KANSAS CITY POWER AND LIGHT
ENERGY OPTIMIZER EVALUATION
– PROGRAM YEAR 2007 –

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INTRODUCTION

Kansas City Power and Light's (KCP&L's) Energy Optimizer program (or Air Conditioner Cycling program) – delivered by Honeywell DMC Services L.L.C. – helps limit growing energy demands on the system by controlling participants' air conditioners for up to four hours during particularly hot summer days.

Energy Optimizer participants receive a Honeywell programmable thermostat and the installation of this thermostat (valued at $300) at no cost. The installer inspects the customer's air conditioning system, helps program and test the thermostat, provides the customer with a Quick Reference Guide, and leaves the old thermostat with the customer.

The thermostat contains a wireless receiver that responds to signals sent from KCP&L when peak demand is at its highest and energy curtailment is needed. In 2007, the receivers were used to initiate cycling events – where KCP&L cycled the compressor on and off for no longer than four hours – and ramping events – where KCP&L increased the temperature by one degree every hour, up to three degrees. When operating properly, the thermostats display the word "SAVE" while KCP&L has control of the thermostat. The thermostat returns to the original setting after the four hour period. Besides the thermostat display, there is no other customer notification of peak saving days.

The peak saving days can be called between May and September when demand loads are the highest (never on holidays or weekends). Energy Optimizer participants may choose to opt out of these events one time per month either by phone or internet. They can also select a pre-cooling feature to pre-cool their home prior to all events.

In 2007, four different control strategies were tested on six event days. The initial plan was to test three different four-hour strategies: two cycling strategies and one temperature ramp-up strategy. The two cycling strategies were flexible strategies that changed the cycling level each hour. For example, the modest strategy would cycle the air conditioners 20 minutes on and 10 minutes off for the first hour (33% off); 15 minutes on and 15 minutes off for the second hour (50% off); 10 minutes on and 20 minutes off for the third hour (67% off); and 20 minutes on and 10 minutes off for the last hour (33% off). The flexible cycling strategies were tested to see if load impacts for an identified peak hour could be increased without significantly decreasing customer comfort during the overall event. For the ramp-up strategy, KCP&L increased the customers' temperature by one degree per hour to a maximum of 3 degrees. However, after the third event, it was decided that the temperature ramp-up strategy should be replaced with another cycling strategy for the remainder of the program events. In addition, the length of each event was shortened from four to three hours. The four control strategies are:

- **Strategy A - Aggressive Cycling**
  - 4-hour: 50% - 67% - 67% - 50%
  - 3-hour: 50% - 67% - 67%
- **Strategy B - Modest Cycling**
  - 4-hour: 33% - 50% - 67% - 33%
  - 3-hour: 33% - 50% - 67%
- **Old Strategy C - Temperature ramp-up**
  - 4-hour: 1 - 2 - 3 - 3 degrees

- 3-hour: 1 - 2 - 3degrees

- **New C - Moderate (50%) Cycling**
  - 3-hour: 50% - 50% - 50%

Table 1 presents the six peak saving days in 2007, the length of each event, and which of the strategies were tested.

Table 1: KCP&L Peak Saving Days, Times and Strategies for the Energy Optimizer Program

Event #	Date	Time	Strategy
1	Aug-7	2 p.m. to 6 p.m.	A, B, Old C
2	Aug-8	2 p.m. to 6 p.m.	A, B, Old C
3	Aug-9	3 p.m. to 6 p.m.	A, B, Old C
4	Aug-13	3 p.m. to 6 p.m.	A, B, New C
5	Aug-14	3 p.m. to 6 p.m.	A, B, New C
6	Aug-15	3 p.m. to 6 p.m.	A, B, New C

The 2007 cycling and ramp-up strategies were tested on a total of 896 unique participants: 448 in Missouri and 448 in Kansas, and 448 single family homes and 448 multifamily homes.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The ODC team conducted both a process-based survey and an impact evaluation of the 2007 Energy Optimizer program. Key findings and recommendations from our research are presented below.

Finding: The load reduction analysis finds that the program does indeed produce substantive and measurable effects on air conditioning load during control periods. Specifically:

- **The results from the 2007 evaluation are very similar to the 2006 results.** The 2007 regression model showed that cycling the air conditioners 15 minutes on and 15 minutes off (50%, or moderate, cycling) produces an average decrease of 1.04 kW for each hour of the control period for Missouri single family homes and 0.96 kW for Kansas single family homes. Results for multifamily homes are 0.48 kW in Missouri and 0.40 kW in Kansas. The resulting estimated savings are presented in Table 2. Results are very similar across both years.

Table 2: Energy Optimizer Impacts by State and House Type (for moderate 50% cycling control strategy)

State – House Type	2006 Impact (Average kW)	2007 Impact (Average kW)
Missouri		
Single Family	-1.11	-1.04
Multifamily	-0.53[a]	-0.48
Kansas		
Single Family	-0.92	-0.96
Multifamily	-0.53	-0.40

[a] The difference across states for the multifamily impacts in 2006 was not statistically significant at the 95% confidence level (the t-value was below 1.9).

- **Strategies that reached 67% cycling achieved a greater level of load reduction than the moderate 50% cycling strategy.** To be effective, these flexible strategies would need to be matched carefully to the expected system peak hour. Table 3 compares the load impacts observed for the different strategies.

Table 3: Average kW Impacts for Different Cycling Strategies 2007[a]

CONTROL STRATEGY And State	Single Family			Multifamily		
	3-4 p.m.	4-5 p.m.	5-6 p.m.	3-4 p.m.	4-5 p.m.	5-6 p.m.
AGGRESSIVE CYCLING	***50%***	***67%***	***67%***	***50%***	***67%***	***67%***
Missouri	-0.82	-1.33	-1.36	-0.38	-0.61	-0.63
Kansas	-0.75	-1.23	-1.26	-0.31	-0.51	-0.52
MODEST CYCLING	***33%***	***50%***	***67%***	***33%***	***50%***	***67%***
Missouri	-0.54	-0.97	-1.28	-0.25	-0.45	-0.59
Kansas	-0.50	-0.90	-1.18	-0.21	-0.37	-0.49
MODERATE 50% CYCLING	***50%***	***50%***	***50%***	***50%***	***50%***	***50%***
Missouri	-0.82	-1.06	-1.02	-0.38	-0.49	-0.47
Kansas	-0.75	-0.98	-0.94	-0.31	-0.41	-0.39

[a] Discrepancies between the reported control strategy and the control event logs as well as unusual weather patterns made results for August 7 and August 8 difficult to estimate accurately. The aggressive and modest cycling results are based on the other four control event days.

- **The temperature ramp-up strategy with a three degree increase in temperature showed impacts (-1.02 for Single Family) equivalent to the impact achieved with 50% cycling (-0.96 to –1.04).** The main difference between the temperature ramp-up and 50% cycling strategies is not the maximum impact achievable, but the shape of the impact over the control period. The impacts for 50% cycling are relatively constant after the first hour, while the impacts for temperature ramp-up slowly increase and then slightly decrease over the control period.

Recommendation: KCPL should consider utilizing a flexible cycling strategy that reaches a 67% cycling level since it creates greater system impacts and does not appear to cause significant difference in the customers' awareness of the control event, comfort levels or in opt-out rates.

Finding: Program impacts for multifamily customers are less than half of what is seen for single family customers. This is true in both Missouri and Kansas. The most striking difference between single family and multifamily homes is the magnitude of the normal load curve for each group. The average load curve exceeds 5.5 kW at its peak during Hour Ending 18 (6 p.m.) for single family customers, while it is less than 1.5 kW for multifamily customers. This large difference in average normal load on very hot days explains why there is such a difference in the level of program impacts for single family and multifamily customers. While the level of program impacts is smaller for multifamily customers, they are actually contributing a larger share of their total load during control events than single family customers.

Recommendation: Benefit/cost ratios for offering the thermostat program to multifamily customers should be reviewed since they are delivering less than half of the program benefits while program costs are probably similar to those for single family customers. It may be possible to improve the impacts from multifamily installations with pre-screening on the size of the air conditioner. For example, CPS Energy in San Antonio requires that 2.5 tons of air conditioning load is present in a multifamily home before they can participate in their "Peak Savers" thermostat load control program.

Finding: During 2007, the program experienced implementation difficulties with cycling times on the first day. As a result, the customer perceptions reported for the aggressive strategy do not exactly reflect the cycling strategy design. In addition, the length of the events was changed from four hours to three hours after the second event day, reducing the direct comparability of customer responses for the three cycling strategies.

Recommendation: While we believe that – despite these limitations – results on customer perceptions of the different cycling strategies are valid, KCP&L should continue to monitor customer comfort and satisfaction with different strategies during future program years.

Finding: Participants experienced low levels of discomfort during the 2007 peak saving day events. Most participants either were not home during the event (29%) or did not notice a change in temperature (46%). Even among participants interviewed after the aggressive cycling event only 21% of single family participants and 26% of multifamily participants noticed a change in temperature during the event. Overall, the percentage of participants noticing a change in temperature did not differ significantly between the three cycling strategies or between single family and multifamily participants.

Approximately 44% of participants who were home and noticed a change in temperature during an event reported being somewhat uncomfortable (34%) or very uncomfortable (10%). This represents 10% of all participants in the 2007 peak saving events. Participants interviewed after the aggressive cycling strategy were more likely to say they were somewhat or very uncomfortable than those interviewed after the moderate and modest strategies. Overall 90% of participants reported that they did not experience any level of discomfort on peak saving days.

Recommendation: Since few participants experienced any discomfort during events KCP&L should continue with the cycling strategy that achieves the greatest load reduction. However, KCP&L and Honeywell may want to look for ways to improve the comfort of the 10% of participants who did feel uncomfortable since it may help to increase overall satisfaction with the program.

Finding: Few participants are aware that they could pre cool and opt out of an event.

Recommendation: Given that comfort during the peak saving days is not a major problem for program participants, the lack of awareness and use of these program features is not a major issue that needs to be addressed by the program. However, given the limitations discussed above, comfort levels should be continued to be monitored. If discomfort becomes an issue, the program may wish to increase promotion of the opt out or pre cool option. Because a large percentage of customers are not home during the events or do not notice that events take place while at home, the number of customers using these features is not likely to rise substantially but might be used by those most uncomfortable during events.

Finding: While few participants (16%) called KCP&L during the summer of 2007 regarding a problem, more than one-third of them stated that their questions were not answered in a timely manor. These participants had problems reaching a KCP&L representative, not getting a call back, or were told their air conditioning unit was causing the problem.

Recommendation: KCP&L and Honeywell may want to increase staff in the call center on control days in order to answer customer questions in a more timely fashion.

Finding: Four out of five customers were satisfied with their new thermostat. Those who were not satisfied found it hard to program and operate, and about 10% of participants report not having received the reference guide. Participants report that installers programmed the thermostat in about two-thirds of homes, but half of these customers changed the programming later.

Recommendation: KCP&L and Honeywell should take additional steps to help customers understand and use their thermostats. KCP&L may want to consider: 1) talking participants through the Quick Reference Guide while onsite, or having the customer program the thermostat under their guidance, 2) specifically pointing out the 800 number and website in the Quick Reference Guide that can be used to assist the customers, and/or 3) following up with customers after the installation process to ensure that they are not having troubles programming their thermostat. Notably, 'providing more explanation and instructions on the thermostat' was the most frequently mentioned recommendation given by program participants.

Finding: Few customers (3%) report any difficulties in signing up for the program; but KCP&L should be aware of the fact that the process of participating and the motivations for participating are very different for multifamily homes compared to single family homes. (Savings are also different.) Multifamily customers usually learn about the program from the landlord, and in many cases, the landlord is the one driving the decision to participate for multifamily participants. Customers in apartments are much less likely to participate on their own, often indicating that they don't know the reason for participating or it was not their choice to participate.

Recommendation: KCP&L and Honeywell need to understand the large differences between single family and multifamily participants (i.e., in how they sign up, why they participate, knowledge of the benefits of the program, overall satisfaction with the program, and savings). Because of these differences, KCP&L and Honeywell may want to tailor the multifamily portion of the program for these participants, and find ways to inform and serve this group better. Since landlords appear to be the primary driver of participation for many multifamily participants, KCP&L and Honeywell may also want to conduct additional research with landlords. (Notably, our survey research focused on multifamily units that had individual contact information in the program database. We did not call units where the only contact information was the landlord or property management company. As such, it is likely that the differences between multifamily and single family customers are even more pronounced than shown in our research.)

METHODOLOGY

The ODC team conducted both an impact and a process evaluation of this program. Our methodologies are presented below.

IMPACT METHODOLOGY

The focus of this evaluation was to conduct a load reduction analysis ("LRA") of the program during the summer of 2007. The purpose of the impact evaluation was to estimate the load reduction associated with directly controlling air conditioners through either cycling the compressor via the thermostat or adjusting the temperature on the thermostat. This analysis used statistical modeling approaches that related metered electricity usage to weather conditions and the control events. Only single family and multifamily residential participants were included in this impact analysis, given the relatively few commercial participants available at the time of the analysis.

To address these issues, the LRA used the following data:

- Interval whole-house metering data
- Hourly temperature and humidity data spanning July and August
- Records of control dates, intervals, and duration.

In addition to the data described above, we also have data collected by Honeywell from the thermostats from a sample of 153 participants.[1] That data includes:

- Compressor run-time
- Indoor temperature
- Indicator for receipt of control signal

This information was used to determine the effect of the program on indoor temperature.

The sample design called for the following number of metered sites:

Table 4: Metered Data Sample Sizes

	Missouri	Kansas	Total
Single family residential	224	224	448
Multifamily residential	224	224	448
Total	448	448	896

[1] Honeywell was charged with collecting this data from 150 households to support the impact analysis but because of problems getting into the participants' homes and problems with the data, Honeywell was only able to collect useful data on 43 households.

The 2007 control test plan introduced rotating strategies on each control event day, including a comparison group that received no control signals during each event. (In general research this would be called a control group, but given that this is a study of control events the name 'control group' becomes confusing, so it will be referred to as the comparison group.) The total sample was divided into four random sample groups and each group received a different control strategy during each event day. This mitigated the chance that some control strategies would only get tested on days that were cooler than other test days. The rotating comparison group also created the possibility of being able to directly compare impacted load shapes to normal load shapes on each control event day. Table 5 presents the rotating control strategies used in 2007.

Table 5: Strategies Tested on Control Event Days in 2007

Event #	Date	Day of Week	Start Hour	Stop Hour	Duration (hours)	Sample Group 1	Sample Group 2	Sample Group 3	Sample Group 4
1	Aug 7	Tues	14	18	4	A	B	Old C	D
2	Aug 8	Wed	14	18	4	B	Old C	D	A
3	Aug 9	Thurs	15	18	3	Old C	D	A	B
4	Aug 13	Mon	15	18	3	D	A	B	New C
5	Aug 14	Tues	15	18	3	A	B	New C	D
6	Aug 15	Wed	15	18	3	B	New C	D	A
Control Strategies *A – Aggressive Cycling B - Modest Cycling Old C – Temperature Ramp-up D – No Control (Comparison Group) New C – Moderate 50% Cycling*									

PROCESS METHODOLOGY

Following the cycling events in August 2007, ODC conducted a total of 468 interviews with participants in the Energy Optimizer program (280 with single family participants and 188 with multifamily participants, as classified by Honeywell's program database). We selected single family customers from a sample of participants who signed up before the peak saving days so that we could ask respondents about the events. Notably, our research focused on multifamily units that had individual contact information in the program database. We did not call units where the only contact information was the landlord or property management contact. As such, it is likely that the differences between single family and multifamily customers are even more pronounced than shown in our research.

The process related results are based on households (not thermostats or number of air conditioning units). Results are weighted to reflect the distribution of participant types in the program (75% single family homes, and 25% multifamily homes). The survey represents both Missouri and Kansas respondents. However, there were no noticeable process-related differences between respondents in the two states. Therefore, process results are presented for the Energy Optimizer program as a whole.

Table 6: Number of Interviews by Event Date and Strategy

Event #	Date	Duration	Strategy	Calls Completed
1	Aug-7	4 hours	A – Cycle aggressive	70 SF / 70 MF
2	Aug-8	4 hours	B – Cycle modest	70 SF / 35 MF
3	Aug-9	3 hours	Old C – Ramp 1 degree per hour	None
4	Aug-13	3 hours	B – Cycle modest	70 SF / 13 MF
5	Aug-14	3 hours	New C – Cycle moderate (50%)	70 SF / 70 MF
6	Aug-15	3 hours	New C – Cycle moderate (50%)	

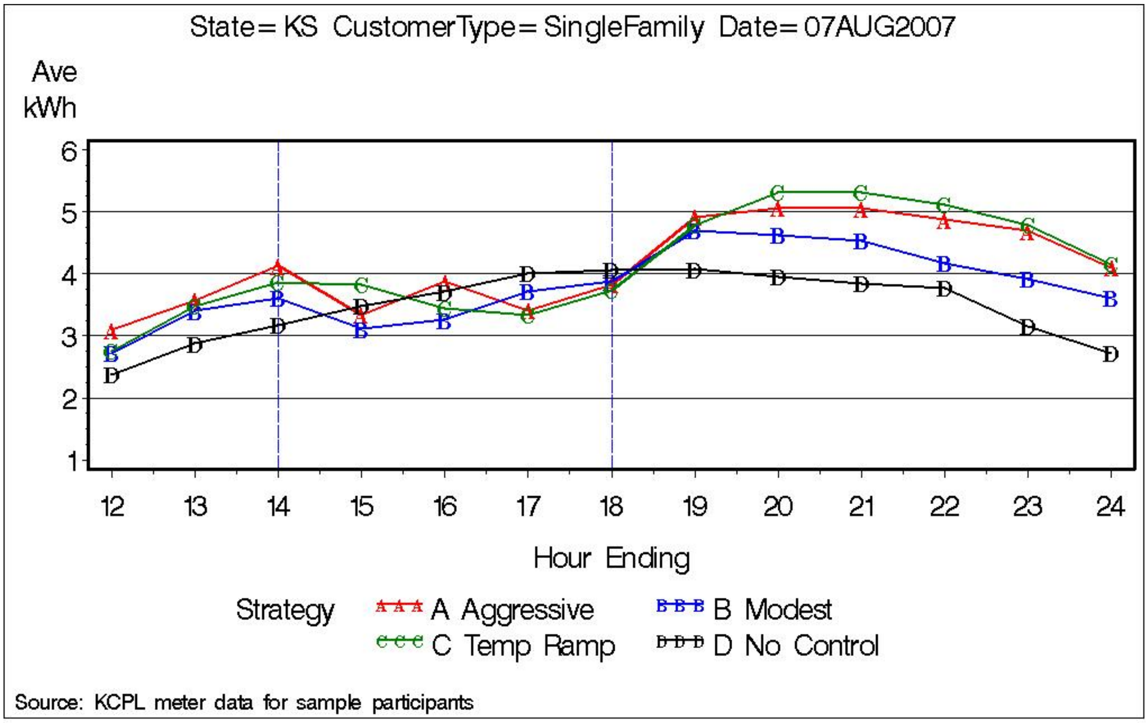
IMPACT FINDINGS

This section presents the results of the impact evaluation of the KCP&L's Energy Optimizer program for the summer of 2007. The purpose of the impact evaluation was to estimate the load reduction associated with several air conditioner cycling strategies and a temperature ramp-up strategy. Our analysis used statistical modeling approaches that related metered electricity usage to weather conditions and the control events.

Load Shape Overview

The simplest approach to determining program impacts is to compare the average load curves for each strategy that was tested with the comparison group on each control event day. Impact Appendix A presents the full set of these load curves for each customer group of interest, on each control event day. An example of these load curves is presented in Figure 1 which shows the data for Kansas single family participants on August 7.

Figure 1: Load Shapes for Kansas Single Family Homes on August 7



These load curves are typical of what is seen in all of the other charts in the Appendix. Clearly, the control strategies do affect the average load shape during the control hours, with a drop in consumption for both the cycling and temperature ramp-up strategies. This figure also suggests that there may be an increase in consumption after the control period – the "snapback" effect.

However, the exact average impacts are difficult to measure because the comparison group usage on each event day tends to run higher or lower than the other groups before the event begins.

Impacts could be estimated by normalizing the comparative load shapes, but this still leaves the problem of different weather conditions on each event day.

Summarizing load impacts by measuring differences from the comparison group on each event day could be useful for giving some insight into the effect of the program, but it cannot tell the full story. These graphs cannot separate out the effect of different starting points and different weather conditions from the effect of the program. Therefore, these results may be misleading. Better estimates of impacts can be developed by using a time-series, cross-sectional regression model that incorporates all the available data. The benefit of this model is that it controls for many non-program effects such as differences in weather as well as differences in the magnitude of energy usage across customers. The regression approach is described further below.

Analysis Approach

The evaluation team's preferred approach is to directly model kW load, rather than relying upon simple or calibrated representative day comparisons, or on approaches that model duty cycles as a stand-alone estimation method. In this approach, the measured hourly kW load is the dependent variable in a regression equation that includes weather terms, household demographics, and the control. In essence, a structural model of the AC load is developed. The impact of the control is simply the coefficient on the control variable. This approach is intuitively appealing and has produced very precise estimates of program effects.

This analysis further refines this approach by using pooled time-series and cross-sectional data (panel data). That is, all hourly observations over the summer for all households are combined into one model. In order to capture differences across households, the model includes a constant term that is specific to each household (termed a fixed-effects model). This constant term captures the effect on hourly AC load of all the variables that do not change over time. Thus, this model indirectly controls for such things as the orientation of the house, the size of the house, and the characteristics of the AC.

In order to quantify the impacts of the program, a fixed-effect panel data model was used that combined weather data with the interval meter data. For this analysis, data are available both across households (i.e., cross-sectional) and over time (i.e., time-series). The fixed effects model can be viewed as a type of differencing model in which all characteristics of the home – which (1) are independent of time and (2) determine the level of hourly electricity use – are captured within the house-specific constant terms. In other words, differences in housing characteristics that cause variation in the level of energy consumption, such as building size and structure, are captured by constant terms representing each unique house.

Algebraically, the fixed-effect panel data model is described as follows:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it},$$

where:

y_{it} = Energy consumption for home *i* during hour *t*

α_i = constant term for home *i*

ß = vector of coefficients

x_{it} = vector of variables that represent factors causing changes in AC consumption for home *i* during hour *t* (i.e., weather and control strategies)

ε_{it} = error term for home *i* during hour *t*.

Cycling Results

The hourly demand model was estimated over all metered participants during the months of July and August. The model uses weather variables and indicators for the hour of the day to capture general daily usage patterns. Because the number of multifamily and single family participants in the sample is not in the same proportion as that in the general population, we analyze the results separately by house type (single family versus multifamily) and by state (Missouri versus Kansas). Table 7 presents the model estimated over the single family sample, and Table 8 presents the model estimated over the multifamily sample.[2]

Results from both 2006 and 2007 are presented side-by-side for comparison purposes.[3] There were small differences in the model structure and the weather variables used in the two years, but the impact coefficients presented here are comparable. In 2007, the Temperature-Humidity Index (THI)[4] was used instead of separate temperature and humidity variables. The THI has a closer relationship to air-conditioning use.

[2] Separate models were estimated for the two house types to allow for different responses to the weather and hourly variables in the variables. For example, a single family customer's usage increases by 0.11 kWh for each degree increase in temperature, while a multifamily customer increases by only 0.06 kWh. A single model cannot capture this difference and may thus bias the estimated program impacts.

[3] The 2006/2007 comparison only includes the 50% strategy since it was the only cycling strategy used in 2006.

[4] THI=(0.55 x Outdoor Dry Bulb Temperature) + (0.2 x Dewpoint Temperature) - 48.5

Table 7: Energy Optimizer Single Family Impacts (for moderate 50% cycling control strategy)

Variable	2006 Coefficient (t-value)	2007 Coefficient (t-value)
Hour is a control event and the single family customer's AC is being cycled[a]	-0.92 (-33.9)	-0.96 (-34.7)
Hour is a control event and the single family customer's AC is being cycled and the customer is in Missouri (additive effect to the term above)	-0.19 (-5.1)	-0.08 (-2.0)
Temperature	0.11 (234.5)	
Humidity	0.02 (70.0)	
THI		0.13 (223.6)
Sample Size Households	284,272 253	400,633 443
R-Squared	58%	60%
[a] There was no variation in the cycling impact by hour of the control hour. In other words, the impact was consistent at 0.92 kWh across all hours of the curtailment event. In the 2007 model, this is true for the second and third hours of the event, but impacts during the first hour are 75% of what is reported here because of the 30-minute randomized start for these events. (See also page 15.)		

This table shows that the estimated impacts for 2006 and 2007 are very similar. The biggest change is that there is less difference between Kansas and Missouri homes. In addition to having a smaller difference between the states, there is also a reduction in the statistical significance of the difference. Given a t-value of only –2.0, the difference in impacts between the two states is statistically significant at the 95% confidence level, but just barely. Overall, the consistency of results from year to year, given a completely new set of data, gives credibility to the impact estimates and the validity of the sample designs.

Table 8: Energy Optimizer Multifamily Impacts (for moderate 50% cycling control strategy)

Variable	2006 Coefficient (t-value)	2007 Coefficient (t-value)
Hour is a control event and the multifamily customer's AC is being cycled	-0.53 (-18.2)	-0.40 (-20.2)
Hour is a control event and the multifamily customer's AC is being cycled and the customer is in Missouri (additive effect to the term above)	0.02 (0.5)	-0.08 (-2.86)
Temperature	0.06 (156.1)	
Humidity	0.01 (46.8)	
THI		0.06 (145.1)
Sample Size Households	254,837 295	363,438 437
R-Squared	52%	48%

For multifamily homes, there is more of a difference in impact estimates between 2006 and 2007. While 2006 showed no statistically significant difference in impact estimates for the two states, 2007 data shows that Missouri customers had a larger impact. This is consistent with the Single Family results.

The resulting estimated savings are presented in Table 9.

Table 9: Energy Optimizer Impacts by State and House Type (for moderate 50% cycling control strategy)

State – House Type	2006 Impact (Average kW per hour)	2007 Impact (Average kW per hour)
Missouri		
Single Family	-1.11	-1.04
Multifamily	-0.53[a]	-0.48
Kansas		
Single Family	-0.92	-0.96
Multifamily	-0.53	-0.40

[a] The difference across states for the multifamily impacts in 2006 was not statistically significant at the 95% confidence level (the t-value was below 1.9).

The results from the 2007 regression model show that cycling the air conditioners 15 minutes on and 15 minutes off (50% cycling) produces an average decrease of 1.04 kW for each hour of the control period for Missouri single family homes and 0.96 kW for Kansas single family homes. Results for multifamily homes are 0.48 kW in Kansas and 0.40 kW in Missouri. Based upon the distribution of participant types in the program as of January 3, 2007, (25% multifamily and 75% single family), this implies that the actual average impact per participant across the whole program is 0.86 kW. In conclusion, the Energy Optimizer program does produce measurable and statistically significant reductions in participants' energy use during cycling events.

The flexible cycling strategies were also analyzed and compared to the moderate 50% strategy. **Strategies that reached 67% cycling achieved a greater level of load reduction than the moderate 50% cycling strategy.** To be effective, these flexible strategies would need to be matched carefully to the expected system peak hour. Table 10 compares the load impacts observed for the different strategies.

Table 10: Average kW Impacts for Different Cycling Strategies 2007[a]

CONTROL STRATEGY And State	Single Family			Multifamily		
	3-4 p.m.	4-5 p.m.	5-6 p.m.	3-4 p.m.	4-5 p.m.	5-6 p.m.
AGGRESSIVE CYCLING	***50%***	***67%***	***67%***	***50%***	***67%***	***67%***
Missouri	-0.82	-1.33	-1.36	-0.38	-0.61	-0.63
Kansas	-0.75	-1.23	-1.26	-0.31	-0.51	-0.52
MODEST CYCLING	***33%***	***50%***	***67%***	***33%***	***50%***	***67%***
Missouri	-0.54	-0.97	-1.28	-0.25	-0.45	-0.59
Kansas	-0.50	-0.90	-1.18	-0.21	-0.37	-0.49
MODERATE 50% CYCLING	***50%***	***50%***	***50%***	***50%***	***50%***	***50%***
Missouri	-0.82	-1.06	-1.02	-0.38	-0.49	-0.47
Kansas	-0.75	-0.98	-0.94	-0.31	-0.41	-0.39

[a] Discrepancies between the reported control strategy and the control event logs as well as unusual weather patterns made results for August 7 and August 8 difficult to estimate accurately. The aggressive and modest cycling results are based on the other four control event days.

When reviewing the impacts reported in this table it is important to keep in mind that there was a 30-minute randomized start used with all of the strategies. For example, during the first half-hour of the moderate 50% cycling event, each air-conditioner began their control at a randomized moment within that time frame. On average, each air-conditioner was only under control for half of the first half hour. Looking at this on an hourly basis, the average air-conditioner was only controlled at 50% cycling for 75% of the hour. That is why impacts for the first hour of the moderate 50% cycling strategy are less than what is achieved in the succeeding hours. The same pattern holds true for all of the events in all of the hours. A 67% cycling hour that follows a 50% cycling hour will show less impact than a 67% cycling hour that follows a 67% cycling hour. The former actually has an hourly equivalent of 50% cycling for 15 minutes and 67% cycling for 45 minutes.

Temperature Ramp-up Results

In addition to the three cycling strategies, the Energy Optimizer program also included temperature ramp-up strategies during the summers of 2006 and 2007. In 2006, there were not enough temperature ramp-up control events to meaningfully report results by house type or by state. There were also questions about the temperature ramp-up degrees and times, which made the reported results imprecise. For those reasons, the 2007 data are not compared to 2006 data. Table 11 presents the 2007 results by house type and state.

Table 11: Energy Optimizer Impacts – Temperature Ramp-up
(Dependent variable is hourly kW, summer 2007)

Variable	Single Family Coefficient (t-value)	Multifamily Coefficient (t-value)
Hour is the first hour of a control event and the customer's thermostat is being increased 1 degree from the setpoint	-0.19 (-2.9)	-0.09 (-2.0)
Hour is the second hour of a control event and the customer's thermostat is being increased 2 degrees from the setpoint	-0.56 (-8.5)	-0.19 (-4.1)
Hour is the third hour of a control event and the customer's thermostat is being increased 3 degrees from the setpoint	-1.02 (-15.3)	-0.35 (-7.3)
Hour is the fourth hour of a control event and the customer's thermostat is being increased 3 degrees from the setpoint	-0.90 (-13.2)	-0.22 (-4.5)
Customer is in Missouri	Not Statistically Significant	Not Statistically Significant
THI	0.12 (219.9)	0.06 (143.3)
Sample Size Households	385,092 443	347,902 437
R-Squared	60%	48%

The results from the regression models in Table 11 present several interesting features of impacts from the temperature ramp-up strategy.

- There is no statistically significant difference between Kansas and Missouri customers. The t-values for these Missouri coefficients generally range from 0.3 to 1.6, so we cannot be assured that these coefficients are different from zero at the 95% confidence level.
- The impacts vary by hour in the expected pattern. A one degree increase in temperature causes very little impact in the first hour. Impacts grow during the second and third hours as the temperature ramp-up increases by one degree each hour. In the fourth hour, impacts decrease a bit as the thermostat holds its three degree increase above setpoint. More air-conditioning is shut-off as the setpoint increases than when it holds constant, but holding constant at three degrees above setpoint creates more load reduction than is seen at two degrees above setpoint. This pattern is consistent with what is seen when similar temperature ramp-up strategies have been tested at other utilities.
- The total impact achieved with a three degree increase in the temperature (-1.02 for single family) is equivalent to the impact achieved with 50% cycling (-0.96 to –1.04). The main difference between the two strategies is not the maximum impact achievable, but the shape of the impact over the control period. The impacts for 50% cycling are relatively constant after the first hour, while the impacts for temperature ramp-up slowly increase and then slightly decrease over the control period.

Comparison of Cycling and Temperature Ramp-up Strategies

Figure 2a through 2d present the modeled load impacts for each tested control strategy. These figures allow comparison of the impacts from the different strategies. The loads are modeled for a day that has a THI equal to the average hourly THI seen on August 9, 13, 14 and 15 of 2007. These were the four hottest days of control testing in 2007. The average maximum temperature for this group of days was 98 degrees with an average dewpoint temperature of 69 degrees (average relative humidity of 39%). Showing modeled normal loads and impacts for the same weather day enables a direct comparison of the effects of the different control strategies.

The temperature ramp-up strategy in these figures starts at 2:00 p.m. for a four-hour control period with initial impacts seen at 3:00 p.m. (Hour Ending 15). This is done because all of the temperature ramp-up control events lasted four hours. All of the cycling strategies start at 3:00 p.m. for three-hour control periods with initial impacts seen at 4:00 p.m. (Hour Ending 16). The three-hour control periods are shown for the cycling strategies since this was the predominant type of implementation for those strategies. All strategies, both temperature ramp-up and cycling, end at 6:00 p.m. (Hour Ending 18).

It should be noted that because of the 30-minute randomized starts, the control periods also end randomly within 30 minutes after the scheduled end of the control cycle. Between 6 p.m. and 7 p.m. (Hour Ending 19), some air-conditioners are still being controlled while others start recovering. This mixture of actions moderates the snapback effect that is seen at 7 p.m. (Hour Ending 19). By 8 p.m. (Hour Ending 20), all air-conditioners have been in full recovery mode for the past hour.

Between 7 p.m. and 8 p.m. (Hour Ending 20) is the height of snapback for all of the cycling strategies, while snapback for the temperature ramping strategy is more moderate with the greatest snapback being pushed out to 9 p.m. (Hour Ending 21). It should be noted that technical problems after the ramping strategy might account for this difference: After the ramp-up events, thermostats for some customers did not reset to their pre-event setting, in effect prolonging the duration of the event beyond 6 p.m.

The first two figures below compare single family and multifamily impacts for Missouri customers. The most striking difference between these two groups is the magnitude of the normal load curve. The average load curve exceeds 5.5 kW at its peak during 5 p.m. to 6 p.m. (Hour Ending 18) for single family customers, while it is less than 1.5 kW for multifamily customers. This large difference in average normal load on very hot days explains why there is such a difference in the level of program impacts for single family and multifamily customers. While the level of program impacts is smaller for multifamily customers, they are actually contributing a larger share of their total load during control events than single family customers.

The second two figures present similar information for Kansas. A comparison of all four figures shows that Kansas impacts are slightly less than the Missouri impacts.

Figure 2a: Load Impacts by Control Strategy for Missouri Single Family Customers

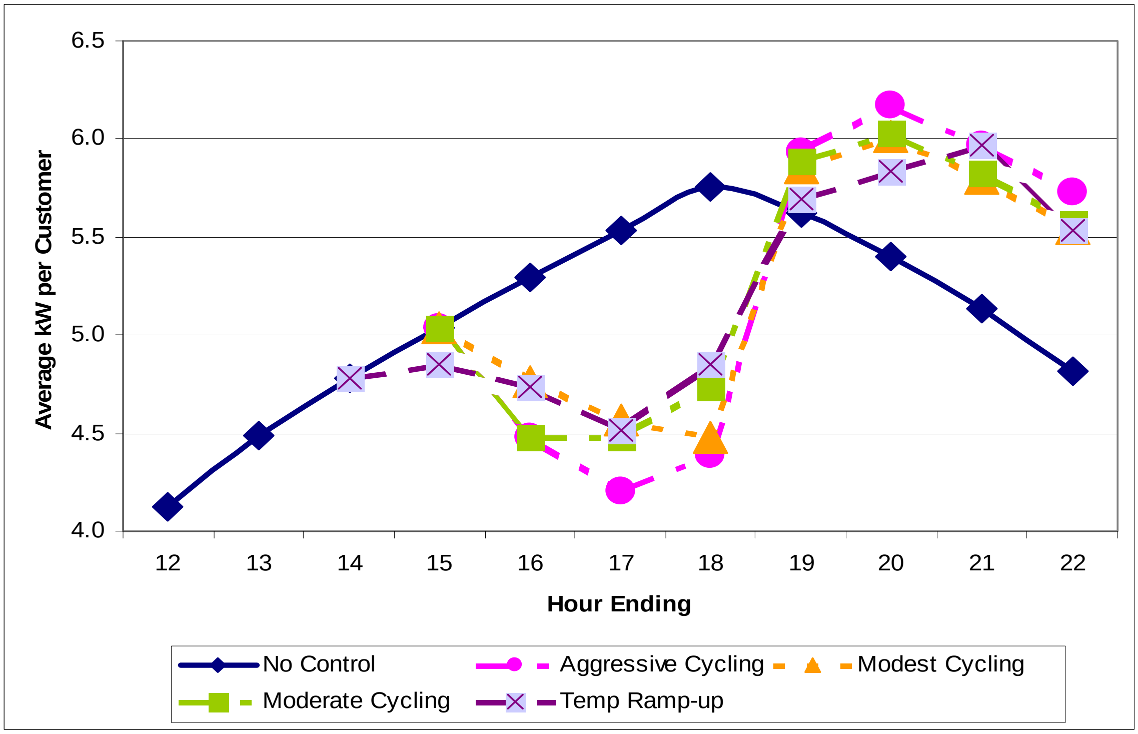


Figure 2b: Load Impacts by Control Strategy for Missouri Multifamily Customers

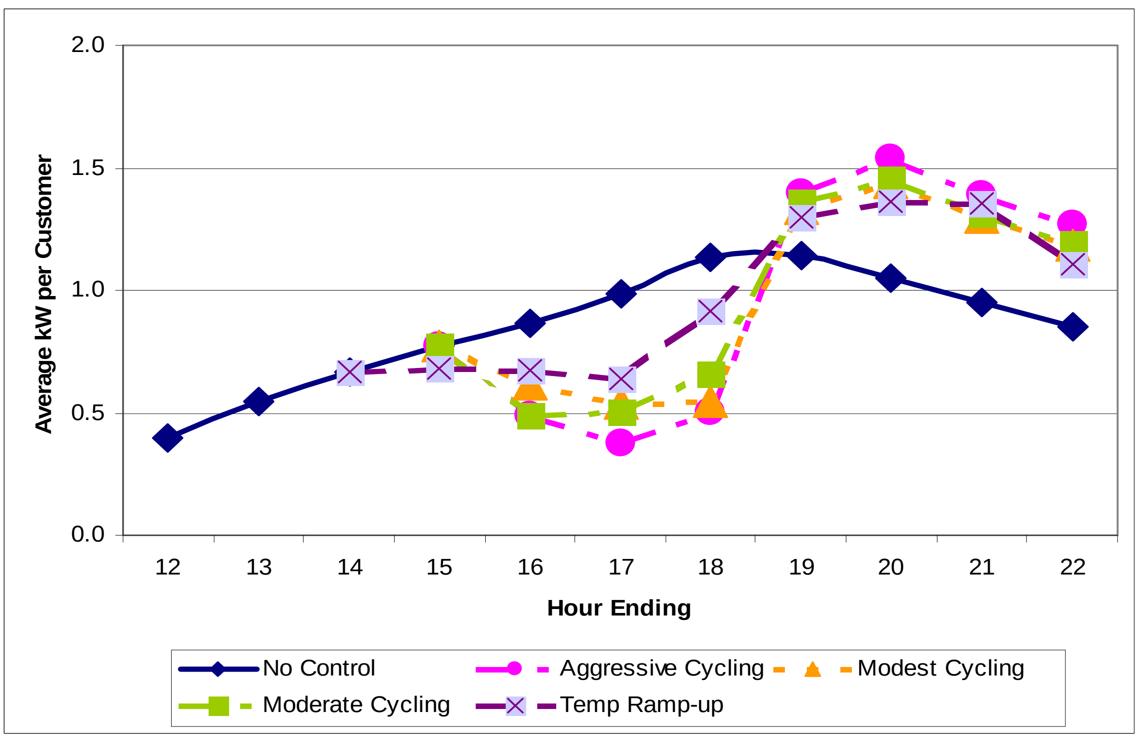


Figure 2c: Load Impacts by Control Strategy for Kansas Single Family Customers

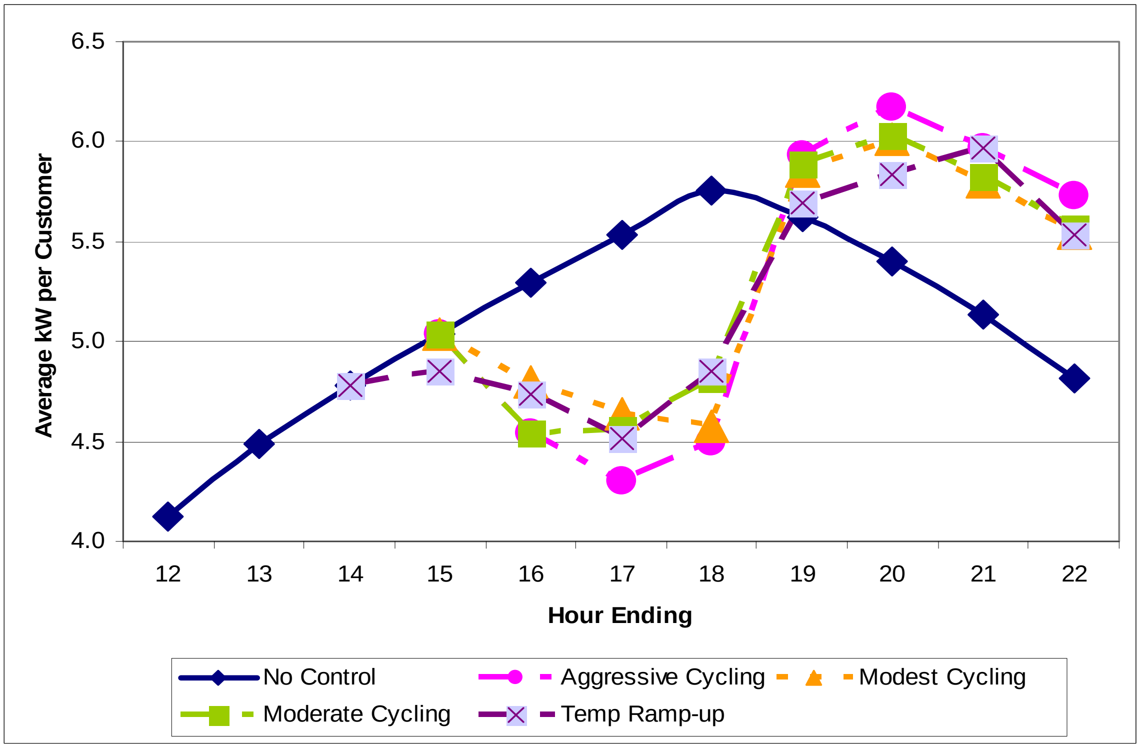
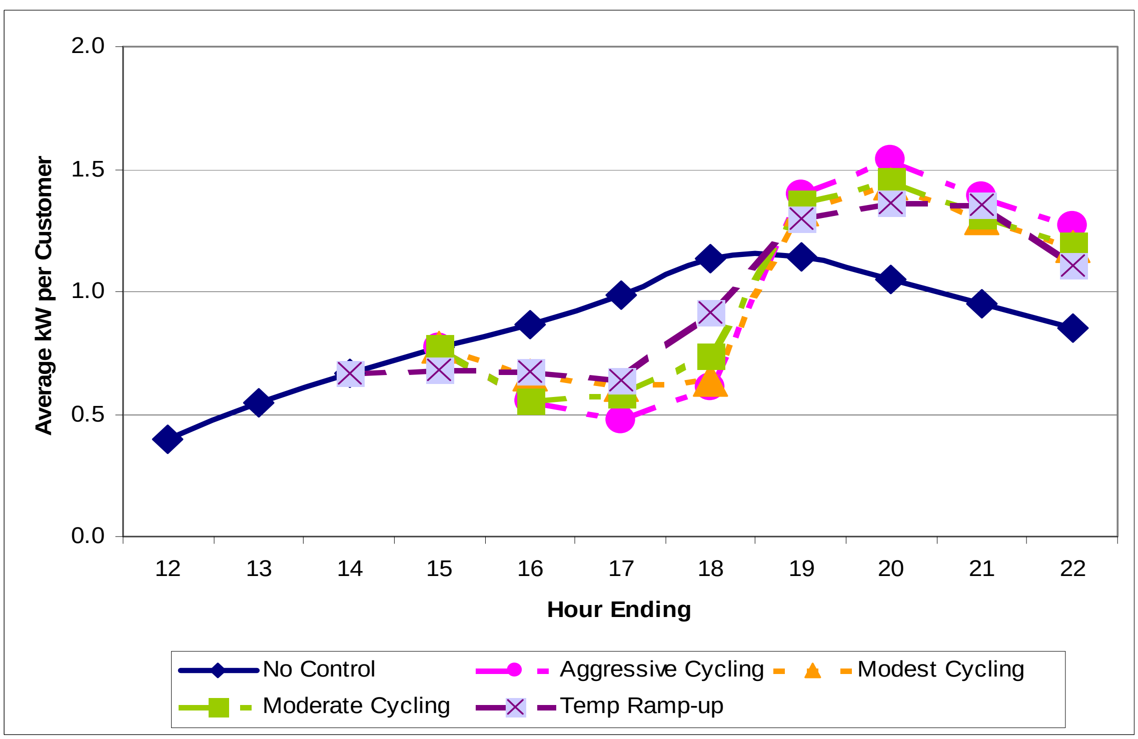


Figure 2d: Load Impacts by Control Strategy for Kansas Multifamily Customers



Analysis of Thermostat Data

Energy Optimizer thermostats collect information on indoor temperature, compressor run-time, and receipt of control signals. All of this data is useful as supporting information for the impact evaluation.

Technicians conducted home visits at a sample of participating homes to download the thermostat data for analysis. Given the expense of this data collection effort, care was taken to select those thermostats that were most likely to have a complete set of control day data. Thermostats with high packet success rates were identified to be part of this sample.

The technicians downloaded data from 153 separate thermostats. Unfortunately, some difficulty was encountered in identifying the correct customer associated with each of the thermostat downloads. Only 123 could be merged with a valid customer number, and only 118 of these had more than one day of data for August.

The control signals received by this group of 118 were compared to what was expected for the sample group to which they were assigned based on their customer number match. It appears that approximately 12% of this group had an incorrect customer match because they were receiving control signals when their sample group was in a 'no control' event. However, it is unknown what sample group they should be in.

The three figures below show indoor temperature data and air-conditioner run-time data for the four tested control strategies. Approximately two-thirds of the sample is for single family homes and one-third is for multifamily. When looking at this data it must be remembered that 12% of the customers may not be in the correct group.

Figure 3a and Figure 3b show a pronounced increase in the average indoor temperatures during the control periods, but the average never increases more than two degrees, even for the temperature ramp-up strategy. Of course, some individual customers might experience greater temperature increases, but the average increases are very mild.

It is interesting to note that the multifamily homes keep their indoor temperature settings noticeably lower than the single family homes. This may reflect their smaller size and the fact that they have fewer walls exposed to the outdoor temperatures. They can afford to keep their homes cooler because their energy needs stay low, as evidenced by the lower energy use levels shown previously for multifamily homes.

Figure 3a: Average Indoor Temperatures on Control Event Days for Single Family

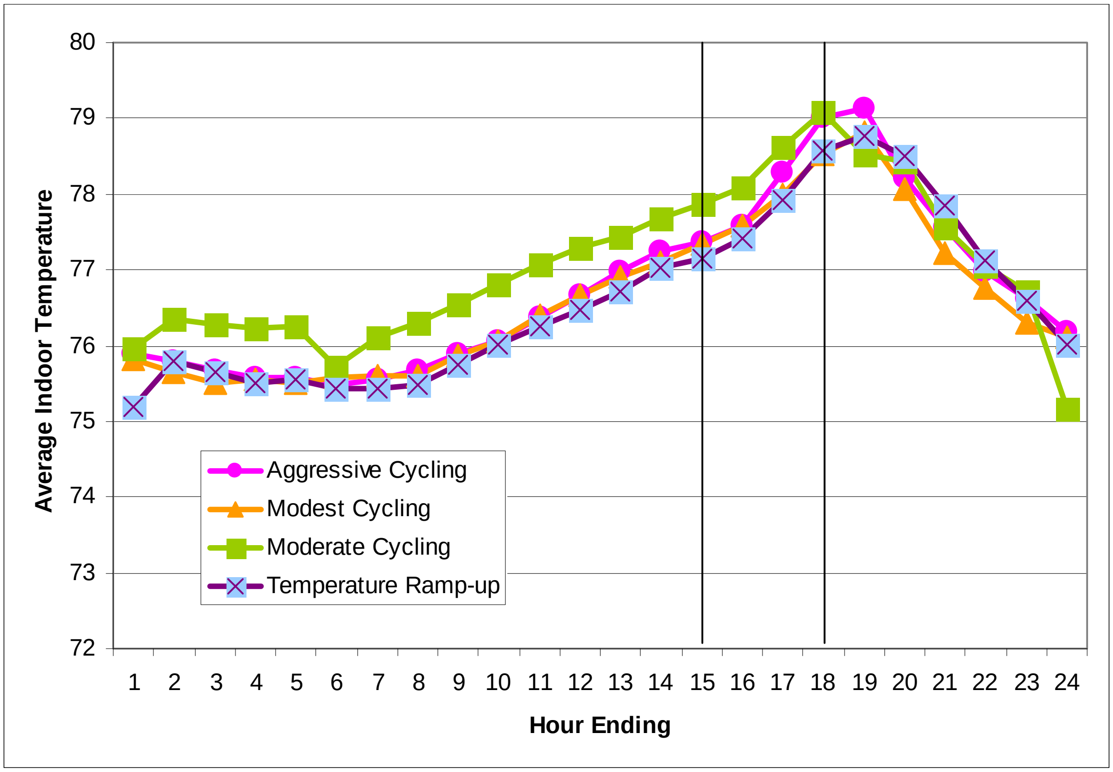


Figure 3b: Average Indoor Temperatures on Control Event Days for Multifamily

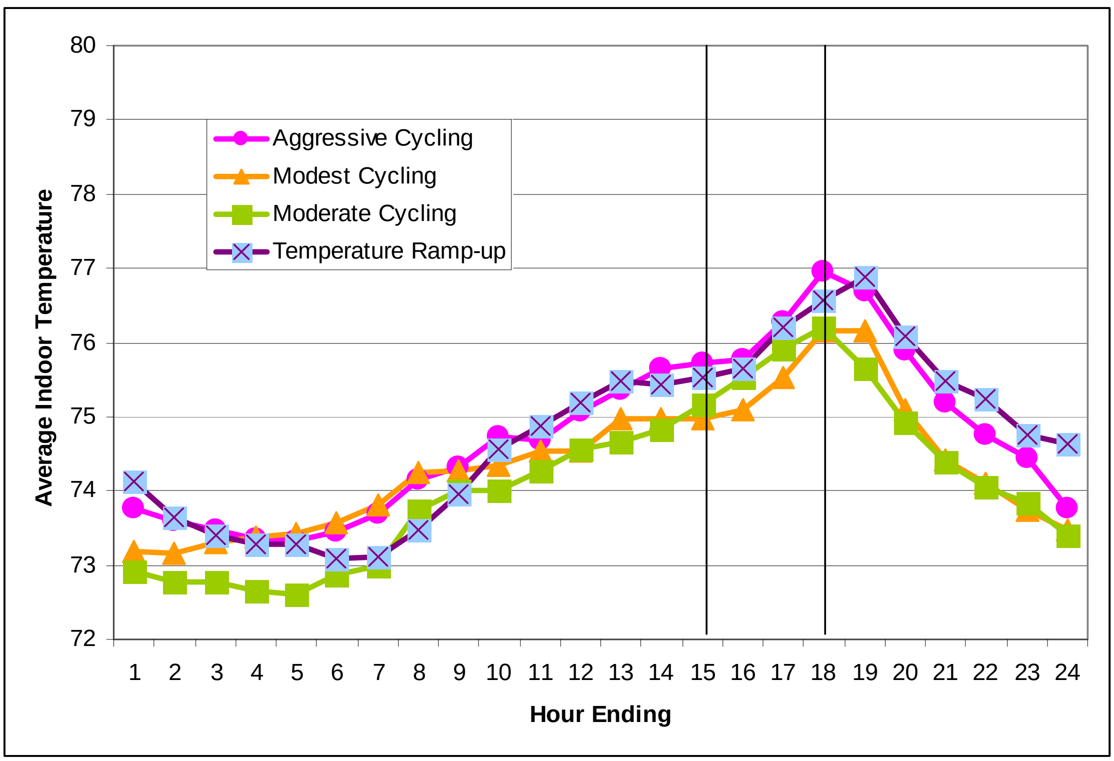
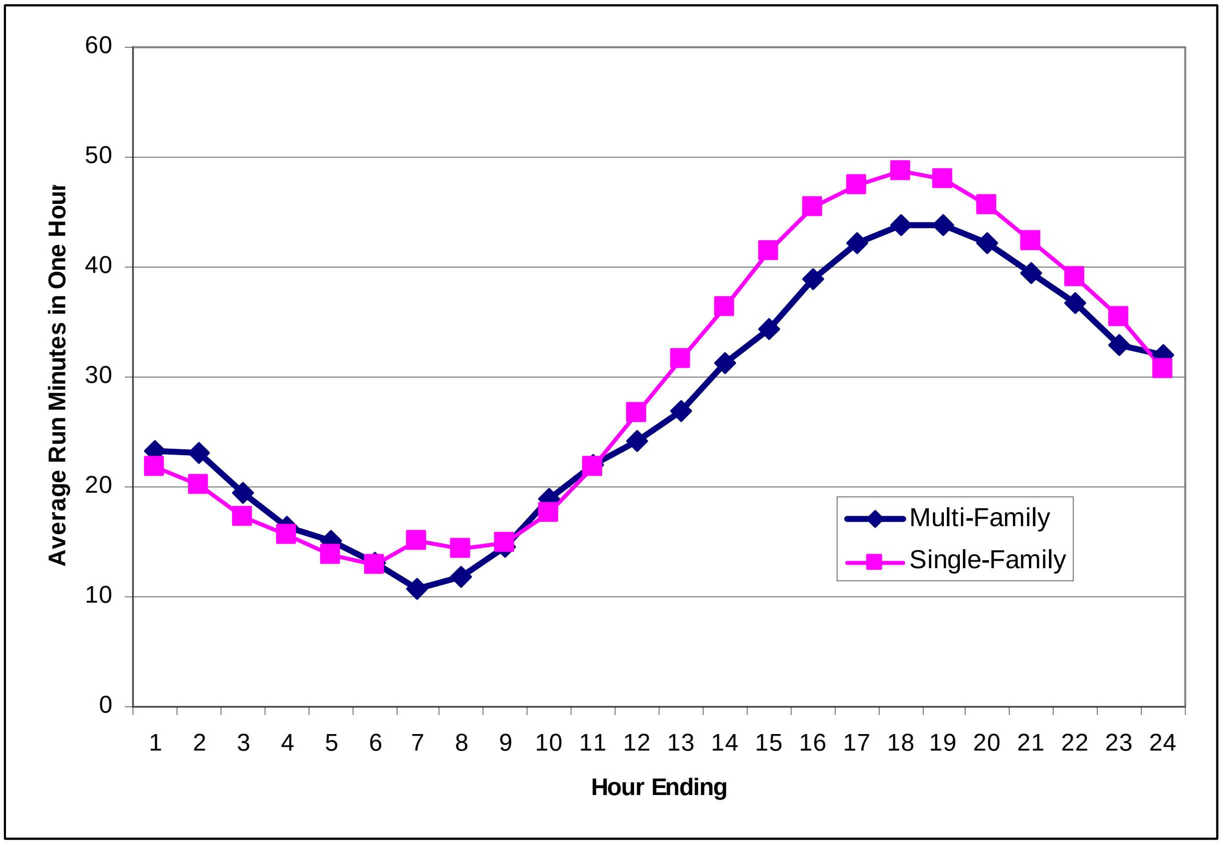


Figure 4 presents the average air-conditioner run times on the six hottest weekdays of August that did not have control events. This information is useful for understanding how much more air-conditioning capacity is available if temperatures rise beyond what was seen during August. For example, single family air-conditioners are running almost 50 minutes between 5 p.m. and 6 p.m. (Hour Ending 18), or 83% of total air-conditioning capacity. That means higher temperatures could cause air-conditioning loads to increase by a maximum of 17%.

Figure 4: Average Air-Conditioning Run Times on Hot August Days



Another interesting finding shown on this figure is that multifamily air-conditioning run times are very close to single family run times. If these sample results are indicative of the whole population, this would indicate that smaller air-conditioning units are the cause of the difference in load impacts by house type on control event days, not different levels of use.

Discussion of Results

Summit Blue has conducted numerous impact evaluations of similar residential air condition load control programs and has found very similar results to the results presented in this report. For example, Table 12 presents the results of our evaluation of Idaho Power's 2005 Cool Credit Program. For a 50% cycling program with temperatures at 95+ degrees, we found an impact of 1.16 kW.

Table 12: Idaho Power 2005 AC Cool Credit Program Impacts (average kW)

Cycling and Temperature	Impact
67% cycling at 95+	1.32
67% cycling at 90-95	0.89
50% cycling at 95+	1.16
50% cycling at 90-95	0.81

Table 13 presents the results of a 2006 evaluation of a residential AC cycling program for an east coast utility. In that program, we found that a 50% cycling at 95° produced 0.92 kW.

Table 13: Estimated Impacts (average kW) at different cycling and temperature conditions – East Coast Utility

Cycling (% off)	Outside Temperature		
	<90°	90°	95°
25%	0.23	0.33	0.46
50%	0.46	0.66	0.92
75%	0.68	0.98	1.37

These and other published results show that the 1.00 kWh results for single family homes in this evaluation are comparable with what other utilities have found with their programs.

Predicting Impacts for Future Events

The load impact models developed from the 2007 program data can be used to predict the level of load reduction that will occur during future control events at different temperature and humidity levels. A series of look-up tables are presented below that can be used to make this a simple task.

The first step is to determine the Temperature-Humidity Index (THI) based on the outdoor temperature and the dewpoint temperature. The dewpoint temperature is a measure of the humidity level.

The second step is to find the average expected kW reduction per customer based on the THI and the cycling level. For example, 33% cycling means that the air-conditioner load is reduced by 33%. If the cycling level is 33% and the THI is 20, the expected load reduction is 0.71 kW per single-family customer and 0.30 kW per multi-family customer. These values can be multiplied times the total number of customers in the program to estimate the total expected load impact. Note that estimates developed in this way should be reduced by the percentage of overrides that are expected.

Table 14: Look-up Tables for Load Reduction from Cycling

Find Temperature-Humidity Index (THI) based on Outdoor Temperature and Dewpoint Temperature					
	Outdoor Temperature				
Dewpoint Temperature	96	98	100	102	104
60	16	17	19	20	21
65	17	18	20	21	22
70	18	19	21	22	23
75	19	20	22	23	24
80	20	21	23	24	25

Find Average kW Reduction per Customer based on THI and Cycling Level					
	THI				
	16	18	20	22	24
Single Family Customers					
33% Cycling	-0.57	-0.64	-0.71	-0.78	-0.86
50% Cycling	-0.85	-0.96	-1.06	-1.17	-1.28
67% Cycling	-1.14	-1.28	-1.43	-1.57	-1.71
Multifamily Customers					
33% Cycling	-0.24	-0.27	-0.30	-0.33	-0.36
50% Cycling	-0.35	-0.40	-0.44	-0.49	-0.53
67% Cycling	-0.47	-0.53	-0.59	-0.65	-0.71

Conclusions

In general, this program performs as well as if not better than other residential air conditioner direct load control programs. The average impacts of -0.96 to -1.04 kWh for 50% cycling are generally in line with comparable programs during high temperature days (95° or higher). The consistent findings from 2006 and 2007 give credibility to the results.

PROCESS FINDINGS

This section presents the process-related findings for KCP&L's 2007 Energy Optimizer program. The purpose of the process evaluation was to compare customer satisfaction with the three different cycling strategies used in 2007 and to understand customer satisfaction with the program and program processes in general. This section is based on interviews with 468 program participants.

Table 15 summarizes the cycling events called by KCP&L during the summer of 2007 and the interviews completed. While three different strategies were tested on each event day (see also Table 5), sampling concerns restricted our interviews to participants in only one strategy for each event day.

The original interview plan called for participants in the different strategies to be called on successive event days. However, no interviews with participants in the ramp-up strategy were conducted because of technical problems after the event ended. Thermostats for some customers did not reset to their pre-event setting, in effect prolonging the duration of the event beyond 6 p.m. and resulting in many upset customers calling KCP&L. In addition, some thermostats did not display the word "SAVE" while KCP&L had control of the thermostat but displayed a different message, leading customers to believe that their thermostat was broken.

As a result, the interviewing schedule was revised, as presented below, substituting the new moderate cycling strategy for the ramping strategy.

Table 15: Number of Interviews by Event Date and Strategy

Event #	Date	Time	Strategy	Calls Completed
1	Aug-7	2 p.m. to 6 p.m.	A – Cycle aggressive	70 SF / 70 MF
2	Aug-8	2 p.m. to 6 p.m.	B – Cycle modest	70 SF / 35 MF
3	Aug-9	3 p.m. to 6 p.m.	Old C – Ramp 1 degree per hour	None
4	Aug-13	3 p.m. to 6 p.m.	B – Cycle modest	70 SF / 13 MF
5	Aug-14	3 p.m. to 6 p.m.	New C – Cycle moderate (50%)	70 SF / 70 MF
6	Aug-15	3 p.m. to 6 p.m.	New C – Cycle moderate (50%)	

It should be noted that due to implementation difficulties with cycling times on the first day and the different lengths of control events, the process results of the three different cycling strategies are not fully comparable. These issues, and their importance with respect to the process results, are summarized below.

Implementation difficulties: All interviews for the aggressive cycling strategy were conducted after Event #1 on August 7th. After review of the control event logs, it became apparent that the strategy had not been implemented as planned. Instead of cycling units at 50% for one hour, 67% for two hours, and 50% for one hour, the initial cycle at 50% lasted for approximately 1.5 hours, reducing the aggressive 67% cycling time to 1.5 hours instead of two hours. While this resulted in a slightly less aggressive cycling than planned, the strategy was still more aggressive than the other two cycling strategies. In addition, this event lasted four hours instead of the three hours most of the other cycling events lasted. This longer event time should at least partially offset the slight reduction in strategy aggressiveness. We therefore believe that the results for the aggressive strategy are a meaningful representation of cycling strategies that are more aggressive than the modest and moderate strategies also tested during these events.

Different length of control events: Control events were initially planned to last for four hours each. However, after the technical problems with the ramping strategy on August 9th, KCP&L decided to reduce the event time to three hours. Everything else being equal, longer events can be expected to increase customer discomfort. To test for a potential difference in customer perception between a 3-hour and a 4-hour event, ODC compared responses about the 4-hour modest cycling strategy on August 8th with responses about the 3-hour modest cycling strategy on August 13th. There were no significant differences in participants noticing temperature changes or their level of comfort between the events immediately before and after the ramping strategy.

COMPARISON OF 2007 CYCLING STRATEGIES

The impact evaluation showed that strategies that include a 67% cycle result in the highest load reductions. However, greater energy savings need to be weighed against the level of discomfort experienced by the participating customers and their satisfaction/dissatisfaction with the program. This section compares customer perceptions of the three cycling strategies employed during the 2007 peak saving days.

Awareness of Peak Saving Days

Awareness of the peak saving days during 2007 is low. While most participants (70%) are aware of KCP&L's general ability to control their homes' temperature on very hot days, less than a quarter (22%) were aware that KCP&L actually did control their thermostats on the 2007 peak saving days. Single family participants are significantly more likely to be aware of KCP&L's general ability to control their thermostats and of the peak saving days than multifamily participants. Interestingly, participants' awareness of the peak saving days did not differ significantly for the three different cycling strategies.

Table 16: Participant Awareness of KCP&L Ability to Control Thermostats and Peak Saving Days

	Weighted Total (n=468)	Single Family (n=280)	Multifamily (n=188)
Aware that KCP&L Can Control Air Conditioner			
Yes	70%	79%*	43%
No	29%	20%	57%*
Don't know	1%	1%	<1%
Aware of 2007 Peak Saving Days			
Yes	22%	23%*	17%
No	77%	75%	82%*
Don't know	2%	2%	1%

* Significantly different from the comparison group at the 90% level

While nearly one quarter (22%) of participants knew that KCP&L was controlling their temperature during 2007 events, only 10% saw the message on their thermostat. Other participants knew KCP&L was controlling their temperature because they felt their home was hot, they noticed the temperature was not where they set it, or they called KCP&L.

One reason for participants' lack of awareness of the peak saving days is that they were not at home during the time of the event. Overall, 28% of participants were not at home during the 2007 events, each of which began at either 2 p.m. or 3 p.m. and ended at 6 p.m. Multifamily participants were less likely to be at home than single family participants.

Table 17: At Home During 2007 Peak Saving Event

	Weighted Total (n=468)	Single Family (n=280)	Multifamily (n=188)
Yes	71%	73%*	65%
No	28%	26%	34%*
Don't know/Refused	1%	1%	1%

* Significantly different from the comparison group at the 90% level

Comfort on Peak Saving Days

Participants experienced low levels of discomfort during the 2007 peak saving day events. Most participants either were not home during the event (29%) or did not notice a change in temperature (46%). Even among participants interviewed after the aggressive cycling event only 21% of single family participants and 26% of multifamily participants noticed a change in temperature during the event. Overall, the percentage of participants noticing a change in temperature did not differ significantly between the three cycling strategies or between single family and multifamily participants.

Figure 5: Noticed Change in Temperature

Figure 5a: Single Family

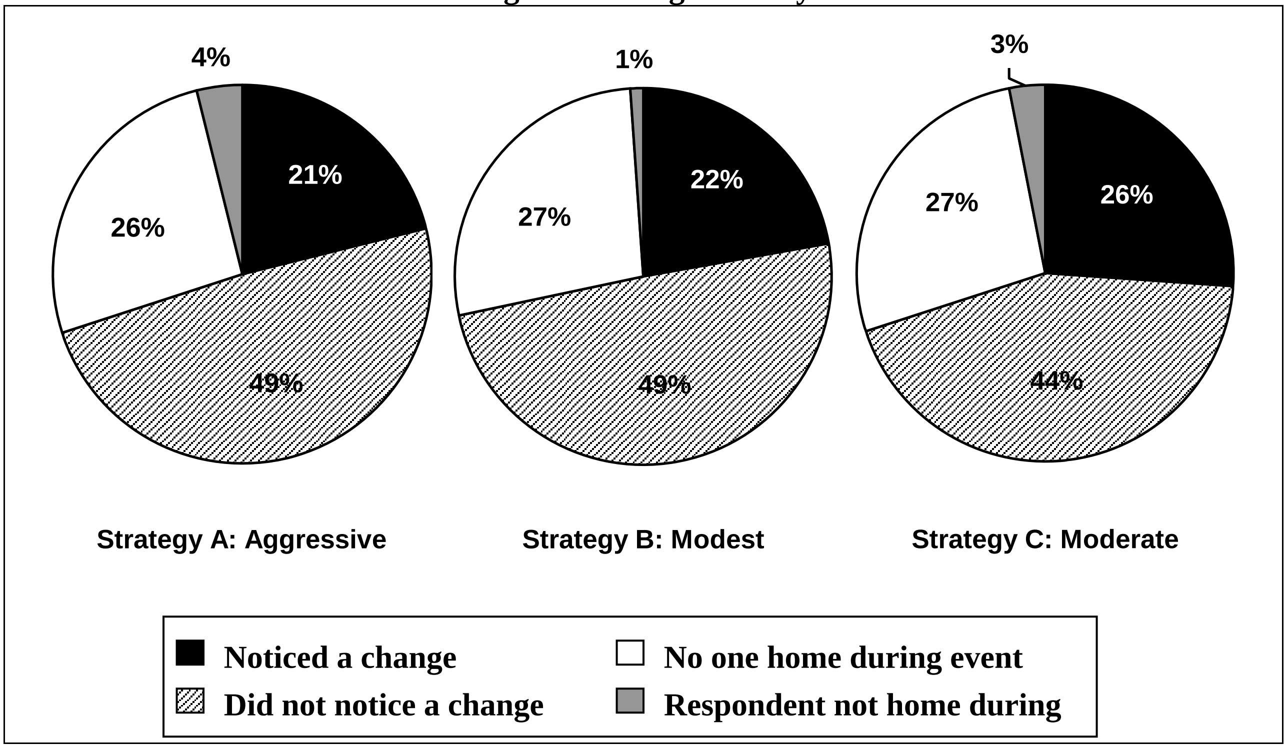
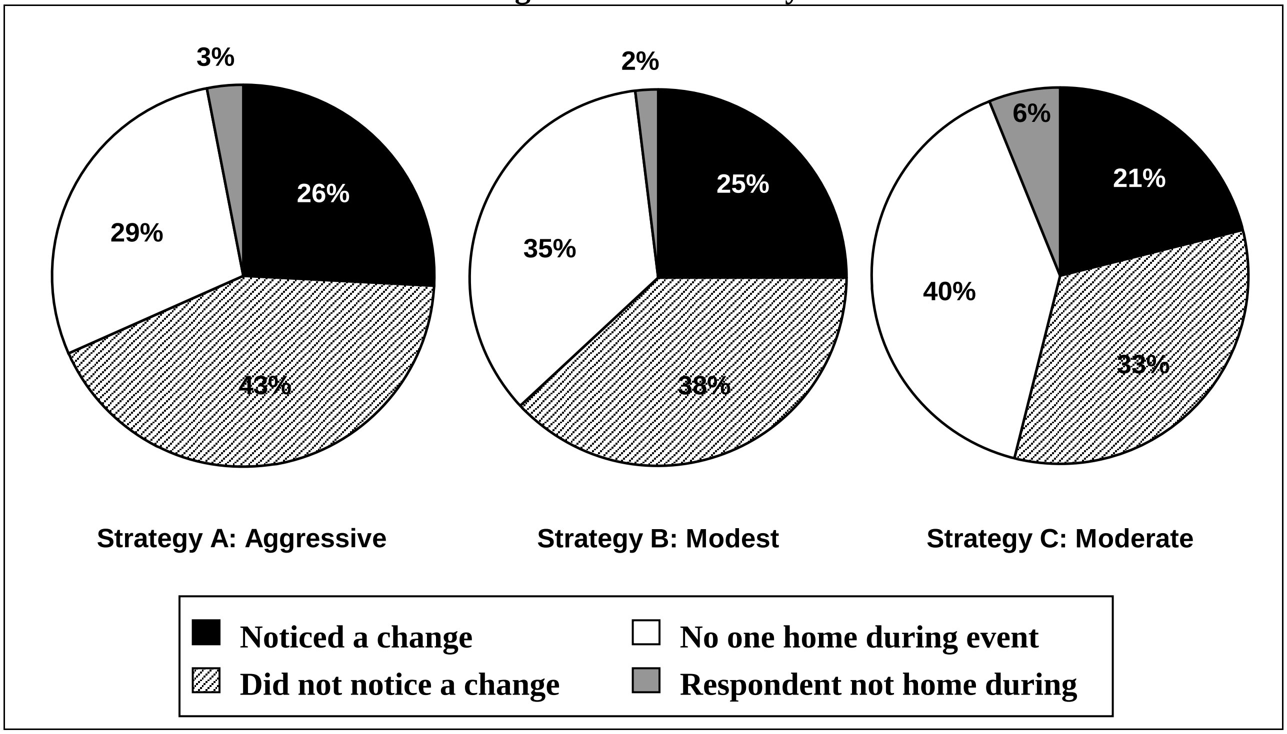


Figure 5b: Multifamily



Approximately 44% of participants who were home and noticed a change in temperature during an event reported being somewhat uncomfortable (34%) or very uncomfortable (10%). This represents 10% of all participants in the 2007 peak saving events. Participants interviewed after the aggressive cycling strategy were more likely to say they were somewhat or very uncomfortable than those interviewed after the moderate and modest strategies.

Table 18 summarizes participants' awareness of the temperature change and their comfort level during the peak saving events, by home type and cycling strategy.

Table 18: Comfort During Event

		Single Family			Multifamily		
	Wght. Total (n=468)	Strategy A: Aggressive (n=70)	Strategy B: Modest (n=140)	Strategy C: Moderate (n=70)	Strategy A: Aggressive (n=70)	Strategy B: Modest (n=48)	Strategy C: Moderate (n=70)
Very comfortable	3%	3%	3%	1%	6%	4%	3%
Somewhat comfortable	9%	1%	11%*	14%*	9%	15%	9%
Somewhat uncomfortable	8%	14%^	6%	9%	9%	4%	3%
Very uncomfortable	2%	3%	2%	1%	1%	2%	4%
Don't know/Other	1%	-	-	-	1%	-	3%
Didn't notice a change[1]	46%	49%	49%	44%	43%	38%	33%
Nobody home during event[1]	29%	26%	27%	27%	29%	35%	40%
Other[2]	3%	4%	1%	3%	3%	2%	6%

[1] Includes "don't know" and refused responses.
[2] Not asked about level of comfort; the adult home during the event was not available to respond to the survey.
* Significantly different than the single family aggressive strategy at the 90% level.
^ Significantly different than the single family moderate strategy at the 90% level.

Awareness and Use of Program Features

Energy Optimizer participants may choose to opt out of peak saving days one time per month. They can also select a pre-cooling feature to pre-cool their home prior to all events. Among participants who are aware that KCP&L can control their thermostat, about half (52%) are aware that they could opt out of having their temperature adjusted while only about one quarter (24%) are aware that they could ask KCP&L to pre cool their home prior to an event. Single family participants are more likely to be aware of the opt out option than multifamily participants (56% compared to 31%). There was no difference in the awareness of the pre cool option between single family and multifamily participants.

Table 19: Awareness of Program Features
(among those that were aware KCP&L can control their air conditioner)

	Aware of Opt Out			Aware of Pre Cool		
	Weighted Total (n=328)	Single Family (n=221)	Multifamily (n=81)	Weighted Total (n=327)	Single Family (n=221)	Multifamily (n=80)
Yes	52%	56%*	31%	24%	25%	19%
No	45%	41%	67%*	72%	71%	76%
Don't know	3%	3%	2%	4%	4%	5%

* Significantly different from the comparison group at the 90% level

Very few participants chose to opt out of the 2007 peak saving events or pre cool their homes prior to the events. While participants are less likely to be aware of the pre cool option (24%) than the opt out option (52%), those who are aware are more likely to pre cool their home (18%) than to opt out of the event altogether (5%). Single family participants tend to be more likely to use these program features than multifamily participants.

Given that comfort during the peak saving days is not a major problem for program participants, the lack of awareness and use of these program features is not an issue that needs to be addressed by the program.

Table 20: Use of Opt Out Feature
(among those aware of opt out option)

	Wght. Total (n=171)	Single Family			Multifamily		
		Strat. A: Aggressive (n=31)	Strat. B: Modest (n=55)	Strat. C: Moderate (n=38)	Strat. A: Aggressive (n=10)	Strat. B: Modest (n=9)	Strat. C: Moderate (n=6)
Opted out	5%	6%	9%	-	-	-	17%
Didn't opt out	90%	84%*	89%^	95%	100%	100%	83%
Don't know if opted out	4%	10%	2%	5%	-	-	-

* Significantly different from the multifamily aggressive strategy at the 90% level
^ Significantly different from the multifamily modest strategy at the 90% level

Table 21: Use of Pre Cool Feature
(among those aware of pre cool option)

	Wght. Total (n=80)	Single Family			Multifamily		
		Strat. A: Aggressive (n=10)	Strat. B: Modest (n=29)	Strat. C: Moderate (n=17)	Strat. A: Aggressive (n=6)	Strat. B: Modest (n=4)	Strat. C: Moderate (n=5)
Pre cooled	18%	30%	21%	6%	33%	25%	-
Didn't pre cool	77%	60%	72%	94%*	67%	75%	100%^
Don't know if pre cooled	5%	10%	7%	-	-	-	-

* Significantly different from the single family aggressive and modest strategies at the 90% level
^ Significantly different from the multifamily aggressive strategy at the 90% level

Program thermostats also enable participants to control the temperature setting of their thermostats remotely, using the Internet. However, only 10% of participants in the 2007 peak saving days have used the Internet to control the temperature in their homes. Most of those that have used the Internet have only used it once or twice.

Table 22: Using the Internet to Control Temperature

	Weighted Total (n=370)	Single Family (n=228)	Multifamily (n=135)
Have use Internet to control temperature	10%	11%	4%
Frequently (more than once a week)	*1%*	*1%*	*<1%*
Occasionally (less than once a week)	*2%*	*3%*	*<1%*
Only once or twice	*6%*	*7%*	*3%*
Never	-	-	-
Have not use Internet to control temperature	89%	88%	94%^
Don't Know	1%	1%	1%

Program Difficulties Encountered

Overall, 16% of participants called KCP&L during the 2007 summer regarding problems with their thermostat, the website, or other aspects of the program. While almost two-thirds (61%) of those who called indicate that their questions or problems were addressed in a timely manner 37% report that they were not satisfied with the process. Reasons for dissatisfaction include not being able to reach a KCP&L representative, no one calling them back, or being told that the problem was with their air conditioning unit.

Table 23: Called KCP&L Regarding Problem

		Single Family			Multifamily		
	Weighted Total (n=468)	Strategy A: Aggressive (n=70)	Strategy B: Modest (n=140)	Strategy C: Moderate (n=70)	Strategy A: Aggressive (n=70)	Strategy B: Modest (n=48)	Strategy C: Moderate (n=70)
Called KCP&L	16%	19%^	16%	16%	9%	19%	17%
Questions were addressed	*10%*	*11%*	*9%*	*11%*	*7%*	*4%*	*11%*
Questions were not addressed	*6%*	*7%*	*6%*	*4%*	*1%*	*15%^*	*6%*
Don't know	*<1%*	-	*1%*	-	-	-	-
Didn't call KCP&L	83%	80%	83%	83%	91%*	81%	81%
Don't know	1%	1%	1%	1%	-	-	1%

^ Significantly different from the multifamily aggressive strategy at the 90% level
* Significantly different from the multifamily moderate strategy and single family aggressive strategy at the 90% level

Participants were also asked if they noticed problems with their air conditioner or thermostat immediately following the peak saving day events. Very few participants (3%) report having noticed abnormal AC or thermostat operations after the event.

Table 24: AC and Thermostat Operation After Event

		Single Family			Multifamily		
	Weighted Total (n=468)	Strategy A: Aggressive (n=70)	Strategy B: Modest (n=140)	Strategy C: Moderate (n=70)	Strategy A: Aggressive (n=70)	Strategy B: Modest (n=48)	Strategy C: Moderate (n=70)
Operated normally	62%	73%	67%	74%	37%	33%	36%
Didn't operate normally	3%	3%	4%	1%	1%	4%	1%
Don't know	5%	3%	6%	7%	6%	4%	6%
Not aware the KCP&L can control AC	30%	21%	23%	17%	56%	58%	58%

GENERAL SATISFACTION WITH PROGRAM AND PROGRAM PROCESSES

This section compares process findings from the 2006 and 2007 surveys. For more details on the 2006 evaluation, please refer to Opinion Dynamic's 2006 Energy Optimizer Evaluation report (submitted to KCP&L in January 2007).

Process of and Reasons for Participating

Most customers who participated in the Energy Optimizer program learned about the program though bill inserts or other written materials. However, the process of participating (including learning about the program and signing up) is very different for multifamily homes compared to single family homes. Participants who live in single family homes are significantly more likely to hear about the program through written material and bill inserts while participants who live in a multifamily building are more likely to hear about the program from their landlord. Overall, half of all multifamily participants learned about the program through their landlord. (See Table 25 below.) In 2007, participants started finding out about the program through new information channels, including "word of mouth" and KCP&L's website.

Table 25: How Customers Learned about the Energy Optimizer Program
(multiple responses)

	Single Family		Multifamily	
	2007 (n=229)	**2006 (n=105)**	**2007 (n=135)**	**2006 (n=70)**
Utility bill insert	42%[#]	55%^*	8%	19%[#]
Written materials	32%[#]	32%*	20%	17%
Landlord	1%	-	47%^	50%
Referrals or word of mouth	12%	-	7%	-
Newspaper	3%[#]	4%	1%	3%
TV promo	3%[#]	3%	1%	-
Website	3%	-	3%	-
Phone call from KCP&L	1%	-	2%	-
Just showed up to install it	<1%	-	3%^	-
Already here when I moved in	1%	-	1%	-
Other	<1%	7%	1%	9%
Don't know	3%	3%	5%	3%
Refused	-	1%	1%	-

^ Significantly higher than 2007 single family at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
* Significantly higher than 2006 multifamily at the 90% level

Few participants had trouble signing up for the program. Those who did stated that they had to wait to sign up or hear back from KCP&L or that they had to wait for their landlord to approve participation in the program.

Table 26: Problems Signing Up for Program

	Single Family		Multifamily	
	2007 (n=229)	**2006 (n=105)**	**2007 (n=135)**	**2006 (n=70)**
Yes	3%	-	2%	3%
No	93%[#]	98%^	87%	94%
Don't recall	4%	2%	10%*^	3%

^ Significantly higher than 2007 single family at the 90% level
* Significantly higher than 2006 multifamily at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level

Most single family homes participate in the Energy Optimizer program primarily to save money (43%) or to save energy (41%). Notably, the relative importance of money savings compared to energy savings in 2007 has changed compared to 2006. While participants were almost twice as to indicate money savings (59%) than energy savings (30%) as a reason to participate in 2006, the two reasons were almost identical in 2007. This could indicate increasing awareness of energy issues among KCP&L's single family customers. Among multifamily customers, the landlord is the main reason for participation in the program (46%).

Table 27: Reasons for Participating
(multiple responses)

	Weighted Total		Single Family		Multifamily	
	2007 (n=371)	**2006 (n=115)**	**2007 (n=229)**	**2006 (n=105)**	**2007 (n=135)**	**2006 (n=70)**
Save money	38%	54% [a]	43%[#]	59%^*	19%	13%
Save energy	35%	29%	41%[Ω#]	30%*	18%	17%
New thermostat	23%	18%	28%[#]	19%*	6%	6%
General positive comments	-	4%	-	4%	-	9%
Landlord	11%	3%	1%	-	46%^	34%
More control over heating/cooling	9%	3%	10%	3%	7%	3%
Web-based control	2%	-	2%		1%	-
Seemed like a good idea	5%	-	7%[#]	-	1%	-
Not my choice	3%	-	1%	-	10%^	-
Installed in home by previous occupant	1%	-	1%	-	3%	-
Other	1%	2%	-	1%	2%	7%
Don’t know	5%	4%	3%	2%	9%^	21%[#]
Refused	<1%	-	-	-	1%	1%

[a] Significantly higher than 2007 at the 90% level
^ Significantly higher than 2007 single family at the 90% level
[Ω] Significantly higher than 2006 single family at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
* Significantly higher than 2006 multifamily at the 90% level

In 2006 and 2007, saving money and saving energy were the main program benefits identified by Energy Optimizer participants. However, in 2007, significantly more participants identify getting a new thermostat and having more control over the temperature as important benefits compared to 2006. While 23% of participants say that more control over temperature and energy usage is a benefit of participating, only 9% say this was their reason for participating.

Since multifamily customers usually learn about the program from the landlord, and in many cases, the landlord is the one driving the decision to participate, multifamily customers often indicate that they do not know the reason for participating or are not familiar with the benefits of the program.

Table 28: Benefits of Participating
(multiple responses)

	Weighted Total		Single Family		Multifamily	
	2007 (n=468)	**2006 (n=117)**	**2007 (n=280)**	**2006 (n=105)**	**2007 (n=188)**	**2006 (n=70)**
Save money	30%	38%*	32%	38%*	26%	39%*
Save energy	29%	34%*	32%	35%	21%	26%
New thermostat	24%*	10%	27%*	11%	17%*	1%
More control over temp.	23%*	15%	23%*	15%	25%*	14%
Landlord	3%	-	1%	-	8%	-
Internet	1%	-	1%	-	-	-
None	12%	11%	9%	11%	20%*	10%
Don’t know/refused	11%	17%*	10%*	6%	13%	20%*

* Significantly different from comparison group

Over half of participants (56%) did not identify any drawbacks to participating in the program. Of those who mentioned drawbacks, 10% find the thermostat was hard to program or they don't know how to use it and 9% do not like that that they do not have control over the temperature in their home.

Table 29: Drawbacks of Participating (2007)
(multiple responses)

	Weighted Total (n=468)	Single Family (n=280)	Multifamily (n=188)
Thermostat hard to program/don't know how to use	10%	8%	16%*
Don't have control over temperature	9%	9%	10%
Temperature fluctuates/doesn't stay where set	7%	7%	6%
Too hot	6%	6%	6%
Bills are higher	2%	2%	3%
Other	3%	3%	2%
None/no problems	56%	57%	55%
Don't know/refused	11%	12%	9%

* Significantly different from comparison group

About half of participants think that KCP&L is offering the Energy Optimizer program to help customers save energy. Fourteen percent of 2007 participants identify controlling peak load demand and 12% reducing brownouts and blackouts as reasons. Single family participants are more likely to identify these reasons than multifamily participants, potentially because multifamily participants are less likely to see the marketing materials.

Table 30: Reasons KCP&L Offers Program
(multiple responses)

	Weighted Total		Single Family		Multifamily	
	2007 (n=371)	2006 (n=117)	2007 (n=229)	2006 (n=105)	2007 (n=135)	2006 (n=70)
They want customers to save energy	55%	49%	53%	50%*	60%*	40%
They want customers to save money	27% [b]	20%	24%	19%	37%^	30%[Ω]
To control demand/peak load	14%	19% [a]	15%[#]	21%*	7%	6%
Reduce brownouts/blackouts	12% [b]	4%	14%[Ω#]	5%	6%	-
Keep customers happy	8% [b]	4%	8%	4%*	8%*	1%
Keep new power plants from being built	5%* [b]	2%	6%[Ω#]	2%	1%	4%
To have control	-	2%	-	2%	-	-
Other	2%	1%	2%	1%	1%	4%
Don't know	10%	15% [a]	9%	13%	13%^	30%[#Ω]
Refused	-	1%	-	1%	-	-

[a] Significantly higher than 2007 at the 90% level
[b] Significantly higher than 2006 at the 90% level
^ Significantly higher than 2007 single family at the 90% level
[Ω] Significantly higher than 2006 single family at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
* Significantly different from comparison group at the 90% level

Satisfaction with the Installation Process

Overall 72% of participants were home during the installation of the thermostat. These participants were asked to rate their satisfaction with the process of installing the programmable thermostat, including the scheduling, installation time, and the professionalism of the installer on a 10-point scale (where 1 is "very dissatisfied" and 10 is "very satisfied"). Multifamily participants (60%), since they have a landlord who could let the installer into their home, were more likely not to be at home when the thermostat was installed than single family participants (17%). Almost all participants who were home during the installation are satisfied with the installation process.

Table 31: Satisfaction with Installation Process

	Weighted Total		Single Family		Multifamily	
	2007 (n=371)	**2006 (n=117)**	**2007 (n=229)**	**2006 (n=105)**	**2007 (n=135)**	**2006 (n=70)**
Home during installation	72%	83% [a]	82%[#]	86%*	39%	54%[#]
Satisfaction with Installation process						
Rating 8-10	*64%*	*74% [a]*	*74%[#]*	*76%**	*31%*	*47%[#]*
Rating 4-7	*5%*	*7%*	*5%*	*7%*	*5%*	*4%*
Rating 1-3	*1%*	*2%*	*1%*	*2%*	*1%*	*1%*
Don't know	*2%*	*<1%*	*1%*	*1%*	*2%*	*1%*
Not home during installation	27% [b]	17%	17%	14%	60%*^	46%[Ω]
Don't know	1%	-	1%	-	1%	-

[a] Significantly higher than 2007 at the 90% level
[b] Significantly higher than 2006 at the 90% level
* Significantly higher than 2006 multifamily at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
[Ω] Significantly higher than 2006 single family at the 90% level
^ Significantly higher than 2007 single family at the 90% level

Similarly, most customers who were home when the thermostat was installed think that the program and thermostat were thoroughly explained. Compared to 2006, the percent of participants who did not receive a thorough explanation of the thermostat significantly decreased from 14% to 6%.

Table 32: Thorough Explanation of the Program/Thermostat

	Weighted Total		Single Family		Multifamily	
Program/Thermostat Explanation Received During Installation	**2007 (n=267)**	**2006 (n=96)**	**2007 (n=187)**	**2006 (n=90)**	**2007 (n=53)**	**2006 (n=38)**
Received Thorough Explanation	91%	84%	93%[#]	84%	79%	84%[#]
Did Not Receive Thorough Explanation	6%	14% [a]	5%	14%*^	17%^*	8%
Don't know	3%	2%	2%	1%	4%	8%[Ω]

[a] Significantly higher than 2007 at the 90% level
[b] Significantly higher than 2006 at the 90% level
* Significantly higher than 2006 multifamily at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
[Ω] Significantly higher than 2006 single family at the 90% level
^ Significantly higher than 2007 single family at the 90% level

Satisfaction with the Thermostat

Participants were asked to rate their satisfaction with the new programmable thermostat on a 10-point scale (where 1 is "very dissatisfied" and 10 is "very satisfied"). About three-quarters of participants indicate being satisfied with the new thermostat (an 8, 9 or 10 on the 10-point scale). Single family participants are significantly more likely to be satisfied with the new thermostat than multifamily participants.

Participants who were dissatisfied (a 1, 2, or 3 on the 10-point scale) with the new programmable thermostat stated they found the thermostat difficult and to program; a few participants stated that the thermostat does not work. Satisfaction ratings increased slightly (but not significantly) between 2006 and 2007.

Table 33: Satisfaction with New Thermostat

	Weighted Total		Single Family		Multi Family	
	2007 (n=371)	2006 (n=117)	2007 (n=228)	2006 (n=105)	2007 (n=135)	2006 (n=70)
Rating 8-10	79%	74%	81%#	75%	72%	61%
Rating 4-7	16%	16%	16%	15%	16%	24%
Rating 1-3	3%	5%	1%	5%	10%	10%^
Don't know	2%	5%	2%	5%	1%	4%

Significantly higher than 2007 multifamily at the 90% level
^ Significantly higher than 2007 single family at the 90% level

Most participants (71%) had manual thermostats prior to participating in the program. Of those who already had a programmable thermostat, only half used the programming feature to vary their temperature throughout the day prior to participating in the Energy Optimizer program. This lack of experience with programming thermostats may be one reason why some customers find the Honeywell thermostats difficult to use. Multifamily customers (82%) are more likely to have owned a manual thermostat than single family customers (68%).

Table 34: Replaced Thermostat Characteristics

	Weighted Total		Single Family		Multifamily	
Thermostat prior to Program Participation	2007 (n=371)	2006 (n=117)	2007 (n=228)	2006 (n=105)	2007 (n=135)	2006 (n=70)
Programmable	20%	17%	24%#	18%	5%	11%
OLD therm. programmed	*11%*	*13%*	*14%#*	*14%**	*1%*	*6%#*
OLD therm not programmed	*9% b*	*4%*	*10%Ω#*	*4%*	*4%*	*6%*
Manual	71%	77%	68%	77%^	82%^	79%
Other	1%	-	-	-	1%	1%
Don't know	8%	5%	7%	5%	11%	9%

b Significantly higher than 2006 at the 90% level
Significantly higher than 2007 multifamily at the 90% level
^ Significantly higher than 2007 single family at the 90% level
Ω Significantly higher than 2006 single family at the 90% level
* Significantly higher than 2006 multifamily at the 90% level

While the majority of participants (79%) recall receiving the reference guide in 2007, this percentage is significantly lower than the percentage of customers who recalled receiving the reference guide in 2006.

Table 35: Received Reference Guide

	Weighted Total		Single Family		Multi Family	
	2007 (n=370)	2006 (n=117)	2007 (n=228)	2006 (n=105)	2007 (n=135)	2006 (n=70)
Yes	79%	89%[a]	79%	89%^	80%	91%[#]
No	11%[b]	5%	10%[Ω]	5%	14%	7%
Don't know	9%	6%	11%[#]	7%	6%	1%

[a] Significantly higher than 2007 at the 90% level
[b] Significantly higher than 2006 at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
[Ω] Significantly higher than 2006 single family at the 90% level
^ Significantly higher than 2007 single family at the 90% level

Participants report that installers programmed the thermostats almost two-thirds of the time. Notably, however, half of the time the installer programmed the thermostat, the participant still felt it necessary to reprogram the thermostat because it was not set to the temperatures that they would want.

Table 36: Who Programmed the New Thermostat

	Weighted Total		Single Family		Multifamily	
Person Programming the Thermostat	2007 (n=370)	2006 (n=117)	2007 (n=228)	2006 (n=105)	2007 (n=135)	2006 (n=70)
Installer	62%	67%	61%	68%	66%	60%
Respondent/Someone else in the household	33%	28%	33%	28%	31%	33%
Not Programmed	2%	3%	2%	3%	1%	6%[#]
Don't Know	4%	2%	4%	2%	1%	1%

[#] Significantly higher than 2007 multifamily at the 90% level

Table 37: Thermostat Programming Changes

	Weighted Total		Single Family		Multifamily	
Changed Programming	2007 (n=229)	2006 (n=78)	2007 (n=139)	2006 (n=71)	2007 (n=88)	2006 (n=70)
Yes	53%	52%	55%	52%	47%	48%
No	47%	47%	45%	46%	53%	52%
Don't know	-	1%	-	1%	-	-

As described above, most participants (89%) do not use the Internet to control the temperature setting on their new thermostat. (See also Table 22 above.)

Program Benefits

The program promotes saving of as much as 20% on annual energy bills. However, most participants (48%) have not noticed a decrease in their electric bills, compared to 26% who have.

While our research did not explore the reasons why some people perceived a decrease in their bill and others did not, those who noticed a decrease in their bill are more likely to feel that they have more control over their thermostat (63% compared to 38% among those who said they did not see a decrease). Significantly more participants noticed a decrease in their electric bill in 2006 compared to 2007 (34% compared to 26%).

Table 38: Noticed Decrease in Electric Bill

Have you noticed a decrease in your electric bill since participating in this program?	Weighted Total		Single Family		Multifamily	
	2007 (n=370)	2006 (n=117)	2007 (n=228)	2006 (n=105)	2007 (n=135)	2006 (n=70)
Yes	26%	34% [a]	23%	35%^*	37%*^	26%
No	48%[b]	39%	48%	39%	48%	41%
Too soon to tell	15%	12%	16%	10%	11%	29%[#Ω]
Don't Know	11%	14%	12%[#]	15%*	4%	4%

[a] Significantly higher than 2007 at the 90% level
b Significantly higher than 2006 at the 90% level
Significantly higher than 2007 multifamily at the 90% level
ΩSignificantly higher than 2006 single family at the 90% level
^ Significantly higher than 2007 single family at the 90% level
* Significantly higher than 2006 multifamily at the 90% level

About one quarter (27%) of those who have noticed a decrease think they are saving between 1% and 5% on their electric bill. About one in five participants (19%) think they are saving between 6% and 10%.

Table 39: Percent Decrease in Electric Bill

	Weighted Total		Single Family		Multifamily	
Perceived Percentage Decrease	2007 (n=98)	2006 (n=40)	2007 (n=53)	2006 (n=37)	2007 (n=50)	2006 (n=18)
Between 1% and 5%	27%	23%	25%	24%*	32%*	11%
Between 6% and 10%	19%	22%	19%	22%	20%	22%
Between 11% and 15%	12%[b]	2%	11%[Ω]	3%	14%	-
Between 16% and 20%	5%	3%	6%	3%	4%	11%
Between 21% and 25%	3%	4%	2%	3%	4%	17%
Over 25%	7%	9%	4%	8%	14%^	22%[Ω]
Don't know	27%	36%	34%[#]	38%	12%	17%

[b] Significantly higher than 2006 at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
[Ω]Significantly higher than 2006 single family at the 90% level
^ Significantly higher than 2007 single family at the 90% level
* Significantly higher than 2006 multifamily at the 90% level

The marketing materials for this program emphasize that this program can help customers "Take Control" of their energy usage. Significantly more participants in 2007 (46%) than in 2006 (32%) feel they have more control over their energy use since installing the new thermostat. Only 18% feel that they have less control over their energy use, indicating that participants put more emphasis on the increase in control in day-to-day life than the temporary loss of control during peak saving events.

Table 40: Control over Energy Usage

Perceived Control over Energy Usage Since Installing the New Thermostat	Weighted Total 2007 (n=370)	Weighted Total 2006 (n=117)	Single Family 2007 (n=228)	Single Family 2006 (n=105)	Multifamily 2007 (n=135)	Multifamily 2006 (n=70)
More	46%[b]	32%	45%[Ω]	32%*	49%*	24%
Same	31%	51%[a]	34%[#]	52%^	19%	43%[#]
Less	18%[b]	11%	16%[Ω]	10%	27%^	24%[Ω]
Don't know	6%	6%	5%	6%	5%	9%

[a] Significantly higher than 2007 at the 90% level
[b] Significantly higher than 2006 at the 90% level
[#] Significantly higher than 2007 multifamily at the 90% level
[Ω] Significantly higher than 2006 single family at the 90% level
^ Significantly higher than 2007 single family at the 90% level
* Significantly higher than 2006 multifamily at the 90% level

Participant Suggestions for Improving the Program

Most participants (74%) had no suggestions for improving the program. Those who did generally suggested more help and explanation, including technical help and better instructions and manuals.

Table 41: Suggestions to Improve Program
(multiple responses)

Do you have any suggestions for how to improve the program?	Weighted Total (n=468)
Don't want KCP&L controlling thermostat	5%
More technician help	4%
More detailed operation instruction	4%
Improve thermostat	3%
Better communication	3%
Improve website	2%
Simplify manual	1%
Other	6%
No suggestions	74%
Don't know/refused	2%

2007 Survey Demographics

Table D1: Own or Rent Home

	Total Weighted (n=468)	Single Family (n=280)	Multifamily (n=188)
Own	71%	92%*	6%
Rent	26%	4%	89%
Other	1%	1%	1%
Don’t know	3%	3%	4%

*Significantly higher than multifamily at the 90% level

Table D2: Type of Residence

	2007 Total Weighted (n=468)	Single Family (n=280)	Multifamily (n=188)
Single Family	69%	88%*	12%
Duplex or two family	2%	2%	2%
Apartment/Condo 2-4 unit	10%	1%	38%^
Townhouse/row house	5%	5%	7%
Apartment/Condo more than 5 units	10%	1%	37%^
Other	<1%	1%	1%
Refused	2%	1%	4%

* Significantly higher than multifamily at the 90% level
^ Significantly higher than single family at the 90% level

Table D3: Number of People in Home (Year-Round)

	2007 Total Weighted (n=468)	Single Family (n=280)	Multifamily (n=188)
1	21%	15%	39%^
2	34%	34%	33%
3	14%	16%*	6%
4	13%	14%*	8%
5	5%	6%	3%
6+	3%	3%	1%
Don’t know/refused	11%	11%	11%

*Significantly higher than multifamily at the 90% level
^ Significantly higher than single family at the 90% level

Table D4: Education

	2007 Total Weighted (n=468)	Single Family (n=280)	Multifamily (n=188)
Some high school or less	1%	<1%	4%^
High school graduate	18%	17%	22%
Technical, trade school	8%	8%	9%

Four year college degree	45%	47%	39%
Post graduate/professional	19%	19%	18%
Refused	9%	9%	8%

^ Significantly higher than single family at the 90% level

Table D5: Income

	2007 Total Weighted (n=468)	Single Family (n=280)	Multifamily (n=188)
Under $20,000	3%	1%	8%^
$20,000-$39,999	15%	11%	26%^
$40,000-$59,999	13%	11%	17%
$60,000-$79,999	10%	9%	10%
$80,000-$99,999	7%	9%*	1%
$100,000-$149,999	7%	9%*	2%
$150,000 or over	4%	4%	2%
Don't know	2%	2%	3%
Refused	39%	42%*	31%

Significantly higher than multifamily at the 90% level

^ Significantly higher than single family at the 90% level

Table D6a: Home during Summer Days

	Weighted Total (n=468)	Single Family (n=280)	Multifamily (n=188)
1-2 pm	61%	65%*	49%
2-3 pm	59%	64%*	46%
3-4 pm	63%	68%	51%
4-5 pm	73%	77%*	62%
5-6 pm	81%	84%*	71%
6-7 pm	85%	88%*	79%
Don't know/refused	7%	6%	10%

* Significantly different from the comparison group at the 90% level

Table D6b: Temperature Settings on Weekday Afternoons

	Weighted Total (n=468)	Single Family (n=280)	Multifamily (n=188)
65-69 degrees	3%	1%	7%
70-72 degrees	14%	11%	23%
73-74 degrees	18%	19%	15%
75-77 degrees	35%	35%	35%
78-79 degrees	19%	21%	12%
80-85 degrees	9%	10%	6%
Don't know/refused	3%	3%	3%

APPENDIX: LOAD CURVES ON EVENT DAYS

This appendix presents a series of charts that show average load curves for the different groups of interest on each control event day. Several different control strategies were tested on each control event day.

The groups of interest are:
1) Single Family Kansas
2) Single Family Missouri
3) Multifamily Kansas
4) Multifamily Missouri

The control event days are:
1) Tuesday, August 7, 2007
2) Wednesday, August 8, 2007
3) Thursday, August 9, 2007
4) Monday, August 13, 2007
5) Tuesday, August 14, 2007
6) Wednesday, August 15, 2007

The control strategies are:

	Hour 1	Hour 2	Hour 3	Hour 4
A – Aggressive Cycling	50%	67%	67%	50%
B – Modest Cycling	33%	50%	67%	33%
C – Temperature Ramp-up	1°	2°	3°	3°
D – No Control (comparison group)				
E – Moderate (50%) Cycling	50%	50%	50%	50%

Responses to the different control strategies tested on each control event day can be observed in these charts. However, the exact average impacts are difficult to measure because the comparison group usage on each event day tends to run higher or lower than the other groups before the event begins. Impacts could be estimated by normalizing the comparative load shapes, but this still leaves the problem of different weather conditions on each event day. Summarizing load impacts by measuring differences from the comparison group on each event day is not particularly useful.

The best estimate of average impacts comes from the regression model presented in the body of this report. The regression model can take all of these factors into account and correct for them. It can also include the information on base usage from days when no control events occurred. This makes more efficient use of all the data that is available.

The charts presented in this Appendix are useful as a reference. They serve as a picture of what actually happened to each group on each event day. The detail presented here is useful when trying to understand the summary information.

The purpose of these charts is to present a clear picture of differences between groups and strategies, so customers that used pre-cooling or overrides are not included in the average load curves that are shown. The effects of those individual actions are best dealt with separately, as adjustments to normal load impacts.

Figure A1: Kansas Single Family Load Curves on August 7

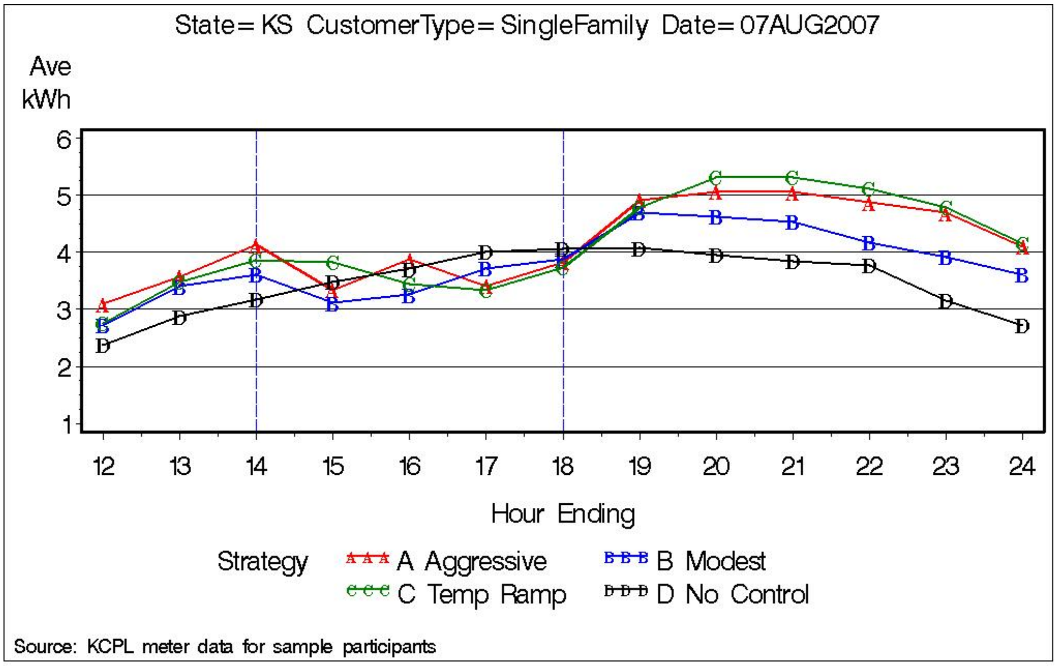
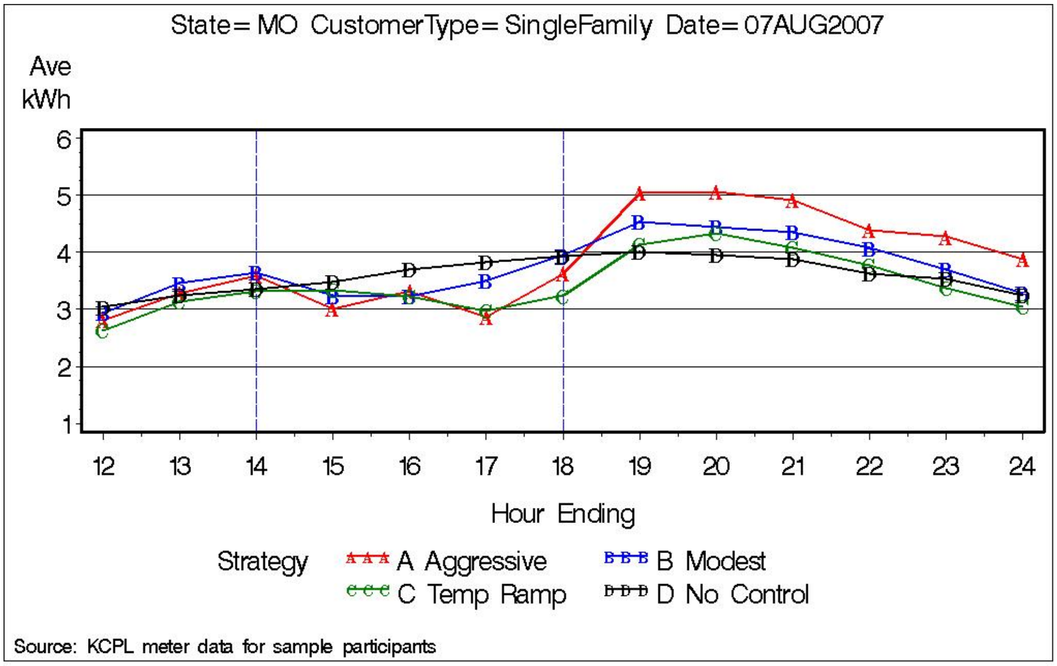


Figure A2: Missouri Single Family Load Curves on August 7



Both states show snapback for all control strategies. The Kansas No Comparison group shows less average use than the other groups before the control event starts. The Temperature Ramp strategy shows less snapback in Missouri.

Figure A3: Kansas Single Family Load Curves on August 8

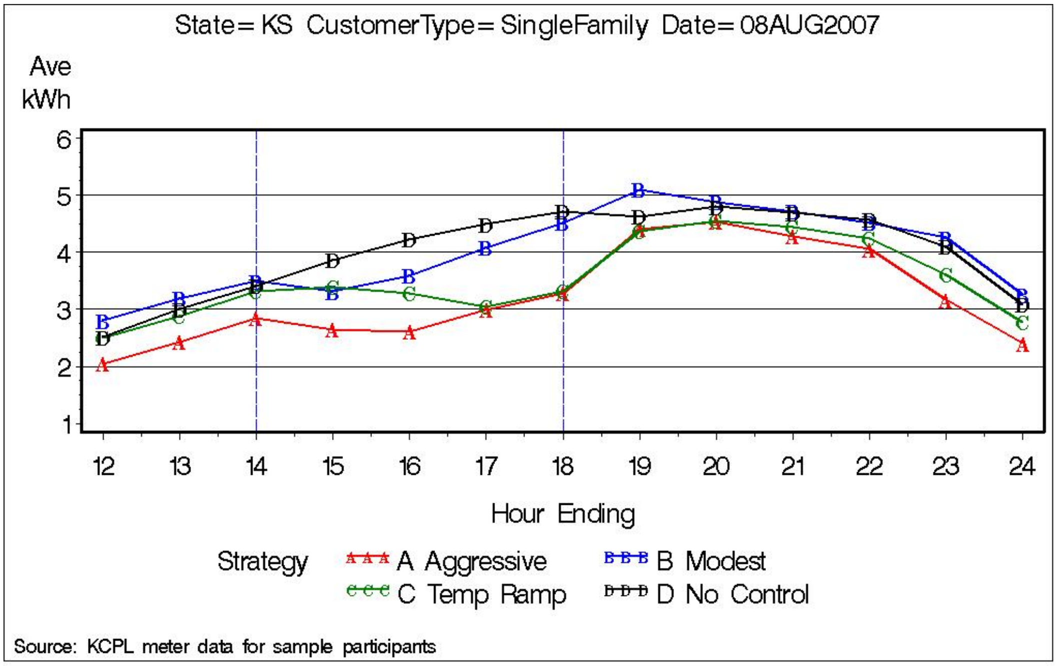
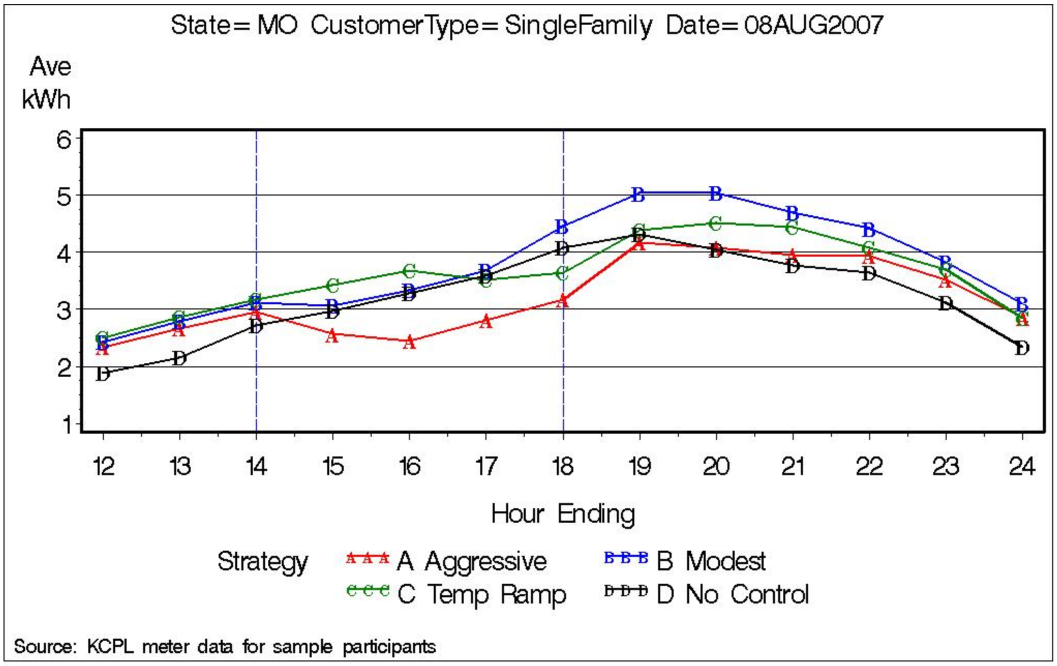


Figure A4: Missouri Single Family Load Curves on August 8



These charts show the classic slow response of the Temp Ramp strategy. There is no obvious immediate response to Temp Ramp in Missouri, but this is whole house data so there may be offsetting use. It may also be a possible indication of poor signal reception.

Figure A5: Kansas Single Family Load Curves on August 9

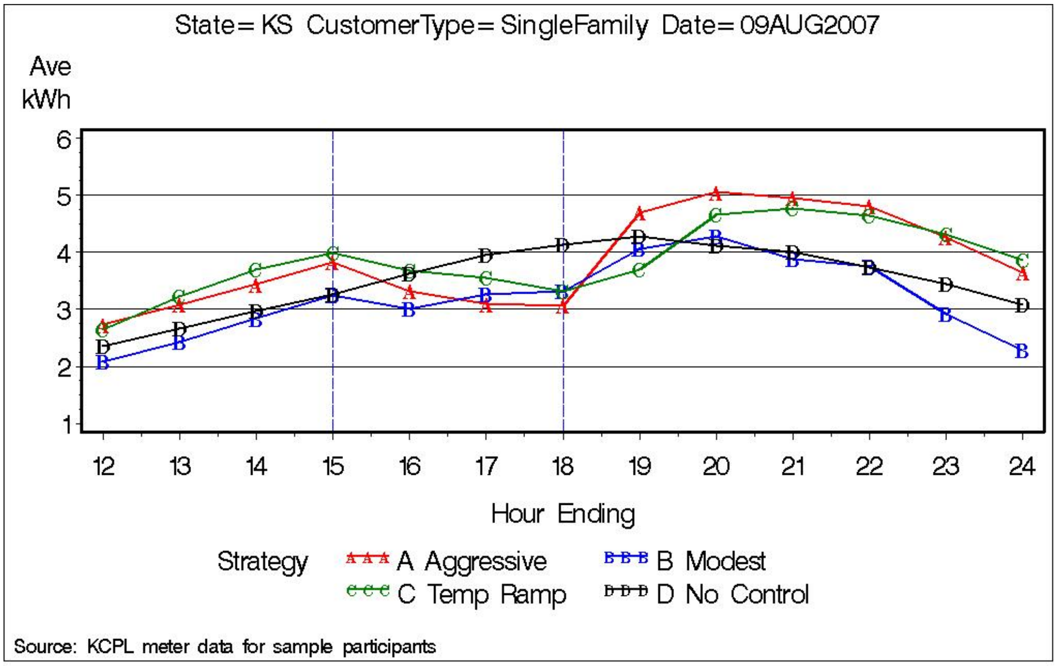
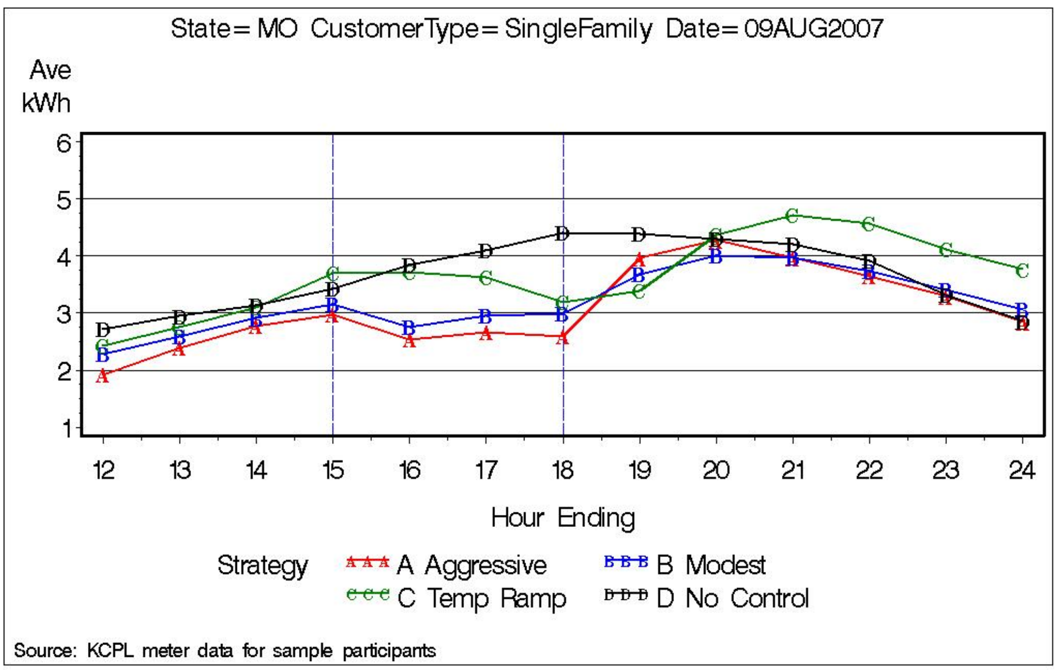


Figure A6: Missouri Single Family Load Curves on August 9



Starting on August 9, control events begin at 3:00 pm instead of 2:00 pm. The two cycling strategies show similar load reduction and snapback. The Temp Ramp load reductions seem to continue for an extra hour, reflecting the technical problem encountered on that day (some thermostats not resetting at the end of the event).

Figure A7: Kansas Single Family Load Curves on August 13

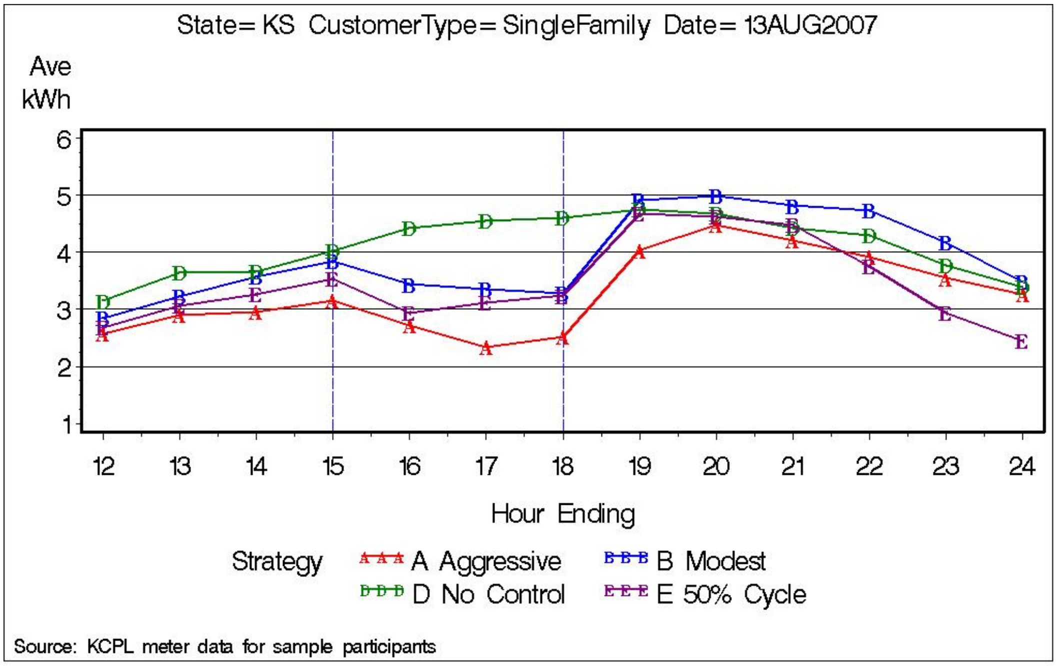
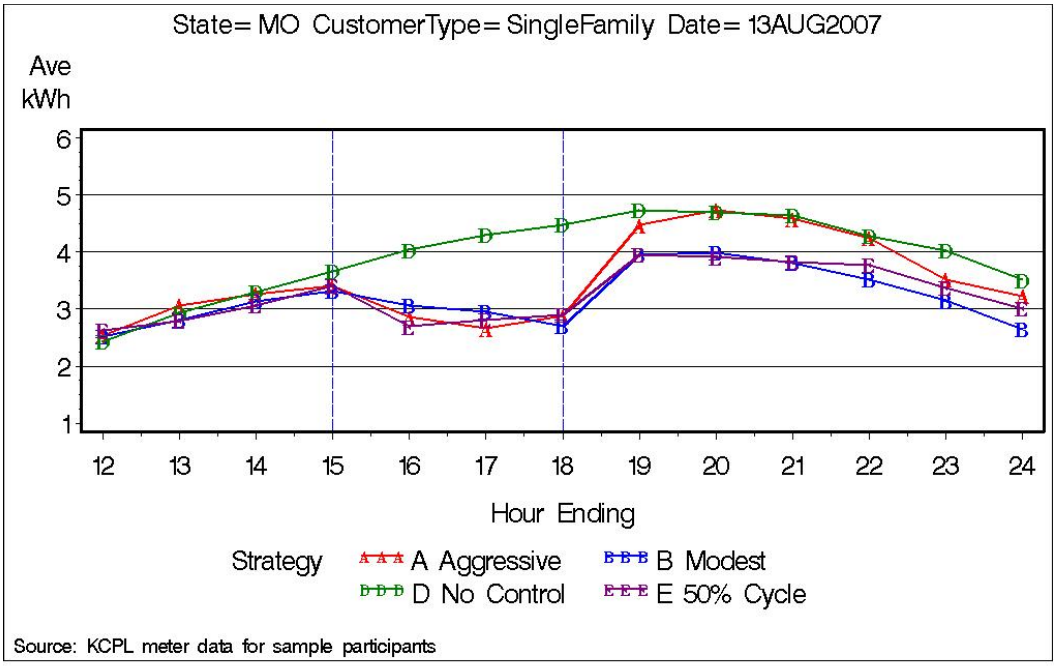


Figure A8: Missouri Single Family Load Curves on August 13



Beginning with August 13, the Temp Ramp strategy is dropped and replaced with a moderate (50%) cycling strategy. The three cycling strategies show amazingly similar load reductions in Missouri, but virtually no snapback compared to the comparison group.

Figure A9: Kansas Single Family Load Curves on August 14

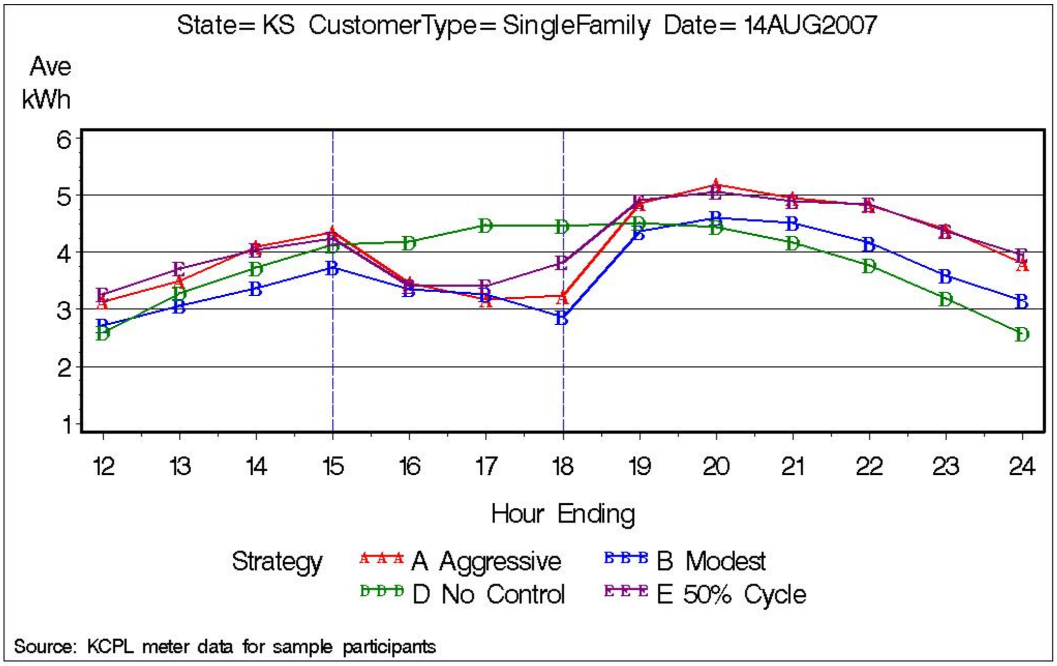
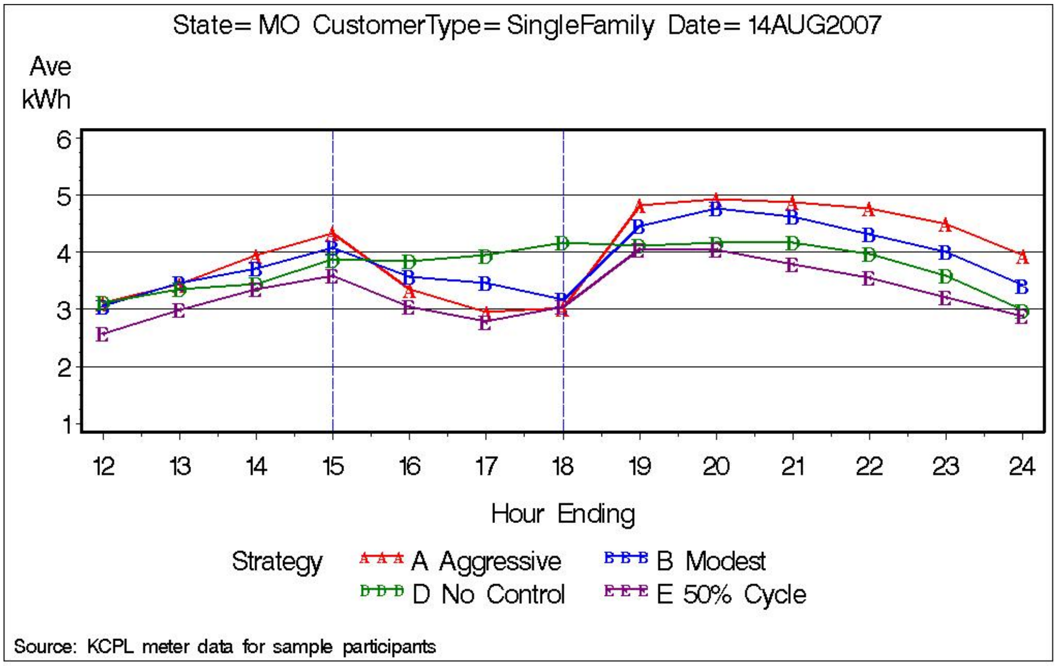


Figure A10: Missouri Single Family Load Curves on August 14



August 14 and 15 were the hottest control event days with temperatures reaching 100°. Differing starting points at the beginning of the event for each customer group make it difficult to assess relative impacts, but the shape for each cycling strategy is consistent.

Figure A11: Kansas Single Family Load Curves on August 15

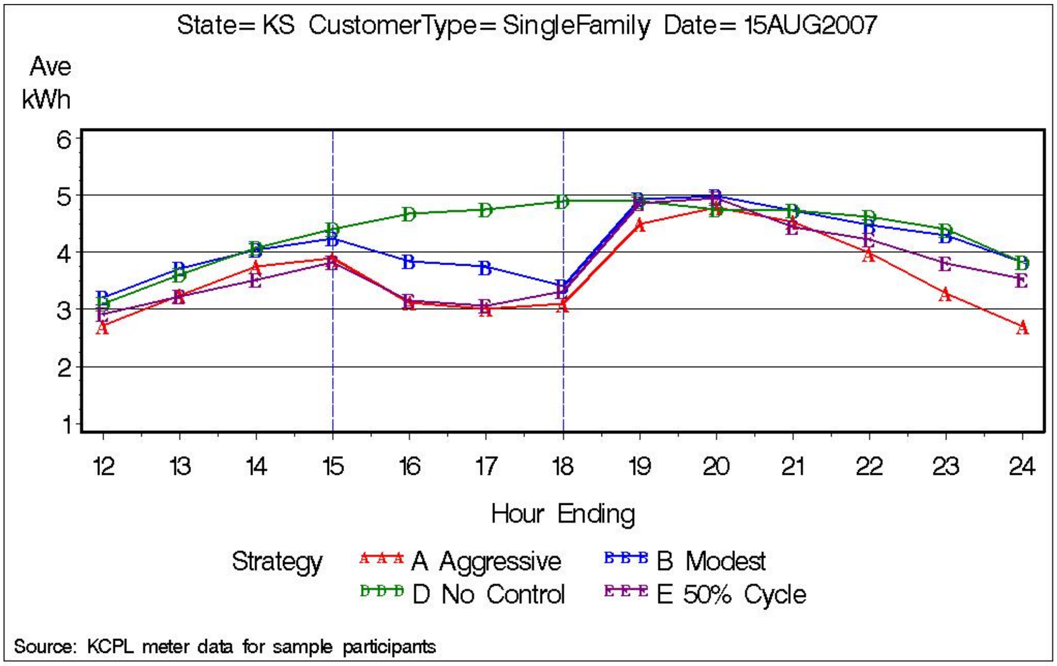
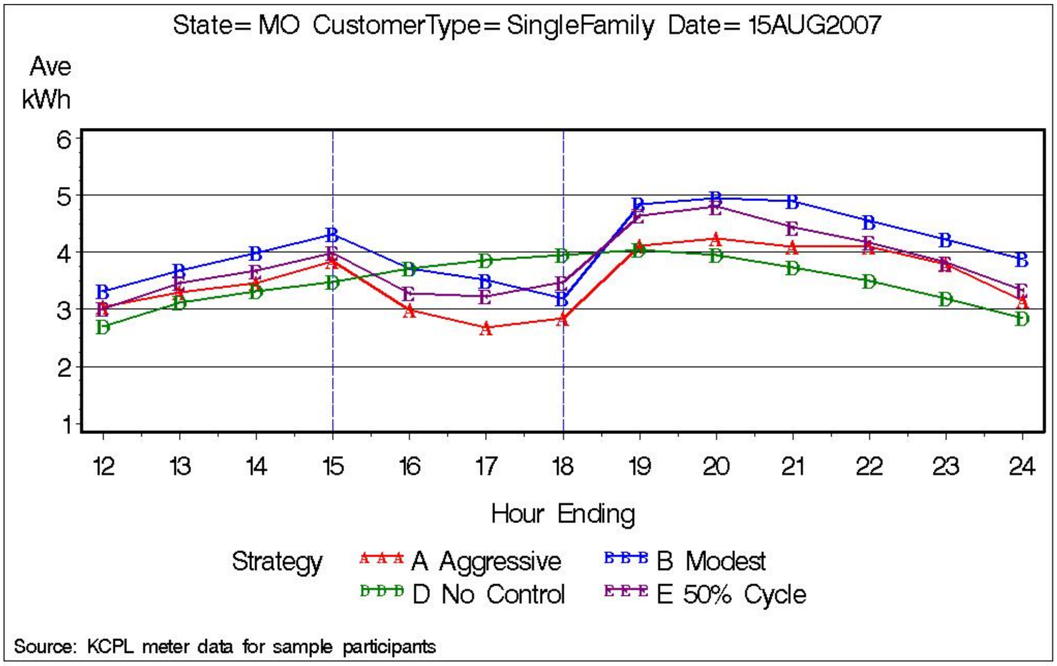


Figure A12: Missouri Single Family Load Curves on August 15



Again, differing starting points at the beginning of the control period make it difficult to assess impacts. The Kansas No Comparison group has a high starting point on this day which reduces the apparent snapback. The Missouri No Comparison group starts low, magnifying it.

Figure A13: Kansas Multifamily Load Curves on August 7

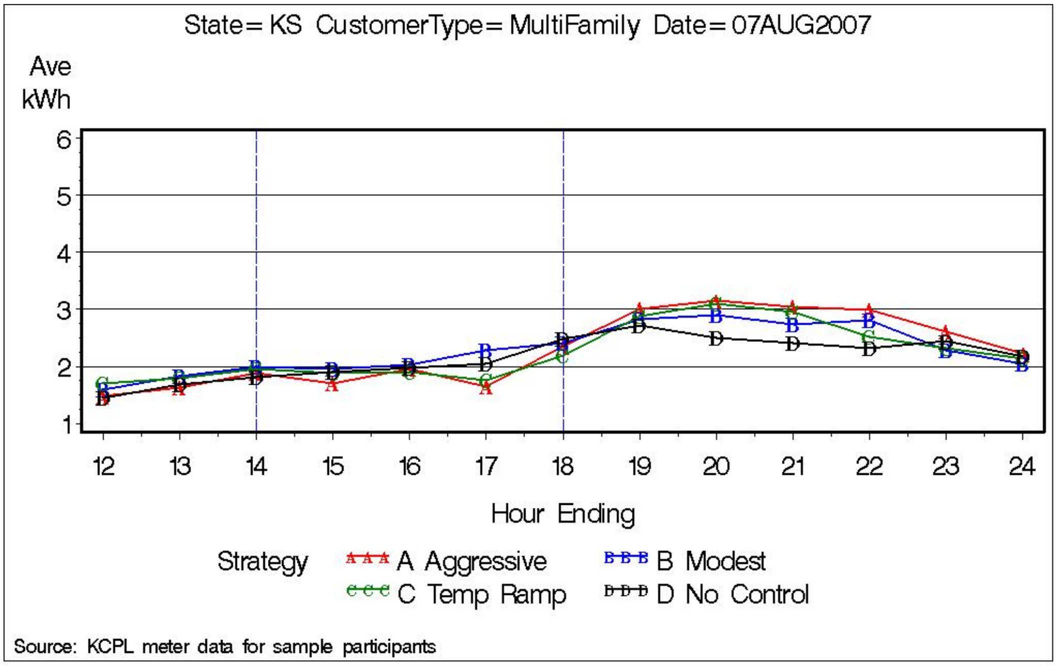
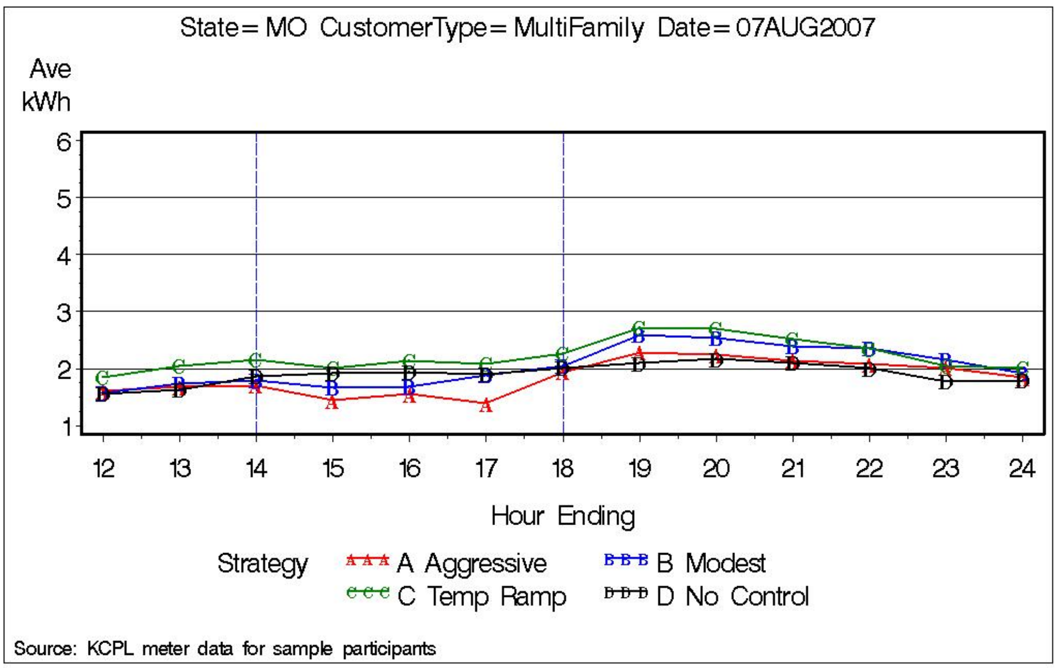


Figure A14: Missouri Multifamily Load Curves on August 7



The most obvious difference between the single family and multifamily load curves is the considerably lower average energy usage for multifamily customers. Where average household load reached 5 kW for single family homes, it stays under 3 kW for multifamily.

Figure A15: Kansas Multifamily Load Curves on August 8

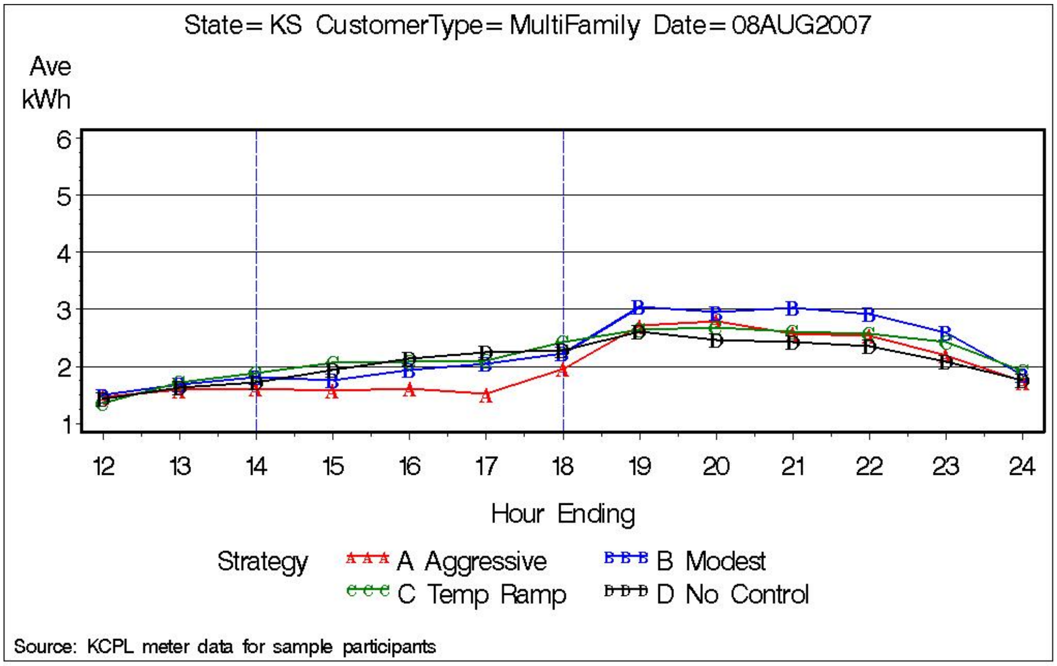
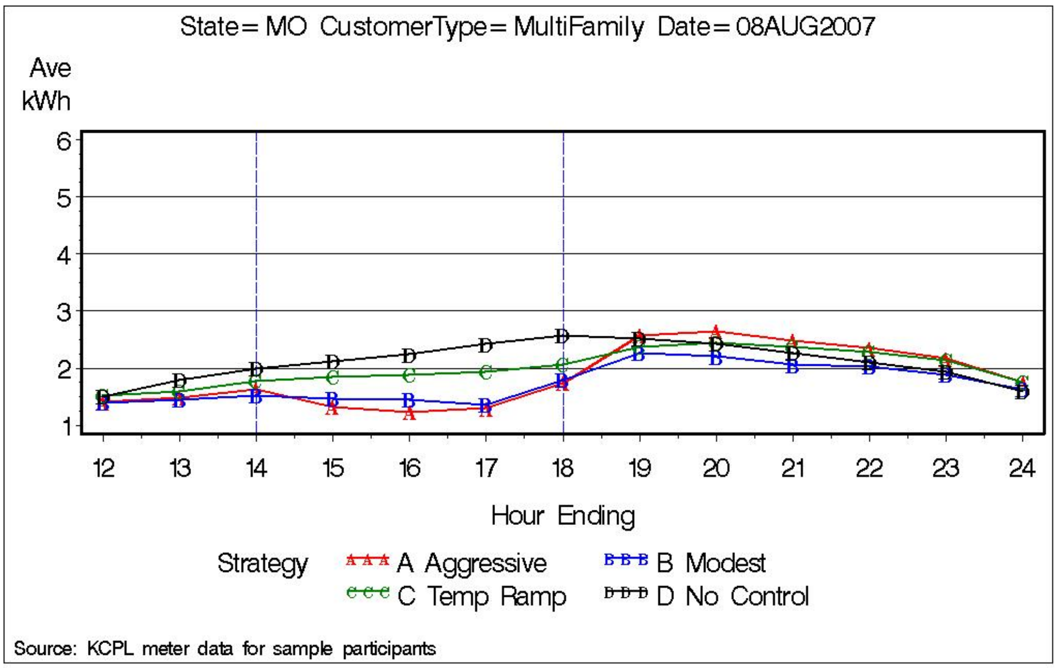


Figure A16: Missouri Multifamily Load Curves on August 8



The Aggressive Cycling strategy stands out as being very effective in both Kansas and Missouri. In Missouri, the Modest Cycling strategy is almost equally as effective. There is little obvious impact from either Modest Cycling or Temp Ramp in Kansas.

Figure A17: Kansas Multifamily Load Curves on August 9

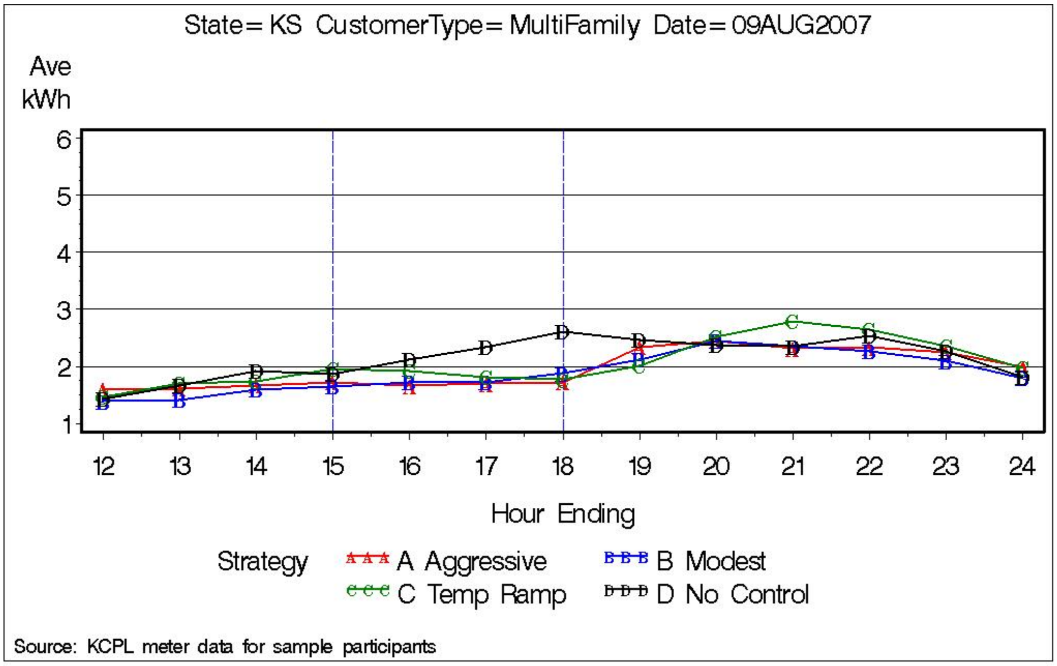
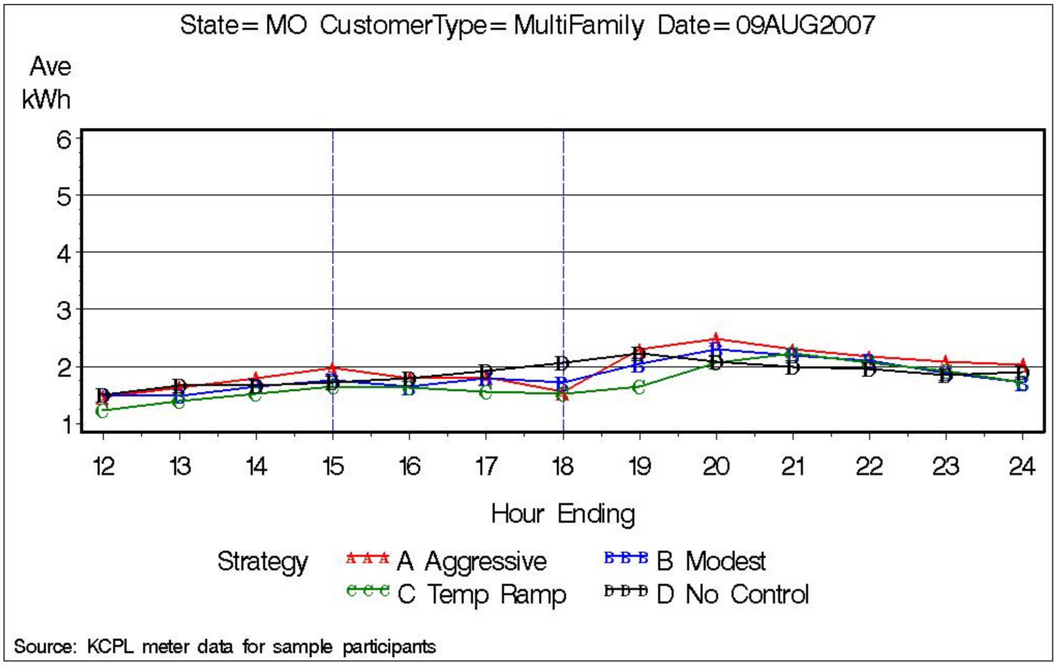


Figure A18: Missouri Multifamily Load Curves on August 9



Starting on August 9, control events begin at 3:00 pm instead of 2:00 pm. The cycling events show snapback immediately after the end of the control event, but the Temp Ramp event shows delayed snapback, again reflecting the delayed resetting of the thermostats after the event ended.

Figure A19: Kansas Multifamily Load Curves on August 13

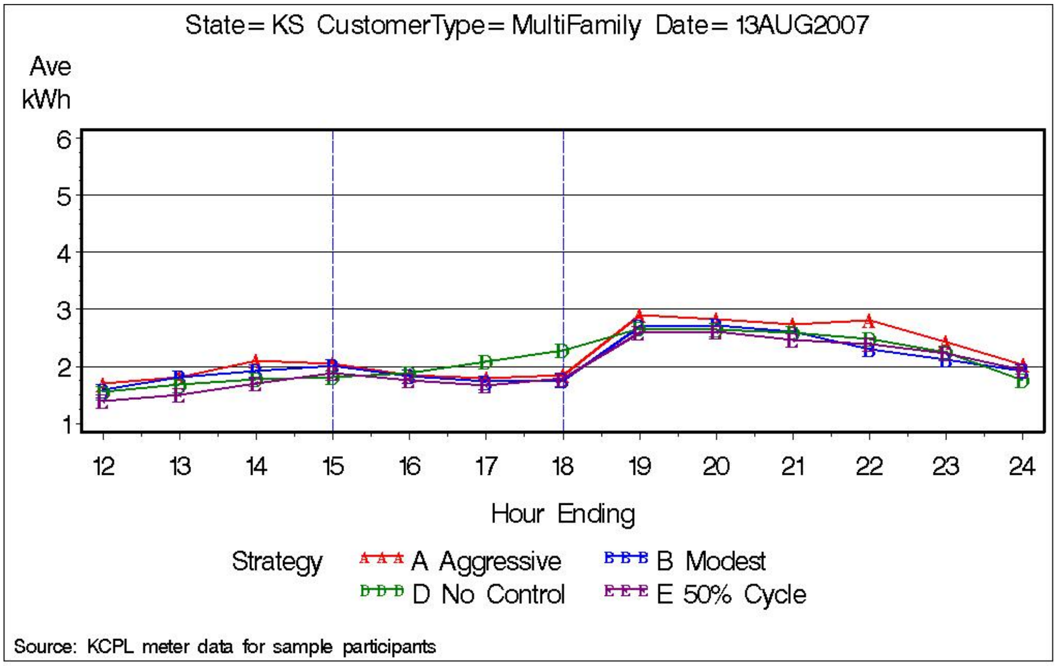
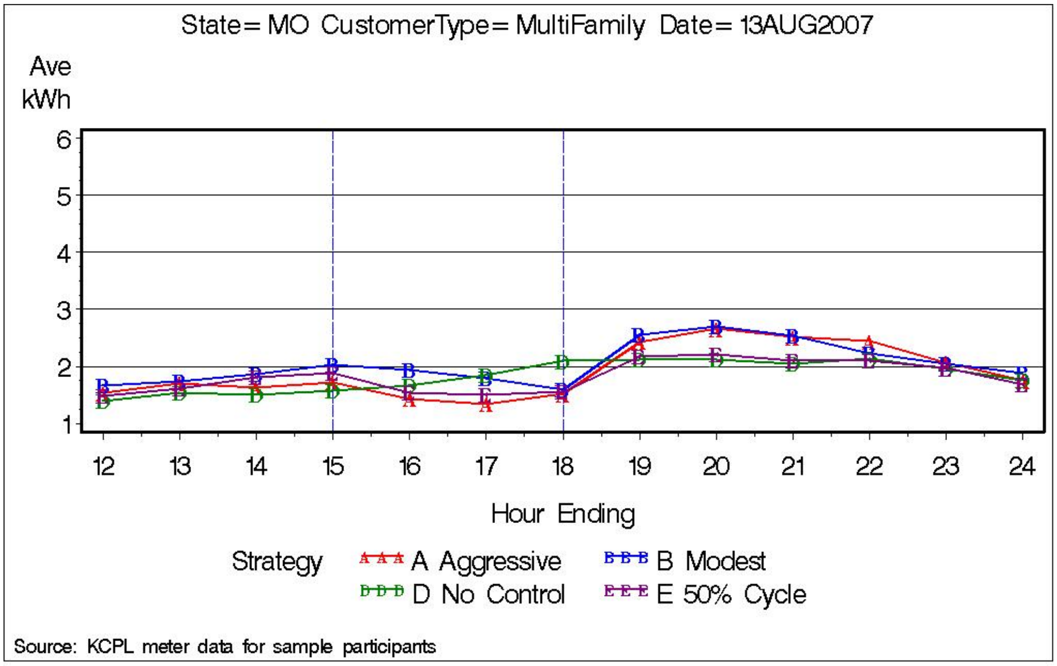


Figure A20: Missouri Multifamily Load Curves on August 13



Beginning on August 13, the Temp Ramp events were dropped and replaced with straight moderate (50%) cycling events. The Kansas data shows a great similarity in the load impacts from the three cycling strategies on this particular event day.

Figure A21: Kansas Multifamily Load Curves on August 14

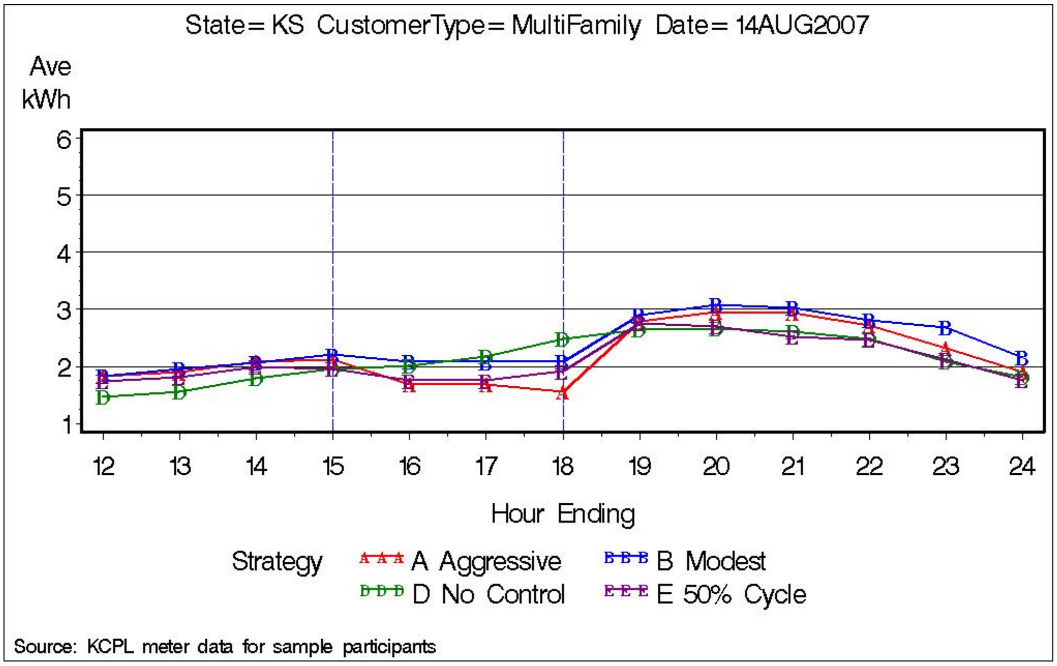
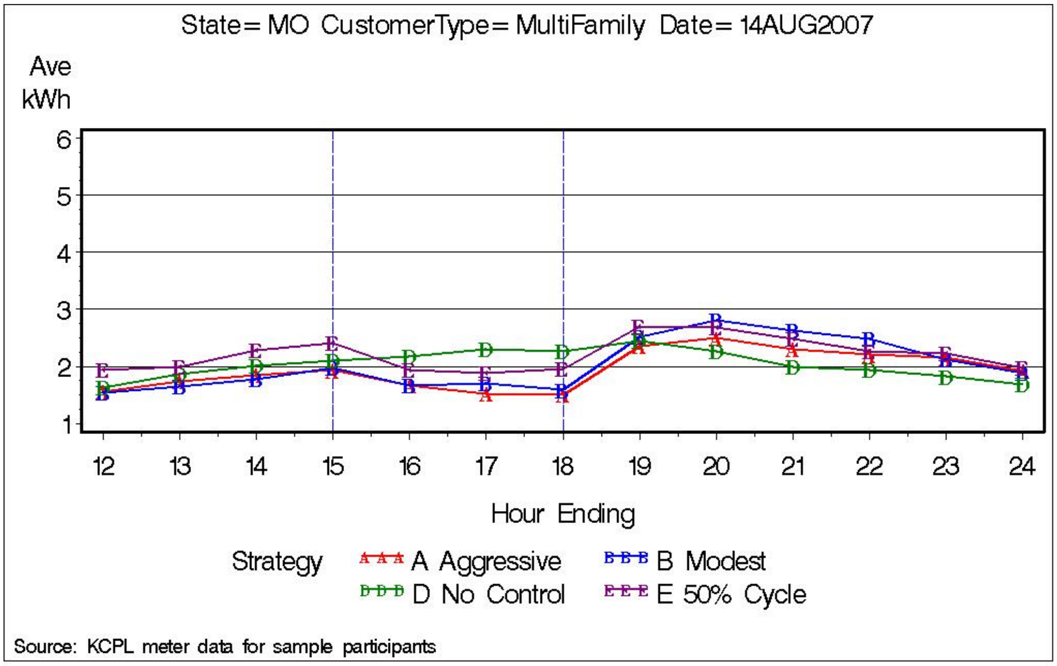


Figure A22: Missouri Multifamily Load Curves on August 14



This is an example of how variation in group usage before the control events makes it difficult to assess load reductions and snapbacks from unadjusted data. August 14 and 15 were the hottest control event days with temperatures reaching 100°.

Figure A23: Kansas Multifamily Load Curves on August 15

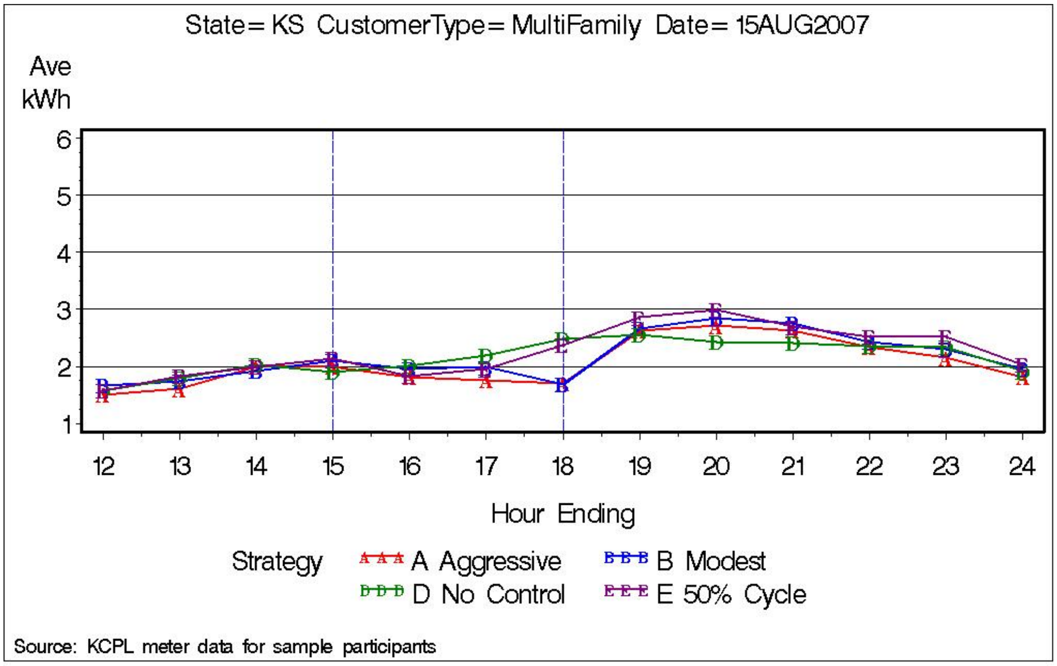
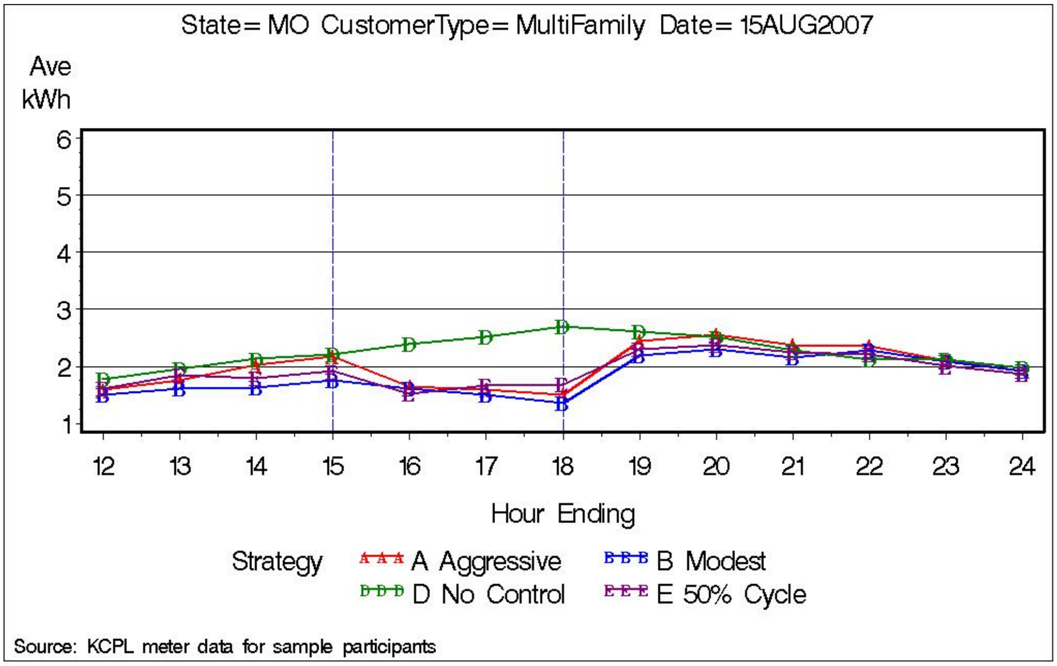


Figure A24: Missouri Multifamily Load Curves on August 15



On this particular control event day, the Aggressive Cycling control signals sent to the multifamily group did not match the regular pattern for Aggressive Cycling. After moving from 50% to 67% cycling, it dropped back to 50% after 15 minutes.