	1.06	1.25	1.63	0.52	0.91	1.06	1.54	1.82	2.05	2.67
	84.2	0.27	0.50	0.59	0.90	1.07	1.26	1.65	0.52	0.91	1.07	1.55	1.83	2.07	2.69
	84.3	0.28	0.50	0.59	0.91	1.07	1.26	1.66	0.52	0.92	1.08	1.56	1.84	2.08	2.70
	84.4	0.28	0.50	0.60	0.92	1.08	1.27	1.67	0.53	0.93	1.09	1.57	1.85	2.10	2.72
	84.5	0.28	0.51	0.60	0.92	1.09	1.28	1.68	0.53	0.94	1.09	1.58	1.87	2.11	2.74
	84.6	0.28	0.51	0.61	0.93	1.10	1.29	1.69	0.54	0.94	1.10	1.59	1.88	2.13	2.76
	84.7	0.29	0.52	0.61	0.94	1.11	1.30	1.70	0.54	0.95	1.11	1.60	1.89	2.14	2.78
	84.8	0.29	0.52	0.62	0.94	1.11	1.31	1.71	0.55	0.96	1.12	1.62	1.91	2.15	2.79
	84.9	0.29	0.53	0.62	0.95	1.12	1.32	1.72	0.55	0.97	1.13	1.63	1.92	2.17	2.81
	85	0.30	0.53	0.63	0.96	1.13	1.33	1.73	0.56	0.97	1.14	1.64	1.93	2.18	2.83
	85.1	0.30	0.54	0.63	0.96	1.14	1.34	1.74	0.56	0.98	1.14	1.65	1.95	2.20	2.85
	85.2	0.30	0.54	0.64	0.97	1.14	1.35	1.75	0.57	0.99	1.15	1.66	1.96	2.21	2.86
	85.3	0.30	0.54	0.64	0.98	1.15	1.35	1.77	0.57	1.00	1.16	1.67	1.97	2.22	2.88
	85.4	0.31	0.55	0.65	0.99	1.16	1.36	1.78	0.58	1.00	1.17	1.68	1.99	2.24	2.90
	85.5	0.31	0.55	0.65	0.99	1.17	1.37	1.79	0.58	1.01	1.18	1.69	2.00	2.25	2.92
	85.6	0.31	0.56	0.66	1.00	1.17	1.38	1.80	0.59	1.02	1.19	1.71	2.01	2.27	2.94
	85.7	0.31	0.56	0.66	1.01	1.18	1.39	1.81	0.59	1.03	1.19	1.72	2.03	2.28	2.95
	85.8	0.32	0.57	0.67	1.01	1.19	1.40	1.82	0.60	1.04	1.20	1.73	2.04	2.29	2.97
	85.9	0.32	0.57	0.67	1.02	1.20	1.41	1.83	0.60	1.04	1.21	1.74	2.05	2.31	2.99
	86	0.32	0.58	0.68	1.03	1.21	1.42	1.84	0.61	1.05	1.22	1.75	2.06	2.32	3.01
	87	0.35	0.62	0.73	1.10	1.28	1.51	1.95	0.65	1.13	1.30	1.86	2.20	2.46	3.18

Table 53 Deemed AC Cycling Savings by Connected kW for 15-Minutes Ending 4:00pm

Time Of Day	WTHI	Predicted Savings by Duty Cycle Strategies AC Demand < 3.5 kW							Predicted Savings by Duty Cycle Strategies AC Demand > 3.5 kW						
		27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
4:00 PM	70	0.02	0.04	0.03	0.05	0.04	0.07	0.20	0.03	0.06	0.08	0.11	0.09	0.14	0.33
	71	0.02	0.04	0.03	0.05	0.12	0.16	0.31	0.03	0.06	0.08	0.11	0.22	0.28	0.51
	72	0.02	0.04	0.03	0.12	0.19	0.25	0.42	0.03	0.06	0.08	0.23	0.35	0.43	0.68
	73	0.02	0.04	0.08	0.19	0.27	0.34	0.53	0.03	0.13	0.17	0.35	0.47	0.57	0.86
	74	0.02	0.08	0.13	0.26	0.35	0.42	0.63	0.07	0.20	0.26	0.46	0.60	0.72	1.03
	75	0.05	0.13	0.18	0.32	0.42	0.51	0.74	0.12	0.28	0.35	0.58	0.73	0.87	1.20
	76	0.07	0.17	0.23	0.39	0.50	0.60	0.85	0.17	0.35	0.43	0.70	0.86	1.01	1.38
	77	0.10	0.21	0.28	0.46	0.58	0.69	0.95	0.21	0.42	0.52	0.82	0.99	1.16	1.55
	78	0.13	0.26	0.33	0.53	0.65	0.78	1.06	0.26	0.50	0.61	0.93	1.12	1.30	1.73
	79	0.15	0.30	0.38	0.60	0.73	0.86	1.17	0.30	0.57	0.70	1.05	1.25	1.45	1.90
	80	0.18	0.35	0.42	0.67	0.81	0.95	1.27	0.35	0.65	0.78	1.17	1.38	1.59	2.07
	81	0.21	0.39	0.47	0.74	0.88	1.04	1.38	0.40	0.72	0.87	1.28	1.50	1.74	2.25
	82	0.24	0.43	0.52	0.81	0.96	1.13	1.49	0.44	0.79	0.96	1.40	1.63	1.89	2.42
	83	0.26	0.48	0.57	0.87	1.04	1.22	1.59	0.49	0.87	1.05	1.52	1.76	2.03	2.60
	84	0.29	0.52	0.62	0.94	1.11	1.30	1.70	0.53	0.94	1.13	1.64	1.89	2.18	2.77
	84.1	0.29	0.53	0.63	0.95	1.12	1.31	1.71	0.54	0.95	1.14	1.65	1.90	2.19	2.79
	84.2	0.29	0.53	0.63	0.96	1.13	1.32	1.72	0.54	0.96	1.15	1.66	1.92	2.21	2.80
	84.3	0.30	0.54	0.64	0.96	1.14	1.33	1.73	0.55	0.96	1.16	1.67	1.93	2.22	2.82
	84.4	0.30	0.54	0.64	0.97	1.14	1.34	1.74	0.55	0.97	1.17	1.68	1.94	2.24	2.84
	84.5	0.30	0.54	0.65	0.98	1.15	1.35	1.75	0.56	0.98	1.18	1.69	1.95	2.25	2.86
	84.6	0.31	0.55	0.65	0.98	1.16	1.36	1.77	0.56	0.99	1.19	1.71	1.97	2.26	2.87
	84.7	0.31	0.55	0.66	0.99	1.17	1.37	1.78	0.57	0.99	1.19	1.72	1.98	2.28	2.89
	84.8	0.31	0.56	0.66	1.00	1.17	1.38	1.79	0.57	1.00	1.20	1.73	1.99	2.29	2.91
	84.9	0.31	0.56	0.67	1.01	1.18	1.38	1.80	0.57	1.01	1.21	1.74	2.01	2.31	2.93
	85	0.32	0.57	0.67	1.01	1.19	1.39	1.81	0.58	1.02	1.22	1.75	2.02	2.32	2.94
	85.1	0.32	0.57	0.67	1.02	1.20	1.40	1.82	0.58	1.02	1.23	1.76	2.03	2.34	2.96
	85.2	0.32	0.57	0.68	1.03	1.21	1.41	1.83	0.59	1.03	1.24	1.78	2.04	2.35	2.98
	85.3	0.32	0.58	0.68	1.03	1.21	1.42	1.84	0.59	1.04	1.25	1.79	2.06	2.37	2.99
	85.4	0.33	0.58	0.69	1.04	1.22	1.43	1.85	0.60	1.05	1.26	1.80	2.07	2.38	3.01
	85.5	0.33	0.59	0.69	1.05	1.23	1.44	1.86	0.60	1.05	1.27	1.81	2.08	2.40	3.03
	85.6	0.33	0.59	0.70	1.05	1.24	1.45	1.87	0.61	1.06	1.27	1.82	2.10	2.41	3.05
	85.7	0.34	0.60	0.70	1.06	1.24	1.45	1.88	0.61	1.07	1.28	1.83	2.11	2.43	3.06
	85.8	0.34	0.60	0.71	1.07	1.25	1.46	1.89	0.62	1.07	1.29	1.85	2.12	2.44	3.08
	85.9	0.34	0.61	0.71	1.07	1.26	1.47	1.90	0.62	1.08	1.30	1.86	2.13	2.45	3.10
	86	0.34	0.61	0.72	1.08	1.27	1.48	1.92	0.62	1.09	1.31	1.87	2.15	2.47	3.12
	87	0.37	0.65	0.77	1.15	1.34	1.57	2.02	0.67	1.16	1.40	1.99	2.28	2.61	3.29

Table 54 Deemed AC Cycling Savings by Connected kW for 15-Minutes Ending 5:00pm

Time Of Day	WTHI	Predicted Savings by Duty Cycle Strategies AC Demand < 3.5 kW							Predicted Savings by Duty Cycle Strategies AC Demand > 3.5 kW						
		27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
5:00 PM	**70**	0.02	0.04	0.05	0.05	0.08	0.16	0.28	0.04	0.08	0.07	0.10	0.20	0.27	0.49
	71	0.02	0.04	0.05	0.12	0.17	0.25	0.39	0.04	0.08	0.07	0.22	0.33	0.41	0.67
	72	0.02	0.04	0.05	0.19	0.25	0.34	0.50	0.04	0.08	0.16	0.34	0.46	0.56	0.84
	73	0.02	0.08	0.11	0.26	0.33	0.43	0.61	0.04	0.16	0.25	0.45	0.59	0.71	1.02
	74	0.05	0.13	0.16	0.33	0.41	0.52	0.73	0.09	0.24	0.34	0.57	0.72	0.85	1.19
	75	0.07	0.17	0.22	0.40	0.49	0.61	0.84	0.14	0.32	0.42	0.69	0.85	1.00	1.36
	76	0.10	0.22	0.27	0.47	0.58	0.70	0.95	0.19	0.40	0.51	0.81	0.98	1.15	1.54
	77	0.13	0.26	0.33	0.54	0.66	0.79	1.07	0.24	0.48	0.60	0.92	1.11	1.29	1.71
	78	0.16	0.31	0.38	0.61	0.74	0.88	1.18	0.29	0.56	0.69	1.04	1.24	1.44	1.89
	79	0.18	0.35	0.43	0.68	0.82	0.96	1.29	0.34	0.64	0.78	1.16	1.37	1.58	2.06
	80	0.21	0.40	0.49	0.75	0.91	1.05	1.41	0.39	0.72	0.86	1.28	1.50	1.73	2.23
	81	0.24	0.44	0.54	0.82	0.99	1.14	1.52	0.44	0.80	0.95	1.39	1.63	1.88	2.41
	82	0.26	0.49	0.60	0.89	1.07	1.23	1.63	0.49	0.88	1.04	1.51	1.75	2.02	2.58
	83	0.29	0.53	0.65	0.96	1.15	1.32	1.75	0.54	0.96	1.13	1.63	1.88	2.17	2.76
	84	0.32	0.58	0.71	1.03	1.23	1.41	1.86	0.59	1.04	1.21	1.75	2.01	2.32	2.93
	84.1	0.32	0.58	0.71	1.04	1.24	1.42	1.87	0.60	1.05	1.22	1.76	2.03	2.33	2.95
	84.2	0.32	0.59	0.72	1.04	1.25	1.43	1.88	0.60	1.06	1.23	1.77	2.04	2.35	2.96
	84.3	0.33	0.59	0.72	1.05	1.26	1.44	1.89	0.61	1.07	1.24	1.78	2.05	2.36	2.98
	84.4	0.33	0.59	0.73	1.06	1.27	1.45	1.91	0.61	1.07	1.25	1.79	2.07	2.37	3.00
	84.5	0.33	0.60	0.73	1.06	1.28	1.46	1.92	0.62	1.08	1.26	1.80	2.08	2.39	3.02
	84.6	0.34	0.60	0.74	1.07	1.28	1.47	1.93	0.62	1.09	1.27	1.82	2.09	2.40	3.03
	84.7	0.34	0.61	0.74	1.08	1.29	1.48	1.94	0.63	1.10	1.28	1.83	2.10	2.42	3.05
	84.8	0.34	0.61	0.75	1.09	1.30	1.48	1.95	0.63	1.11	1.29	1.84	2.12	2.43	3.07
	84.9	0.34	0.62	0.76	1.09	1.31	1.49	1.96	0.64	1.11	1.29	1.85	2.13	2.45	3.09
	85	0.35	0.62	0.76	1.10	1.32	1.50	1.97	0.64	1.12	1.30	1.86	2.14	2.46	3.10
	85.1	0.35	0.63	0.77	1.11	1.32	1.51	1.99	0.65	1.13	1.31	1.87	2.16	2.48	3.12
	85.2	0.35	0.63	0.77	1.11	1.33	1.52	2.00	0.65	1.14	1.32	1.89	2.17	2.49	3.14
	85.3	0.36	0.64	0.78	1.12	1.34	1.53	2.01	0.66	1.15	1.33	1.90	2.18	2.51	3.16
	85.4	0.36	0.64	0.78	1.13	1.35	1.54	2.02	0.66	1.15	1.34	1.91	2.19	2.52	3.17
	85.5	0.36	0.64	0.79	1.13	1.36	1.55	2.03	0.67	1.16	1.35	1.92	2.21	2.54	3.19
	85.6	0.36	0.65	0.79	1.14	1.37	1.56	2.04	0.67	1.17	1.36	1.93	2.22	2.55	3.21
	85.7	0.37	0.65	0.80	1.15	1.37	1.57	2.05	0.68	1.18	1.36	1.94	2.23	2.56	3.23
	85.8	0.37	0.66	0.80	1.16	1.38	1.57	2.06	0.68	1.19	1.37	1.96	2.25	2.58	3.24
	85.9	0.37	0.66	0.81	1.16	1.39	1.58	2.08	0.69	1.19	1.38	1.97	2.26	2.59	3.26
	86	0.37	0.67	0.82	1.17	1.40	1.59	2.09	0.69	1.20	1.39	1.98	2.27	2.61	3.28
	87	0.40	0.71	0.87	1.24	1.48	1.68	2.20	0.74	1.28	1.48	2.10	2.40	2.76	3.45

Table 55 Deemed AC Cycling Savings by Connected kW for 15-Minutes Ending 6:00pm

Time Of Day	WTHI	Predicted Savings by Duty Cycle Strategies AC Demand < 3.5 kW							Predicted Savings by Duty Cycle Strategies AC Demand > 3.5 kW						
		27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
6:00 PM	**70**	0.02	0.03	0.05	0.11	0.16	0.24	0.41	0.03	0.07	0.05	0.19	0.26	0.39	0.63
	71	0.02	0.03	0.05	0.18	0.24	0.33	0.52	0.03	0.07	0.14	0.31	0.39	0.53	0.80
	72	0.02	0.08	0.10	0.25	0.32	0.42	0.62	0.03	0.15	0.22	0.42	0.53	0.67	0.97
	73	0.04	0.12	0.16	0.32	0.40	0.51	0.73	0.08	0.22	0.31	0.54	0.66	0.81	1.14
	74	0.07	0.16	0.21	0.39	0.48	0.59	0.84	0.13	0.30	0.39	0.65	0.79	0.96	1.31
	75	0.09	0.21	0.26	0.46	0.56	0.68	0.95	0.17	0.37	0.48	0.76	0.92	1.10	1.49
	76	0.12	0.25	0.31	0.53	0.64	0.77	1.06	0.22	0.45	0.56	0.88	1.06	1.24	1.66
	77	0.15	0.29	0.37	0.59	0.73	0.86	1.16	0.27	0.52	0.65	0.99	1.19	1.39	1.83
	78	0.17	0.34	0.42	0.66	0.81	0.95	1.27	0.31	0.60	0.73	1.11	1.32	1.53	2.00
	79	0.20	0.38	0.47	0.73	0.89	1.04	1.38	0.36	0.68	0.81	1.22	1.45	1.67	2.17
	80	0.23	0.43	0.53	0.80	0.97	1.12	1.49	0.41	0.75	0.90	1.34	1.58	1.81	2.34
	81	0.25	0.47	0.58	0.87	1.05	1.21	1.59	0.45	0.83	0.98	1.45	1.72	1.96	2.51
	82	0.28	0.51	0.63	0.94	1.13	1.30	1.70	0.50	0.90	1.07	1.56	1.85	2.10	2.68
	83	0.30	0.56	0.68	1.01	1.21	1.39	1.81	0.55	0.98	1.15	1.68	1.98	2.24	2.85
	84	0.33	0.60	0.74	1.08	1.29	1.48	1.92	0.59	1.06	1.24	1.79	2.11	2.38	3.03
	84.1	0.33	0.60	0.74	1.08	1.30	1.49	1.93	0.60	1.06	1.25	1.80	2.13	2.40	3.04
	84.2	0.34	0.61	0.75	1.09	1.31	1.49	1.94	0.60	1.07	1.25	1.82	2.14	2.41	3.06
	84.3	0.34	0.61	0.75	1.10	1.32	1.50	1.95	0.61	1.08	1.26	1.83	2.15	2.43	3.08
	84.4	0.34	0.62	0.76	1.10	1.32	1.51	1.96	0.61	1.09	1.27	1.84	2.17	2.44	3.09
	84.5	0.34	0.62	0.76	1.11	1.33	1.52	1.97	0.62	1.09	1.28	1.85	2.18	2.45	3.11
	84.6	0.35	0.63	0.77	1.12	1.34	1.53	1.98	0.62	1.10	1.29	1.86	2.19	2.47	3.13
	84.7	0.35	0.63	0.77	1.12	1.35	1.54	1.99	0.63	1.11	1.30	1.87	2.21	2.48	3.15
	84.8	0.35	0.63	0.78	1.13	1.36	1.55	2.00	0.63	1.12	1.30	1.88	2.22	2.50	3.16
	84.9	0.35	0.64	0.78	1.14	1.36	1.56	2.01	0.63	1.12	1.31	1.90	2.23	2.51	3.18
	85	0.36	0.64	0.79	1.14	1.37	1.57	2.02	0.64	1.13	1.32	1.91	2.25	2.53	3.20
	85.1	0.36	0.65	0.79	1.15	1.38	1.57	2.04	0.64	1.14	1.33	1.92	2.26	2.54	3.21
	85.2	0.36	0.65	0.80	1.16	1.39	1.58	2.05	0.65	1.15	1.34	1.93	2.27	2.55	3.23
	85.3	0.36	0.66	0.80	1.17	1.40	1.59	2.06	0.65	1.16	1.35	1.94	2.29	2.57	3.25
	85.4	0.37	0.66	0.81	1.17	1.40	1.60	2.07	0.66	1.16	1.35	1.95	2.30	2.58	3.27
	85.5	0.37	0.66	0.82	1.18	1.41	1.61	2.08	0.66	1.17	1.36	1.96	2.31	2.60	3.28
	85.6	0.37	0.67	0.82	1.19	1.42	1.62	2.09	0.67	1.18	1.37	1.98	2.33	2.61	3.30
	85.7	0.37	0.67	0.83	1.19	1.43	1.63	2.10	0.67	1.19	1.38	1.99	2.34	2.63	3.32
	85.8	0.38	0.68	0.83	1.20	1.44	1.64	2.11	0.68	1.19	1.39	2.00	2.35	2.64	3.33
	85.9	0.38	0.68	0.84	1.21	1.44	1.64	2.12	0.68	1.20	1.40	2.01	2.37	2.65	3.35
	86	0.38	0.69	0.84	1.21	1.45	1.65	2.13	0.69	1.21	1.41	2.02	2.38	2.67	3.37
	87	0.41	0.73	0.89	1.28	1.53	1.74	2.24	0.73	1.28	1.49	2.14	2.51	2.81	3.54

Table 56 Deemed AC Cycling Savings by Connected kW for 15-Minutes Ending 7:00pm

Time Of Day	WTHI	Predicted Savings by Duty Cycle Strategies AC Demand < 3.5 kW							Predicted Savings by Duty Cycle Strategies AC Demand > 3.5 kW						
		27%	43%	50%	67%	75%	83%	100%	27%	43%	50%	67%	75%	83%	100%
7:00 PM	70	0.02	0.03	0.05	0.14	0.22	0.31	0.49	0.03	0.06	0.12	0.28	0.37	0.49	0.72
	71	0.02	0.07	0.09	0.21	0.30	0.39	0.60	0.03	0.13	0.20	0.39	0.49	0.63	0.90
	72	0.02	0.11	0.14	0.28	0.37	0.47	0.70	0.07	0.20	0.28	0.50	0.62	0.77	1.07
	73	0.05	0.14	0.19	0.34	0.45	0.56	0.80	0.11	0.27	0.36	0.61	0.75	0.91	1.24
	74	0.07	0.18	0.23	0.41	0.52	0.64	0.90	0.16	0.34	0.44	0.72	0.87	1.04	1.42
	75	0.10	0.22	0.28	0.48	0.60	0.72	1.00	0.20	0.41	0.52	0.83	1.00	1.18	1.59
	76	0.12	0.26	0.33	0.54	0.67	0.80	1.10	0.24	0.48	0.60	0.93	1.13	1.32	1.76
	77	0.15	0.30	0.37	0.61	0.75	0.89	1.21	0.28	0.56	0.68	1.04	1.25	1.46	1.94
	78	0.17	0.33	0.42	0.68	0.82	0.97	1.31	0.33	0.63	0.76	1.15	1.38	1.59	2.11
	79	0.19	0.37	0.47	0.74	0.89	1.05	1.41	0.37	0.70	0.84	1.26	1.50	1.73	2.28
	80	0.22	0.41	0.51	0.81	0.97	1.13	1.51	0.41	0.77	0.92	1.37	1.63	1.87	2.46
	81	0.24	0.45	0.56	0.88	1.04	1.21	1.61	0.45	0.84	1.00	1.47	1.76	2.01	2.63
	82	0.27	0.49	0.61	0.94	1.12	1.30	1.71	0.49	0.91	1.07	1.58	1.88	2.14	2.80
	83	0.29	0.53	0.65	1.01	1.19	1.38	1.82	0.54	0.98	1.15	1.69	2.01	2.28	2.98
	84	0.32	0.56	0.70	1.08	1.27	1.46	1.92	0.58	1.05	1.23	1.80	2.14	2.42	3.15
	84.1	0.32	0.57	0.71	1.08	1.28	1.47	1.93	0.58	1.06	1.24	1.81	2.15	2.43	3.17
	84.2	0.32	0.57	0.71	1.09	1.28	1.48	1.94	0.59	1.07	1.25	1.82	2.16	2.44	3.18
	84.3	0.32	0.57	0.72	1.10	1.29	1.49	1.95	0.59	1.07	1.26	1.83	2.17	2.46	3.20
	84.4	0.33	0.58	0.72	1.10	1.30	1.49	1.96	0.60	1.08	1.26	1.84	2.19	2.47	3.22
	84.5	0.33	0.58	0.72	1.11	1.30	1.50	1.97	0.60	1.09	1.27	1.85	2.20	2.49	3.24
	84.6	0.33	0.59	0.73	1.12	1.31	1.51	1.98	0.61	1.09	1.28	1.86	2.21	2.50	3.25
	84.7	0.33	0.59	0.73	1.12	1.32	1.52	1.99	0.61	1.10	1.29	1.88	2.23	2.51	3.27
	84.8	0.34	0.59	0.74	1.13	1.33	1.53	2.00	0.61	1.11	1.30	1.89	2.24	2.53	3.29
	84.9	0.34	0.60	0.74	1.14	1.33	1.53	2.01	0.62	1.12	1.30	1.90	2.25	2.54	3.31
	85	0.34	0.60	0.75	1.14	1.34	1.54	2.02	0.62	1.12	1.31	1.91	2.26	2.55	3.32
	85.1	0.34	0.61	0.75	1.15	1.35	1.55	2.03	0.63	1.13	1.32	1.92	2.28	2.57	3.34
	85.2	0.35	0.61	0.76	1.16	1.36	1.56	2.04	0.63	1.14	1.33	1.93	2.29	2.58	3.36
	85.3	0.35	0.61	0.76	1.16	1.36	1.57	2.05	0.63	1.14	1.34	1.94	2.30	2.60	3.38
	85.4	0.35	0.62	0.77	1.17	1.37	1.58	2.06	0.64	1.15	1.34	1.95	2.31	2.61	3.39
	85.5	0.35	0.62	0.77	1.18	1.38	1.58	2.07	0.64	1.16	1.35	1.96	2.33	2.62	3.41
	85.6	0.36	0.62	0.78	1.18	1.39	1.59	2.08	0.65	1.17	1.36	1.97	2.34	2.64	3.43
	85.7	0.36	0.63	0.78	1.19	1.39	1.60	2.09	0.65	1.17	1.37	1.98	2.35	2.65	3.44
	85.8	0.36	0.63	0.79	1.20	1.40	1.61	2.10	0.66	1.18	1.38	1.99	2.36	2.66	3.46
	85.9	0.36	0.64	0.79	1.20	1.41	1.62	2.11	0.66	1.19	1.38	2.01	2.38	2.68	3.48
	86	0.37	0.64	0.79	1.21	1.42	1.63	2.12	0.66	1.19	1.39	2.02	2.39	2.69	3.50
	87	0.39	0.68	0.84	1.28	1.49	1.71	2.22	0.71	1.27	1.47	2.12	2.52	2.83	3.67

Appendix I: Technical Memo – Pooling Water Heating Cycling Program Estimates

This memo presents the contractor's opinion regarding the potential to pool future efforts to assess water heating impacts. Currently, three of the LRWG members, PEPCO, BGE and Conectiv, indicated active data collection programs for their water heating load management reporting efforts.

Sample Design and Deployment. In 2001, PEPCO installed end-use monitoring on a simple random sample of 60 program participants. Similarly, Conectiv installed end-use metering on a sample of 73 sites. BGE deployed end-use monitoring on a two-dimensional stratified sample of program participants. The BGE sample is stratified by time-of-use versus non time-of-use. One might assume that time-of-use customers may have altered their consumption patterns, e.g., do laundry and dishwashing in the evening, to take economic advantage of the time-of-use rate. Prior to pooling the data, statistical test could be run on the water heating profiles by TOU domain to examine similarities and differences. Comparisons could be conducted by hour or time-of-use period.

Cycling Strategy. The water heating control programs invoke 100% cycling of the water heaters for the selected control period. The water heater tank provides sufficient storage capacity to allow these units to be cycled off for extended periods of time, e.g., several hours, without inconveniencing the customer.

Monitoring Strategy. There were differences in the monitoring techniques deployed. PEPCO used a simple run-time logger to gather information on the amount of time the water heater was on in any given 15-minute period. The run time information was coupled with nameplate data to estimate the kW loading of the water heater. BGE installed 15-minute load recorders on the water heaters to directly measure the load impacts. The differences in data collection strategy should not hinder the development of a cross sample estimate.

Gross and Net Impacts. Similar to the discussion on AC-DLC, the evaluation can be directed at assessing the gross or net impacts of the program. This depends on the analysis construct. Since the load interruption is 100%, the anticipated gross impacts can be estimated from a simplified end-use metering study. This study could be implemented across the PJM footprint and provide a robust dataset for estimating the water heating load of the respective jurisdictions. Zonal specific weights could be constructed and applied based on some known characteristic of the population, e.g., monthly, seasonal, or annual energy use, to derive the zonal estimates. Net estimates would be developed by implementing a separate operability study similar to those proposed for the AC-DLC evaluation. Alternatively net impacts could be estimated by observing the actual performance of the monitored units on event and non-event days, similar to the analysis completed by BGE.

Water Heating Sensitivity to External Variables. At issue is the sensitivity of the water heating load to external variables. We have examined a substantial amount of electric water heating end-use data over the years. One of our current projects involves the collection of more than 200 end-use metering points allocated by varying tank capacities and water heating element configurations. While there are certainly differences at the individual customer level, in aggregate water heating load is quite stable. There is some seasonality in the load but the load is much more time dependent than weather dependent. Figure 20 presents a plot of average diversified water heating demand for the hours 7am through 8pm versus temperature[23]. In Figure 21 a load duration curve for specific hours are presented. Clearly the most load is available in the early morning and early evening hours when compared to the 1pm period. We may be able to condense the time-temperature matrix to a simple time dependent matrix.

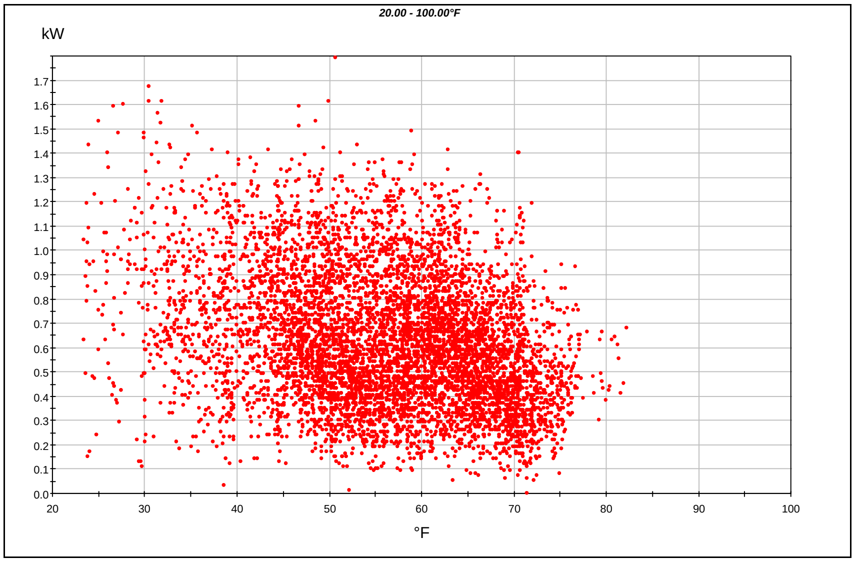

Figure 20 Water Heating Demand versus Temperature

[23] The data in Figure 20 is not from the mid-Atlantic region and is shown for illustrative purposes only.

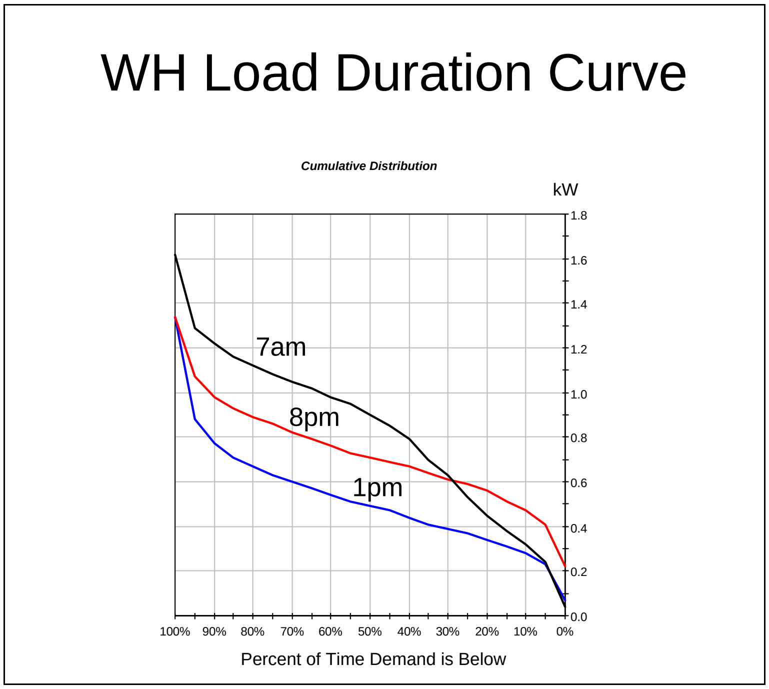

Figure 21 WH Load Duration Curve

Variables of Interest. Average weekday loads for the period 1pm through 8pm could be used for developing the appropriate sample size for a PJM zonal water heating study. Under this construct, no events would need to be called to estimate the 100% cycling impacts associated with a planned control. If, however, ancillary variables like payback were of interest then actual events would need to be observed in order to estimate the amount of payback.

Estimated Savings. Table 57 presents a summary of the estimated kW impact per switch for the three service territories. Savings estimates for 1998, 2001 and 2002 are presented for BGE. As evidenced by the table, these estimates appear very stable.

Table 57 Water Heating Estimated Savings

Hour Ending	PEPCO	BGE 1998	BGE 2001	BGE 2002	Conectiv
1pm	0.26	0.27	0.26	0.25	0.35
2pm	0.23	0.28	0.23	0.20	0.33
3pm	0.20	0.26	0.22	0.20	0.31
4pm	0.21	0.25	0.20	0.19	0.34
5pm	0.23	0.26	0.23	0.24	0.39
6pm	0.32	0.30	0.31	0.29	0.43
7pm	0.35	0.36	0.35	0.30	0.42
8pm	0.31	0.41	0.37	0.34	0.40
Average	0.27	0.30	0.27	0.25	0.37

M&V Recommendation. The project team believes that a PJM zonal study could be planned and conducted across the various jurisdictions with water heating programs. The analysis could include a pooled analysis that reflects the unique characteristics of the individual participant populations.   Here again, the project team does not believe the estimates will change dramatically with new data and a historical reanalysis of the existing data should be sufficient to develop “deemed” savings estimates.

Appendix J: Water Heating Cycling Program Estimates

Appendix J contains the detail tables for weekdays and weekends for the 15 minute time period ending at each hour between the hours of 7am and 9pm.

Table 58 Weekday WH Savings by WTHI Temperature Bin (100% Cycling)

WTHI	7am	8am	9am	10am	11am	Noon	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm
22	0.82	0.96	0.74	0.58	0.54	0.50	0.46	0.43	0.42	0.40	0.46	0.58	0.70	0.70	0.56
23	0.81	0.96	0.73	0.57	0.53	0.50	0.46	0.43	0.41	0.40	0.45	0.57	0.70	0.69	0.56
24	0.81	0.95	0.72	0.57	0.53	0.49	0.46	0.43	0.41	0.40	0.45	0.57	0.69	0.69	0.56
25	0.80	0.94	0.72	0.57	0.53	0.49	0.45	0.42	0.41	0.39	0.45	0.56	0.68	0.68	0.56
26	0.80	0.93	0.71	0.56	0.52	0.48	0.45	0.42	0.40	0.39	0.44	0.56	0.68	0.67	0.55
27	0.79	0.92	0.70	0.56	0.52	0.48	0.45	0.42	0.40	0.39	0.44	0.55	0.67	0.67	0.55
28	0.79	0.92	0.70	0.55	0.51	0.48	0.44	0.41	0.40	0.38	0.44	0.55	0.67	0.66	0.55
29	0.78	0.91	0.69	0.55	0.51	0.47	0.44	0.41	0.39	0.38	0.43	0.55	0.66	0.66	0.55
30	0.78	0.90	0.68	0.54	0.51	0.47	0.44	0.41	0.39	0.38	0.43	0.54	0.65	0.65	0.54
31	0.77	0.89	0.68	0.54	0.50	0.46	0.43	0.40	0.39	0.37	0.43	0.54	0.65	0.65	0.54
32	0.77	0.89	0.67	0.54	0.50	0.46	0.43	0.40	0.38	0.37	0.42	0.53	0.64	0.64	0.54
33	0.76	0.88	0.66	0.53	0.49	0.46	0.43	0.40	0.38	0.37	0.42	0.53	0.64	0.64	0.54
34	0.75	0.87	0.66	0.53	0.49	0.45	0.42	0.39	0.38	0.37	0.42	0.52	0.63	0.63	0.53
35	0.75	0.86	0.65	0.52	0.49	0.45	0.42	0.39	0.37	0.36	0.41	0.52	0.62	0.63	0.53
36	0.74	0.85	0.65	0.52	0.48	0.44	0.41	0.39	0.37	0.36	0.41	0.51	0.62	0.62	0.53
37	0.74	0.85	0.64	0.51	0.48	0.44	0.41	0.38	0.36	0.36	0.41	0.51	0.61	0.61	0.53
38	0.73	0.84	0.63	0.51	0.47	0.44	0.41	0.38	0.36	0.35	0.40	0.50	0.61	0.61	0.52
39	0.73	0.83	0.63	0.51	0.47	0.43	0.40	0.38	0.36	0.35	0.40	0.50	0.60	0.60	0.52
40	0.72	0.82	0.62	0.50	0.47	0.43	0.40	0.37	0.35	0.35	0.40	0.50	0.59	0.60	0.52
41	0.72	0.81	0.61	0.50	0.46	0.42	0.40	0.37	0.35	0.35	0.39	0.49	0.59	0.59	0.52
42	0.71	0.81	0.61	0.49	0.46	0.42	0.39	0.37	0.35	0.34	0.39	0.49	0.58	0.59	0.51
43	0.71	0.80	0.60	0.49	0.45	0.42	0.39	0.36	0.34	0.34	0.39	0.48	0.58	0.58	0.51
44	0.70	0.79	0.59	0.49	0.45	0.41	0.39	0.36	0.34	0.34	0.38	0.48	0.57	0.58	0.51
45	0.70	0.78	0.59	0.48	0.45	0.41	0.38	0.36	0.34	0.33	0.38	0.47	0.56	0.57	0.51
46	0.69	0.77	0.58	0.48	0.44	0.40	0.38	0.36	0.33	0.33	0.38	0.47	0.56	0.57	0.50
47	0.68	0.77	0.57	0.47	0.44	0.40	0.38	0.35	0.33	0.33	0.37	0.46	0.55	0.56	0.50
48	0.68	0.76	0.57	0.47	0.44	0.40	0.37	0.35	0.33	0.33	0.37	0.46	0.55	0.55	0.50
49	0.67	0.75	0.56	0.46	0.43	0.39	0.37	0.35	0.32	0.32	0.37	0.46	0.54	0.55	0.50
50	0.67	0.74	0.55	0.46	0.43	0.39	0.37	0.34	0.32	0.32	0.36	0.45	0.53	0.54	0.49
51	0.66	0.73	0.55	0.46	0.42	0.38	0.36	0.34	0.32	0.32	0.36	0.45	0.53	0.54	0.49
52	0.66	0.73	0.54	0.45	0.42	0.38	0.36	0.34	0.31	0.31	0.36	0.44	0.52	0.53	0.49
53	0.65	0.72	0.54	0.45	0.42	0.38	0.35	0.33	0.31	0.31	0.35	0.44	0.52	0.53	0.49
54	0.65	0.71	0.53	0.44	0.41	0.37	0.35	0.33	0.31	0.31	0.35	0.43	0.51	0.52	0.48
55	0.64	0.70	0.52	0.44	0.41	0.37	0.35	0.33	0.30	0.31	0.35	0.43	0.50	0.52	0.48
56	0.64	0.70	0.52	0.43	0.40	0.36	0.34	0.32	0.30	0.30	0.34	0.42	0.50	0.51	0.48
57	0.63	0.69	0.51	0.43	0.40	0.36	0.34	0.32	0.30	0.30	0.34	0.42	0.49	0.51	0.48
58	0.63	0.68	0.50	0.43	0.40	0.36	0.34	0.32	0.29	0.30	0.34	0.41	0.48	0.50	0.47
59	0.62	0.67	0.50	0.42	0.39	0.35	0.33	0.31	0.29	0.29	0.33	0.41	0.48	0.49	0.47
60	0.61	0.66	0.49	0.42	0.39	0.35	0.33	0.31	0.29	0.29	0.33	0.41	0.47	0.49	0.47
61	0.61	0.66	0.48	0.41	0.38	0.34	0.33	0.31	0.28	0.29	0.33	0.40	0.47	0.48	0.47
62	0.60	0.65	0.48	0.41	0.38	0.34	0.32	0.30	0.28	0.28	0.32	0.40	0.46	0.48	0.46
63	0.60	0.64	0.47	0.40	0.38	0.34	0.32	0.30	0.28	0.28	0.32	0.39	0.45	0.47	0.46
64	0.59	0.63	0.46	0.40	0.37	0.33	0.32	0.30	0.27	0.28	0.32	0.39	0.45	0.47	0.46
65	0.59	0.62	0.46	0.40	0.37	0.33	0.31	0.29	0.27	0.28	0.31	0.38	0.44	0.46	0.46
66	0.58	0.62	0.45	0.39	0.36	0.32	0.31	0.29	0.27	0.27	0.31	0.38	0.44	0.46	0.45
67	0.58	0.61	0.45	0.39	0.36	0.32	0.31	0.29	0.26	0.27	0.31	0.37	0.43	0.45	0.45
68	0.57	0.60	0.44	0.38	0.36	0.32	0.30	0.28	0.26	0.27	0.30	0.37	0.42	0.44	0.45
69	0.57	0.59	0.43	0.38	0.35	0.31	0.30	0.28	0.25	0.26	0.30	0.37	0.42	0.44	0.45
70	0.56	0.58	0.43	0.37	0.35	0.31	0.29	0.28	0.25	0.26	0.30	0.36	0.41	0.43	0.44
71	0.56	0.58	0.42	0.37	0.35	0.30	0.29	0.27	0.25	0.26	0.29	0.36	0.41	0.43	0.44
72	0.55	0.57	0.41	0.37	0.34	0.30	0.29	0.27	0.24	0.26	0.29	0.35	0.40	0.42	0.44
73	0.54	0.56	0.41	0.36	0.34	0.30	0.28	0.27	0.24	0.25	0.29	0.35	0.39	0.42	0.43
74	0.54	0.55	0.40	0.36	0.33	0.29	0.28	0.26	0.24	0.25	0.28	0.34	0.39	0.41	0.43
75	0.53	0.54	0.39	0.35	0.33	0.29	0.28	0.26	0.23	0.25	0.28	0.34	0.38	0.41	0.43
76	0.53	0.54	0.39	0.35	0.33	0.28	0.27	0.26	0.23	0.24	0.28	0.33	0.38	0.40	0.43
77	0.52	0.53	0.38	0.34	0.32	0.28	0.27	0.25	0.23	0.24	0.27	0.33	0.37	0.40	0.42
78	0.52	0.52	0.37	0.34	0.32	0.28	0.27	0.25	0.22	0.24	0.27	0.33	0.36	0.39	0.42
79	0.51	0.51	0.37	0.34	0.31	0.27	0.26	0.25	0.22	0.24	0.27	0.32	0.36	0.38	0.42
80	0.51	0.51	0.36	0.33	0.31	0.27	0.26	0.24	0.22	0.23	0.26	0.32	0.35	0.38	0.42
81	0.50	0.50	0.36	0.33	0.31	0.26	0.26	0.24	0.21	0.23	0.26	0.31	0.35	0.37	0.41
82	0.50	0.49	0.35	0.32	0.30	0.26	0.25	0.24	0.21	0.23	0.26	0.31	0.34	0.37	0.41
83	0.49	0.48	0.34	0.32	0.30	0.26	0.25	0.23	0.21	0.22	0.25	0.30	0.33	0.36	0.41
84	0.49	0.47	0.34	0.31	0.29	0.25	0.25	0.23	0.20	0.22	0.25	0.30	0.33	0.36	0.41
85	0.48	0.47	0.33	0.31	0.29	0.25	0.24	0.23	0.20	0.22	0.25	0.29	0.32	0.35	0.40
86	0.47	0.46	0.32	0.31	0.29	0.24	0.24	0.22	0.20	0.22	0.24	0.29	0.32	0.35	0.40
87	0.47	0.45	0.32	0.30	0.28	0.24	0.23	0.22	0.19	0.21	0.24	0.28	0.31	0.34	0.40

Table 59 Weekend WH Savings by WTHI Temperature Bin (100% Cycling)

WTHI	7am	8am	9am	10am	11am	Noon	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm
22	0.39	0.58	0.75	0.91	0.87	0.77	0.70	0.63	0.62	0.60	0.62	0.63	0.72	0.68	0.57
23	0.38	0.58	0.75	0.90	0.86	0.76	0.70	0.63	0.61	0.59	0.61	0.63	0.72	0.67	0.56
24	0.38	0.57	0.74	0.90	0.85	0.76	0.69	0.62	0.61	0.59	0.61	0.62	0.71	0.67	0.56
25	0.38	0.57	0.74	0.89	0.84	0.75	0.69	0.62	0.60	0.58	0.60	0.62	0.70	0.66	0.56
26	0.38	0.57	0.73	0.88	0.84	0.75	0.68	0.61	0.60	0.58	0.60	0.61	0.70	0.66	0.56
27	0.37	0.57	0.73	0.87	0.83	0.74	0.68	0.61	0.60	0.57	0.59	0.61	0.69	0.65	0.55
28	0.37	0.56	0.72	0.86	0.82	0.73	0.67	0.60	0.59	0.57	0.59	0.60	0.68	0.65	0.55
29	0.37	0.56	0.72	0.86	0.82	0.73	0.67	0.60	0.59	0.56	0.58	0.60	0.68	0.64	0.55
30	0.37	0.56	0.71	0.85	0.81	0.72	0.66	0.59	0.58	0.56	0.58	0.59	0.67	0.64	0.54
31	0.37	0.55	0.71	0.84	0.80	0.72	0.66	0.59	0.58	0.55	0.57	0.59	0.66	0.63	0.54
32	0.36	0.55	0.70	0.83	0.79	0.71	0.65	0.59	0.57	0.55	0.57	0.58	0.66	0.63	0.54
33	0.36	0.55	0.70	0.82	0.79	0.70	0.64	0.58	0.57	0.54	0.57	0.58	0.65	0.62	0.54
34	0.36	0.55	0.69	0.82	0.78	0.70	0.64	0.58	0.56	0.54	0.56	0.57	0.64	0.62	0.53
35	0.36	0.54	0.69	0.81	0.77	0.69	0.63	0.57	0.56	0.53	0.56	0.57	0.64	0.61	0.53
36	0.36	0.54	0.68	0.80	0.77	0.69	0.63	0.57	0.55	0.53	0.55	0.56	0.63	0.61	0.53
37	0.35	0.54	0.68	0.79	0.76	0.68	0.62	0.56	0.55	0.52	0.55	0.56	0.62	0.60	0.52
38	0.35	0.54	0.67	0.78	0.75	0.67	0.62	0.56	0.54	0.52	0.54	0.55	0.62	0.60	0.52
39	0.35	0.53	0.67	0.78	0.74	0.67	0.61	0.55	0.54	0.51	0.54	0.55	0.61	0.59	0.52
40	0.35	0.53	0.66	0.77	0.74	0.66	0.61	0.55	0.53	0.51	0.53	0.54	0.60	0.59	0.51
41	0.35	0.53	0.66	0.76	0.73	0.66	0.60	0.54	0.53	0.51	0.53	0.54	0.60	0.58	0.51
42	0.34	0.52	0.65	0.75	0.72	0.65	0.60	0.54	0.52	0.50	0.52	0.53	0.59	0.58	0.51
43	0.34	0.52	0.65	0.75	0.71	0.64	0.59	0.54	0.52	0.50	0.52	0.53	0.58	0.57	0.51
44	0.34	0.52	0.64	0.74	0.71	0.64	0.59	0.53	0.51	0.49	0.51	0.52	0.58	0.57	0.50
45	0.34	0.52	0.64	0.73	0.70	0.63	0.58	0.53	0.51	0.49	0.51	0.52	0.57	0.56	0.50
46	0.33	0.51	0.63	0.72	0.69	0.63	0.58	0.52	0.50	0.48	0.50	0.51	0.56	0.56	0.50
47	0.33	0.51	0.63	0.71	0.69	0.62	0.57	0.52	0.50	0.48	0.50	0.51	0.56	0.55	0.49
48	0.33	0.51	0.62	0.71	0.68	0.61	0.57	0.51	0.49	0.47	0.49	0.50	0.55	0.55	0.49
49	0.33	0.51	0.62	0.70	0.67	0.61	0.56	0.51	0.49	0.47	0.49	0.50	0.54	0.54	0.49
50	0.33	0.50	0.61	0.69	0.66	0.60	0.56	0.50	0.48	0.46	0.48	0.49	0.54	0.54	0.49
51	0.32	0.50	0.61	0.68	0.66	0.60	0.55	0.50	0.48	0.46	0.48	0.49	0.53	0.53	0.48
52	0.32	0.50	0.60	0.67	0.65	0.59	0.55	0.49	0.47	0.45	0.47	0.48	0.52	0.52	0.48
53	0.32	0.50	0.60	0.67	0.64	0.58	0.54	0.49	0.47	0.45	0.47	0.47	0.52	0.52	0.48
54	0.32	0.49	0.59	0.66	0.64	0.58	0.54	0.48	0.46	0.44	0.46	0.47	0.51	0.51	0.47
55	0.32	0.49	0.59	0.65	0.63	0.57	0.53	0.48	0.46	0.44	0.46	0.46	0.50	0.51	0.47
56	0.31	0.49	0.58	0.64	0.62	0.57	0.52	0.48	0.45	0.43	0.45	0.46	0.50	0.50	0.47
57	0.31	0.48	0.58	0.63	0.61	0.56	0.52	0.47	0.45	0.43	0.45	0.45	0.49	0.50	0.46
58	0.31	0.48	0.57	0.63	0.61	0.55	0.51	0.47	0.44	0.42	0.44	0.45	0.48	0.49	0.46
59	0.31	0.48	0.57	0.62	0.60	0.55	0.51	0.46	0.44	0.42	0.44	0.44	0.48	0.49	0.46
60	0.31	0.48	0.56	0.61	0.59	0.54	0.50	0.46	0.43	0.41	0.43	0.44	0.47	0.48	0.46
61	0.30	0.47	0.56	0.60	0.58	0.54	0.50	0.45	0.43	0.41	0.43	0.43	0.46	0.48	0.45
62	0.30	0.47	0.55	0.60	0.58	0.53	0.49	0.45	0.42	0.41	0.42	0.43	0.46	0.47	0.45
63	0.30	0.47	0.55	0.59	0.57	0.52	0.49	0.44	0.42	0.40	0.42	0.42	0.45	0.47	0.45
64	0.30	0.47	0.54	0.58	0.56	0.52	0.48	0.44	0.41	0.40	0.41	0.42	0.44	0.46	0.44
65	0.29	0.46	0.54	0.57	0.56	0.51	0.48	0.43	0.41	0.39	0.41	0.41	0.44	0.46	0.44
66	0.29	0.46	0.53	0.56	0.55	0.50	0.47	0.43	0.40	0.39	0.40	0.41	0.43	0.45	0.44
67	0.29	0.46	0.53	0.56	0.54	0.50	0.47	0.42	0.40	0.38	0.40	0.40	0.42	0.45	0.43
68	0.29	0.45	0.52	0.55	0.53	0.49	0.46	0.42	0.39	0.38	0.39	0.40	0.42	0.44	0.43
69	0.29	0.45	0.52	0.54	0.53	0.49	0.46	0.42	0.39	0.37	0.39	0.39	0.41	0.44	0.43
70	0.28	0.45	0.51	0.53	0.52	0.48	0.45	0.41	0.38	0.37	0.38	0.39	0.40	0.43	0.43
71	0.28	0.45	0.51	0.52	0.51	0.47	0.45	0.41	0.38	0.36	0.38	0.38	0.40	0.43	0.42
72	0.28	0.44	0.50	0.52	0.51	0.47	0.44	0.40	0.37	0.36	0.37	0.38	0.39	0.42	0.42
73	0.28	0.44	0.50	0.51	0.50	0.46	0.44	0.40	0.37	0.35	0.37	0.37	0.38	0.42	0.42
74	0.28	0.44	0.49	0.50	0.49	0.46	0.43	0.39	0.36	0.35	0.36	0.37	0.38	0.41	0.41
75	0.27	0.44	0.49	0.49	0.48	0.45	0.43	0.39	0.36	0.34	0.36	0.36	0.37	0.41	0.41
76	0.27	0.43	0.48	0.48	0.48	0.44	0.42	0.38	0.35	0.34	0.35	0.36	0.36	0.40	0.41
77	0.27	0.43	0.48	0.48	0.47	0.44	0.42	0.38	0.35	0.33	0.35	0.35	0.36	0.40	0.41
78	0.27	0.43	0.47	0.47	0.46	0.43	0.41	0.37	0.34	0.33	0.34	0.35	0.35	0.39	0.40
79	0.27	0.42	0.47	0.46	0.46	0.43	0.40	0.37	0.34	0.32	0.34	0.34	0.34	0.39	0.40
80	0.26	0.42	0.46	0.45	0.45	0.42	0.40	0.36	0.33	0.32	0.33	0.34	0.34	0.38	0.40
81	0.26	0.42	0.46	0.45	0.44	0.41	0.39	0.36	0.33	0.31	0.33	0.33	0.33	0.38	0.39
82	0.26	0.42	0.45	0.44	0.43	0.41	0.39	0.36	0.32	0.31	0.32	0.33	0.32	0.37	0.39
83	0.26	0.41	0.45	0.43	0.43	0.40	0.38	0.35	0.32	0.31	0.32	0.32	0.32	0.37	0.39
84	0.25	0.41	0.44	0.42	0.42	0.40	0.38	0.35	0.31	0.30	0.32	0.32	0.31	0.36	0.38
85	0.25	0.41	0.44	0.41	0.41	0.39	0.37	0.34	0.31	0.30	0.31	0.31	0.30	0.35	0.38
86	0.25	0.41	0.43	0.41	0.40	0.38	0.37	0.34	0.30	0.29	0.31	0.30	0.30	0.35	0.38
87	0.25	0.40	0.43	0.40	0.40	0.38	0.36	0.33	0.30	0.29	0.30	0.30	0.29	0.34	0.38