RLW ANALYTICS

AmerenUE
Residential TOU Pilot Study
Load Research Analysis – 2005 Program Results

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AmerenUE
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Residential Time-Of-Use (RTOU) Pilot Study
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1 EXECUTIVE SUMMARY

AmerenUE in conjunction with the Missouri Collaborative launched a Residential Time-Of-Use (RTOU) Pilot study in the Spring of 2004. This report documents the results for the second summer, i.e., June through August 2005, of the Pilot study.

1.1 Overview

The RTOU Pilot study encompassed two innovative rate offerings that provide financial incentives for customers to modify their consumption patterns during higher priced "critical peak periods" (i.e., CPP). Originally, the rate offerings were organized into three treatment groups for the Pilot study and included:

Treatment Group #1 - These customers received a three-tier time-of-use rate[1] with high differentials;

Treatment Group #2 - These customers received the same time-of-use rate as the first treatment group but were also subject to a critical peak pricing (CPP) element; and

Treatment Group #3 - These customers received the same treatment, i.e., TOU rate and CPP, as treatment group number two but had enabling technology, i.e., a "smart" thermostat, installed by AmerenUE. The enabling technology automatically increased the customer's thermostat setting during critical peak pricing events.

For 2005, the first treatment group, i.e., the time-of-use rate only, was dropped from the Pilot Study. The principal reason for dropping the time-of-use only group was that this group failed to display a significant shift in load from the on-peak to the mid-peak or off-peak periods. Therefore, the second year pilot focused on the critical peak pricing element and those customers with "smart" thermostats. Fifteen-minute interval load monitoring equipment was available on the total premise load for a statistically representative sample of customers in each treatment group. In addition to the treatment groups, the Company constructed control groups for use in the analysis. Once again, fifteen-minute interval load monitoring equipment was available on a statistically representative sample of control group customers. Data collection began in the late Spring and continued until mid September.

1.2 Analysis Summary

Table Ex 1 presents a listing of several of the key analysis variables included in the study. These include the average CPP demand, the July 21^{tst} demand, the on-peak, mid-peak, off-peak and CPP use during the defined time of use periods and the average summer[2] use. The table presents the information for each treatment group (i.e., rate options) for customers in the control group and the

[1] The TOU rates differ by season (i.e., summer versus winter).
[2] Due to bill cycle issues, the summer 2005 season was defined as June 28, 2005 through August 31, 2005.

voluntary study group (i.e., test group). The table includes the average as well as the achieved relative precision estimated for the sample.

Study Group	Rate Options	Maximum Sample Size	Estimated Average (kW or kWh) and Estimated Relative Precision (%): Average CPP Demand (kW)	July 21st Demand (kW)	Time-Of-Use On-Peak Period #1 (kWh)	Time-Of-Use Mid-Peak Period #2 (kWh)	Time-Of-Use Off-Peak Period #3 (kWh)	CPP Event Use Period #4 (kWh)	Average Summer Use (kWh)
Control Group	**Standard Residential Rate**	277	5.56	5.71	927	2,054	4,495	252	7,729
			±3.0%	±3.4%	±2.9%	±2.9%	±3.2%	±3.0%	±3.0%
Voluntary Study Groups	**Standard Residential Rate**	211	5.34	5.45	884	1,934	4,147	240	7,205
			±3.6%	±3.9%	±3.6%	±3.6%	±3.4%	±3.6%	±3.3%
	3-Tier TOU w/ CPP	141	4.84	4.89	896	2,019	4,450	219	7,584
			±6.8%	±5.6%	±5.0%	±4.5%	±5.0%	±5.5%	±4.7%
	3-Tier TOU w/ CPP and Smart Thermostat	104	4.04	4.09	863	1,901	4,017	182	6,963
			±8.6%	±9.6%	±6.3%	±6.1%	±5.4%	±8.7%	±5.5%

Table Ex 1 – Key Summary Statistics

Table Ex 2 presents the T-Test comparisons for the control and voluntary study group (i.e., RTOU Group). The table presents the seasonal average use by time of use period, the absolute difference, the T-value[3] or test result, the probability of getting a higher T-value, and the result of the test. The null hypothesis is that the two test statistics are equal. For both study groups, only the energy consumed during the critical peak pricing event displayed a statistical difference.

Three Tier TOU with CPP (CPP)						
Jun 1 - Aug 31 TOU Period	Control Group (kWh)	RTOU Group (kWh)	Difference Control-RTOU (kWh)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	7,729	7,584	145.00	0.58	0.56	Cannot Reject
Off-Peak Use	4,495	4,450	45.00	0.28	0.78	Cannot Reject
Mid-Peak Use	2,054	2,019	35.00	0.54	0.59	Cannot Reject
On-Peak Use	927	896	31.00	0.96	0.34	Cannot Reject
CPP Use	252	219	33.10	3.92	0.00	Reject
Percent Off-Peak	58.2%	58.7%	-0.5%	1.02	0.31	Cannot Reject
Percent Mid-Peak	26.6%	26.6%	0.0%	0.15	0.88	Cannot Reject
Percent On-Peak	12.0%	11.8%	0.2%	(0.72)	0.47	Cannot Reject
Per CPP	3.3%	2.9%	0.4%	4.08	0.00	Reject
Three Tier TOU with CPP and Thermostat (CPP-THERM)						
Jun 1 - Aug 31 TOU Period	Control Group (kWh)	RTOU Group (kWh)	Difference Control-RTOU (kWh)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	7,205	6,963	242	0.98	0.33	Cannot Reject
Off-Peak Use	4,147	4,017	130	0.91	0.37	Cannot Reject
Mid-Peak Use	1,934	1,901	33	0.46	0.65	Cannot Reject
On-Peak Use	884	863	21	0.64	0.52	Cannot Reject
CPP Use	240	182	58	5.99	0.00	Reject
Percent Off-Peak	57.6%	57.7%	-0.1%	0.26	0.79	Cannot Reject
Percent Mid-Peak	26.8%	27.3%	-0.5%	1.36	0.18	Cannot Reject
Percent On-Peak	12.3%	12.4%	-0.1%	0.49	0.63	Cannot Reject
Per CPP	3.3%	2.6%	0.7%	(8.18)	0.00	Reject

Table Ex 2 – Seasonal Time-Of-Use Usage Comparisons

Table Ex 3 presents similar findings for the eight critical peak pricing periods. The table presents the average demand for the control and RTOU treatment groups, the absolute difference, the T-value or test statistic, the p-value (i.e., the probability of getting a larger T-value) and whether or not we can reject the null hypothesis that the corresponding demands were equal. In all instances we can conclude that the demands of the RTOU treatment group were statistically lower than

[3] High T-values lead us to reject the null hypothesis that the two statistics are equal.

those of the control group. An additional 0.52 kW on average was achieved by the group with the enabling technology.

Three Tier TOU with CPP (CPP)									
CPP Event			Control	RTOU Pilot	Difference	Percent			
	Hour Ending		Group	Group	Control-RTOU	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5.35	4.85	0.50	9.3%	2.63	0.0088	Reject
21-Jul-05	3:00 PM	6:59 PM	5.71	4.91	0.80	14.1%	3.75	0.0002	Reject
22-Jul-05	3:00 PM	6:59 PM	5.84	5.05	0.79	13.5%	3.54	0.0005	Reject
26-Jul-05	3:00 PM	6:59 PM	5.98	4.91	1.06	17.8%	5.28	0.0000	Reject
2-Aug-05	3:00 PM	6:59 PM	5.38	4.73	0.65	12.1%	3.24	0.0013	Reject
9-Aug-05	3:00 PM	6:59 PM	5.64	4.74	0.90	16.0%	4.33	0.0000	Reject
10-Aug-05	3:00 PM	6:59 PM	5.01	4.24	0.76	15.2%	4.00	0.0000	Reject
19-Aug-05	3:00 PM	6:59 PM	5.61	4.88	0.74	13.1%	3.54	0.0004	Reject
Average			5.56	4.84	0.72	13.0%	3.90	0.0001	Reject

Three Tier TOU with CPP and Thermostat (CPP-THERM)									
CPP Event			Control	RTOU	Difference	Percent			
	Hour Ending		Group	Group	Control-RTOU	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5.02	4.30	0.72	14.4%	2.93	0.0036	Reject
21-Jul-05	3:00 PM	6:59 PM	5.37	4.09	1.27	23.7%	5.22	0.0001	Reject
22-Jul-05	3:00 PM	6:59 PM	5.38	4.18	1.20	22.4%	5.39	0.0001	Reject
26-Jul-05	3:00 PM	6:59 PM	5.56	4.38	1.18	21.2%	4.93	0.0001	Reject
2-Aug-05	3:00 PM	6:59 PM	5.23	3.66	1.57	30.0%	6.30	0.0001	Reject
9-Aug-05	3:00 PM	6:59 PM	5.47	4.01	1.46	26.7%	5.76	0.0001	Reject
10-Aug-05	3:00 PM	6:59 PM	4.95	3.82	1.13	22.8%	4.95	0.0001	Reject
19-Aug-05	3:00 PM	6:59 PM	5.38	3.97	1.41	26.1%	5.49	0.0001	Reject
Average			5.29	4.05	1.24	23.5%	6.05	0.0001	Reject

Table Ex 3 – CPP Event Day Comparisons

Table Ex 4 presents the T-test comparisons for the system peak hours in June, July and August. There were no critical peak pricing events called on these days. Interestingly, the demand on Monday, July 25 was lower for the RTOU CPP group when compared to the control group. For all other system peak events, the average hourly demand at the time of the system peak were not statistically different.

Three Tier TOU with CPP (CPP)								
System Peak		Control	RTOU Pilot	Difference	Percent			
		Group	Group	Control-RTOU	Difference			
Date	Time	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
29-Jun-2005	5pm	5.60	5.39	0.21	3.8%	1.13	0.258	Cannot Reject
25-Jul-2005	4pm	6.06	5.23	0.83	13.7%	3.60	0.000	Reject
3-Aug-2005	5pm	5.57	5.29	0.28	5.0%	1.33	0.183	Cannot Reject

Three Tier TOU with CPP and Thermostat (CPP-THERM)								
System Peak		Control	RTOU Pilot	Difference	Percent			
		Group	Group	Control-RTOU	Difference			
Date	Time	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
29-Jun-2005	5pm	5.32	5.27	0.05	0.9%	0.19	0.848	Cannot Reject
25-Jul-2005	4pm	5.52	5.26	0.26	4.7%	1.01	0.314	Cannot Reject
3-Aug-2005	5pm	5.32	5.04	0.28	5.3%	1.21	0.226	Cannot Reject

Table Ex 4 – System Peak Comparisons

Payback was defined as the three-hour period immediately following the CPP event. Table Ex 5 presents a summary of the payback periods immediately following each of the eight CPP events. In all cases the payback load associated with the RTOU CPP treatment group was not statistically different from their control group counterpart. In contrast, for the RTOU CPP-Therm treatment group all but two paybacks were found to be statistically significant.

Three-Tier TOU Rate with CPP (CPP)									
CPP Event			Control	RTOU	Difference	Percent			
	Payback Period		Group	Group	RTOU-Control	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	7pm	10pm	4.77	4.74	(0.02)	-0.5%	0.12	0.902	Cannot Reject
21-Jul-05	7pm	10pm	5.56	5.39	(0.18)	-3.2%	0.83	0.408	Cannot Reject
22-Jul-05	7pm	10pm	5.42	5.24	(0.18)	-3.3%	0.85	0.395	Cannot Reject
26-Jul-05	7pm	10pm	5.03	5.01	(0.02)	-0.4%	0.09	0.928	Cannot Reject
2-Aug-05	7pm	10pm	5.02	5.09	0.07	1.3%	(0.35)	0.723	Cannot Reject
9-Aug-05	7pm	10pm	5.14	5.27	0.13	2.5%	(0.65)	0.513	Cannot Reject
10-Aug-05	7pm	10pm	4.63	4.56	(0.07)	-1.6%	0.34	0.735	Cannot Reject
19-Aug-05	7pm	10pm	5.35	5.11	(0.24)	-4.5%	1.08	0.279	Cannot Reject
Average			5.12	5.05	(0.06)	-1.3%	0.34	0.731	Cannot Reject

Three-Tier TOU Rate with CPP and Thermostat (CPP-THERM)									
CPP Event			Control	RTOU	Difference	Percent			
	Payback Period		Group	Group	RTOU-Control	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	7pm	10pm	4.28	5.13	0.85	19.9%	(4.21)	0.000	Reject
21-Jul-05	7pm	10pm	5.21	5.75	0.54	10.4%	(2.55)	0.011	Reject
22-Jul-05	7pm	10pm	5.07	5.73	0.66	13.1%	(2.74)	0.007	Reject
26-Jul-05	7pm	10pm	4.71	5.59	0.88	18.6%	(4.56)	0.000	Reject
2-Aug-05	7pm	10pm	4.89	5.48	0.59	12.1%	(2.79)	0.006	Reject
9-Aug-05	7pm	10pm	5.35	5.39	0.04	0.8%	(0.19)	0.847	Cannot Reject
10-Aug-05	7pm	10pm	4.77	4.89	0.12	2.6%	(0.59)	0.556	Cannot Reject
19-Aug-05	7pm	10pm	4.79	5.63	0.84	17.6%	(3.65)	0.000	Reject
Average			4.88	5.45	0.57	11.6%	(3.05)	0.003	Reject

Table Ex 5 – Payback Comparisons

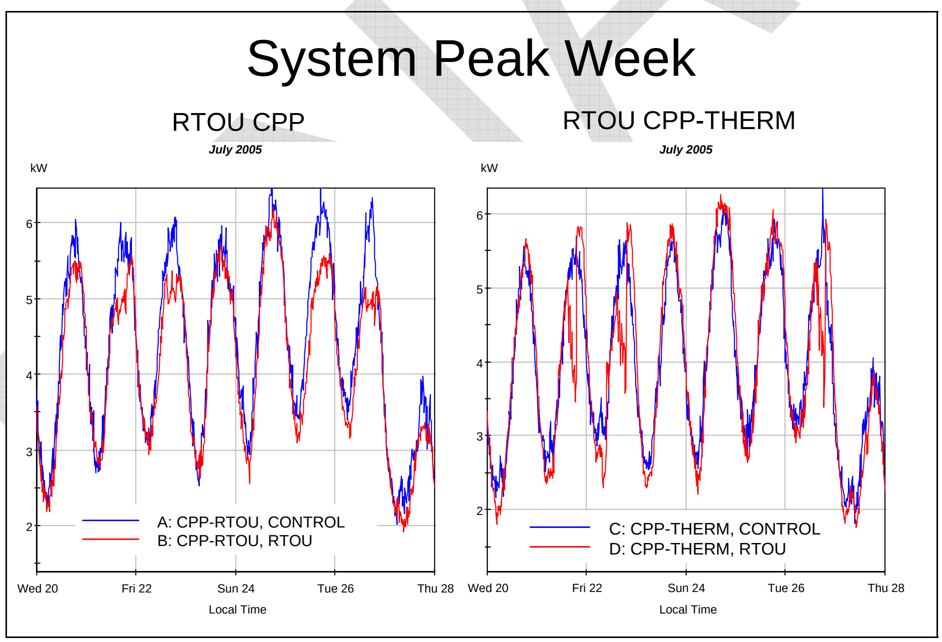

Figure Ex 1 – Summer Peak Week

Figure Ex 1 presents the average 15-minute load shape for each of the treatment groups compared to the single composite control group[4] for the week encompassing the system peak day, i.e., Monday, July 25, 2005. This highlights one of the challenges associated with trying to capture the load reduction on the system peak day. The program had called two events the week leading up to the peak and an event on the Tuesday immediately following the event but missed the system peak. The load associated with each of the treatment groups shows significant load

[4] The composite control group is used for demonstration purposes. In the actual analysis the control group constructed for each treatment group was used in the analysis.

reductions during the event calls. The treatment group receiving the enabling technology displays a substantially different load shape when compared to the CPP only group. The treatment group shows a sharp decrease in load during the event. Interestingly, the RTOU CPP only group shows lower load on the system peak day of Monday, July 25, 2005. Load profiles for all CPP event days that compare the RTOU treatment group load with the individual control group load are included in Appendix A.

To further explore the effects of the time-of-use rate, we examined the average demand during days when the temperature on at least three of the on-peak hours exceeded 90°F. A total of nine days met this criterion. For both groups we could not reject the hypothesis that the two average demands calculated across the on-peak hours were equal.

Three Tier TOU with CPP (CPP)						
Control Group (kW)	RTOU Pilot Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
5.37	5.09	0.28	5.2%	1.61	0.107	Cannot Reject
Three Tier TOU with CPP and Thermostat (CPP-THERM)						
Control Group (kW)	RTOU Pilot Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
5.07	4.99	0.08	1.6%	0.42	0.680	Cannot Reject

Table Ex 6 – Average Demand on Non Event Days over 90°F

1.3 General Conclusions

The study results indicate the following:

- The critical peak pricing component of the time-of-use rate does motivate customers to reduce demand during the CPP event periods.
- The enabling technology was a key component of the offering with the groups receiving the "smart" thermostat displaying much stronger load response (more than double) during CPP events when compared to the CPP only group.
- The RTOU: CPP and the RTOU: CPP-Therm groups did not display a significant shift in load during the on-peak or mid-peak periods to the off-peak.
- The researchers believe that there was insufficient evidence to conclude that the second year CPP: TOU participants substantially improved their load reductions in the second year when compared to their first year of participation. However, the percentage of total use during the CPP period was statistically lower in 2005 when compared to 2004.
- The CPP: TOU-Therm participants displayed an average demand reduction during CPP events that was 0.53 kW greater in 2005 when compared to 2004 on a weather adjusted basis. There was a slight reduction in the percentage of on-peak use in 2005 when compared to 2004 but this difference was not statistically significant.
- Second year control group participants that were moved to the test groups in 2005 confirmed that CPP rate is effective in reducing demand. Both the new CPP: TOU and the CPP:TOU-Therm customers reduced a statistically significant amount of load during the CPP periods when they received the CPP rates. Both groups also had lower CPP period usage after receiving the CPP rates.

AmerenUE
Residential Time-Of-Use (RTOU) Pilot Study
Management Report

2 INTRODUCTION

This document provides a comprehensive review and analysis of the Residential Time-Of-Use (RTOU) Pilot Project conducted by AmerenUE in collaboration with the Missouri Collaborative. The Missouri Collaborative consists of the Office of Public Counsel (OPC), the Missouri Public Service Commission (MPSC), the Department of Natural Resources (DNR) and two industrial intervener groups. AMEREN, the OPC and the MPSC have been the most active parties with regard to the TOU Pilot Study. The data collection period covered in this report is for the 2005 Summer defined as June 28, 2005 through August 31, 2005[5].

2.1 Background

AMEREN is an energy services company providing electricity to 2.3 million customers and natural gas to 900,000 customers in Illinois and Missouri. A map of the AMEREN service territory is presented in Figure 1. The current project is applicable to the AmerenUE's Missouri retail electric service territory.

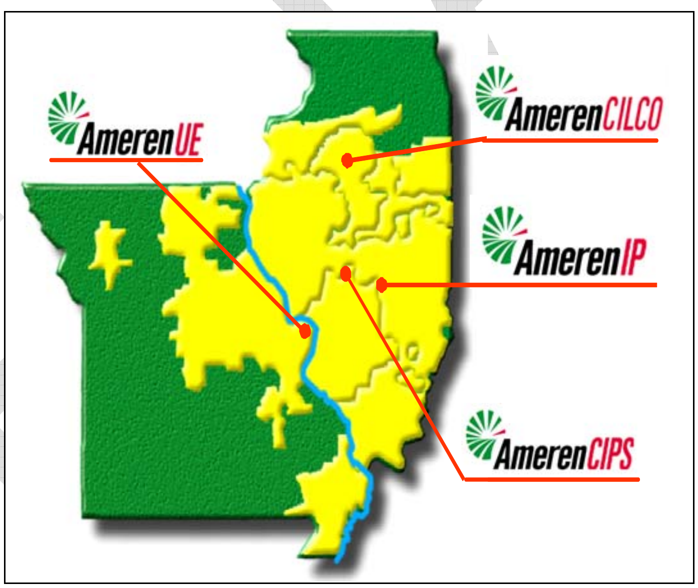

Figure 1 – AMEREN Power Service Territory

The TOU Pilot Study is the result of the July 30, 2002 Missouri Commission Report and Order Approving Stipulation and Agreement that resolved the Case No. EC-2002-1. Public Counsel filed testimony in May 2002 proposing a TOU pilot study in that case. In December of 2003, the Collaborative agreed to a pilot concept. Such agreement laid the foundation for the current project work.

[5] The treatment groups were removed from study during their September bill cycle. This resulted in no data being available after September 22, 2005. Due to bill cycle issues, we have elected to use the period June 28, 2005 through August 31, 2005 as the 2005 analysis period.

During the summer of 2004, AmerenUE implemented a pilot program to test residential time-of-use rates (RTOU), residential time-of-use rates with a critical peak pricing component (CPP), and residential time-of-use rates with a critical peak pricing component and enabling technology. The enabling technology was a programmable thermostat that could be modified during CPP events, e.g., rolled up 1°F each hour during the control.

The results of the 2004 pilot study are documented in "Load Research Analysis – First Look Results," *RLW Analytics*, February, 2005. The 2004 analysis indicated that there was very little to be gained by implementing just the residential time-of-use rate. In addition, the pilot provided results that suggested that the critical peak pricing event was effective in moving load away from the event period. Furthermore, the 2004 results suggested that significant changes were occurring with the introduction of the enabling technology.

At a February, 2005 meeting and subsequent conference call, the collaborative agreed to continue and extend the pilot through the summer 2005. Some changes were recommended and agreed to during these meetings and were documented in the 2005 Project Plan.

2.2 Purpose, Goals and Objectives

Project Purpose: Obtain information needed to determine if and how residential time-of-use rates will be beneficial in Missouri.

2.2.1 Report Goals and Analysis

The primary goals of the 2005 Residential TOU Pilot Study analysis are as follows:

- Confirm that the time-of-use with critical peak pricing (CPP) rate and CPP rate coupled with enabling technology caused a statistically significant change in customers' energy use during periods of potentially high prices;
- Confirm the magnitude of load reduction during on-peak and CPP periods and the amount of energy shift from on-peak to mid-peak or off-peak periods;
- Examine whether or not a second year of participation increases the customer's ability to shift load during CPP events or from the on-peak to mid-peak or off-peak periods;
- Confirm that CPP and/or CPP with enabling technology increases customer awareness and produces positive results in conservation, i.e., reductions in total consumption; and
- Examine the cost-effectiveness[6] of this type of programs.

3 PROJECT DESIGN

3.1 Experimental Design

In addition to the Test/Control experimental design employed in 2004, the 2005 Pilot Study includes a pre/post experimental design component.

[6] Cost effectiveness and cost benefit of the TOU pilot is outside the scope of the Load Research Analysis Plan.

The 2005 Pilot Study continued to follow customers in the 2004 "Test" groups under the RTOU-CPP treatment and the RTOU-CPP with Thermostats (RTOU-CPP-Therm) treatment. In addition to carrying over the existing test/control experimental design, the 2005 Pilot Study recruited "Control Group" customers from the 2004 Pilot Study into the "Test" groups for both RTOU-CPP and RTOU-CPP-Therm. This allows the examination of these customers within a pre/post experimental design[7].

3.1.1 Treatment Groups

For 2005, Four Treatment Groups were formed.

After much discussion, the Collaborative parties agreed to **drop** the residential time-of-use only treatment group. In addition, the parties agreed to construct the following four groups:

Test Group #1 - The customers in test group number one were a continuation of customers from the 2004 RTOU CPP group;

Test Group #2 - The customers in test group number two were a continuation of customers from the 2004 RTOU CPP-Therm group.

Test Group #3 - The customers in test group number three were recruited from the 2004 Pilot Study control group. In 2005, these customers were given the RTOU rate with the CPP element.

Test Group #4 - Finally, the customers in test group number four were recruited from the 2004 Pilot study control group. In 2005 these customers were subjected to the RTOU with CPP and received the enabling technology.

The four test groups were organized into the following two principal treatment groups that were compared to their respective control groups in the primary analysis:

Treatment Group #1 - RTOU customers with a critical peak pricing component; and

Treatment Group #2 - RTOU customers with a critical peak pricing component and the thermostat as the enabling technology.

In addition, supplemental analysis was conducted to examine the impacts associated with the pre/post experimental designs.

3.1.2 Control Groups

Control Groups will be formed for each of Treatment Group.

For 2005, we continue to employ the Test/Control experimental design. Therefore each *Test* group, (i.e., treatment group) is paired with a control group of similar size. In 2004 the parties agreed to select the control groups using daily energy usage, if available, matched to each "test" participant. If daily energy use is not available then summer seasonal use for the pre participation period was used to match the "test" and the "control" group participants. In 2005, some of the control group customers were continued from 2004 while others were recruited new.

[7] The pre/post experimental design is a result of pilot customers recruited into the new treatment groups (groups #3 and #4) come from the 2004 control group sample of 297 customers.

3.1.3 Target Populations

High Summer Use Residential Customers will be targeted.

Once again, only high summer use residential customers will be targeted. Winter use is defined as the billing months December through February and summer is defined as the billing months June through September. The specific definitions used to classify the residential customers are displayed in Table 1. Customers with more than 1500 kWh in the summer are classified as high summer use customers.

Strata	Description	Winter Use	Summer Use
1	Low Winter/Low Summer	0-1150 kWh	0-1500 kWh
2	High Winter/Low Summer	>1150 kWh	0-1500 kWh
3	Low Winter/High Summer	0-1150 kWh	>1500 kWh
4	High Winter/High Summer	>1150 kWh	>1500 kWh

Table 1 – Residential Domains

Table 2 presents updated population characteristics used in the 2005 analysis for the residential class broken down by low/high winter/summer use. Approximately 264,000 customers are classified as high summer use customers.

Stratum	Description	Count	Proportion
3	Low Winter/High Summer	113,110	42.9%
4	High Winter/High Summer	150,602	57.1%
	Totals	263,712	100.0%

Table 2 – AmerenUE Residential Population

3.1.4 Geographical Constraint

The Residential TOU Pilot Study will be geographically constrained to the City of St Louis and St. Louis County.

Here again, to help control the cost and to expedite the implementation of the 2005 Residential TOU Pilot Study, the project team elected to constrain the project to an area that encompasses the City of St. Louis and St. Louis County. Geographically constraining the project provides the following benefits:

- Minimizes the cost incurred implementing the enabling technology, i.e., the “smart” thermostats. The selected “smart” thermostat technology uses a one-way paging strategy to allow for remote programming of the thermostats. Therefore, AmerenUE needs licenses with paging companies to provide the communications backbone. Spreading the project throughout the state increases the number of providers needed.
- By limiting the study to St. Louis City and County, it reduces the training needed of Call Center personnel to implement the program.
- Reduces the cost of installing and subsequent follow-ups (if needed) on the “smart” thermostats.

- Thermostat installers will have less distance between installations by limiting the geographic area, thus expediting the installations.

Figure 2 presents the geographical target area of the City of St. Louis and St. Louis County.

Figure 2 – Geographic Target Area

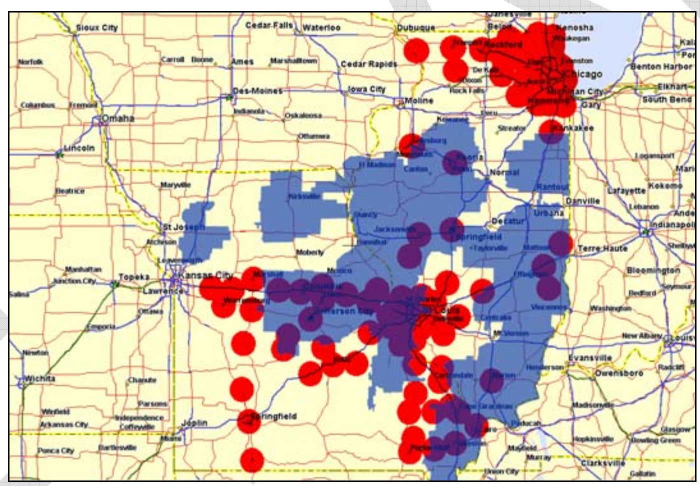

Figure 3 – Paging coverage

Figure 3 presents the paging coverage for the City of St. Louis and St. Louis County area. The paging system has excellent coverage in this area.

3.1.5 Project Duration

AmerenUE agreed to fund the Residential TOU Pilot Study through September 2005.

The agreement was to continue the pilot study through September 2005.

3.1.6 Sample Design

A stratified sample was used to select the "new" program participants.

Focusing on the high use residential customers lends itself to a stratified sample design utilizing the third and fourth strata of the residential cost-of-service stratification. Table 3 presents the distribution of approximately 264,000 customers in our generalized target population. The numbers presented in the table below is updated using the 2005 data.

Stratum	Description	Winter Use	Summer Use	Count	Proportion
3	Low Winter/High Summer	0-1,150 kWh	>1,500 kWh	113,110	42.9%
4	High Winter/High Summer	>1,150 kWh	>1,500 kWh	150,602	57.1%
			Totals	263,712	100.0%

Table 3 – Residential TOU Pilot Sample Design

3.1.7 Sample Sizes

The planned sample sizes provided meaningful results.

The 2004 sample sizes used in the Residential TOU Pilot Study were sufficient to provide meaningful results. Table 4 presents results for the July 13th peak day during 2004. The table includes the achieved precision, the implied error ratio, the required sample size to meet the ±10% precision at the 90% confidence level and the implied precision using the proposed sample of 75. While these results are relative to the system peak day it should be noted that the results do vary for each variable of interest, as well as, for each CPP event day and hour. Following the recommendation in the Project Plan, substantially more customers were recruited into the 2005 sample to allow for additional analysis following the pre/post experimental design.

Study Group	Rate Options	Maximum Sample Size	July 13th System Peak Demand (kW)	Implied Error Ratio (%)	Required Sample Size for 90/10	Implied Precision with Sample of n=75	Actual Installed Sample
Control Group	Standard Residential Rate	89	5.68	42%	47	±8.0%	135
	Standard Residential Rate	117	6.05	36%	34	±6.7%	174
Voluntary Study Groups	3-Tier TOU w/ CPP	87	4.85	50%	69	±9.6%	146
	3-Tier TOU w/ CPP and Smart Thermostat	78	4.07	47%	59	±8.9%	104

Table 4 – Sample Size Requirements and Recommendations

As a result of some preliminary analysis that indicated the control groups were statistically different than their study group counterparts during the pre-participation period (i.e., summer 2003), an alternative control group approach was used. Under the alternative strategy, the full control group was used with replacement to select a 2:1 match for each study group participant based on the customer's pre-period consumption. This resulted in 277 control group customers for the CPP-RTOU group and 211 control group customers for the CPP-THERM group. Table 5 presents the results of a T-Test conducted on the control groups. The T-Test examined whether or not the 2003 seasonal energy use for the control group are statistically different than their study group counterpart. Clearly, the control groups are very similar to their study counterparts with the CPP-RTOU group within 141 kWh or 1.6% and the CPP-THERM group separated by just 6 kWh or less than 1%.

Study Group	Rate Options	Analysis Sample Size	Per-Period Consumption (kWh)	Study-Control Difference (kWh)	T-Test Value	Probability Pr>|t|	Decision Rule on Ho: Study=Control
Control Group	Standard Residential Rate	277	8,423				
	Standard Residential Rate	211	7,955				
Voluntary Study Groups	3-Tier TOU w/ CPP	141	8,564	141	0.478	0.633	Cannot Reject
	3-Tier TOU w/ CPP and Smart Thermostat	104	7,949	(6)	(0.024)	0.981	Cannot Reject

Table 5 – Comparison of Study and Control Groups

3.2 Enabling Technology

The Cannon/Honeywell ExpressGate™ thermostat will continue to be used.

3.2.1 Thermostat Features

The Cannon/Honeywell thermostat selected for use in this project is displayed in Figure 4.

Figure 4 – Cannon/Honeywell ExpressStatThermostat – Settings

The Cannon/Honeywell thermostat is capable of precise temperature control with four time and temperature settings per day. The thermostat has the capacity to handle weekday, Saturday and Sunday schedules. Figure 5 presents the Web screen used to program the thermostat. As evidenced by the figure, the thermostat can be set at different temperatures for waking, leaving, returning and sleeping. Of course, these could be adjusted to correspond with the AmerenUE TOU periods.

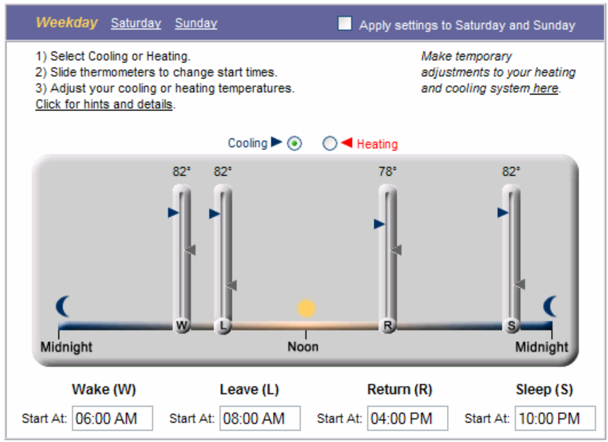

Figure 5 – Thermostat Settings

Thermostat – Control Features

From a control perspective, the thermostat can accommodate simple cycling strategies, cycling strategies with pre-defined limits, ramped temperature control and randomization. The project team has elected to use ramped temperature control allowing the customers to choose their comfort setting by time-of-use period and modify their thermostat during CPP events. Under this customer choice method, the thermostat can be set to roll up a predetermined number of degrees for selected periods. Cannon Technologies Incorporated (CTI) has developed six distinct schedules for customers to invoke during the critical peak pricing period. The offering is presented in Figure 6 and is based on a four hour CPP period.

Degree Per Hour	Maximum Change	Pre Cool (2 degrees)
1	4	No
2	4	No
2	6	No
2	8	No
2	6	Yes
2	8	Yes

Figure 6 – Customer Choice: Degree Roll-Up

Thermostat – Data Logging Capabilities

The Cannon/Honeywell thermostat is capable of securing specific data elements to assist the evaluation. The following elements can be collected on an hourly basis. The thermostat can store up to 90 days of data.

- Temperature,
- Compressor run times, and
- Shed times.

While this information would certainly be beneficial to the evaluation, we do not view it as critical to successfully satisfying the major evaluation objectives, i.e., estimating the demand reduction at system peak, CPP, etc.

3.3 Residential TOU/CPP Rate Design

A three-part time-of-use (TOU) rate with high differentials will be used along with an even more severe critical peak-pricing (CPP) component.

The Residential TOU rate was developed by the AmerenUE Rate Engineering Department. It is important to note that the TOU rates were not based of the true costs of serving loads during the indicated pricing period, but instead designed to gauge customer reaction to "high" prices. In other words, while the average cents/kWh realization resulting from these rates recover the Company's costs of providing service, such costs do not vary as widely by rating period as the TOU prices suggest. The time-of-use rates are detailed below.

The summer billing season uses a four-hour on-peak period defined as hour beginning 3:00PM to hour ending 7:00PM.

Summer: Three-Tier TOU with CPP		**Rate**
Off Peak	(Weekday 10PM–10AM, Weekends, Holidays)	4.80 cents/kWh
Mid Peak	(Weekdays 10AM– 3PM and 7PM-10PM)	7.50 cents/kWh
Peak	(Weekday 3PM – 7PM)	16.75 cents/kWh
CPP	(Weekday 3PM – 7PM, 10 times per summer)	30.00 cents/kWh

3.4 CPP Customer Notification

Customers were provided day-ahead notification of the Critical Peak Price.

Twenty-four hours before a CPP period was to be called, AmerenUE placed an automated, outbound telephone call to all pilot participants to distribute a pre-recorded notification message. In addition, the notification appeared at the AmerenUE webpage for the TOU pilot program and was emailed to pilot participants requesting email notification.

In addition, the “smart” thermostats were sent a control message to raise temperature to a predetermined level. Customers were able to opt out of a CPP control period by contacting AmerenUE’s Call Center or at the Cannon Technologies web site. It is important to note that customers were not able to override the CPP control period directly from the smart thermostat.

3.5 Customer Billing

Customers will be billed from the interval load data collected for the evaluation.

The 2005 stage of the TOU Pilot program was slated to begin June 1, 2005. However, each customer will start being billed under the pilot rates on the first day of their June billing cycle. This means that the participants first TOU bill in the summer of 2005 would come as the July bill for the billing period beginning sometime in June but not necessarily June 1, 2005.

The Pilot participants were billed from their evaluation data. The evaluation data were collected on a 15-minute basis using the Company's CellNet automatic meter reading (AMR) system. After CellNet has collected the data, the data were sent to the ARES Lodestar billing system. The Lodestar system will validate, estimate, and edit the data as necessary. Then, the system summarized the interval data to the Residential Time-Of-Use periods. The TOU information was sent to the Customer Service System (CSS) for billing and the interval load data was sent to the Load Research group for retention and analysis.

3.6 CPP Event Calls

During the pilot test AmerenUE staff put into place an algorithm that was used to call a CPP event anytime the temperature was forecasted to be at least 90^{o} F. In 2005, the temperature was expected to exceed 90^{o}F on 46 days for a total of 326 hours (including weekends and holidays). Table 6 presents a summary by month. The extremely hot summer presented a unique challenge, i.e., determining when to call the CPP event that we did not encounter in 2004.

	Number of	
Month	Days	Hours
June	15	100
July	14	116
August	17	110
Totals	46	326

Table 6 – Count of Days with Temperatures at 90^{o}F or above

AmerenUE staff called CPP events on a total of eight days. The event dates and times are presented in Table 7. All events were called for the full four hour period defined as hour beginning 3pm through hour ending 7pm.

Date	Start Time	End Time	Total Hours
30-Jun-05	3:00 PM	6:59 PM	4
21-Jul-05	3:00 PM	6:59 PM	4
22-Jul-05	3:00 PM	6:59 PM	4
26-Jul-05	3:00 PM	6:59 PM	4
2-Aug-05	3:00 PM	6:59 PM	4
9-Aug-05	3:00 PM	6:59 PM	4
10-Aug-05	3:00 PM	6:59 PM	4
19-Aug-05	3:00 PM	6:59 PM	4
Total Event Hours			32

Table 7 – CPP Event Calls

In 2005, the CPP events missed each of the summer monthly system peaks. The monthly system peak dates and times are displayed in Table 8.

Date	DOW	Time
29-Jun-2005	Wednesday	5pm
25-Jul-2005	Monday	4pm
3-Aug-2005	Wednesday	5pm

Table 8 – System Peak Dates and Times

4 PROJECT ANALYSIS

This section documents the analysis conducted to date for this project. The following analysis elements are explored:

- Determine the significance between the means for the following analysis variables:
  - Demand at the monthly AmerenUE system peaks;
  - Average demand during the critical peak pricing (CPP) periods;
  - Average summer energy use by time-of-use categories; and
  - Average payback for the three-hour period immediately following the CPP periods.

The analysis is conducted for each of the two treatment groups, i.e., CPP, and CPP-THERM.

4.1 Analysis of Treatment Group CPP

This section details the analysis conducted for the treatment group of RTOU pilot participants that were subjected to both the time-of-use rate and the critical peak-pricing component.

4.1.1 Available Sample

The CPP treatment group received the residential time of use rate with the critical peak-pricing component. The "control" group was represented by a sample of 277 customers and the "test" group (i.e., RTOU group) was represented by a sample of 141 customers. The distribution by strata, the population counts and the case weights are displayed in Table 9.

Group	Stratum	Description	Population Size	Sample Size	Case Weight (N/n)
Test-CPP	3	Low Winter/High Summer	113,110	65	1,740.15
Test-CPP	4	High Winter/High Summer	150,602	76	1,981.61
Totals - Test Group			263,712	141	
Control-CPP	3	Low Winter/High Summer	113,110	132	856.89
Control-CPP	4	High Winter/High Summer	150,602	145	1,038.63
Totals - Control Group			263,712	277	

Table 9 – Available Sample: CPP Treatment

In the analysis, the "control" and "test" groups were weighted and extrapolated to represent the full population of stratum 3 and 4 customers. Following the expansion the average demand per customer was calculated by dividing through by the total population size.

4.1.2 Hourly Load Estimates

Figure 7 presents the results of the analysis. The figure displays the "control" group in blue and the "treatment" group (i.e., RTOU) in red. To the left of the figure are EnergyPrints that display the hourly load in three dimensions. The day of the year is on the y-axis, the time of day on the x-axis and the demand is displayed on the z-axis as a color gradient with low levels of load in the black-blue spectrum and high levels of load in the yellow-white spectrum. The graph shows the "control" group having slightly higher peak demands than the RTOU group.

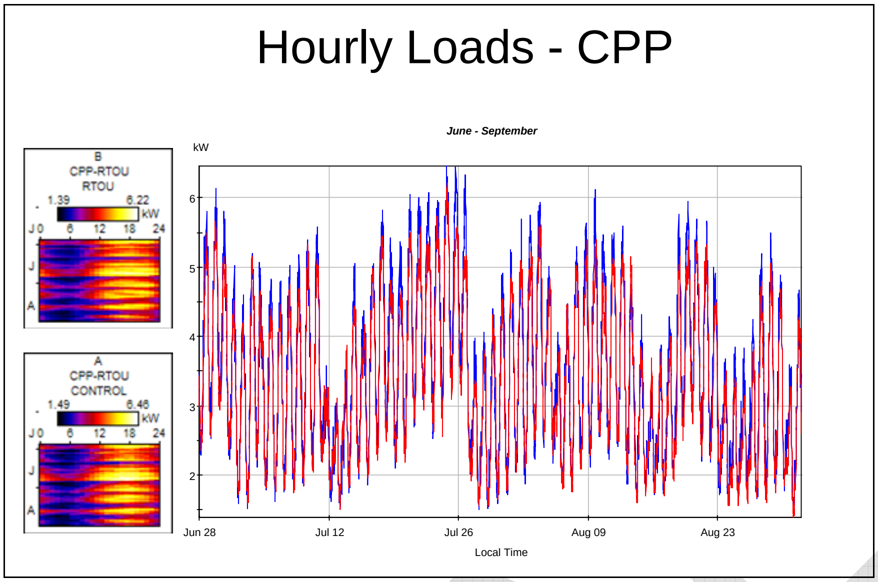

Figure 7 – Hourly Load Estimates: CPP Treatment

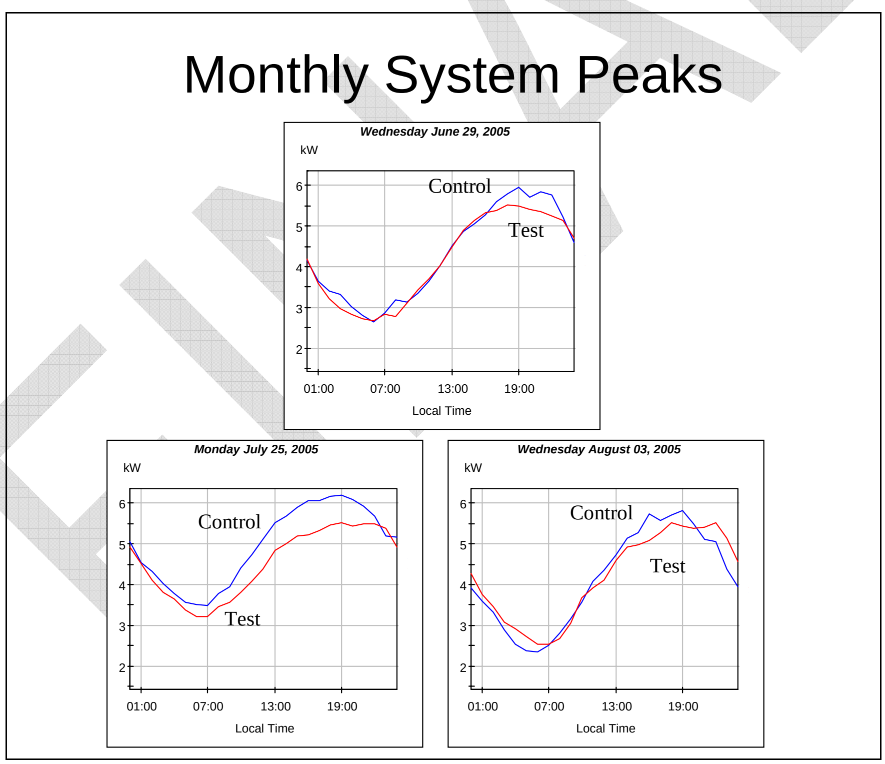

Figure 8 – Monthly System Peaks: CPP Treatment

Figure 8 presents the control group versus the RTOU-CPP group for each of the monthly system peaks. These include:

- Wednesday, June 29, 2005,
- Monday, July 25, 2005, and
- Wednesday, August 3, 2005.

There was insufficient data for the Thursday, September 22, 2005 peak to conduct a comparison.

Three Tier TOU with CPP (CPP)								
System Peak		Control Group	RTOU Pilot Group	Difference Control-RTOU	Percent Difference			
Date	Time	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
29-Jun-2005	5pm	5.60	5.39	0.21	3.8%	1.13	0.258	Cannot Reject
25-Jul-2005	4pm	6.06	5.23	0.83	13.7%	3.60	0.000	Reject
3-Aug-2005	5pm	5.57	5.29	0.28	5.0%	1.33	0.183	Cannot Reject

Table 10 – T-Test for System Peak Demand: CPP Treatment

To test whether or not there is a significant difference we conducted a T-test under the null hypothesis that the two means were equal. Since a critical peak pricing event was not called on any of the system peak days, the analysis results test just the impact of the RTOU rate. Table 10 presents the outcome of the analysis. For June and August system peak days, we are unable to reject the hypothesis and must conclude that the time-of-use rate alone does not statistically reduce the demand at the time of the system peak. This is consistent with the findings from 2004. However, there was a statistical difference noted on Monday, July 25, 2005 between the RTOU-CPP group and the control group. On this day, the test group is considerably lower (i.e., up to 0.83 kW) than the control group. If we examine that system peak week more closely (see Figure 9), then we notice that the test group was lower during the Thursday and Friday, which were both CPP days, leading up to the peak Monday. Interestingly, the loads on Saturday and Sunday prior to the peak were nearly identical. Tuesday after the peak Monday was also a CPP day and customers received the CPP notification for the next day around 9am on Monday. Having CPP days on both Thursday and Friday before and Tuesday after the peak Monday may have caused the statistically significant difference on the system peak day.

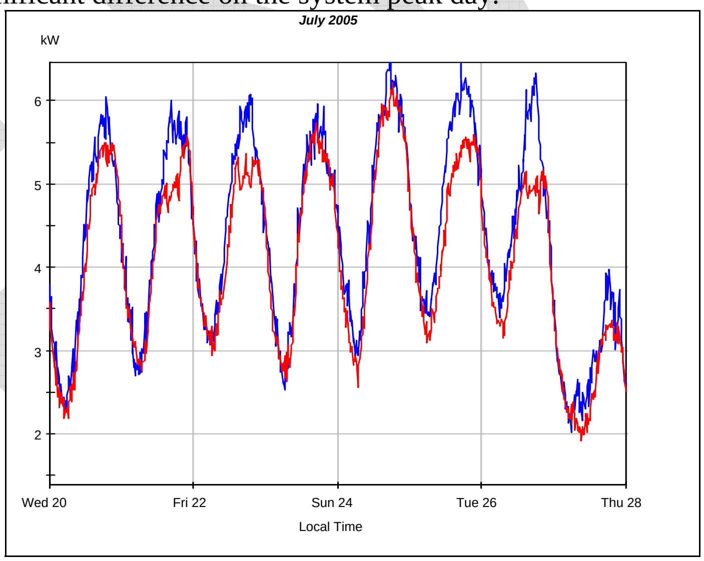

Figure 9 – System Peak Week

4.1.3 Demand on "Hot" Days

To further examine the effects of the time-of-use rate, we examined the demand of the test and control group customers on days where the temperature during the on-peak period exceeded 90°F. CPP event days were separately analyzed and therefore excluded from this analysis. The following dates were included in the analysis:

Non Event Days Over 90^{o}F		
June	July	August
29-Jun-2005	20-Jul-2005	1-Aug-2005
	25-Jul-2005	8-Aug-2005
		11-Aug-2005
		12-Aug-2005
		13-Aug-2005
		18-Aug-2005

Table 11 – Non Event Days Over 90^{o}F

Three Tier TOU with CPP (CPP)						
Control Group (kW)	RTOU Pilot Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
5.37	5.09	0.28	5.2%	1.61	0.107	Cannot Reject

Table 12 – Non Event Days Over 90^{o}F Analysis Results

Error! Reference source not found. summarizes the analysis. The average "hot period" demands of the control group was 5.37 kW compared to a demand of 5.09 kW for the test group. The 5.2% difference was close to being statistically significant.

4.1.4 CPP Event Day Analysis

During the pilot test, a total of eight CPP events were called for a total of 32 hours. The CPP events were invoked on days when the forecasted temperature was expected to exceed 90^{o} F. The CPP event lasted the entire four-hour on-peak period (i.e., hour beginning 3pm to hour ending 7pm. Table presents the dates and times associated with the eight CPP events.

Date	Start Time	End Time	Total Hours
30-Jun-05	3:00 PM	6:59 PM	4
21-Jul-05	3:00 PM	6:59 PM	4
22-Jul-05	3:00 PM	6:59 PM	4
26-Jul-05	3:00 PM	6:59 PM	4
2-Aug-05	3:00 PM	6:59 PM	4
9-Aug-05	3:00 PM	6:59 PM	4
10-Aug-05	3:00 PM	6:59 PM	4
19-Aug-05	3:00 PM	6:59 PM	4
Total Event Hours			32

Table 13 – CPP Event Day Schedule

Figure 10 presents a comparison of the actual hourly load for the RTOU group with CPP versus the baseline load calculated from the Control group. The solid black lines drawn parallel to the y-axis highlight the event period. In this figure, the graph highlights the difference between the RTOU group and the control in yellow. Clearly, the RTOU group with CPP shows a substantially lower level of load during most of the event period. Figures for each of the event days are contained in Appendix A.

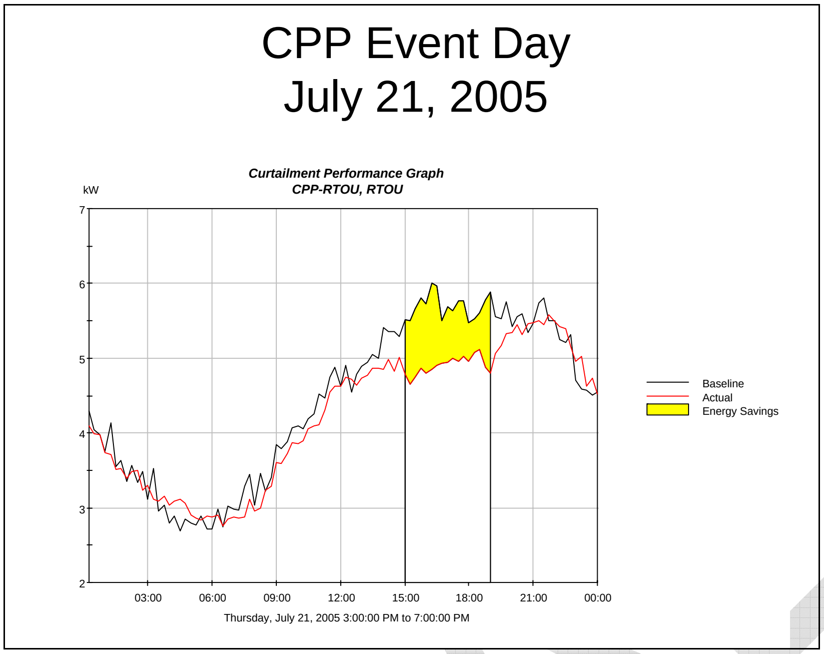

Figure 10 – CPP Event Day: July 21, 2005: CPP Treatment

To determine if there is a statistically significant difference between the RTOU and Control group we set up and conducted a T-Test. For this analysis, we calculate and compare the average demand across the entire CPP event period. The CPP event day analysis results are presented in Table . The RTOU participants demonstrated a statistically lower demand when compared to their Control group counterparts during each of the eight events. In addition, the average demand across all event hours was deemed to be significantly lower.

Three Tier TOU with CPP (CPP)									
CPP Event			Control Group (kW)	RTOU Pilot Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)			
	Hour Ending								
Date	Start	End					T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5.35	4.85	0.50	9.3%	2.63	0.0088	Reject
21-Jul-05	3:00 PM	6:59 PM	5.71	4.91	0.80	14.1%	3.75	0.0002	Reject
22-Jul-05	3:00 PM	6:59 PM	5.84	5.05	0.79	13.5%	3.54	0.0005	Reject
26-Jul-05	3:00 PM	6:59 PM	5.98	4.91	1.06	17.8%	5.28	0.0000	Reject
2-Aug-05	3:00 PM	6:59 PM	5.38	4.73	0.65	12.1%	3.24	0.0013	Reject
9-Aug-05	3:00 PM	6:59 PM	5.64	4.74	0.90	16.0%	4.33	0.0000	Reject
10-Aug-05	3:00 PM	6:59 PM	5.01	4.24	0.76	15.2%	4.00	0.0000	Reject
19-Aug-05	3:00 PM	6:59 PM	5.61	4.88	0.74	13.1%	3.54	0.0004	Reject
Average			5.56	4.84	0.72	13.0%	3.90	0.0001	Reject

Table 14 – T-Test for CPP Event Day Demands: CPP Treatment

4.1.5 Time-Of-Use Energy Analysis

Time-of-use (TOU) periods consistent with the TOU rate tariff were constructed and analyzed by the project team. These periods and their definitions are as follows:

- Average summer energy use[8]: This value was defined as the average energy use across the periods June 1, 2005 through August 31, 2005.
- Average on-peak summer energy use: This value was defined as the four hour period beginning at 3pm through hour ending 7pm on summer weekdays. Summer weekdays are defined as Monday through Friday excluding holidays.
- Average on-peak summer energy use during CPP events: This value was defined as the four hour period beginning at 3pm through hour ending 7pm during the eight called CPP events.
- Average mid-peak summer energy use: This value was defined as an eight-hour weekday period. The period encompasses the five hours beginning at 10am through hour ending 3pm and the three-hour period beginning at 7pm through hour ending 10pm.
- Average off-peak summer energy use: This value was defined as all weekend hours, all holiday hours (defined as July 4, 2005), and all remaining weekday hours (i.e., the twelve hour period beginning at 10pm to hour ending 10am).

A T-test analysis was conducted for each variable of interest. The results of the analysis are displayed in Table . The test and control groups displayed similar levels (and percentages) of overall, off peak use, mid-peak use and on-peak use. Only for the energy used during CPP periods could the null hypothesis that the two samples displayed equal means be rejected. For this period, the total energy used is estimated to be 252 kWh for the control group and 219 kWh for the treatment group. Dividing the total CPP energy use by the eight control periods yields an average daily CPP usage of 31.5 kWh for the control group or 15% more than the 27.4 kWh used by the treatment group.

Three Tier TOU with CPP (CPP)						
Jun 1 - Aug 31 TOU Period	Control Group (kWh)	RTOU Group (kWh)	Difference Control-RTOU (kWh)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	7,729	7,584	145.00	0.58	0.56	Cannot Reject
Off-Peak Use	4,495	4,450	45.00	0.28	0.78	Cannot Reject
Mid-Peak Use	2,054	2,019	35.00	0.54	0.59	Cannot Reject
On-Peak Use	927	896	31.00	0.96	0.34	Cannot Reject
CPP Use	252	219	33.10	3.92	0.00	Reject
Percent Off-Peak	58.2%	58.7%	-0.5%	1.02	0.31	Cannot Reject
Percent Mid-Peak	26.6%	26.6%	0.0%	0.15	0.88	Cannot Reject
Percent On-Peak	12.0%	11.8%	0.2%	(0.72)	0.47	Cannot Reject
Per CPP	3.3%	2.9%	0.4%	4.08	0.00	Reject

Table 15 – T-Test for Average Summer Use by TOU Periods: CPP Treatment

4.1.6 Payback Analysis

Payback is defined as the average demand for the three-hour period immediately following a critical peak-pricing (CPP) event. Table presents the analysis for the payback. The table indicates that the payback for the RTOU group following the CPP event was moderate and not statistically different than the load following the CPP period for the control group. On the eight events the payback averaged approximately 0.06 kW.

[8] Actual data used to estimate the average daily usage was from the time period June 28, 2005 through August 31, 2005.

Three-Tier TOU Rate with CPP (CPP)										
CPP Event			Control	RTOU	Difference	Percent			
	Payback Period		Group	Group	RTOU-Control	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	7pm	10pm	4.77	4.74	(0.02)	-0.5%	0.12	0.902	Cannot Reject
21-Jul-05	7pm	10pm	5.56	5.39	(0.18)	-3.2%	0.83	0.408	Cannot Reject
22-Jul-05	7pm	10pm	5.42	5.24	(0.18)	-3.3%	0.85	0.395	Cannot Reject
26-Jul-05	7pm	10pm	5.03	5.01	(0.02)	-0.4%	0.09	0.928	Cannot Reject
2-Aug-05	7pm	10pm	5.02	5.09	0.07	1.3%	(0.35)	0.723	Cannot Reject
9-Aug-05	7pm	10pm	5.14	5.27	0.13	2.5%	(0.65)	0.513	Cannot Reject
10-Aug-05	7pm	10pm	4.63	4.56	(0.07)	-1.6%	0.34	0.735	Cannot Reject
19-Aug-05	7pm	10pm	5.35	5.11	(0.24)	-4.5%	1.08	0.279	Cannot Reject
Average			5.12	5.05	(0.06)	-1.3%	0.34	0.731	Cannot Reject

Table 16 – T-Test for Payback Analysis: CPP Treatment

4.2 Analysis of Treatment Group CPP-THERM

This section details the analysis conducted for the third treatment group. This group of RTOU pilot participants were subjected to the critical peak-pricing component of the rate but were provided additional enabling technology (see Section 3.2 Enabling Technology for a description of the thermostat) to aid in their load modification. This group is termed the CPP-THERM group.

It is interesting to note that during the test almost all of the customers remained on the default control option (i.e., 1^{o} change per hour with a 4^{o} maximum change). Only four customers elected a control option different than the default setting with three of these customers selecting the highest option (i.e., 2^{o} change per hour with an 8^{o} maximum change).

4.2.1 Available Sample

The CPP-THERM treatment group received the residential time of use rate with the critical peak-pricing component and an ExpresStat thermostat. The "control" group was represented by a sample of 104 customers and the "test" group (i.e., RTOU group) was represented by a sample selected on a 2:1 ratio, or 211 customers. The distribution by strata, the population counts and the case weights are displayed in Table 11. In the analysis each test group was weighted and extrapolated to represent the full population of stratum 3 and 4 customers. Following the expansion the average demand per customer was calculated by dividing through by the total population size.

Group	Stratum	Description	Population Size	Sample Size	Case Weight (N/n)
Test-CPP Therm	3	Low Winter/High Summer	113,110	55	2,056.55
Test-CPP Therm	4	High Winter/High Summer	150,602	49	3,073.51
			263,712	104	
Control-CPP Therm	3	Low Winter/High Summer	113,110	103	1,098.16
Control-CPP Therm	4	High Winter/High Summer	150,602	108	1,394.46
			263,712	211	

Table 11 – Available Sample: CPP-THERM Treatment

4.2.2 Hourly Load Estimates

Figure 11 presents the results of the analysis. The figure displays the "control" group in blue and the "treatment" group (i.e., RTOU) in red. To the left of the figure are EnergyPrints that display the hourly load in three dimensions. The day of the year is on the y-axis, the time of day on the x-axis and the demand is displayed on the z-axis as a color gradient with low levels of load in the black-blue spectrum and high levels of load in the yellow-white spectrum. The graph shows the "control" group having substantially higher peak demands than the RTOU group.

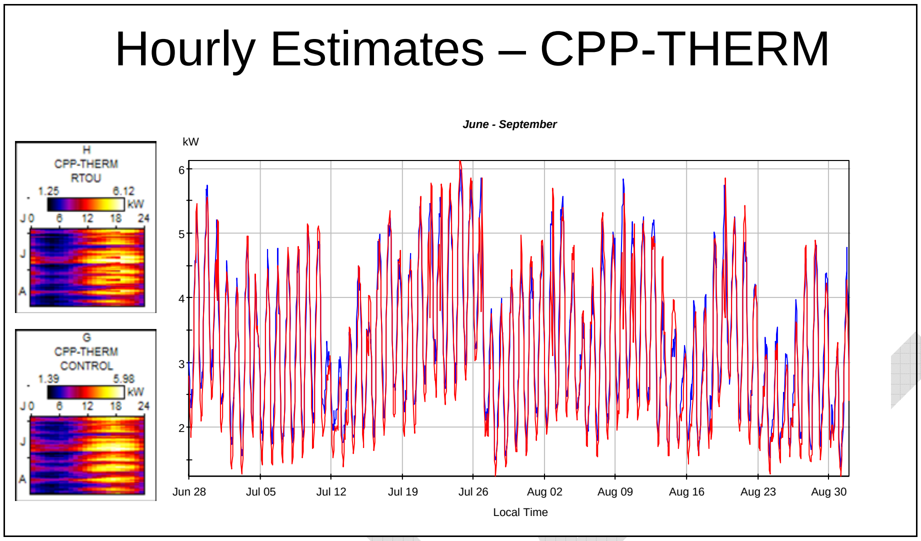

Figure 11 – Hourly Load Estimates: CPP-THERM Treatment

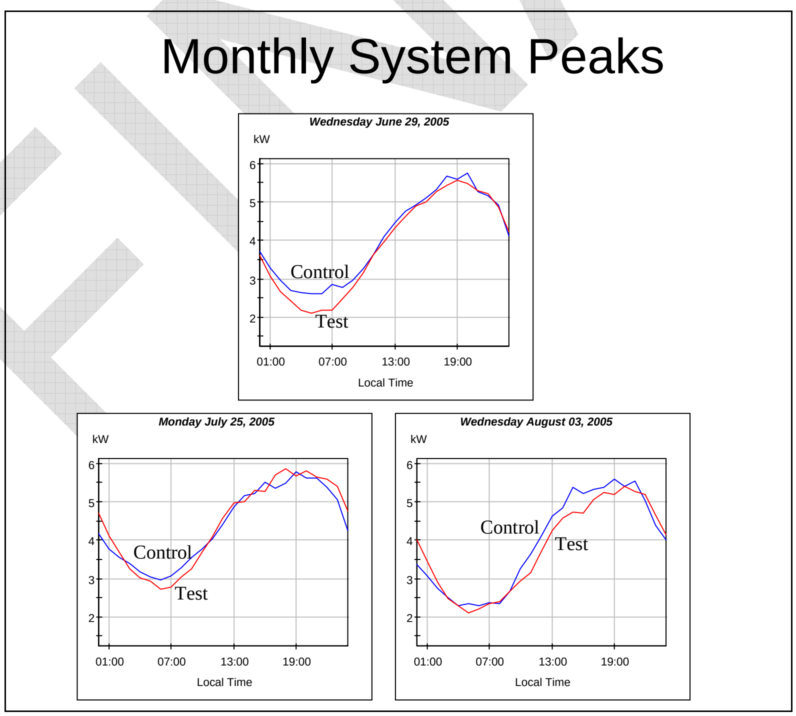

Figure 12 – Monthly System Peaks: CPP-THERM Treatment

4.2.3 Demand at System Peak

Figure 12 displays the hourly demand for the "control" and "treatment" groups on the three summer system peak days. The blue line represents the "control" group and the red line represents the treatment group. Clearly, the loads between the control and treatment groups are very similar. However, to test whether or not there is a significant difference we conducted a T-test under the null hypothesis that the two means were equal. Table 12 presents the outcome of the analysis. The analysis shows that without calling a critical peak pricing event, we are unable to reject the hypothesis that the two means are equal. This is consistent with the 2004 results that indicated the RTOU rate alone was insufficient to cause a statistical difference at the time of system peak.

Three Tier TOU with CPP and Thermostat (CPP-THERM)									
System Peak Date	System Peak Time	Control Group (kW)	RTOU Pilot Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
29-Jun-2005	5pm	5.32	5.27	0.05	0.9%	0.19	0.848	Cannot Reject
25-Jul-2005	4pm	5.52	5.26	0.26	4.7%	1.01	0.314	Cannot Reject
3-Aug-2005	5pm	5.32	5.04	0.28	5.3%	1.21	0.226	Cannot Reject

Table 12 – T-Test for System Peak Demand: CPP-THERM Treatment

4.2.4 Demand on "Hot" Days

To further examine the effects of the time-of-use rate, we examined the demand of the test and control group customers on days where the temperature during the on-peak period exceeded 90^{o}F. CPP event days were separately analyzed and therefore excluded from this analysis. The following dates were included in the analysis:

Non Event Days Over 90^{o}F		
June	July	August
29-Jun-2005	20-Jul-2005	1-Aug-2005
	25-Jul-2005	8-Aug-2005
		11-Aug-2005
		12-Aug-2005
		13-Aug-2005
		18-Aug-2005

Table 19 – Non Event Days Over 90^{o}F

Three Tier TOU with CPP and Thermostat (CPP-THERM)						
Control Group (kW)	RTOU Pilot Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
5.07	4.99	0.08	1.6%	0.42	0.680	Cannot Reject

Table 20 – Non Event Days Over 90^{o}F Analysis Results

Error! Reference source not found. summarizes the analysis. The average "hot period" demands of the control group was 5.07 kW compared to a demand of 4.99 kW for the test group. The 1.6% difference was deemed not to be statistically significant.

4.2.5 CPP Event Day Analysis

During the pilot test a total of eight CPP events were called for a total of 32 hours. The CPP events were invoked on days when the forecasted temperature was expected to exceed 90° F. The CPP event lasted the entire four-hour on-peak period (i.e., hour beginning 3pm to hour ending 7pm. Table presents the dates and times associated with the eight CPP events.

Date	Start Time	End Time	Total Hours
30-Jun-05	3:00 PM	6:59 PM	4
21-Jul-05	3:00 PM	6:59 PM	4
22-Jul-05	3:00 PM	6:59 PM	4
26-Jul-05	3:00 PM	6:59 PM	4
2-Aug-05	3:00 PM	6:59 PM	4
9-Aug-05	3:00 PM	6:59 PM	4
10-Aug-05	3:00 PM	6:59 PM	4
19-Aug-05	3:00 PM	6:59 PM	4
Total Event Hours			32

Table 21 – CPP Event Day Schedule

Figure 13 presents a comparison of the actual hourly load for the RTOU group versus the baseline load calculated from the Control group. The solid black lines drawn parallel to the y-axis highlight the event period. In this figure, the graph highlights the difference between the RTOU group and the control in yellow. Clearly, the RTOU group shows a substantially lower level of load during the entire event period. Figures for each of the event days are contained in Appendix A.

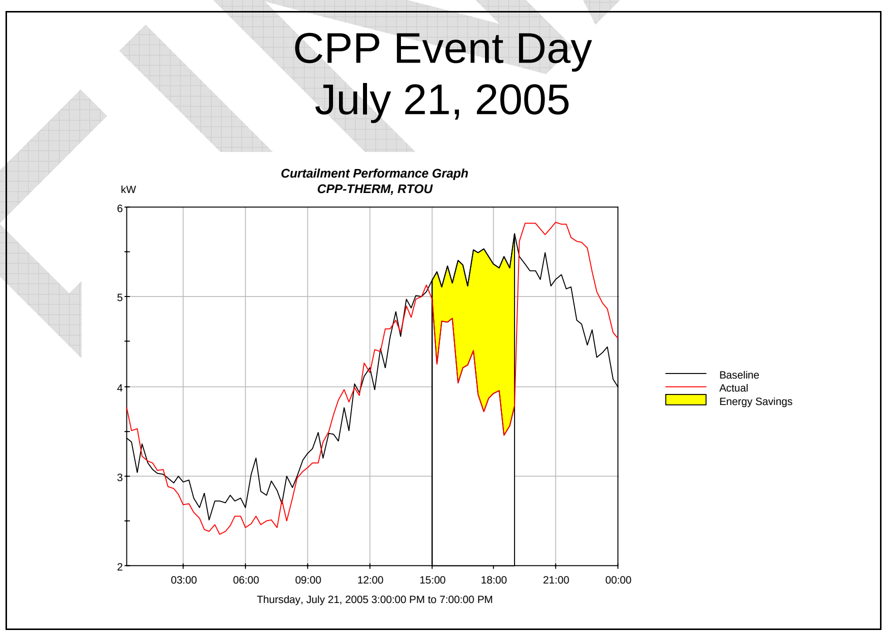

Figure 13 – CPP Event Day July 21, 2005: CPP-THERM Treatment

To determine if there is a statistically significant difference between the RTOU and Control groups we set up and conducted a T-Test. For this analysis, we calculate and compare the average demand across the entire CPP event period. The CPP event day analysis results are presented in Table . The RTOU participants demonstrated a statistically lower demand when compared to their Control group counterparts in all eight events. In addition, the average demand across all event hours was deemed to be significantly lower for the RTOU group.

Three Tier TOU with CPP and Thermostat (CPP-THERM)									
CPP Event			Control Group (kW)	RTOU Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)			
	Hour Ending								
Date	Start	End					T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5.02	4.30	0.72	14.4%	2.93	0.0036	Reject
21-Jul-05	3:00 PM	6:59 PM	5.37	4.09	1.27	23.7%	5.22	0.0001	Reject
22-Jul-05	3:00 PM	6:59 PM	5.38	4.18	1.20	22.4%	5.39	0.0001	Reject
26-Jul-05	3:00 PM	6:59 PM	5.56	4.38	1.18	21.2%	4.93	0.0001	Reject
2-Aug-05	3:00 PM	6:59 PM	5.23	3.66	1.57	30.0%	6.30	0.0001	Reject
9-Aug-05	3:00 PM	6:59 PM	5.47	4.01	1.46	26.7%	5.76	0.0001	Reject
10-Aug-05	3:00 PM	6:59 PM	4.95	3.82	1.13	22.8%	4.95	0.0001	Reject
19-Aug-05	3:00 PM	6:59 PM	5.38	3.97	1.41	26.1%	5.49	0.0001	Reject
Average			5.29	4.05	1.24	23.5%	6.05	0.0001	Reject

Table 22 – T-Test for CPP Event Day Demands: CPP-THERM Treatment

4.2.6 Time-Of-Use Energy Analysis

Time-of-use (TOU) periods consistent with the TOU rate tariff were constructed and analyzed by the project team. These periods and their definitions are as follows:

- Average summer energy use: This value was defined as the average energy use across the periods June 1, 2005 through August 31, 2005.
- Average on-peak summer energy use: This value was defined as the four hour period beginning at 3pm through hour ending 7pm on summer weekdays. Summer weekdays are defined as Monday through Friday excluding holidays.
- Average on-peak summer energy use during CPP events: This value was defined as the four hour period beginning at 3pm through hour ending 7pm during the six called CPP events.
- Average mid-peak summer energy use: This value was defined as an eight-hour weekday period. The period encompasses the five hours beginning at 10am through hour ending 3pm and the three-hour period beginning at 7pm through hour ending 10pm.
- Average off-peak summer energy use: This value was defined as all weekend hours, all holiday hours (defined as July 4, 2005), and all remaining weekday hours (i.e., the twelve hour period beginning at 10pm through hour ending 10am).

Three Tier TOU with CPP and Thermostat (CPP-THERM)						
Jun 1 - Aug 31 TOU Period	Control Group (kWh)	RTOU Group (kWh)	Difference Control-RTOU (kWh)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	7,205	6,963	242	0.98	0.33	Cannot Reject
Off-Peak Use	4,147	4,017	130	0.91	0.37	Cannot Reject
Mid-Peak Use	1,934	1,901	33	0.46	0.65	Cannot Reject
On-Peak Use	884	863	21	0.64	0.52	Cannot Reject
CPP Use	240	182	58	5.99	0.00	Reject
Percent Off-Peak	57.6%	57.7%	-0.1%	0.26	0.79	Cannot Reject
Percent Mid-Peak	26.8%	27.3%	-0.5%	1.36	0.18	Cannot Reject
Percent On-Peak	12.3%	12.4%	-0.1%	0.49	0.63	Cannot Reject
Per CPP	3.3%	2.6%	0.7%	(8.18)	0.00	Reject

Table 23 – T-Test for Average Summer Use by TOU Period: CPP-THERM Treatment

A T-test analysis was conducted for each variable of interest. The results of the analysis are displayed in Table . The test and control groups displayed no statistical differences in load for the seasonal use, off-peak use, mid-peak use, and on-peak use periods. Only the total and percentage of use consumed in the CPP period displays a statistically significant difference. The average energy used in the CPP periods is estimated to be 240 kWh for the control group which is 24% more than the 182 kWh used by the treatment group.

4.2.7 Payback Analysis

Payback is defined as the average demand for the three-hour period immediately following a critical peak-pricing (CPP) event. Table presents the analysis for the payback. The table indicates that the payback for the RTOU group following the CPP event was statistically different than the load following the CPP period for the control group on six of the eight events. On the two days in August, the 7pm to 10pm loads of the two groups were similar.

Three-Tier TOU Rate with CPP and Thermostat (CPP-THERM)									
CPP Event			Control Group (kW)	RTOU Group (kW)	Difference RTOU-Control (kW)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
	Payback Period								
Date	Start	End							
30-Jun-05	7pm	10pm	4.28	5.13	0.85	19.9%	(4.21)	0.000	Reject
21-Jul-05	7pm	10pm	5.21	5.75	0.54	10.4%	(2.55)	0.011	Reject
22-Jul-05	7pm	10pm	5.07	5.73	0.66	13.1%	(2.74)	0.007	Reject
26-Jul-05	7pm	10pm	4.71	5.59	0.88	18.6%	(4.56)	0.000	Reject
2-Aug-05	7pm	10pm	4.89	5.48	0.59	12.1%	(2.79)	0.006	Reject
9-Aug-05	7pm	10pm	5.35	5.39	0.04	0.8%	(0.19)	0.847	Cannot Reject
10-Aug-05	7pm	10pm	4.77	4.89	0.12	2.6%	(0.59)	0.556	Cannot Reject
19-Aug-05	7pm	10pm	4.79	5.63	0.84	17.6%	(3.65)	0.000	Reject
Average			4.88	5.45	0.57	11.6%	(3.05)	0.003	Reject

Table 24 – T-Test for Payback Analysis: CPP-THERM Treatment

4.3 Supplemental Analysis

During the planning for the 2005 Pilot Study evaluation, we elected to incorporate existing Pilot study participants into the various treatment and control groups providing a mechanism to examine the pre/post behavior of pilot participants.

4.3.1 Supplemental Groups

Four supplemental test groups were formed including:

Test Group #1 - The customers in test group number one were a continuation of customers from the 2004 RTOU CPP group. The objective of the pre/post evaluation is to see if these customers decreased the amount of load consumed during critical peak pricing periods during the 2005 pilot;

Test Group #2 - The customers in test group number two were a continuation of customers from the 2004 RTOU CPP-Therm group. Here again, the objective of the pre/post evaluation is to see if these customers were successful in decreasing their usage during CPP events in the 2005 pilot;

Test Group #3 - The customers in test group number three were recruited from the 2004 Pilot Study control group. In 2005, these customers were given the RTOU rate with the CPP element. The objective of the analysis is to see if the pre/post experimental design provides any added insight into the performance of the RTOU CPP treatment group;

Test Group #4 - Finally, the customers in test group number four were recruited from the 2004 Pilot study control group. Here again, the objective of the supplemental analysis is to see if the pre/post experimental design provides any additional insight into the performance of the RTOU CPP-Therm treatment group.

The following sample sizes were available in each of the four supplemental analyses.

Group				21-Jul Sample	Population Count	Weight
Test	2004 Pilot	2005 Pilot	Stratum	(n)	(N)	(N/n)
1	Test Group	RTOU with CPP	3	44	113,110	2,570.682
			4	51	150,602	2,952.980
2	Test Group	RTOU with CPP-Therm	3	38	113,110	2,976.579
			4	44	150,602	3,422.773
3	Control	RTOU with CPP	3	34	113,110	3,326.765
			4	42	150,602	3,585.762
4	Control	RTOU with CPP-Therm	3	24	113,110	4,712.917
			4	22	150,602	6,845.545

Table 13 – Supplemental Analysis (Pre/Post)

4.3.2 Challenges

The fundamental challenge associated with assessing the impacts from the pre/post experimental design is properly accommodating for differences in weather related usage

The summer of 2005 was substantially warmer than the summer of 2004. Figure 14 presents the average hourly temperature for the month of July for 2004 versus 2005. Clearly, the 2005 temperatures are substantially higher than those experienced in 2004. Table 14 presents a tabulation of the number of cooling degree hours for June 1 through August 31 periods in 2004 and 2005, the absolute difference and the percentage difference. The summer of 2005 was approximately 33.5% warmer when compared to the same period in 2004.

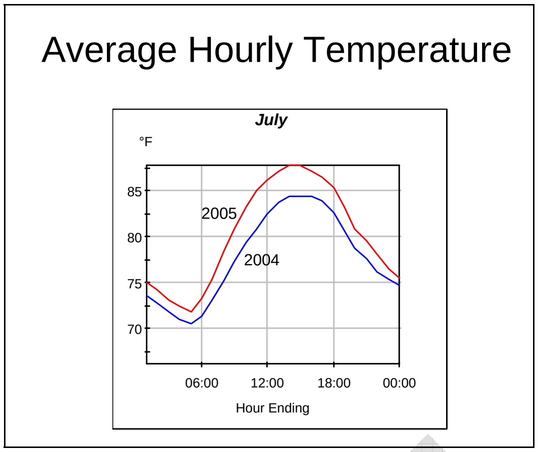

Figure 14 – Average Hourly Temperatures

The challenge is that any modification that we make to the 2004 program year to reflect the higher number of cooling degree hours for 2005 will likely be significantly larger than the impacts we are attempting to measure.

Program Year	Cooling Degree Hours[1]	Difference	
		Absolute	Percent
2004	23,622		
2005	31,540	7,918	33.5%
[1] 65 °F Base			

Table 14 – Cooling Degree Hours

4.3.3 Approach

For this phase of the analysis, the available interval load data for 2004 was used to develop temperature response models for each individual customer. The models focused on summer usage and were developed using data from June 1, 2004 through September 30, 2004. Models[9] were predicted by weekday versus weekend and hour of the day. The actual weather experienced in 2005 was used to "predict" the customer's 2005 load. This predicted "2004" load given 2005 weather conditions was compared to the customer's 2005 actual load in the subsequent statistical analysis.

[9] To optimize the selection of the models, a range of degree-day set points were considered for each customer model. For cooling degree-days the considered set points ranged from 65^0 to 75^0. Mathematically, the models considered can be expressed as follows:

$$BL_{lrid,dow,time} + VL_{lrid,dow,time}$$

$$VL_{lrid,dow,time} = \beta_0 + \beta_1 * CDD(\tau_1)$$

Where

$BL_{lrid,dow,time}$ is the base load of the customer 'LRID', on day of week 'DOW' at hour ending 'Time'

$VL_{lrid,dow,time}$ is the variable load for customer 'LRID', on day of the week 'DOW' at hour ending 'Time'

$CDD(\tau_1)$ are the cooling degree-days with a τ_1 base

4.3.4 Supplemental Findings

The following tables highlight the findings from the analysis following the pre/post experimental design. Table 15 presents the results for the two test groups that were in the program in 2004 and continued in the program in 2005. The top portion of the table is associated with the RTOU CPP group and the bottom half of the table is associated with the RTOU CPP-Therm group. The table presents the results for seasonal energy use[10] defined as June 1, 2005 through August 31, 2005, off-peak energy use, mid-peak energy use, on-peak energy use and usage during the CPP periods. In addition we have provided the percentage of seasonal energy use consumed in each of the time-of-use periods. The table presents the actual usage, the percent difference (i.e., calculated using actual minus predicted), the T-Test statistics, and the probability of getting a large T, and whether or not we could reject the null hypothesis of equal means between the two groups.

Three Tier TOU with CPP (Pre/Post: Test to Test)						
Jun 1 - Aug 31 TOU Period	Predicted Group #1 (kWh)	Actual Group #1 (kWh)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	7,269	7,816	7.5%	1.21	0.229	Cannot Reject
Off-Peak Use	4,289	4,659	8.6%	1.32	0.190	Cannot Reject
Mid-Peak Use	1,922	2,049	6.6%	1.08	0.281	Cannot Reject
On-Peak Use	830	891	7.3%	1.06	0.290	Cannot Reject
CPP Use	229	217	-5.2%	(0.77)	0.443	Cannot Reject
Percent Off-Peak	59.0%	59.6%	1.0%	0.80	0.424	Cannot Reject
Percent Mid-Peak	26.4%	26.2%	-0.9%	(0.45)	0.955	Cannot Reject
Percent On-Peak	11.4%	11.4%	-0.2%	(0.06)	0.653	Cannot Reject
Per CPP	3.2%	2.8%	-11.9%	(2.90)	0.000	Reject
Three Tier TOU with CPP-THERM (Pre/Post: Test to Test)						
Jun 1 - Aug 31 TOU Period	Predicted Group #2 (kWh)	Actual Group #2 (kWh)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	6,492	6,706	3.3%	0.06	0.533	Cannot Reject
Off-Peak Use	3,765	3,797	0.8%	0.16	0.877	Cannot Reject
Mid-Peak Use	1,748	1,873	7.2%	1.28	0.201	Cannot Reject
On-Peak Use	772	855	10.8%	1.82	0.071	Reject
CPP Use	207	180	-12.9%	(1.99)	0.049	Reject
Percent Off-Peak	58.0%	56.6%	-2.4%	(2.14)	0.034	Reject
Percent Mid-Peak	26.9%	27.9%	3.7%	2.06	0.019	Cannot Reject
Percent On-Peak	11.9%	12.7%	7.2%	2.37	0.041	Reject
Per CPP	3.2%	2.7%	-15.7%	(4.23)	0.000	Reject

Table 15 – Comparison of Seasonal Usage: Test to Test Groups

For the RTOU CPP group, the null hypothesis that the means are equal can only be rejected for the percentage of usage consumed in the CPP period. This indicates that there was some additional savings by the test group participants in the second year of program participation. For the RTOU CPP-Therm group, we reject the null hypothesis for the quantity of load consumed in the on-peak and CPP periods. This indicates that during the second year of program participation, the test group increased their on-peak usage but continued to reduce their CPP usage. As a percentage of total load, the CPP-Therm group shows a statistically significant reduction in off-peak use and an increase in on-peak use during the second year of program participation.

[10] The seasonal energy use was calculated using data for the period June 28, 2005 through August 31, 2005 and then normalized the three month seasonal period.

Table 16 presents the same information for the two test groups that started off as control groups but shifted to one of the two treatment groups. Once again, for the RTOU CPP group, we are able to reject the null hypothesis of equality of means for just the CPP usage period. This is further evidence that the only change in load for this group occurs during the CPP period. For the RTOU CPP-Therm group, we see a statistical difference for the amount of energy consumed during the CPP period. In addition, we see a statistically significant increase in the percentage of total energy used during the off-peak period.

Three Tier TOU with CPP (Pre/Post: Control to Test)						
Jun 1 - Aug 31 TOU Period	Predicted Group #3 (kWh)	Actual Group #3 (kWh)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	7,093	7,418	4.6%	0.91	0.366	Cannot Reject
Off-Peak Use	4,081	4,293	5.2%	0.94	0.350	Cannot Reject
Mid-Peak Use	1,889	2,005	6.1%	1.17	0.244	Cannot Reject
On-Peak Use	876	901	2.9%	0.49	0.627	Cannot Reject
CPP Use	247	220	-11.2%	(2.21)	0.029	Reject
Percent Off-Peak	57.5%	57.9%	0.6%	0.40	0.690	Cannot Reject
Percent Mid-Peak	26.6%	27.0%	1.5%	0.84	0.658	Cannot Reject
Percent On-Peak	12.4%	12.1%	-1.7%	(0.44)	0.405	Cannot Reject
Per CPP	3.5%	3.0%	-15.0%	(3.65)	0.000	Reject
Three Tier TOU with CPP-THERM (Pre/Post: Control to Test)						
Jun 1 - Aug 31 TOU Period	Predicted Group #4 (kWh)	Actual Group #4 (kWh)	Percent Difference (%)	T-Test	Pr>|t|	Ho: Control=RTOU
Seasonal Use	7,234	7,264	0.4%	0.06	0.949	Cannot Reject
Off-Peak Use	4,107	4,279	4.2%	0.65	0.515	Cannot Reject
Mid-Peak Use	1,988	1,934	-2.7%	(0.39)	0.699	Cannot Reject
On-Peak Use	891	868	-2.6%	(0.34)	0.738	Cannot Reject
CPP Use	249	184	-26.3%	(3.46)	0.001	Reject
Percent Off-Peak	56.8%	58.9%	3.8%	2.25	0.027	Reject
Percent Mid-Peak	27.5%	26.6%	-3.1%	(1.43)	0.363	Cannot Reject
Percent On-Peak	12.3%	11.9%	-3.0%	(0.91)	0.155	Cannot Reject
Per CPP	3.4%	2.5%	-26.6%	(6.68)	0.000	Reject

Table 16 – Comparison of Seasonal Usage: Control to Test Groups

Table 17 presents the comparisons between the predicted and actual load for the same four test groups. This table presents the predicted and actual average load during the eight CPP events, the absolute load reduction, the percentage reduction, the T-Test statistics, the probability of getting a large T, and the results of the null hypothesis that the two means are equal. It is important to note that the actual load for every group display a lower load than the predicted. For the RTOU CPP group #1, the only statistical difference is calculated for the August 10th event. For the RTOU CPP-Therm test group #2, statistically significant reductions were noted for four of the eight events and in aggregate. For the RTOU CPP test group #3, all but two of the events show a significant load reduction during the CPP event hours. Finally, for the RTOU CPP-Therm test group #4, all but the first event were statistically significant.

Three Tier TOU with CPP (Pre/Post: Test to Test)									
CPP Event			Predicted	Actual	Difference	Percent			
	Hour Ending		Group #1	Group #1	Actual-Predicted	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	4.83	4.75	-0.08	-1.7%	(0.23)	0.821	Cannot Reject
21-Jul-05	3:00 PM	6:59 PM	5.57	5.00	-0.57	-10.2%	(1.52)	0.130	Cannot Reject
22-Jul-05	3:00 PM	6:59 PM	4.92	5.01	0.08	1.7%	0.24	0.811	Cannot Reject
26-Jul-05	3:00 PM	6:59 PM	5.14	4.70	-0.44	-8.6%	(0.61)	0.540	Cannot Reject
2-Aug-05	3:00 PM	6:59 PM	4.98	4.59	-0.39	-7.7%	(1.07)	0.285	Cannot Reject
9-Aug-05	3:00 PM	6:59 PM	4.95	4.88	-0.07	-1.3%	(0.18)	0.857	Cannot Reject
10-Aug-05	3:00 PM	6:59 PM	4.90	4.13	-0.77	-15.8%	(2.23)	0.027	Reject
19-Aug-05	3:00 PM	6:59 PM	5.24	4.92	-0.32	-6.1%	(0.86)	0.391	Cannot Reject
Average			5.07	4.90	-0.17	-3.3%	(0.48)	0.456	Cannot Reject

Three Tier TOU with CPP and Thermostat (Pre/Post: Test to Test)									
CPP Event			Predicted	Actual	Difference	Percent			
	Hour Ending		Group #2	Group #2	Actual-Predicted	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	4.41	4.05	-0.36	-8.2%	(1.37)	0.172	Cannot Reject
21-Jul-05	3:00 PM	6:59 PM	4.96	4.10	-0.86	-17.3%	(2.58)	0.011	Reject
22-Jul-05	3:00 PM	6:59 PM	4.46	4.24	-0.22	-4.9%	(0.77)	0.443	Cannot Reject
26-Jul-05	3:00 PM	6:59 PM	4.69	4.46	-0.22	-4.7%	(0.67)	0.502	Cannot Reject
2-Aug-05	3:00 PM	6:59 PM	4.49	3.77	-0.72	-16.1%	(2.37)	0.019	Reject
9-Aug-05	3:00 PM	6:59 PM	4.46	4.33	-0.13	-3.0%	(0.39)	0.695	Cannot Reject
10-Aug-05	3:00 PM	6:59 PM	4.47	3.77	-0.70	-15.7%	(2.50)	0.014	Reject
19-Aug-05	3:00 PM	6:59 PM	4.69	3.99	-0.69	-14.8%	(2.26)	0.026	Reject
Average			4.58	4.05	-0.53	-11.6%	(1.93)	0.056	Reject

Three Tier TOU with CPP (Pre/Post: Control to Test)									
CPP Event			Predicted	Actual	Difference	Percent			
	Hour Ending		Group #3	Group #3	Actual-Predicted	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5.23	4.93	-0.30	-5.8%	(1.25)	0.213	Cannot Reject
21-Jul-05	3:00 PM	6:59 PM	6.04	5.67	-0.37	-6.2%	(3.70)	0.000	Reject
22-Jul-05	3:00 PM	6:59 PM	5.30	5.07	-0.23	-4.3%	(0.71)	0.477	Cannot Reject
26-Jul-05	3:00 PM	6:59 PM	5.58	4.89	-0.70	-12.5%	(2.46)	0.015	Reject
2-Aug-05	3:00 PM	6:59 PM	5.37	4.79	-0.58	-10.8%	(2.18)	0.031	Reject
9-Aug-05	3:00 PM	6:59 PM	5.31	4.64	-0.67	-12.6%	(2.59)	0.010	Reject
10-Aug-05	3:00 PM	6:59 PM	5.28	4.36	-0.92	-17.4%	(3.70)	0.000	Reject
19-Aug-05	3:00 PM	6:59 PM	5.65	4.89	-0.76	-13.5%	(2.57)	0.011	Reject
Average			5.47	4.81	-0.66	-12.1%	(2.68)	0.008	Reject

Three Tier TOU with CPP and Thermostat (Pre/Post: Control to Test)									
CPP Event			Predicted	Actual	Difference	Percent			
	Hour Ending		Group #4	Group #4	Actual-Predicted	Difference			
Date	Start	End	(kW)	(kW)	(kW)	(%)	T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5.23	4.60	-0.63	-12.1%	(1.28)	0.205	Cannot Reject
21-Jul-05	3:00 PM	6:59 PM	6.09	4.11	-1.98	-32.5%	(4.38)	0.000	Reject
22-Jul-05	3:00 PM	6:59 PM	5.34	4.11	-1.23	-23.0%	(2.81)	0.006	Reject
26-Jul-05	3:00 PM	6:59 PM	5.53	4.27	-1.26	-22.7%	(2.77)	0.007	Reject
2-Aug-05	3:00 PM	6:59 PM	5.43	3.53	-1.90	-35.0%	(4.33)	0.000	Reject
9-Aug-05	3:00 PM	6:59 PM	5.38	3.64	-1.74	-32.4%	(3.83)	0.000	Reject
10-Aug-05	3:00 PM	6:59 PM	5.29	3.88	-1.41	-26.7%	(3.17)	0.002	Reject
19-Aug-05	3:00 PM	6:59 PM	5.71	3.96	-1.75	-30.7%	(3.76)	0.000	Reject
Average			5.50	4.06	-1.44	-26.2%	(3.45)	0.001	Reject

Table 17 – Comparison during CPP Events

4.4 General Conclusions

The study results indicate the following:

- The critical peak pricing component of the time-of-use rate does motivate customers to reduce demand during most of the CPP events.

- The enabling technology was a key component of the offering with the groups receiving the “smart” thermostat displaying much stronger load response (more than double) during CPP events when compared to the CPP only group.
- The conclusion regarding the load shifted between periods was mixed. Both the TOU: CPP and the TOU: CPP-Therm groups displayed a significant shift in load during the CPP periods. However, only the TOU: CPP group displayed a statistically significant shift in energy use between the on-peak and off-peak periods.
- The researchers believe that there was insufficient evidence to conclude that the second year CPP: TOU participants substantially improved their load reductions in the second year when compared to their first year of participation. However, the percentage of total use during the CPP period was statistically lower in 2005 when compared to 2004.
- The CPP: TOU-Therm participants displayed an average demand reduction during CPP events that was 0.53 kW greater in 2005 when compared to 2004 2004 on a weather adjusted basis. There was a slight reduction in the percentage of on-peak use in 2005 when compared to 2004 this difference but this change was not statistically significant.
- Second year control group participants that were moved to the test group in 2005 confirmed that CPP rate is effective in reducing demand. Both the new CPP: TOU and the CPP:TOU-Therm customers reduced a statistically significant amount of load during the CPP periods when they received the CPP rates. Both groups also had lower CPP period usage after receiving the CPP rates.

5 APPENDIX A – CPP EVENT DAY GRAPHS

5.1 CPP Treatment Group

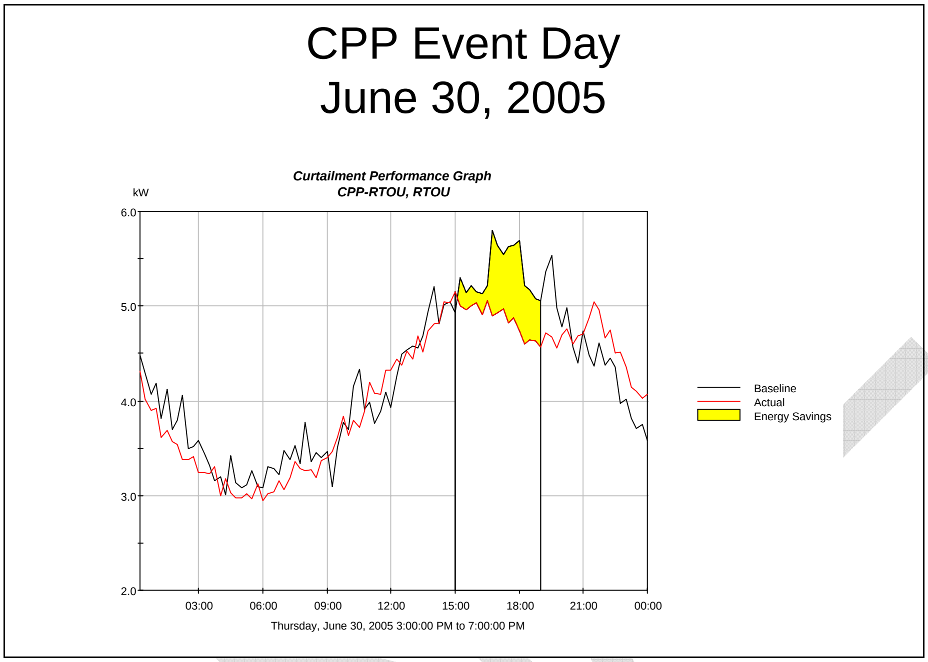

Figure 15 – June 30, 2005: CPP Group

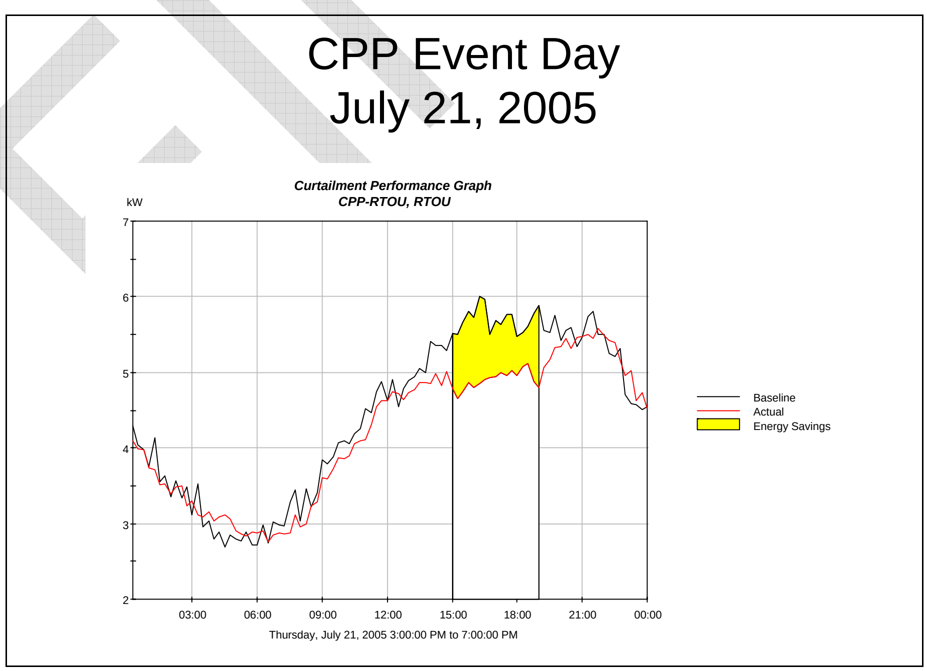

Figure 16 – July 21, 2005: CPP Group

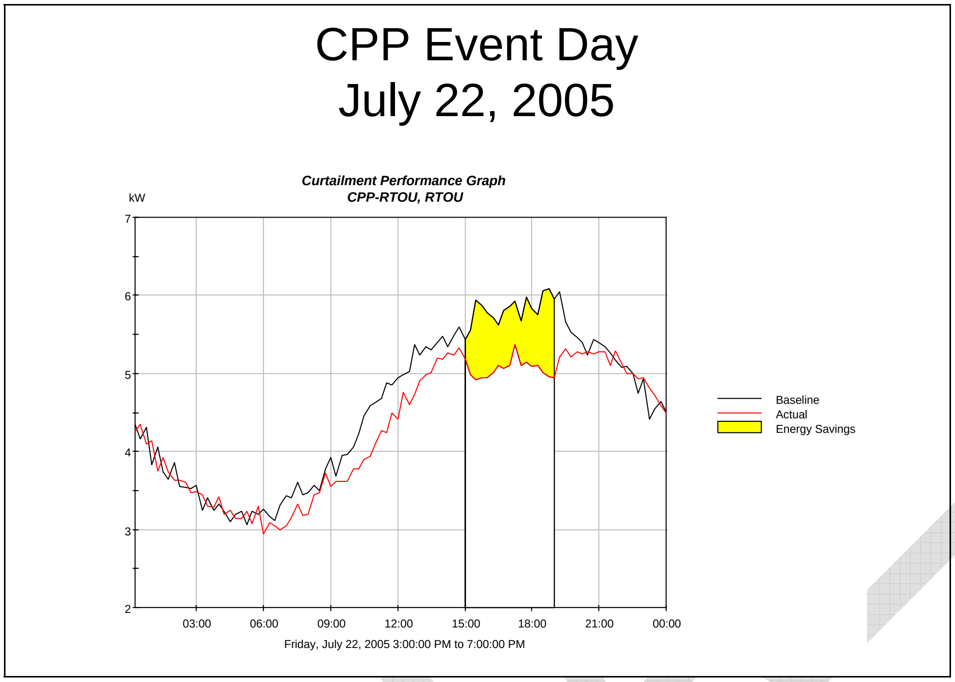

Figure 17 – July 22, 2005: CPP Group

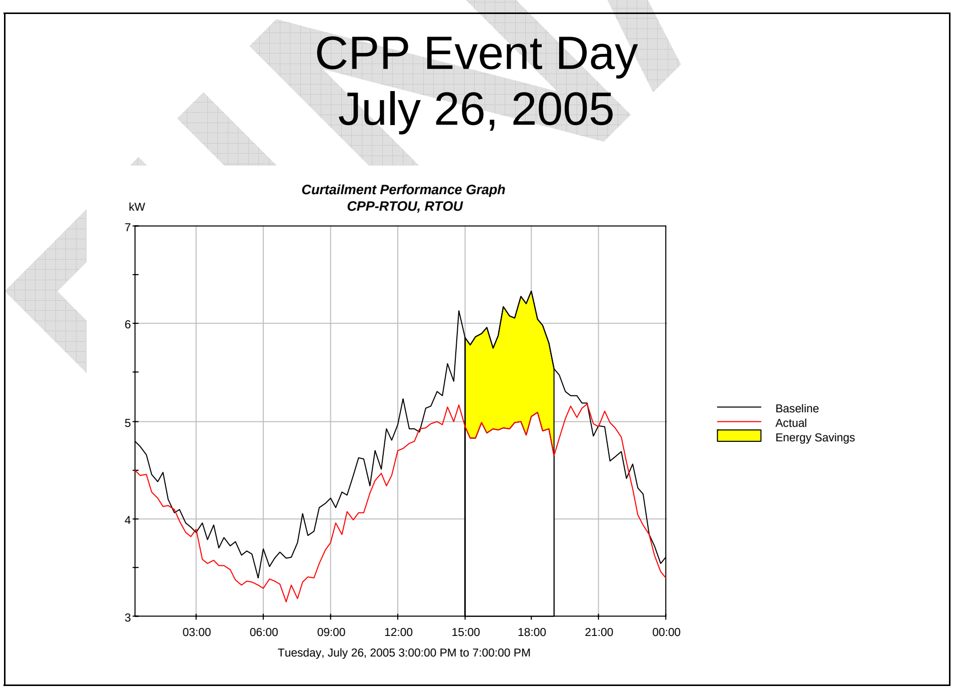

Figure 18 – July 26, 2005: CPP Group

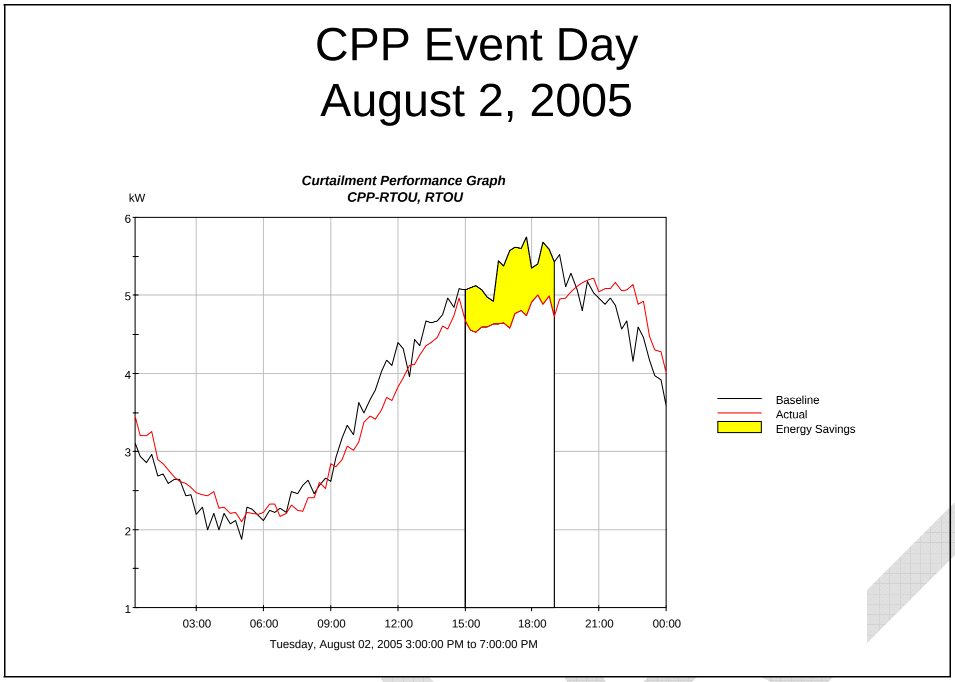

Figure 19 – August 2, 2005: CPP Group

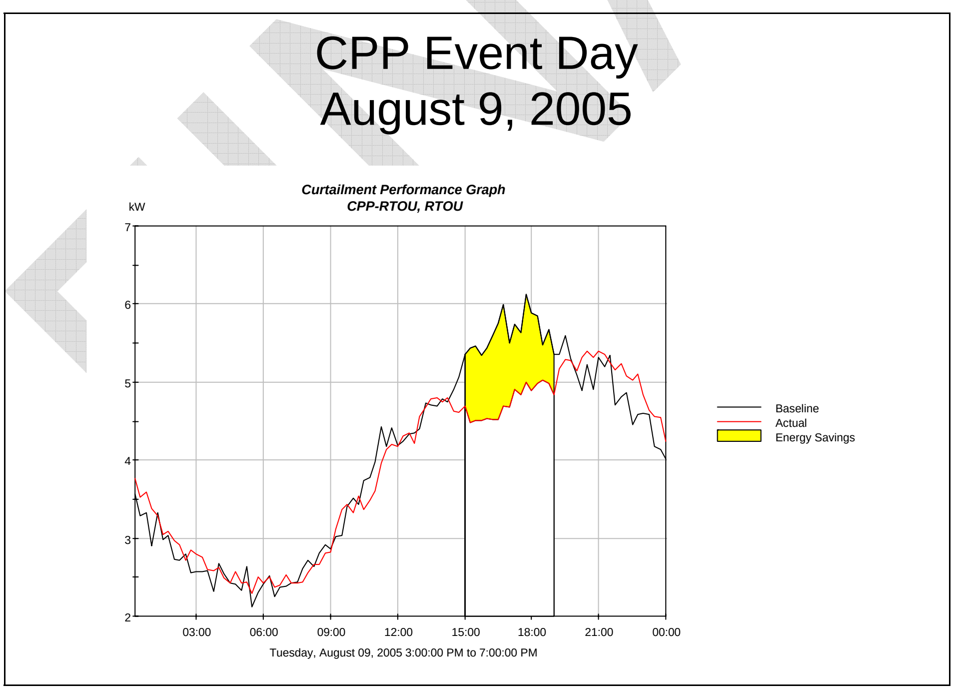

Figure 20 – August 9, 2005: CPP Group

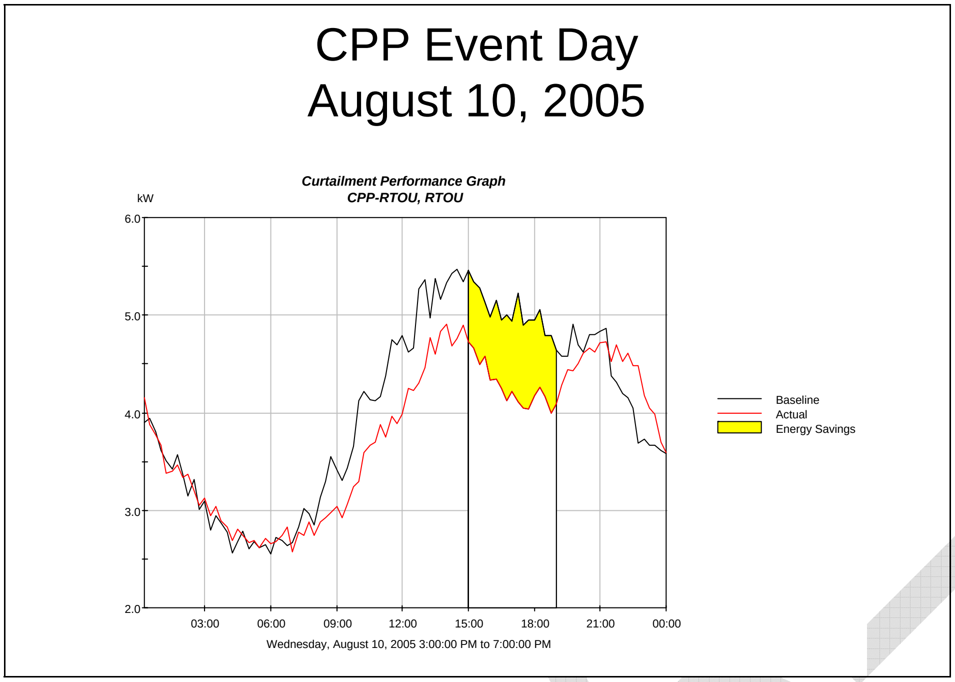

Figure 21 – August 10, 2005: CPP Group

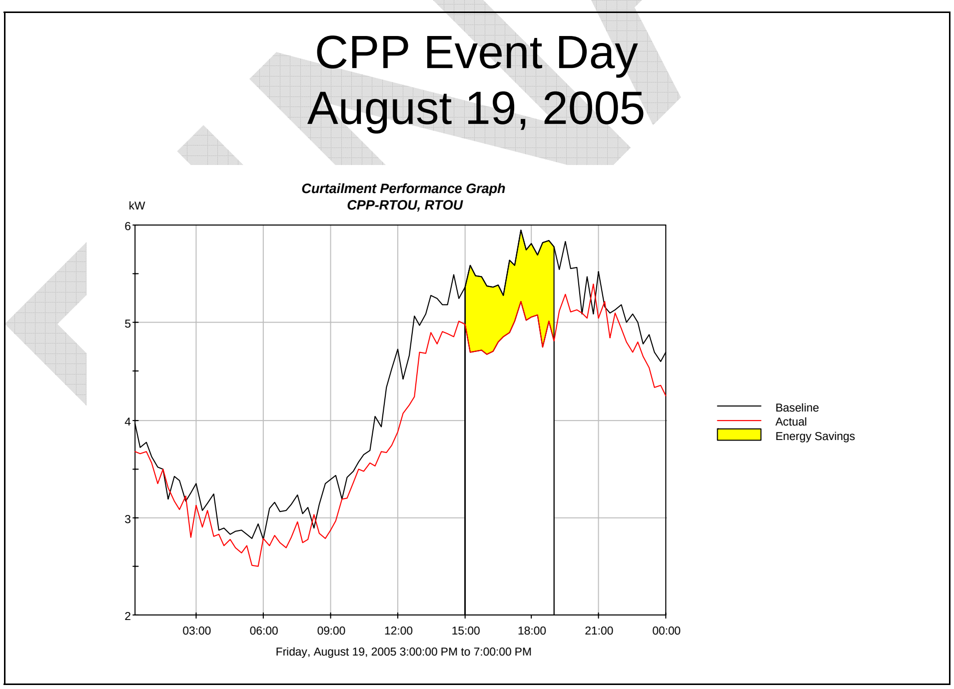

Figure 22 – August 19, 2005: CPP Group

5.2 CPP-THERM Treatment Group

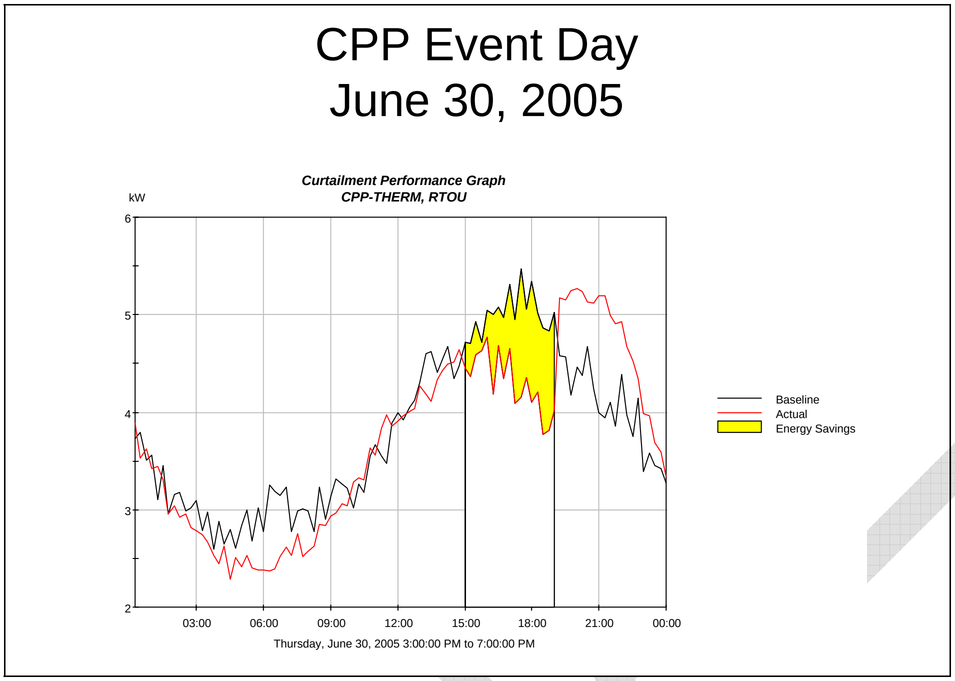

Figure 23 – June 30, 2005: CPP-THERM Group

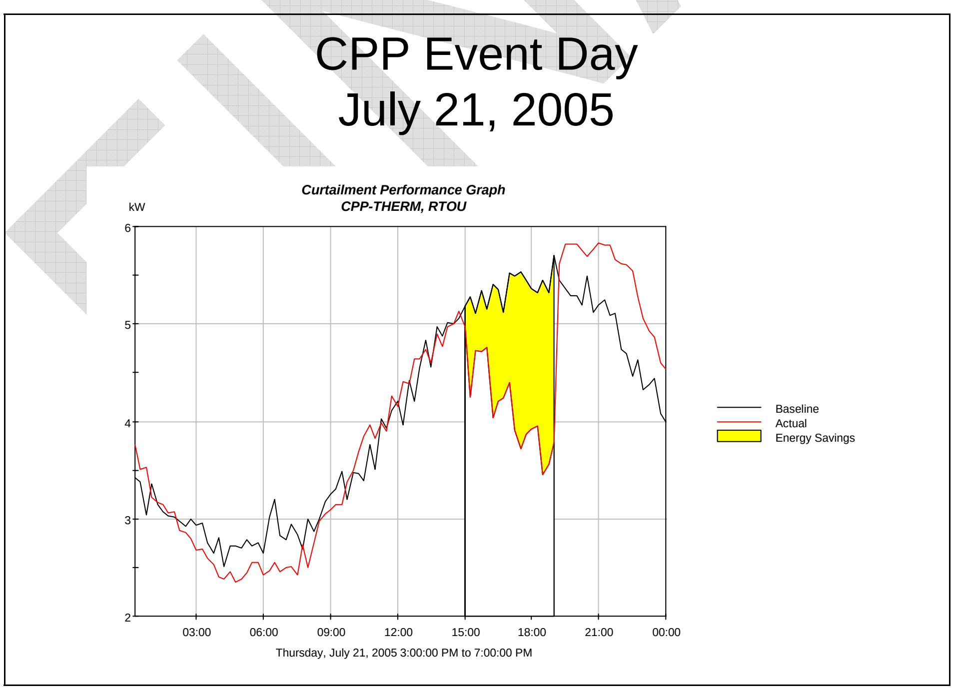

Figure 24 – July 21, 2005: CPP-THERM Group

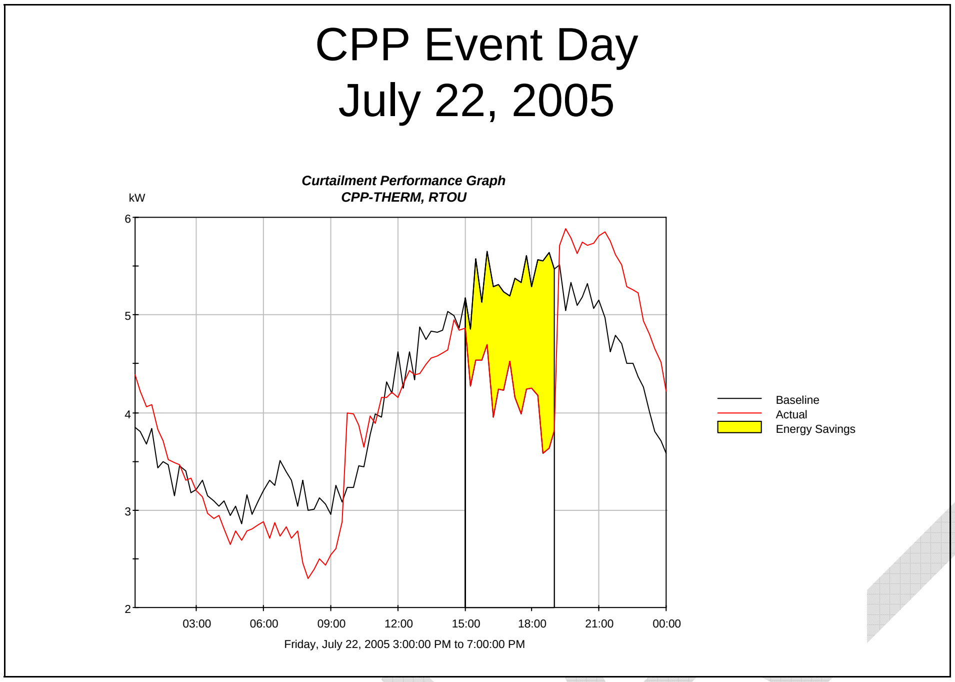

Figure 25 – July 22, 2005: CPP-THERM Group

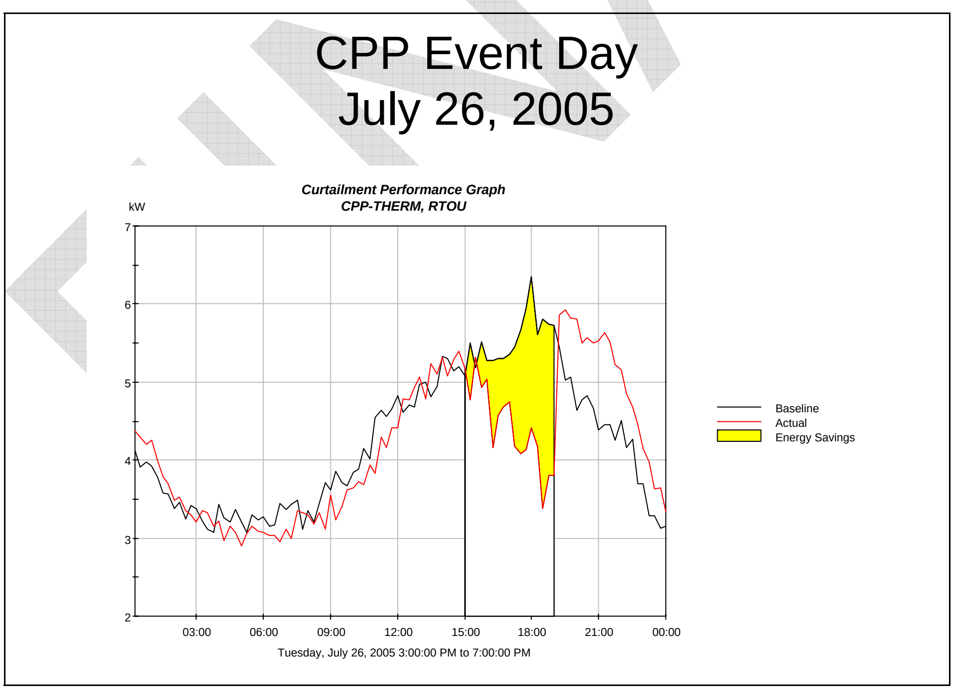

Figure 26 – July 26, 2005: CPP-THERM Group

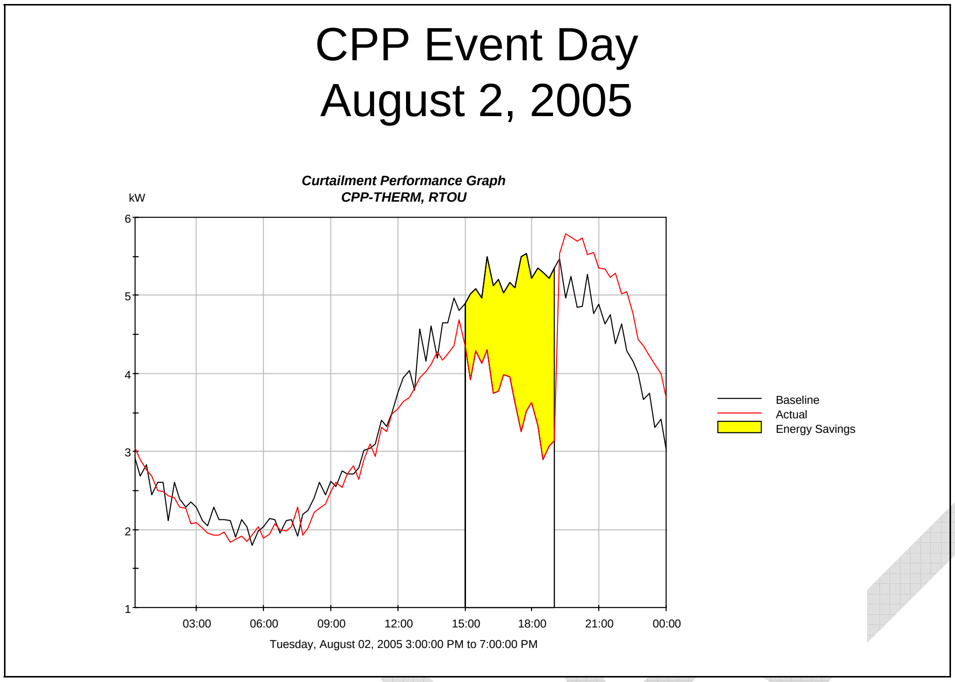

Figure 27 – August 2, 2005: CPP-THERM Group

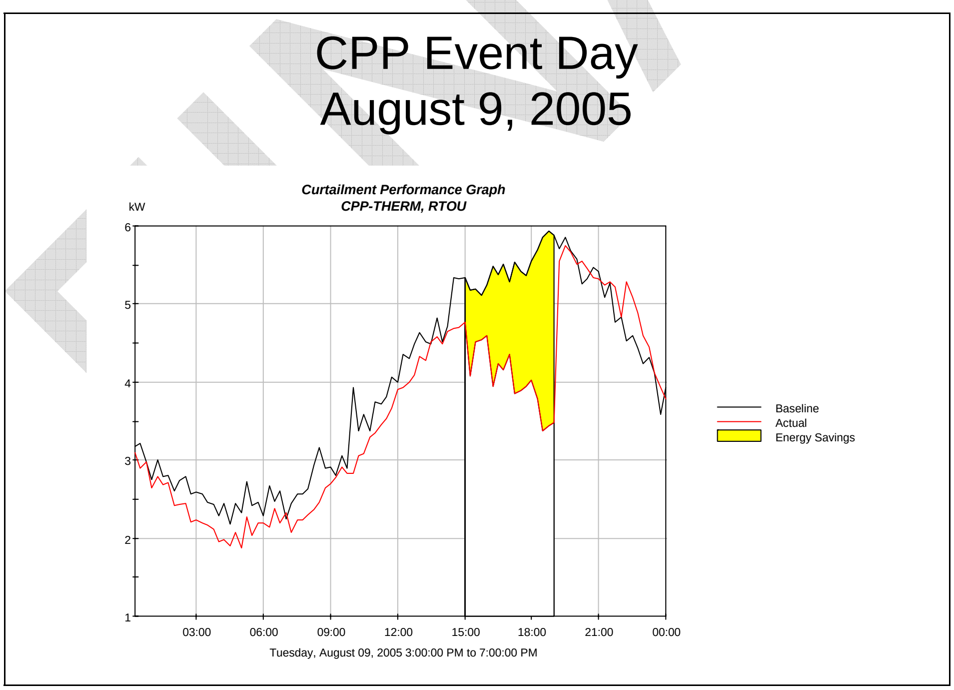

Figure 28 – August 9, 2005: CPP-THERM Group

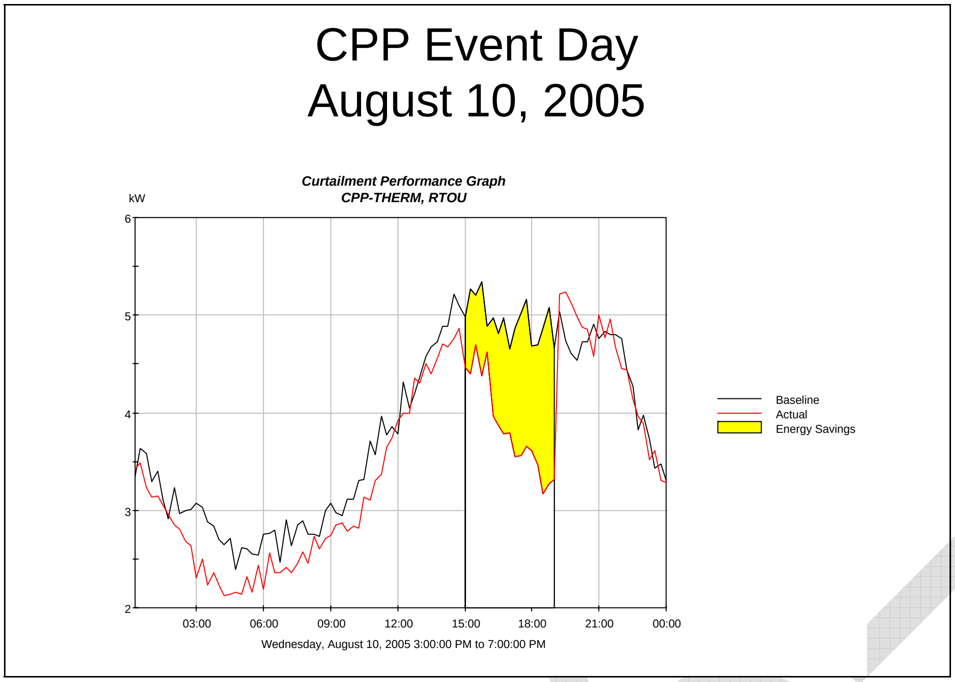

Figure 29 – August 10, 2005: CPP-THERM Group

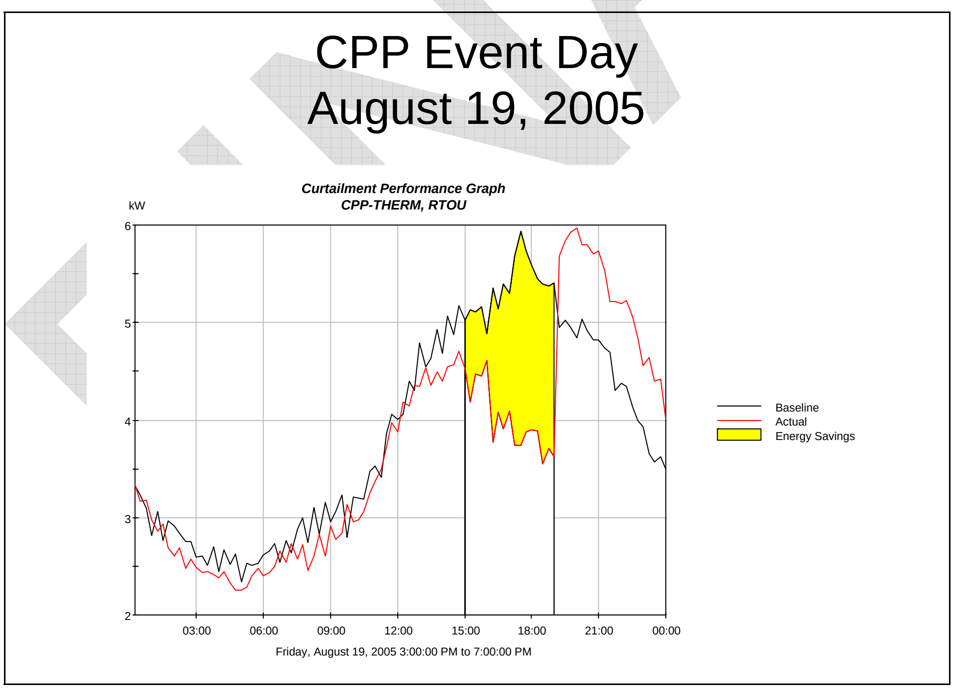

Figure 30 – August 19, 2005: CPP-THERM Group