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2009 Pacific Gas and Electric Company SmartAC Ancillary Services Pilot

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1. EXECUTIVE SUMMARY

In the summer of 2009, PG&E and Lawrence Berkeley National Laboratory (LBNL) implemented a pilot program designed to assess the feasibility of providing spinning and non-spinning reserves to the California Independent System Operator's (CAISO's) Ancillary Service (AS) market using PG&E's SmartAC program, an air conditioner (AC) cycling or direct load control program. Spinning and non-spinning reserves are system resources designed to allow the system operator to rapidly balance supply and demand on the electric grid in case of forced outages occurring on the generation and transmission systems.

The requirements for providing spinning and non-spinning reserve using responsive loads (e.g., air conditioning (AC) direct load control) are evolving in the California market. The Western Electricity Coordinating Council (WECC), for example, currently prohibits provision of spinning reserve with responsive loads. WECC's current requirement is that resources providing spinning and non-spinning reserves be fully operational within 10 minutes of being called by the system operator. Spinning reserves must, in addition, be synchronized to the grid and begin operation immediately. Both spinning and non-spinning reserves must be capable of sustaining operation at full output for up to 2 hours (though, in fact, both reserves are rarely operated for the full two hours). Finally, suppliers must provide real-time information to the CAISO indicating the status of the resources providing spinning or non-spinning reserves.

PG&E's AC direct load control program (SmartAC) controls approximately 135,000 central air conditioners located in the Central Valley and other areas east of the California Coastal Range. PG&E's SmartAC program includes two types of direct load control (DLC) devices: programmable communicating thermostats (PCTs) and direct load control switches (DLC switches). Both types of DLC devices were examined in this pilot.

PG&E's Transmission Operations Center (TOC) schedules SmartAC load control operations using a secure computer terminal located in its center at 77 Beale Street, San Francisco.CA. The terminal is connected via the internet to a signal control computer operated by Cooper Power Systems in Minneapolis, MN. The computer creates and sends load control signals to AC direct load control devices through paging companies with service in the PG&E service territory. It is a one-way communications link. That is, signals are sent to the control devices from the central facility, but the control devices do not return communication acknowledging receipt of the signal or provide other information that would indicate the results of operations.

1.1. Overview of the Pilot

In PG&E's Ancillary Services Pilot (AS Pilot), AC loads were controlled for SmartAC customers on four distribution feeder circuits (feeders) located in Antioch, Fairfield and Fresno. Direct load control devices were instructed to shut off the AC compressor for 15- minute intervals twice daily for most weekday afternoons during the months of August and September 2009.

The feeders in the pilot were selected based on the following criteria:

1. Availability of one-minute interval SCADA measurements from PG&E of megawatts (MW), megavars (MVAR), Amps and ambient temperature.

2. Predominance of residential customers on the feeder. Feeders with large commercial and industrial processes were avoided to ensure that variations in AC loads could be detected on the SCADA measurements above the ambient noise created by large loads.
3. Variation in climate. Locations were selected within the PG&E service territory representing the variation in climate.
4. Pre-existing saturation of SmartAC customers on the feeder. An effort was made to locate feeders with reasonably high saturations of SmartAC customers to minimize the number of new SmartAC customers that needed to be recruited to carry out the test within each feeder.

To assess the time required for the SmartAC program to come under control and the load impacts achievable under varying conditions, AC loads on selected feeders were completely interrupted for 15-minute intervals. This testing protocol is called a "notch" test because it allows observation of the impact of AC direct load control on distribution feeder circuits as well as on individual AC units. A total of 71[1] notch tests were conducted between the hours of 12:00 pm and 7:00 pm during the months of August and September 2009. The tests were conducted twice a day for every week day during those months at different times, separated by 2 hours. The ambient temperatures varied across the feeders under study and by time of day from a low of about 68.5 degrees on August 24th, 2009 at 7:00 PM to a high of about 101.5 degrees on August 28st, 2009 at 3:15 PM.

Loads on the four distribution feeder circuits under study were reported at one-minute intervals throughout the testing period. In addition, AC loads were monitored for a representative sample of 100-110 customers on each distribution feeder circuit. Between 30 and 40 of the AC units on each distribution feeder were measured using telecommunicating loggers that recorded and transmitted load information at one minute intervals for 15 minutes before, during, and after each test operation. Loads on the remaining sampled AC units were measured at 5 minute intervals on standard HOBO loggers.

The results from the telecommunicating loggers were recorded every minute and summarized on a private web page that was made available for review and comment to CAISO and other interested parties inside and outside PG&E. The loads on feeders and AC units were displayed on the web page (one screen for each feeder and one for the overall system) continuously. The screens displayed trends for loads on feeders and AC units and statistics describing the average and total load reduction measured for the monitored appliances.

Load measurements were analyzed at the conclusion of the experiment to determine the latency (and causes of latency) in signal transmission and the load impacts that were achieved under varying conditions of time of day, day of week and temperature conditions.

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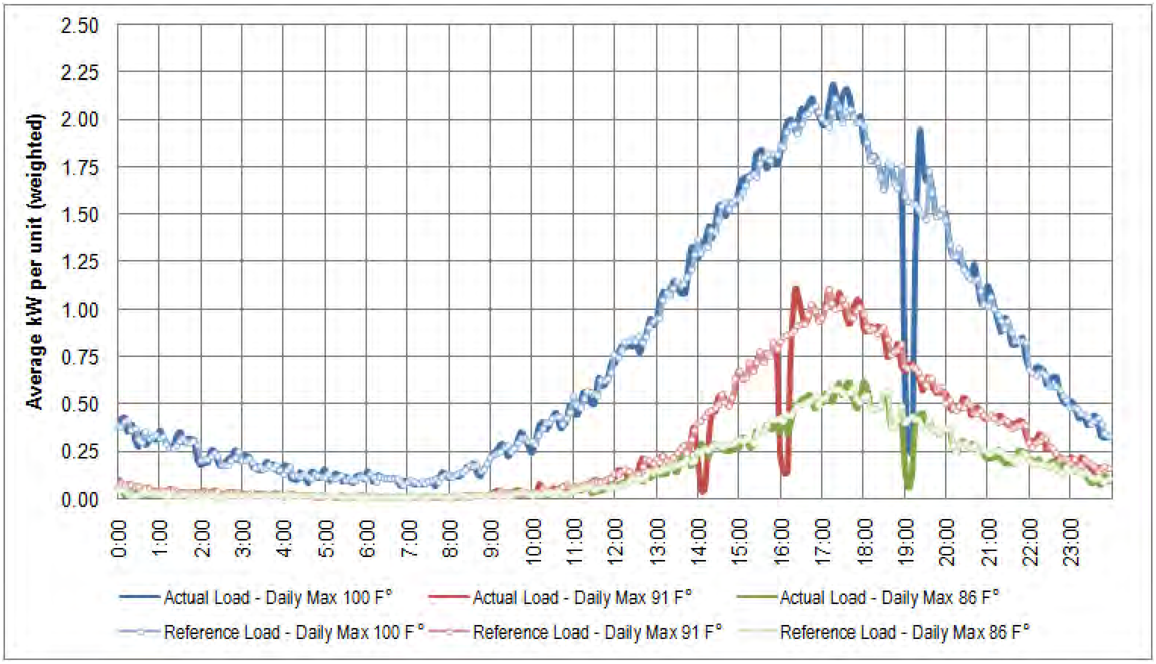
[1] Overall, the system was triggered 76 times. However this study excludes five of those occurrences; one on August 3rd, the first day of operations when no signal was sent and four across October 1st and 2nd when the weather was very cool.

1.2. Summary of Project Achievements

The following are the results obtained from PG&E's AS Pilot:

1. Four distribution substation feeders were selected for testing the capability of PG&E's AC direct load control system as an ancillary services product. The number of residential customers on the feeders ranged from 2,754 to 4,751. A total of 13,646 residential customers were connected to the circuits under study.
2. Sufficient customers were recruited to the SmartAC program to ensure that each of the four circuits contained approximately 500 SmartAC customers – 100 customers with PCTs and approximately 400 customers with DLC switches. Prior to the recruitment process, a total of 1,376 control devices were installed on AC units on the four distribution feeders (about 10.1% saturation). A total of 631 additional customers were recruited and control devices were installed during July 2009 in the areas served by the distribution feeder circuits using a combination of telemarketing and door-to-door sales. At the conclusion of the recruiting effort, the combined participant population for the four feeders under study was 1,994 (about 14.6%).
3. Simulated spinning reserve operations were conducted during the months of August and September 2009. During the tests, which lasted 15 minutes each, loads on air conditioning units on the feeders under study were shed. Loads on feeders and loads for a sample of the air conditioning units in the study were observed before, during and after each control period.
4. For 49 test events for which latency (the duration from start of the event until appliances begin to shed loads) could be accurately measured, the average duration from test start to onset of load control was 69.4 seconds (one minute, 10 seconds). On 95% of the test occasions, onset of load control occurred within 126 seconds (2 minutes and six seconds). In all tests, all available load reductions were obtained within 10 minutes – on average in less than 6 minutes.
5. The load impacts of spinning reserve operations vary substantially with ambient temperature and time of day. In the pilot, the load impacts exhibited the relationships depicted in Figure 1-1. It presents actual and predicted loads for three days in September with daily maximum temperatures of 86 F°, 91 F°, and

Figure 1-1: Example of AC Load Profiles and Impacts by Daily Maximum Temperature and Time of DAY



100 F°. The AC load for the 91 F° day is about double the AC load on the 86 F° day and the AC load for the 100 F° day is almost three and half times larger. In addition, on all three days, the AC load varied substantially by hour. As a result, the AC load impacts were dependent on the weather conditions and the time of day when the load control event is activated. While the AC load and load drops vary substantially, they are highly predictable and generally more load reduction is available for extreme weather events that drive system load peaks.

6. Regression models designed to estimate ex-post load impacts were developed. The load in the absence of events was estimated based on unperturbed load patterns immediately before and after event periods (within an hour), time of day, day of week, ambient temperature, and temperature during the preceding day have been developed. The models explained over 96 percent of the variation in AC load and accurately estimate load impacts for each feeder and device across the temperature spectrum.

7. The cost effectiveness of the program was not assessed because PG&E did not bid into the SmartAC load into the market during the pilot and therefore cannot estimate the revenue stream likely from program participation. However, the costs associated with AS participation have been estimated and are presented in Appendix G. The incremental cost of participation in the AS market is the cost of the development and installation of a telemetry system required to supply CAISO with immediate information concerning performance, development of algorithms for forecasting expected load impacts on a day-ahead basis, and the development of the administrative apparatus required to support bidding (e.g., procedures, protocols and labor).

8. Regression models for predicting day-ahead load impacts by hour were developed using the observed relationship between weather and AC load in the course of the pilot. The predictive models explain 87 percent of the variation around average AC load. In other words, the models accurately predict AC load variation due to ambient temperature conditions, hour of day, and other factors.
9. The AS Pilot successfully demonstrated a reasonably-priced telemetry system capable of reporting sampled AC loads by feeder at one minute intervals with a one minute telemetry delay (i.e., in real time plus 60 seconds). The system was made available to CAISO for day to day monitoring of system operations throughout the latter half of August and September of 2009.
10. This measurement system, which consisted of 130 telemetry points, could easily be scaled up to accommodate a much larger number of telemetry points (at least 10,000). However, no more than 500 telemetry points would be required to support system-wide load impact estimation for purposes of day-ahead load forecasting, settlement and program operations. A telemetry system consisting of approximately 500 measurement points (capable of reporting AC load at one minute intervals in real time plus one minute) at the system level will cost approximately $1.2 million dollars to install in the first year. Thereafter, the annual operating cost of the system will be approximately $300 thousand per year.
11. While the pilot was conducted on pre-scheduled event operations, it is possible to synchronize and automate the dispatch of AC direct load control resources with the electric grid.

2. PROJECT OBJECTIVES

The AS Pilot was designed to accomplish the following objectives:

1. Simulate the provision of spinning and non-spinning reserve by Demand Response (DR) in a manner that will convince system operators of its usefulness.
2. Build operator confidence regarding the value of DR as an alternative to generating machine-based solutions by providing robust technical evidence of system performance.
3. Establish the technical basis for modifying reliability rules to allow utilization of DR for spinning reserves.
4. Demonstrate the reliability of large numbers of small responsive load reductions.
5. Assess the performance of the SmartAC program in providing spinning reserves.
   (a) Determine how long it takes for the PG&E load control system to respond to an instruction to interrupt AC load.
   (b) Determine how much load reduction can be obtained under different operating conditions including temperature, time of day and day of week and climate.
6. Develop a communication and aggregation framework (including telemetry) that is easy to expand when the pilot moves into the program phase possibly in 2010.
7. Assess the investment, benefits and risks associated with entering into the ancillary services market in California and identify any changes to program design, tariffs or operating procedures that may be necessary to do so.

The pilot was also designed to address several of the barriers to proving ancillary services with load control that were identified in PG&E's testimony served in A.08-06-003 Chapter 3 Section F. These barriers include:

1. The need to reliably forecast load – i.e., the magnitude of AC participant load available to provide spinning reserve.
2. The need to call DR by geographical location - building DR AS resources in local areas.
3. The need for a cost effective telemetry design that can be used to call for and observe the impacts of DR as an Ancillary Service – testing of technology for telemetry.

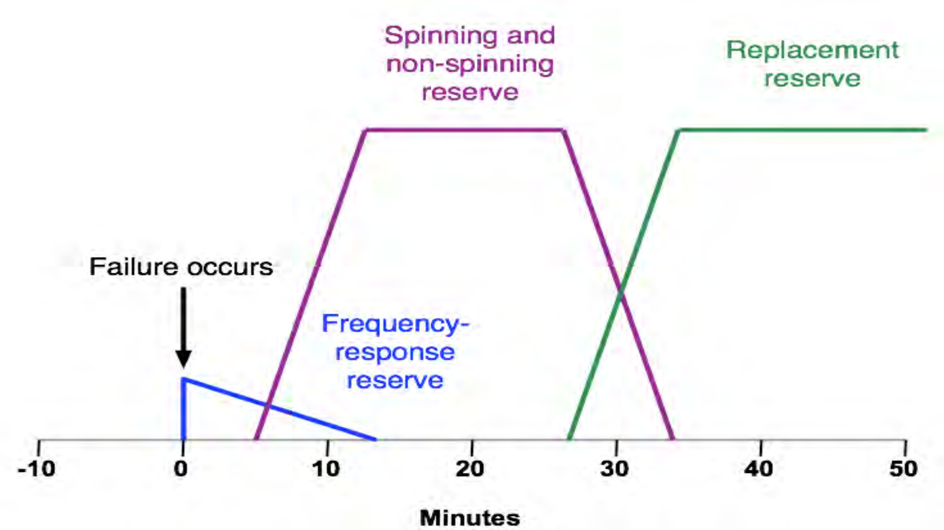
3. INTRODUCTION

3.1. Ancillary Services and Market Rules

Aggregate electricity consumption and production must match in real time in order to maintain the stability and reliability of the electric grid. Because generation and transmission facilities can be unexpectedly forced out of operation, controllable reserves are continuously maintained to cover these unexpected contingencies. There are three types of reserves – 10-minute spinning and non-spinning reserve and 30-minute operating reserves. Historically, 10-minute spinning reserve has been supplied by generating machines supplying increased torque as the system frequency sags. That is, spinning reserves are supplied by generating machines that are synchronized with the load on the grid but have additional generating capacity above their current dispatch point. Non-spinning and 30-minute reserves are resources that are not synchronized with the grid and must be started and synchronized with the grid (e.g. quick start combustion turbines). Currently load control is treated as non-spinning – though it has been argued that the machines under control in a direct load control program are synchronized with the grid and that it makes no sense to classify appliance load control solely as non-spinning.

The operating requirements for the various classes of contingency resources are different. Ten-minute spinning and non-spinning reserves must be fully operational within 10 minutes and in the California market, they must begin production within one minute of the operator's call. Thirty-minute reserves must be fully operational in 30 minutes. Non-spinning reserve (and regulation) is there to supply power needed to bring the system frequency back to normal (i.e., 60 Hz); and 30-minute reserve is there to provide power to enable re-dispatch of the resources formerly providing spinning and non-spinning reserves (and regulation) back to their pre-contingency levels (i.e., the restore their reserve capabilities). Figure 3-1 describes the relationship among these three types of reserve.

Figure 3-1: The Role of Spinning and Non-Spinning Reserves



3.2. DR participation in Ancillary Services Market

Some types of DR are capable of providing these reserve services at lower cost and with better performance than conventional generating facilities. For example, the industry has decades of experience using under-frequency relays on large pre-set, non-voluntary nor compensated blocks of load to avoid catastrophic outages resulting from problems with frequency control. The installation of under-frequency relays, set at much higher frequency thresholds, voluntarily, and in return for compensation on large commercial and industrial loads is a novel DR approach to frequency management that has not been widely adopted in the utility industry. This technology could be an indispensable part of system management. While, historically, most small appliance load control devices (i.e., DLC switches and PCTs) were not designed to respond to system under-frequency problems, SmartAC DLC switches have under frequency and under voltage capability. Thus, it is possible, that frequency response could be supplied by load control devices.

It is possible to cost-effectively substitute rapid load reductions for rapid increases in generation in the operation of the system. Moreover, aggregated direct load control as a source of 10-minute and 30-minute reserve has certain powerful advantages over conventional sources of contingency reserves. They are:

1. There is no fuel cost and there are no emissions associated with the operation of these resources.
2. They can be started more quickly than generating units that have to be cold started and synchronized with the system.
3. Most load control systems have been built to provide emergency reserves and are therefore seldom called, despite their cost-effectiveness relative to the construction of generating equipment. There is substantial unused capacity in these systems that could be more efficiently employed if it were used more frequently.

However, to be used for 10-minute or 30-minute reserve, aggregated load control resources would have to meet certain minimum operating requirements. They are:

1. The size of the available resource has to be demonstrated to be large enough to warrant its use to control system level problems.
2. The reliability of the load control system has to be demonstrated. That is, the likelihood that the system will supply an agreed upon load reduction within the required time period has to be high (at least 95%) and it has to be known and documented.
3. The load control system has to be able to supply an agreed upon load reduction within the timeframe required by the system operator (i.e., 10-minute reserve within 10 minutes and 30-minute reserve within 30 minutes).
4. Because contingency reserves are used when the margin for error in system performance is very low, it is necessary for the system operator to know very quickly whether contingency resources are operating and their production levels. Real time operations are designed to quickly identify and recover from non-performance or under performance of ancillary services providers since the consequence, system collapse, can be catastrophic. Operations are typically designed to automatically dispatch the next resource in the queue should an

ancillary service provider fail to quickly deliver resources. In order to manage the risk associated with non-performance or under performance, it is necessary for the operation system to know the status of these contingency reserves in near real time.

5. For contingency resources obtained by aggregating large numbers of small loads (e.g., AC loads) it is not practical to telemeter every participating load. For example, PG&E's SmartAC program comprises approximately 135,000 control units spread out over thousands of square miles of geography. Instead, reliable statistical sampling procedures must be designed that cost-effectively meet the need for reliable system monitoring

The PG&E AS Pilot was designed to determine whether its SmartAC Program can meet these basic requirements.

4. PILOT DESIGN

4.1. Approach to Pilot

As indicated above, PG&E's SmartAC program is an operational program consisting of approximately 135,000 active air conditioning load control devices. The AS Pilot was designed to be a small scale simulation of using that resource to supply 10-minute spinning and non-spinning reserve. As such, the Pilot consisted of the following components:

1. Four distribution feeder circuits were chosen for study – two in a relatively hot climate (Fresno) and two in a moderate climate on the east side of the Coastal Range (Antioch and Fairfield). The difference in climate is important in that past studies have indicated performance of AC direct load control varies dramatically with ambient temperature. Other considerations involved in selecting the feeders for study included:
    a. one minute SCADA measurements (KW, Amps, MVAR and temperatures) could be accessed through a secure data port maintained by PG&E.
    b. The circuit did not contain large commercial and industrial loads that might mask the impact of AC load control on feeder level measurements.
    c. Sufficient SmartAC customers already existed on the feeder to ensure that recruiting goals could be met quickly (i.e., within one month).
2. The number of SmartAC customers was increased on each of the selected feeders to ensure that approximately 500 SmartAC customers were present – 400 with DLC switches and about 100 with PCTs. This was accomplished using a combination of telemarketing and door to door sales within each feeder.
3. PG&E's AC direct load control system was programmed to cause an immediate and complete shut-down of all AC loads for participating SmartAC customers on the feeders under study; and to return control of the AC unit over a random two minute interval after a 15-minute control period had expired.
4. Simulated ancillary service operations were conducted on all four feeders simultaneously, twice each week day at varying hours between 12:00 pm and 7:00 pm. The test operations were scheduled to occur on a different designated hour each day and repeated two hours later.
5. The impacts of each operation were measured at the feeder level using SCADA and for a sample of approximately 100 – 110 AC units connected to each feeder.
6. The results of measurements from SCADA and from a sample of telecommunicating loggers were collected each minute for a period of 15 minutes before, during and after each simulated spinning reserve operation. These measurements were aggregated and displayed at one minute intervals on a web site that was made available to the CAISO and other interested parties.
7. The latency and load impacts of the operations were then carefully analyzed to determine the performance of the system.

4.2. Technology and Communication

4.2.1. AC Direct Load Control System

Figure 4-1 describes the AC direct load control technology and telecommunications systems used in the AS Pilot. PG&E's AC direct load control system is a one-way communications system provided by Cooper Power Systems. There are two kinds of control devices on the system – DLC switches and PCTs. Both types of control devices have the ability to shed load. Additionally, both DLC switches and PCTs can cycle ACs using a time based algorithm and PCTs have the ability to increase temperature by changing settings. In the AS Pilot test operations, all DLC devices were operated in shed mode and were programmed to immediately curtail appliance operation at the time they received the signal to initiate control.

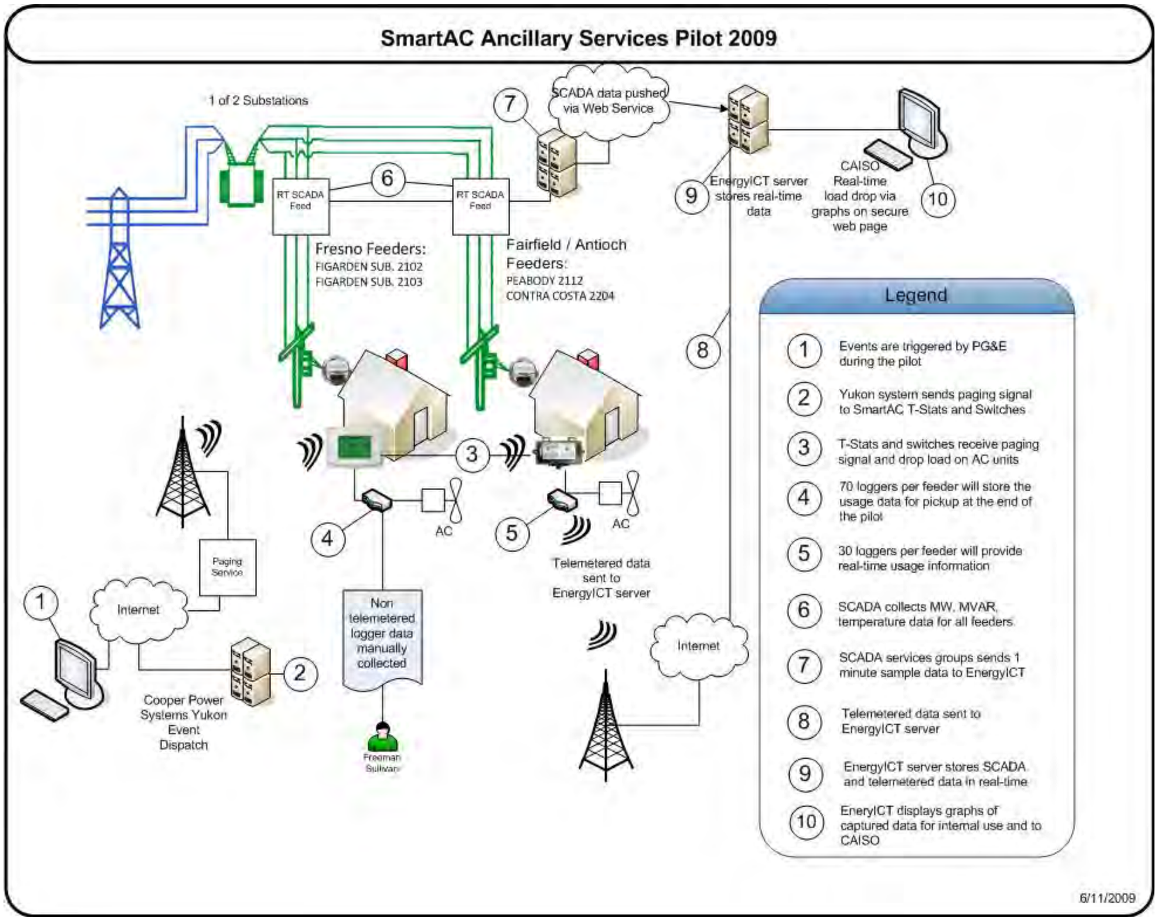
Load control for the AS Pilot was initiated by the PG&E project manager using a locally resident program that allows a remote user to select the start and end times for load control operations and the operating strategies that are to be employed. The mainframe computer that controls all of the SmartAC load control operations for PG&E, known as Yukon, is hosted by Cooper Power Systems in Minnesota.[2] Load control operations were scheduled by the PG&E project manager during the morning of the event day.

The Yukon system is responsible for initiating the scheduled event and sending the load control signals that are to be sent according to the schedule and operating rules that are called for by the user (e.g., PG&E project manager or Transmission Operator in the case of normal load control operations). Messages used to control devices are sent by the Yukon system via a mainframe computer in Minneapolis, MN at the designated time through communicating modems to two paging companies operating in PG&Es service territory. From there the messages are transmitted over 900+ MHz radio frequency bands to the intended control devices.

Two 900 MHz commercial paging companies are used to ensure reliability. Each control device on the PG&E direct load control system is programmed with its address through the paging system. Devices have the ability to receive instructions via messages transmitted through the paging systems. This capability is used for many things, one of which is to change the internal settings on the devices and another is communicating groups for control purposes. The AS Pilot customers were readdressed to a single group code to facilitate efficient scheduling and control.

[2] Cooper Power Systems provides support to a number of utilities throughout the US that are operating load control systems.

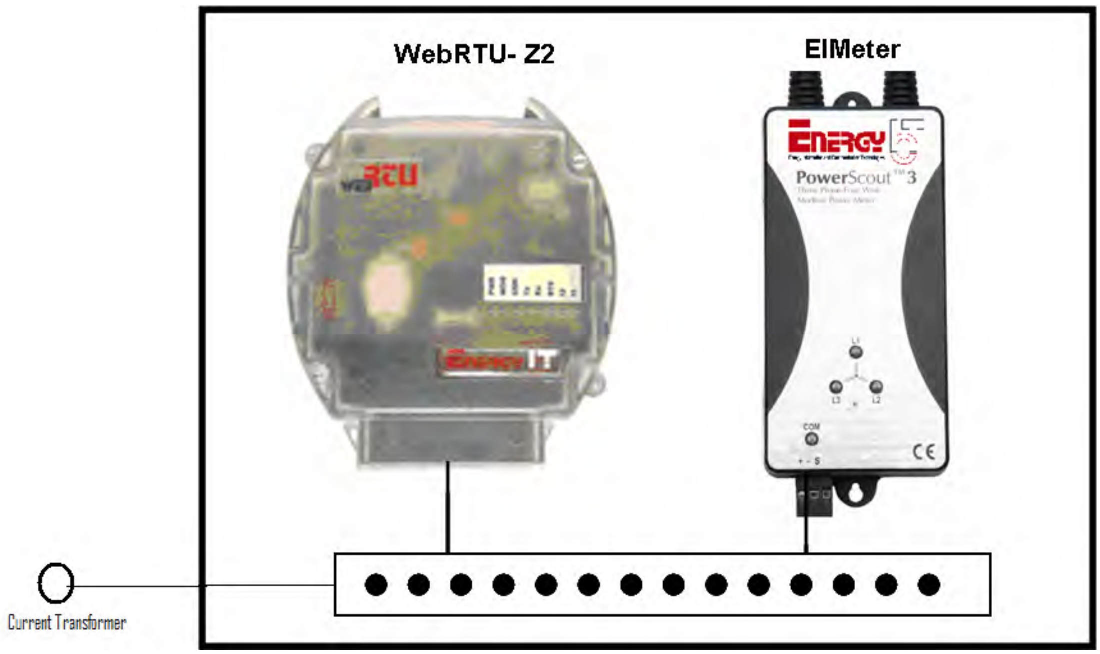
Figure 4-1: AS Pilot Load Control and Communications System



4.2.2. Telemetry and Load Measurement

PG&E does not allow direct access to its SCADA systems because of safety and security considerations. However, information from the SCADA system is stored at one minute intervals on a database that is being updated in real time by PG&E. For the AS Pilot, measurements from this database (i.e., MW, AMPS, MVAR for each phase and ambient temperature) were transmitted by secure FTP via the internet to the mainframe computer system used to support telemetry. In addition to information from the SCADA system, loads on a random sample of 129 AC units were measured at 20 second intervals and stored at one minute intervals for the 15 minutes preceding, during and after each load control test. The measurements recorded for each AC units included kW, kWh and AMPS.[3] The data was integrated and displayed at one minute intervals throughout each test.

Figure 4-2: Description of Telemeter



The telemetry and database management systems for the AS Pilot were supplied by Energy ICT. The telemeter consisted of a combined Dent PowerScout 18 (that translates information from the current transducer into energy and demand measurements); and an EICT WebRTU-Z2 that stored the readings from the PowerScout and communicated with the EICT database management system (EIServer). EIServer is an Oracle database management system engine running Java to create custom database operations and displays. The telemeters communicated with

[3] The system was designed to measure the exact second at which loads responded to load control signals by recording the exact second that load on the appliance dropped by 80% for any period following the commencement of load control operations. The algorithm designed to detect this condition did not work properly and this approach to the measurement of the latency of signal transmission was abandoned.

the EIServer by posting HTTP messages in Internet Protocol using GPRS (cellular communications).

The telemeters reported the measurements for the most recent minute for 15 minute before, during, and after each test operation. They transmitted the measurements to the EIServer which then integrated it with information about the sample and displayed it – refreshing the display at 1 minute intervals. In other words, measurements for the prior minute were displayed live for each event.

The system displayed a graph of the load measurements from the feeder (top left corner); a graph of the load measurements from the sample (bottom left corner); the sample load impact extrapolated to the system (top right corner); and useful statistics describing the load response (e.g. average load impact per control unit, percent of appliances in operation, etc.). In addition to showing the information for each feeder, the loads for all feeders and all sampled AC units were also displayed in a summary tab.

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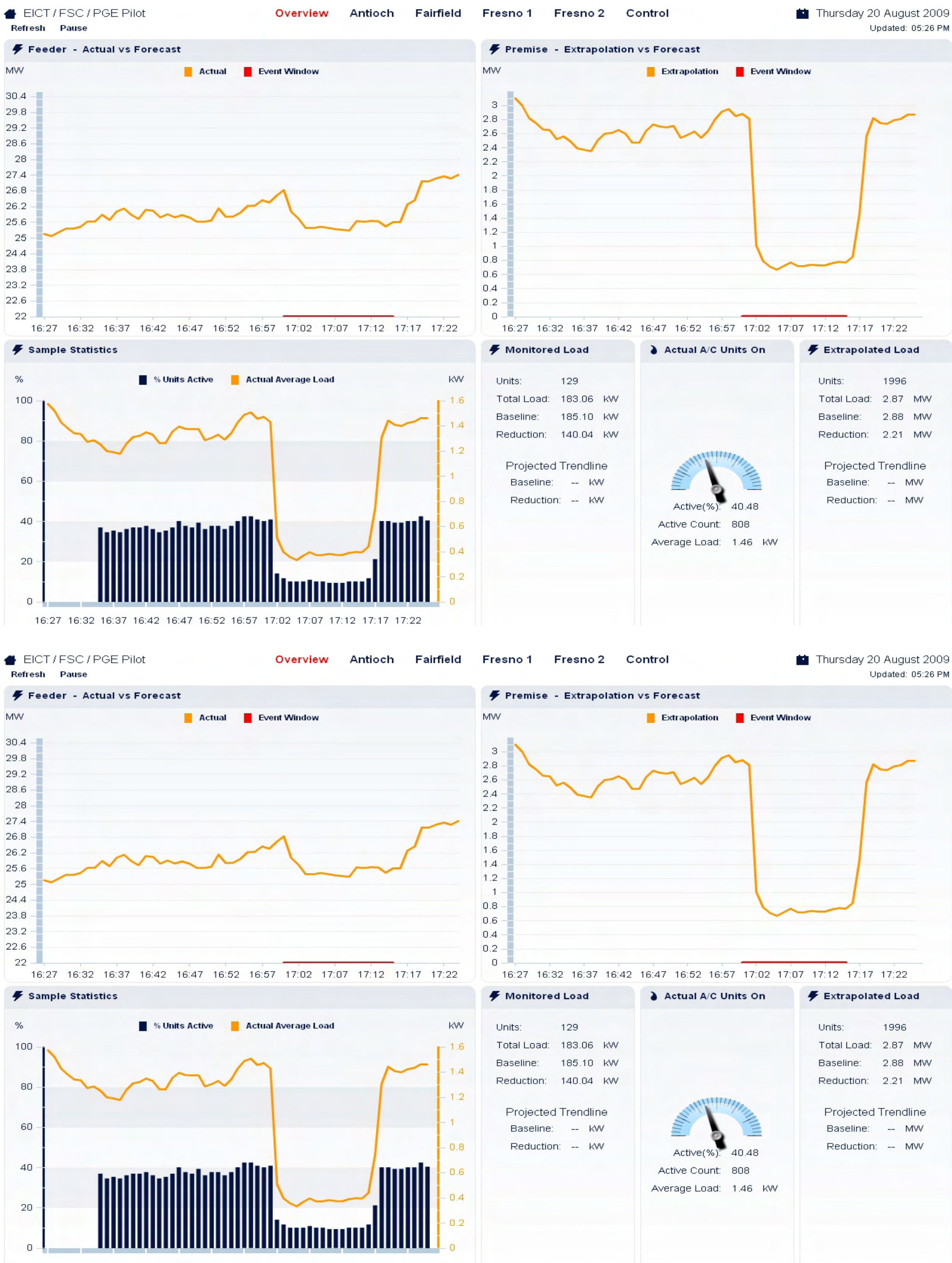
Figure 4-3 displays a screen shot of the output from the telemetry system. The system displayed a graph of the load measurements from the feeder (top left corner); a graph of the load measurements from the sample (bottom left corner); the sample load impact extrapolated to the system (top right corner); and useful statistics describing the load response (e.g. average load impact per control unit, percent of appliances in operation, etc.). In addition to showing the information for each feeder, the loads for all feeders and all sampled AC units were also displayed in a summary tab.

Figure 4-3: Real Time Load Monitoring System – AS Pilot



The screen updated every minute based on the measurements taken in the prior minute. It demonstrated how long it took for control to take effect, how long it took for loads come *under full control and the overall magnitude of load reduction that was achieved.* Throughout the AS Pilot, this screen was monitored and refined to offer the most beneficial information. There are two interesting things to note about the load control operation depicted in Figure 4-3. First, the load control operation is observable on both the feeder measurement (upper left quadrant) and in the sample observations. Second, not all of the appliances that were in operation came under control during the test (lower left quadrant). That is, some of the appliances simply did not respond to the test. Both of these results are observable on the majority of the tests that were conducted.

4.3. Sample Design

Approximately 100 residential customers were recruited from the list of approximately 500 SmartAC customers on each feeder. This resulted in a total of 403 customers for which end-use loggers were installed (about 20.2 percent of all participating households). AC loads for 129 of the AC units (between 30 and 40 on each feeder) were measured using telemeters (about 6.5% of all participating households). AC loads for the remaining 274 were measured using standard Onset HOBO loggers sampling the appliance load at one minute intervals and recording the average at 5 minute intervals.

Table 4-1 displays the SmartAC population, interval data sample, and telemetry sample for the AS Pilot. For the Fresno feeders, PCT's were oversampled in both the interval data and telemetry samples.

Table 4-1: Sample and SmartAC Population Characteristics

		Devices			Percent of Total		
	Feeder	DLC Switches	PCTs	Total	DLC Switches	PCTs	Total
SmartAC Population	Antioch	413	102	515	20.7%	5.1%	25.8%
	Fairfield	406	96	502	20.4%	4.8%	25.2%
	Fresno 1	420	105	525	21.1%	5.3%	26.3%
	Fresno 2	366	86	452	18.4%	4.3%	22.7%
	TOTAL	**1,605**	**389**	**1,994**	**80.5%**	**19.5%**	**100.0%**
Interval Data Sample	Antioch	70	28	98	17.4%	6.9%	24.3%
	Fairfield	84	14	98	20.8%	3.5%	24.3%
	Fresno 1	67	40	107	16.6%	9.9%	26.6%
	Fresno 2	60	40	100	14.9%	9.9%	24.8%
	TOTAL	**281**	**122**	**403**	**69.7%**	**30.3%**	**100.0%**
Telemetry Sample (live event data)	Antioch	20	10	30	15.5%	7.8%	23.3%
	Fairfield	27	3	30	20.9%	2.3%	23.3%
	Fresno 1	26	14	40	20.2%	10.9%	31.0%
	Fresno 2	17	12	29	13.2%	9.3%	22.5%
	TOTAL	**90**	**39**	**129**	**69.8%**	**30.2%**	**100.0%**

The time periods during which loads were to be controlled were systematically sampled and selected at the outset of the experiment. For example, on the first day of experimental operations (Monday August 3rd) the first test was conducted at 12:00 pm.

Two hours later the second test was conducted at 2:00 pm. The next day (Tuesday August 4th) the first test was conducted at 1:00 pm (one hour later than the test on the preceding day); and two hours later the second test was conducted at 3:00 pm. This pattern was repeated throughout the months of August and September with minor deviations.[4]

This time sampling procedure resulted in a large number of observations for each sample point for both event and non-event periods. The total number of 15 minute intervals during which a load control event could have occurred for each customer is 1,344 (42 weekdays X 8 hour event window X 4 intervals). During the study, control operations occurred for 71 fifteen minute intervals, and event load behavior was recorded for each customer for each load control operations. The observation of the impacts of load control over a wide range of times and temperatures provides the basis for applying very powerful regression modeling techniques for estimating the load impacts that can be obtained from AC direct load control at different times of day and under different temperature conditions.

4.4. Enrollment/Recruitment

One of the objectives was to compare the load impacts measured at the feeder level with those measured using sampling of appliance loads. In general, the saturation of the PG&E's SmartAC program is estimated to be less than 8% of customers with central air conditioners and on most feeders the saturation is low enough that variations in the feeder load could obscure the effects of AC load control. Based on the results of SCE's 2007 AS Pilot[5] and information about the variation in PG&E feeder loads, it was determined that the number of controlled AC units on each feeder in the PG&E AS Pilot should be at least 500 and that 100 of the control devices should be PCTs.

As is evident in Table 4-2, a total of 522 additional customers with DLC switches were required among the four test areas along with an additional 109 customers with PCTs. These areas had already been heavily targeted using direct mail advertising intended to convince customers to participate in the SmartAC program. A direct mail recruiting campaign was not expected to yield the necessary enrollments in a timely manner based on prior experience with this approach. In addition, the schedule for the Pilot required that all recruiting and installation of the targeted 631 customers be completed within 30 calendar days. To accomplish this objective alternative marketing efforts and a well coordinated, intensive effort by the recruiter and installer contractor was required.

[4] On days when the first operation was scheduled to occur at 6:00 pm, the second operation was not conducted. Operations were confined to the hours from 12:00 to 7:00 pm.

[5] See: Eto, J., J. Nelson-Hoffman, E. Parker, C. Bernier, P. Young, D. Sheehan, J. Kueck, and B. Kirby. 2009. Demand Response Spinning Reserve Demonstration – Phase 2 Findings from the Summer of 2008. (LBNL-2490E). Available at http://certs.lbl.gov/certs-load-pubs.html

Table 4-2: AS Pilot Feeder Characteristics as of July 1, 2009

Feeder	Feeder Number	Existing DLC Switches	Existing PCTs	Existing Total Controls	Number of customers	Control penetration	DLC Switch Recruits Needed	PCT Recruits Needed	Total Recruits Needed
Fresno 1	254552102	181	44	225	3,246	6.93%	219	56	275
Fresno 2	254552103	284	105	389	2,754	14.12%	116	0	116
Antioch	13652204	314	102	416	2,905	14.32%	86	0	86
Fairfield	63642112	299	47	346	4,741	7.30%	101	53	154
TOTAL		**1,078**	**298**	**1,376**	**13,646**	**10.08%**	**522**	**109**	**631**

Based on the limited time available to accomplish the installation of additional participants on the target feeders, a combination of direct mail-telemarketing and door-to-door marketing campaign was developed. For two of the feeders, the direct-mail telemarketing approach was used exclusively. For one of the feeders, a door-to-door campaign was used exclusively; and for one of the feeders both approaches were used.

The combined direct mail - telemarketing approach consisted of an advance letter to the customer explaining the SmartAC program, asking them to become participants and informing them that a program representative would be calling to follow up and help them complete the enrollment process. About 18% of customers who could be reached using the telephone numbers in PG&E's data base agreed to participate.

In the door-to-door marketing effort, clusters of addresses in small geographical areas (neighborhoods) served by the target feeder were identified and sales personnel were dispatched to knock on doors, explain the SmartAC program, and recruit participants. The same marketing materials that are normally used in marketing the program through direct mail were used to provide more detailed information about the program. About 38% of the households that were contacted in a single pass through the target neighborhoods agreed to participate.

Both the combined direct mail – telemarketing approach and door-to-door sales approach were highly effective and scalable. As is apparent in Table 4-3, the goals of the recruiting program were met within the 30 day interval.

Table 4-3: AS Pilot Feeder Characteristics as of August 1, 2009

Feeder	Feeder Number	Existing DLC Switches	Existing PCTs	Existing Total Controls	Number of customers	Control penetration
Fresno 1	254552102	366	86	452	3,246	13.92%
Fresno 2	254552103	420	105	525	2,754	19.06%
Antioch	13652204	413	102	515	2,905	17.73%
Fairfield	63642112	406	96	502	4,741	10.59%
TOTAL		**1,605**	**389**	**1,994**	**13,646**	**14.61%**

This recruiting effort was not designed to compare the efficacy of current direct mail marketing efforts with the more intensive marketing designs used to achieve increased saturation for purposes of the AS Pilot. It was conducted in an area that had already undergone significant marketing by direct mail and the impact of this prior marketing effort is impossible to separate from the effect of the more intensive efforts that were undertaken to reinforce enrollment.

4.5. Testing Protocols

Signal latency and load impacts of AS Pilot operations were measured for notch tests at different times of day and under different temperature conditions. In a notch test, AC loads are instantly and completely interrupted for a period of time (in this case 15 minutes). At the end of the notch period, control of the appliance is returned to the thermostat. Given the high concentration of SmartAC load control devices on the feeders of interest (i.e., about 15%), it was decided that control should be returned to the thermostats over a random two minute interval at the end of the test period. This approach avoids the possibility of an instantaneous large increase in load

The notch test provides the following useful information:

1. The ability to visually observe the magnitude of load reduction that occurs when load control operations commence – one can literally see the feeder load drop as the test proceeds.
2. The ability to visually observe the recovery of feeder loads at the conclusion of load control operation. The load recovery is the full measure of the feeder level load impact that occurred during the test. It contains the load that was interrupted at the commencement of the test and any additional load that occurs as appliances that were off at the start of the test try to come on.
3. The ability to observe the exact time when appliances begin to respond to control signals.
4. The magnitude of load reduction that occurred throughout the test period.

A further advantage of the notch test is that customers are unlikely to notice its occurrence if the duration of the operation is short (i.e., less than 20 minutes).

4.6. Event Information

Detailed information concerning the dates, start times and temperature conditions under which each of the tests was conducted is found in Appendix A. During the months of August and September 2009, a total of 71 test events were scheduled. Tests were spread among the weekdays. The ambient temperatures at which tests took place varied by hour and within hour from day to day. The highest average temperature at which a test took place was 101.4 F which occurred at 4:00 pm on September 27th in the vicinity of Antioch. The lowest average temperature at which a test took place was 68.5 F at 7:00 pm on August 24th in the vicinity of Fresno.

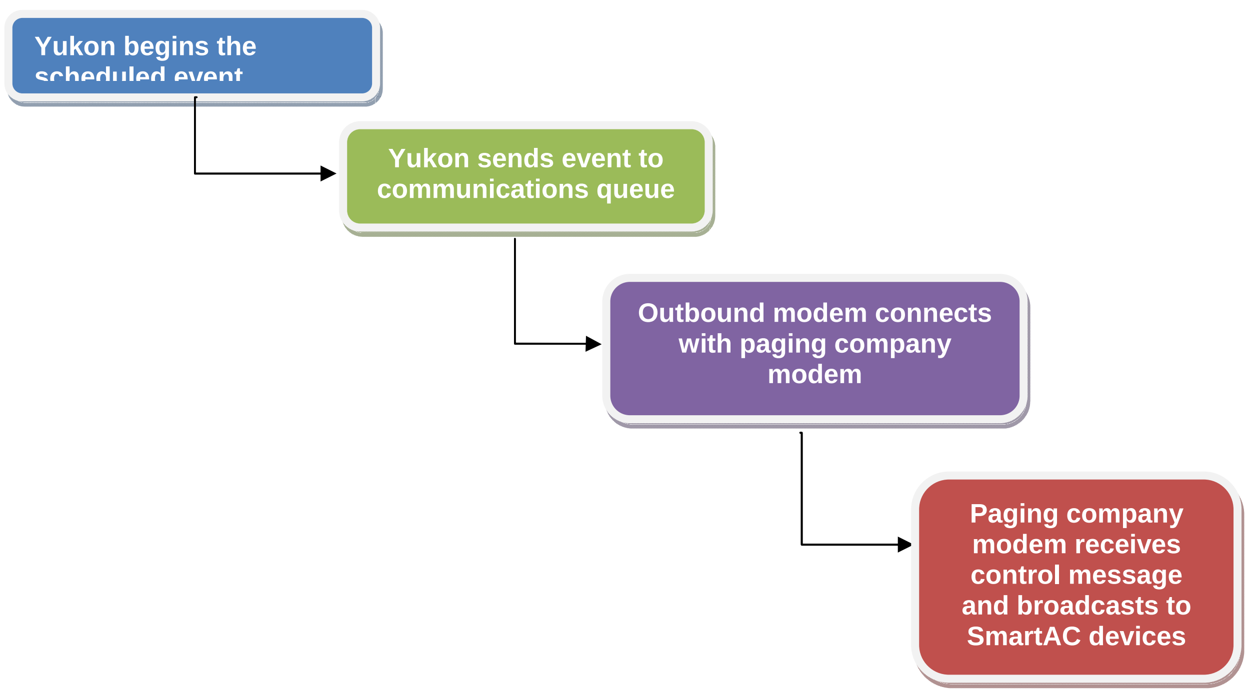
5. SIGNAL LATENCY ANALYSIS

5.1. Background

A direct link with the CAISO allowing it to directly start the AS Pilot was not developed or tested during the pilot. So latency in the communications link between CAISO and the control system was not measured. In the event that PG&E offers up its AC direct load control program as a resource for the AS market, a direct link will be built to CAISO's specifications. For the sake of this pilot, the regular PG&E SmartAC event control trigger process was followed as described in section 4.2.

This process involves several steps. Figure 5-1 below provides an overview of the process. For this pilot, events were scheduled ahead of time. At the start of an event, a control message is queued up and sent out to a single modem assigned per feeder on the Yukon side. Once the modem on the paging company side receives this signal, a page signal is sent out to individual devices instructing them to shut off the AC units. There is the possibility of delay at each of these steps.

Figure 5-1: AS Pilot Communication Diagram



The sum of the delays at each of these steps, from event start to appliance interruption represents total signal latency. There is a distribution of signal latencies across events and devices. This distribution was analyzed in detail including the relationship between signal latency and its various likely causes.

5.2. Methodology

5.2.1. Data Discussion

The latency or delay induced at each stage of the communications process was measured during the experiment. It is possible to measure the latency in the signal outgoing from the Yukon system using communications logs maintained by the Yukon system. From these logs it is possible to measure:

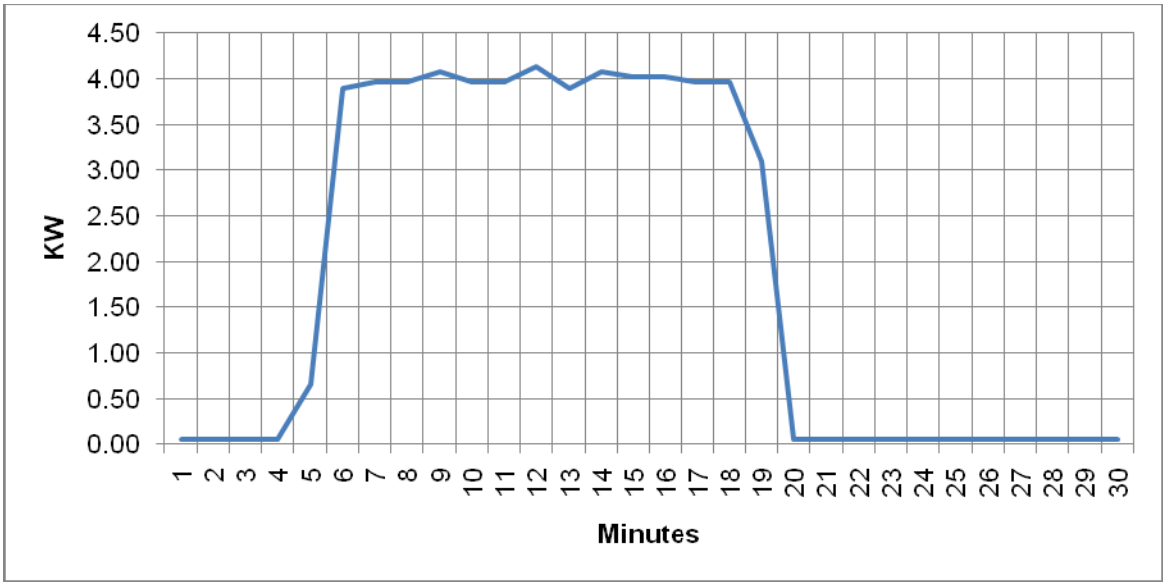
1. the time required for the Yukon system to create the control message that is to be sent to the devices.
2. the time required for the Yukon system to connect to the outgoing modem to transmit the signal to the paging companies.
3. the time required for the paging company modem to acknowledge receipt of the load control message.

It was not possible to directly measure the time required for the paging company to transmit the signals to the control devices because communications logs for the paging system were not available to PG&E. This element of the latency must be inferred from the difference between the time when the paging company modem acknowledged receipt of the control message and the time when the devices in the field began to respond

The total signal latency was measured as the difference between the start time of the event and the time when significantly more devices on the feeders began to turn off than would normally occur if the appliances had not been controlled. The sample of air conditioners with telemeters was used to make this determination. Even though the telemeters recorded AC loads in one minute intervals, it is possible to infer the approximate second when the devices in the sample shut off from interval data measured at the minute level using a straightforward algorithm.

Viewed at one second time periods, the compressor is either on or off. AC loads cycle on and off while in operation in response to calls from the thermostat. Depending on the design of the air conditioner; it is possible for the measured AC load to be greater than zero when the compressor is off. The AC load can take on three states – full load, fan load and no load. In these cases, it is necessary to net out the fan load in the calculation of the latency. Figure 5 shows an example of the typical cycling pattern displayed by a 4 kW AC unit in the participating sample. The figure displays the load on the AC unit each minute throughout a 30-minute period. The load cycles between approximately 0 kW and 4 kW with shoulder measurements that are between 0 kW and 4 kW. In the figure, it is apparent that the AC turns on during the 5^{th} minute, showing a partial load during this minute of about 0.67 kW. Given the cyclical nature of the AC load, this measurement reflects <u>not</u> just an average 0.67 kW load over the whole minute, but 4 kW load for approximately 8 seconds.

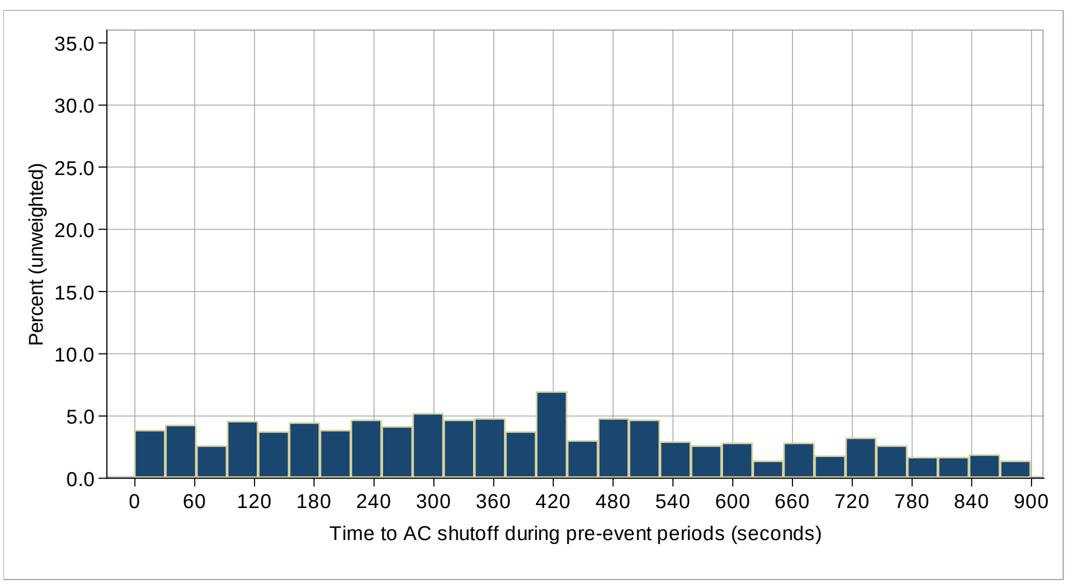
Figure 5-2: Sample Participant Load Over 30 Minutes



To calculate the approximate second at which loads shut down for a given AC, the mean of usage for minutes of full usage (excluding the first and last minutes) is compared to the levels of usage in the last minute. Using the example in Figure 5-2, when on, the AC load is approximately 4 kW. Usage in the final minute is 3.1 kW. Based on the logic outlined above, one can conclude that the AC unit is on for 78% of the final minute or approximately 47 seconds. This is the duration in seconds from the start of the observational period until the appliance shuts down.

Figure 5-3 displays the distribution of durations to shut-off as calculated for the 15 minute periods preceding the events under study. They reflect the natural rate of decay in the cycling rates of the AC units in the study (i.e., the unperturbed rate at which the appliances are shutting down in the absence of the AC control signals).

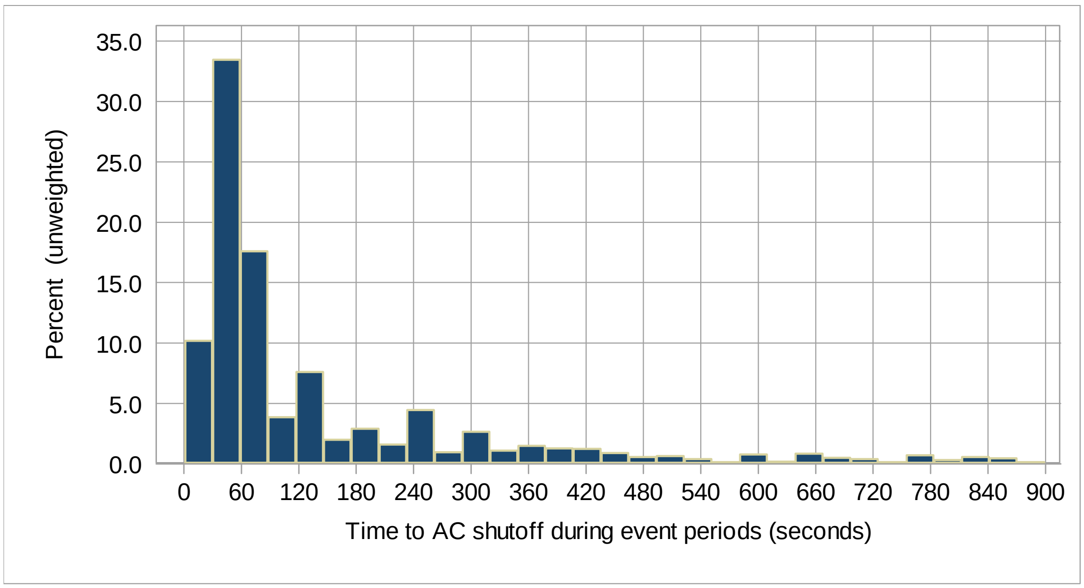
Figure 5-3: Distribution of Times to Shut-Off for 15 Minutes Prior to Events



The graph indicates that the rate at which the appliances shut down rises very slightly from the beginning of the observation period until about 420 seconds (7 minutes) have passed; then declines slowly throughout the remainder of the period. Even after 15 minutes, a small number of devices are still shutting down naturally. A significant fraction of the AC units in these periods shut off naturally during the first two minutes of the 15 minute observation periods.

Figure 5-4 displays the distribution of durations to shut-off observed over all of the AS Pilot test occasions. These test occasions occur exactly 15 minutes after the pre-event measurements described in Figure 5-3. In the Figure 5-4, it is apparent that during AS Pilot test events, most of the appliances shut down within the first two minutes of the start of the test. Comparing Figure 5-3 with Figure 5-4, it is evident that a fairly constant fraction of appliances cease operation in the first several minutes of the pre-event period and that the AC load control signal dramatically changes the rate at which appliances cease operation during the same time period.

Figure 5-4: Distribution of Shut-Off times for 15 Minute AS Pilot Test Events



Comparison of these graphs reveals an important challenge. The appliances are cycling naturally for the period of time before the test event starts. Consequently, some of them will shut down naturally during the first few minutes of the test – the same time during which the signal is expected to take effect. To measure the actual amount of time it takes for the devices to come under control, it is necessary to find the point in time when the rate at which appliances are shutting down exceeds the rate that would normally be expected to occur given the conditions. Since seconds matter in this analysis, a statistical technique is used to identify the exact point in time at which the load control operation begins to affect appliance operation.

5.2.2. Survival Analysis

To determine the time when the devices begin to shut down more quickly than they normally would in the absence of the control signal, survival analysis techniques were used. These techniques are also referred to as time-to-event analysis, with the event in this case being the time to shutoff of an individual AC unit. The survival analysis data structure is characterized by a single observation indicating the time expired between the start of the test and the time an AC unit subsequently shut off. These observations also contain other potential explanatory variables. It is only possible to measure the time to shut-off for devices that are known to be on at the start of the observation period. The survival analysis is designed to answer the questions "how long after the start of the test event did the AC units begin to respond to the control signals; and when is the full impact of the control system felt?" The load impact analysis on the other hand includes all the devices that were monitored (i.e., includes those that would have normally come on if the control had not taken place and answer the question "how much load was dropped?".

5.2.3. Natural Load Drop and Kaplan-Meier Curves

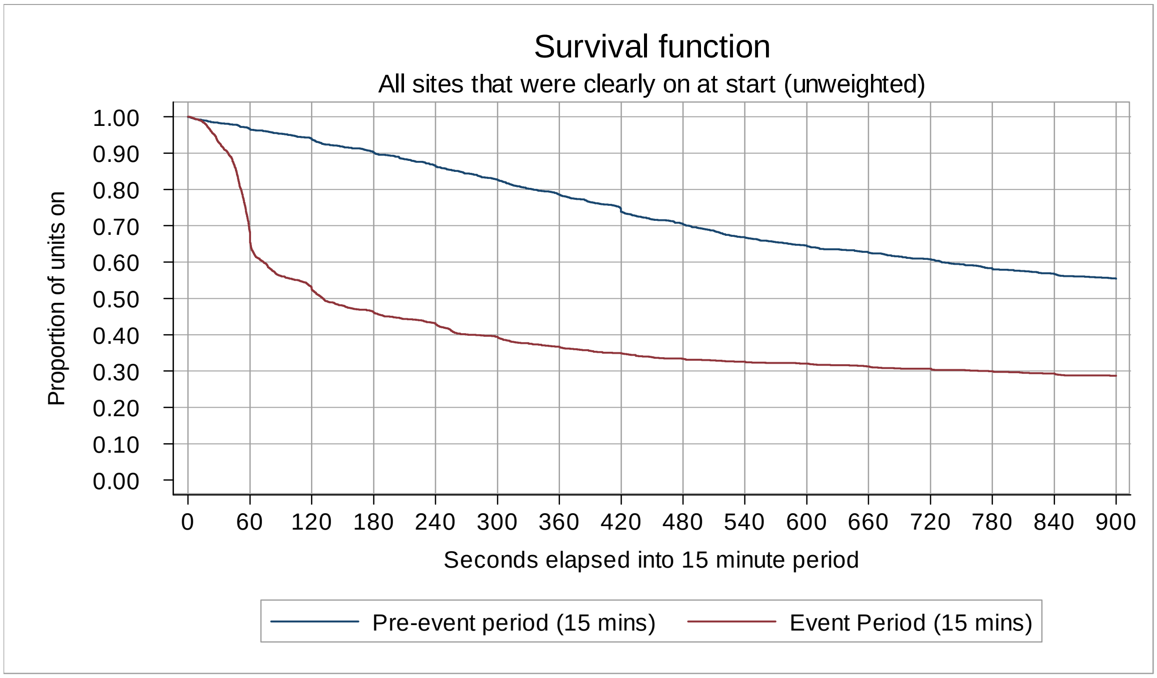
To identify the amount of time required for the AC load control operations to take effect, the rate at which the appliances shut down during 15 minute load control events (the treatment or event periods) was compared with the rate at which appliances shut down naturally during the 15 minutes prior to the load control events (the control periods). The 15 minutes prior to each event were used as a control period since weather conditions, occupancy, and participant characteristics were similar. By comparing the rates at which AC units shut down for these two periods, it was possible to accurately identify the time in seconds after which the event signal began to have an effect on the rate at which the appliances were shutting down.

To accomplish this, Kaplan Meier survival functions were calculated for each of the AS Pilot test events under study. These curves display devices that were on at the beginning of the test period and the percent that remained on as the test event proceeds. Starting at 100 percent, the curves trend downward displaying the percentage of AC units on line during each second following the start of the event. For control periods, the starting point is the 15th minute prior to the commencement of the event.

Figure 5-5 displays the Kaplan Meier survival functions for all of the event periods (dotted red line) and pre-event periods (solid blue line) based on the information collected from the telemeters. The two survival functions on the graph display AC units that were on at the start of the period and show the proportions of units that survive (i.e., remain on) across the 15 minute periods under study (i.e., 15 minutes before the start of the event; and during the event). The effects of the AC load control program on the fraction of appliances that remain on after the start of an event are clear. First of all, it is apparent that the fraction of appliances that remain on during the pre-event periods declines slowly (i.e., about 3.5% per minute). This is not so for the AS Pilot test events. Within the first minute of the event periods, the survival curves diverge dramatically (as devices begin to receive signals). After one minute, about 35 percent of the AC units have shut off during the AS Pilot events. The difference between the slopes of the two lines (red and blue) shows the effect of the load control system on the loads under study. The load control program acts very quickly on average – much of the time in less than 60 seconds.

While not weighted for the all AC units under control, Figure 5-5 also shows that not all the load control devices had come under control by the end of the test periods (900 seconds). By the end of the control periods, about 30% of the sampled devices were still operating. This does not indicate a delay in the operation of the load control program. Instead it reflects the fact that about 30% of the sampled devices did not come under control at all during some of the test occasions.   A careful analysis of this problem suggests that relatively weak paging signals do not reach PCTs inside the homes in the North Fresno area where two of the test feeders were located. This problem does not affect the measurement of the latency in the load control signals. It affects the load impacts that are achieved from system operations. This is discussed in more detail in Section 6.

Figure 5-5: Example Survival Functions for Pre-Event Periods and Event Periods



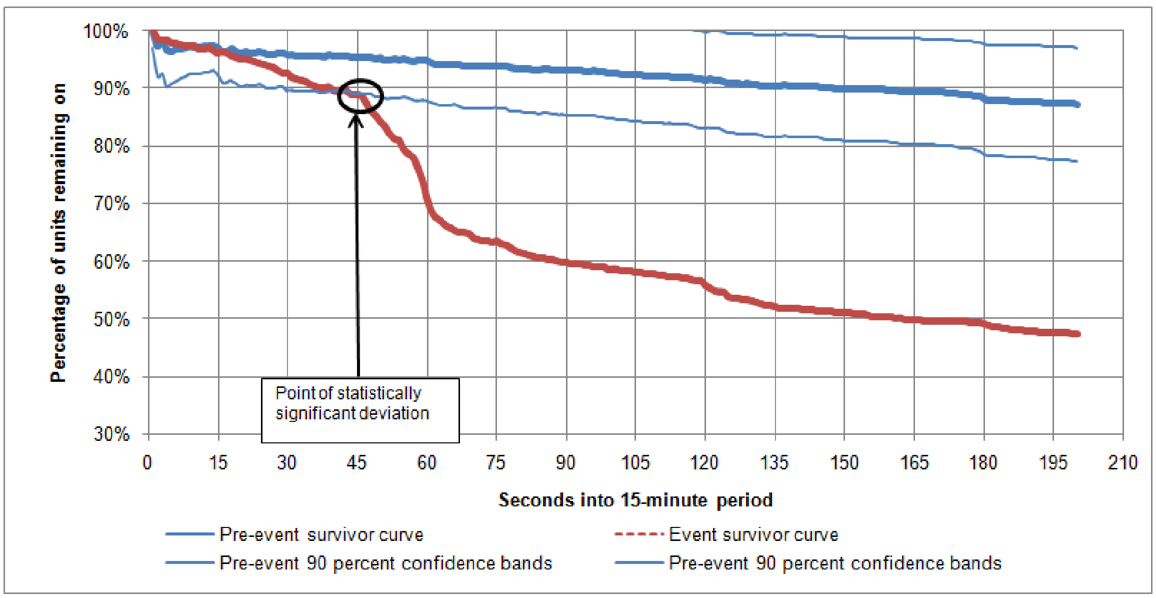
After the first 15 seconds, one percent of the devices in the pre-event group have shut down. Event group shutoffs are marginally quicker; however, the load control signal does not appear to have taken effect at this point. In the next 15 seconds, the shut-off rates in the pre-event and event periods begin to diverge. In the event periods, 5% of the appliances shut down within 26 seconds. In the pre-event periods, it takes more than 90 seconds for this to happen. This comparison suggests that the load control signal can impact appliance operations very soon (within about 30 seconds) of the commencement of load control. It is possible to apply this logic to each and every test event. This is done by comparing corresponding event and pre-event survival curves to find the time when the rate of shut-off in the event period becomes significantly (statistically) higher than the rate of shut-off in the pre-event period for each test. This involved the following steps:

- Identify all AC units that were on at the start of an event or the 15 minutes preceding the event.
- Calculate the lengths of time individual AC units were on during these periods.

- Estimate the naturally occurring AC shut off rate as a function of time based on the data collected from the fifteen minutes immediately prior to each event on an event-by-event basis.
- Estimate the AC shut off rate as a function of time for the event period.
- Calculate the 90% confidence intervals around each Kaplan Meier curve.
- Determine the first point in time at which the confidence intervals no longer overlap the survival curves.

An example of this process is presented graphically below. Figure 5-6 displays the first 200 seconds of the 15 minute event and pre-event periods with the point at which statistically significant deviation of the two curves occurs being highlighted. In the graph, it is apparent that the estimated survival rate for appliances in the event period is significantly lower (statistically) than the survival rate for the pre-event period after about 47 seconds into the event period. It is therefore possible to calculate the times at which the two survival functions diverge for each and every test event in the study by solving for the time (in seconds) when the difference in the survival rates of the two curves becomes statistically significant. This calculation was repeated for each test event.

Figure 5-6: Example Event and Pre-Event Survival Functions with Confidence Bands



5.2.4. Dropped Events and Sample Size Bias

During the first week of testing, a variety of technical issues were observed and rectified. These included:

1. Not all of the DLC devices that were supposed to be participating in the experiment appeared to be responding. This problem was rectified by retransmitting accurate internal identification codes for the participating DLC devices to ensure they recognized the control signals being sent
2. Initially, following AS Pilot operations, the PCTs were not returning control to the routine thermostat function quickly enough. Rather than returning the AC units

back to normal operation over two to three minutes, they were allowing the thermostat function to come back over 15 minutes. This problem was eliminated by reprogramming the control program (Yukon) so that all of the participating devices were shedding load and restoring control to the thermostat function in the same two to three minute manner.

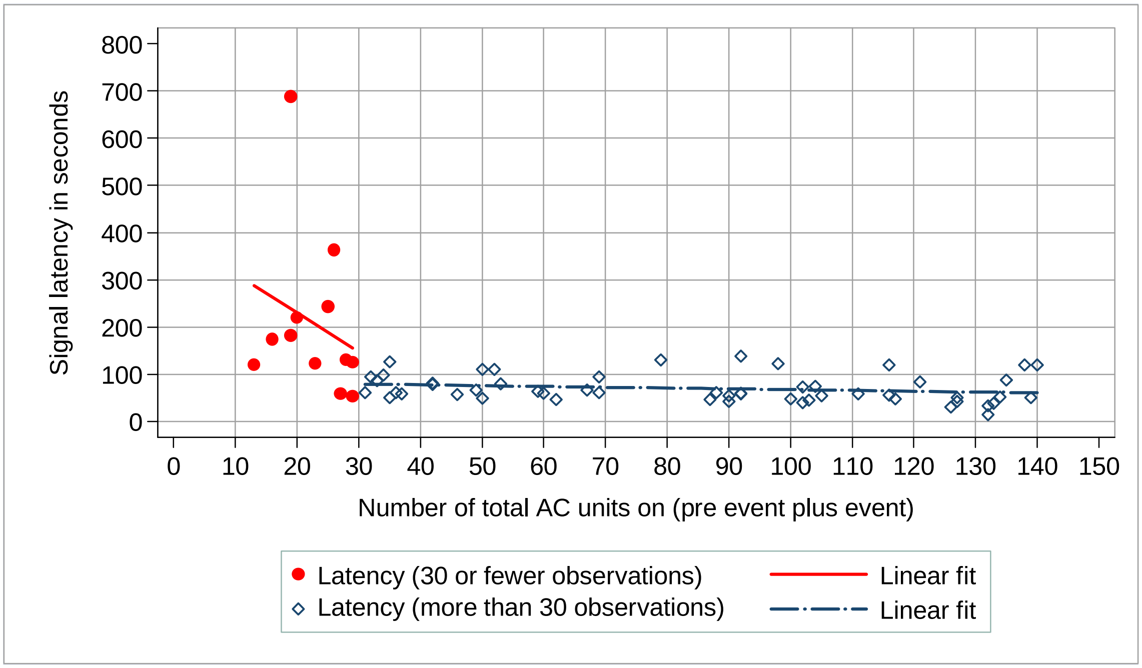
3. It was immediately apparent that not all of the DLC devices responded (i.e., dropped load) during the test events. In an effort to eliminate this problem, the load control system was programmed to resend the control signal after five minutes to increase the likelihood that devices received the intended signals.

These problems were resolved within the first week of testing. However, since the first eight operations observed are not representative of the performance of the system once it was operating correctly, these operations were not included in the signal latency analysis.

The statistical precision of the Kaplan Meyer functions used to detect the approximate time at which load impacts commenced is influenced by the sample size used to estimate them. Correspondingly, the accuracy of the latency estimates derived from comparing the survival functions depends on the number of operating air conditioners observed during each event. The number of AC units on at the start of each event varies with ambient temperature and cannot be controlled through sampling. As the temperature increases (and more AC units come on line) the number of observations available for the subject test increases. Under some conditions the number of AC units available for testing is simply too small to accurately assess the signal latency. With a small number of observations, the lack of statistical power will result in wide confidence bands, which will bias the latency calculations – overestimating the latency.

As it is important that the number of observations not effect latency calculations, an analysis was performed to identify tests for which this might be a problem. The number of observations for each event is the sum of the number of AC units on at the start of the event and the pre-event period. It ranged from zero to 140 units. With less than 10 AC units on, it is not possible to detect a statistically significant deviation of the two curves at all. Above ten observations, it is possible to visually identify differences in the survival curves; however the wide confidence bands around the curves result in an overly conservative estimate of latency because the confidence bands for the survival functions overlap. The relationship between sample size and signal latency is shown in Figure 5-7.

Figure 5-7: Sample Size versus Signal Latency



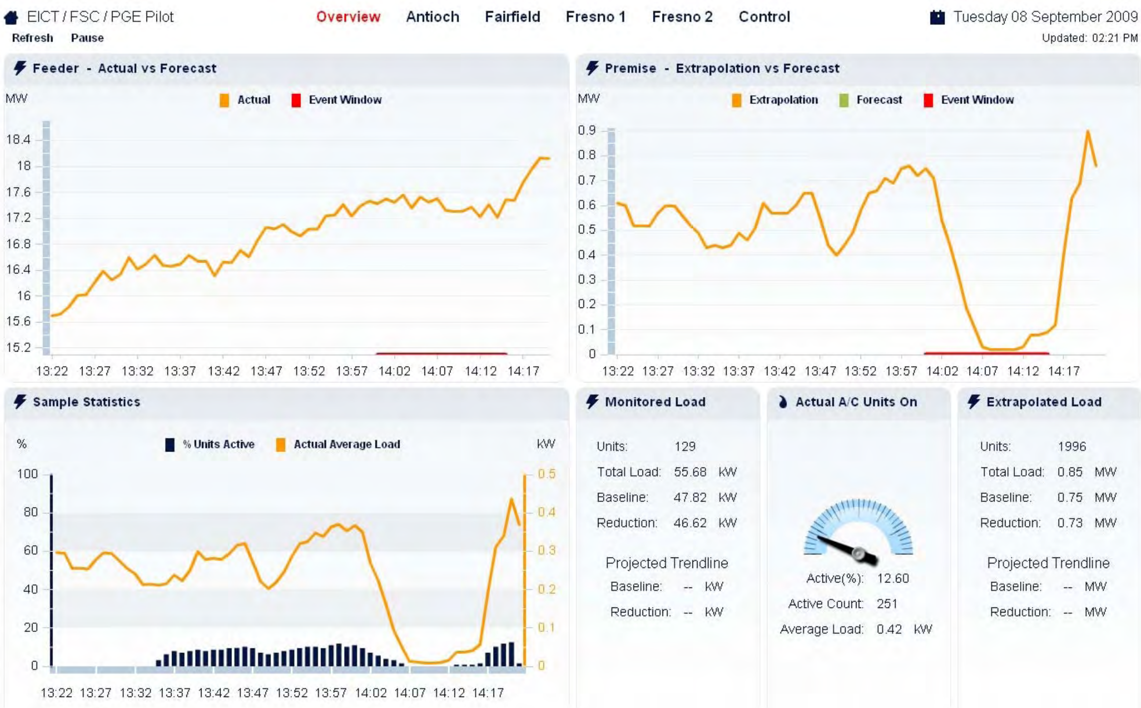
The scatter plot indicates that there is relatively little variation in signal latency when sample sizes are above 30. However, when less than 30 observations are involved, relatively large measurements of latency sometimes occur due to limited statistical power. Fitted Lines have been added for observations with sample sizes above and below 30 to better illustrate this.

A good example of the bias that can result from small sample sizes is found in comparing the signal latency measurements taken for September 8, 2009. There were two operations on that date – one at 2:00 pm (with 26 observations) and another at 4:00 pm (with 59 observations). The calculated latency for the 2:00 pm event was 363 seconds (about six minutes). The latency for the 4:00 pm event was approximately 64 seconds (about one minute).

Figure 5-8 displays the screen shots from the real time monitoring system taken at the end of both events. It is evident in the graphic display that very few devices were in operation at 2:00 pm on the day in question (i.e., about 13%) and that it took a considerable amount of time for the loads to decline significantly in the presence of the control signal. On the same day two hours later, with the system operating in the same way, a second AS Pilot test was conducted. During the 4:00 pm test about 35% of the devices were in operation (because of increased temperature). The latency for this test was only 64 seconds.

Figure 5-8: Live AS Pilot Event Screen Shots for September 8th

2:00 PM



4:00 PM

In both tests, full control of the loads is achieved gradually. However, the beginning point of the load impact is easier to detect because the volatility in the loads in the 15 minutes preceding the tests is lower.

It is difficult to conclude from the above comparison that the latency measurement was not affected by the number of units in operation. Caution must be used when interpreting the latency measurements when the number of AC units on is small. While latency measurements for all tests with more than ten observations are presented, the remaining tables have been organized to separately discuss the results of tests for which at least 30 observations were available.

5.3. Signal Latency Results

Table 5-1 displays the latency measurements observed for the 49 test occasions for which more than 30 observations were available for estimating the response times of the system. The response times for those tests ranged from a low of 14 seconds to a high of 138 seconds. The median time to response was 60 seconds. By 120 seconds (two minutes), responses had occurred in 92 percent of the tests; responses had occurred in 95% of the tests within 126 seconds. The average time to response was 69.4 seconds. Given the statistical distribution of test results obtained over the two month period, there is a 95% chance that the average elapsed time from start of the test to response is between 60.6 and 78.3 seconds.

Table 5-1: Latency Summary Statistics

Percentiles	
1%	14
5%	31
10%	39
25%	48
50%	60
75%	88
90%	120
95%	126
99%	138

Statistics	
Obs	49.00
Mean	69.43
Std. Dev.	30.87
Variance	952.67
Skewness	0.62
Kurtosis	2.47

95% Confidence Interval	
60.56	78.29

Table 5-2 presents the signal latency observed in each test event along with the important details of each test. It is worth noting that all of the events included in the latency analysis were for days when average daily maximum temperatures exceeded 90 degrees F. Relatively few air conditioners are in operation during the same minute when temperatures are less than 90 degrees; and when few AC units are in operation it is impossible to measure signal latency reliably.

Table 5-2: Signal Latency and Operating Conditions by Test Event

Event Date	Event Day	Event Time	Event ID	Latency	Pre-Event Count	Event Count	Fresno Temperature (F)	Fairfield / Antioch Temperature (F)	Weighted Average Temperature (F)
10-Aug	Monday	5:00 PM	10	51	67	72	100.5	98.0	99.3
10-Aug	Monday	7:00 PM	11	33	71	62	98.0	88.5	93.3
11-Aug	Tuesday	3:00 PM	12	60	43	49	101.5	86.0	93.8
11-Aug	Tuesday	6:00 PM	13	56	57	59	96.5	77.0	87.5
12-Aug	Wednesday	3:00 PM	14	59	40	53	98.5	100.0	99.3
12-Aug	Wednesday	5:00 PM	15	31	60	66	99.5	95.5	97.5
13-Aug	Thursday	12:00 PM	16	110	27	25	92.0	89.5	90.8
13-Aug	Thursday	2:00 PM	17	138	46	46	96.0	90.5	93.3
14-Aug	Friday	1:00 PM	18	81	17	25	90.5	78.0	84.3
14-Aug	Friday	3:15 PM	19	19	36	35	94.0	77.5	85.8
17-Aug	Monday	2:00 PM	20	60	27	33	97.5	86.5	92.0
17-Aug	Monday	4:00 PM	21	48	54	46	98.5	91.5	95.0
18-Aug	Tuesday	3:00 PM	22	61	41	47	100.0	88.5	94.3
18-Aug	Tuesday	5:00 PM	23	120	63	77	100.5	90.5	95.5
19-Aug	Wednesday	4:00 PM	24	123	51	47	101.0	81.5	91.3
19-Aug	Wednesday	6:00 PM	25	14	65	67	99.5	71.5	85.5
20-Aug	Thursday	5:00 PM	26	73	49	53	98.0	80.0	89.0
20-Aug	Thursday	7:00 PM	27	74	53	51	93.0	70.5	81.8
24-Aug	Monday	7:00 PM	28	130	41	38	91.5	68.5	80.0
26-Aug	Wednesday	1:00 PM	31	61	15	21	95.0	82.0	88.5
26-Aug	Wednesday	3:00 PM	32	66	33	34	98.5	87.0	92.8
27-Aug	Thursday	2:00 PM	33	110	20	30	96.5	93.5	95.0
27-Aug	Thursday	4:25 PM	34	58	55	56	100.0	97.5	98.8
28-Aug	Friday	3:15 PM	35	120	59	57	99.5	101.5	100.5
28-Aug	Friday	5:15 PM	36	88	64	71	97.5	99.0	98.3
31-Aug	Monday	4:00 PM	37	42	49	42	100.5	83.0	91.8
31-Aug	Monday	6:00 PM	38	55	49	41	94.5	78.0	86.3
1-Sep	Tuesday	5:00 PM	39	54	51	54	99.5	92.0	95.8
1-Sep	Tuesday	7:00 PM	40	40	52	50	95.0	84.0	89.5
2-Sep	Wednesday	5:55 PM	41	120	73	65	100.0	97.0	98.5
3-Sep	Thursday	7:00 PM	42	52	71	63	96.5	85.5	91.0
4-Sep	Friday	12:00 PM	43	94	14	18	91.5	79.5	85.5
4-Sep	Friday	2:00 PM	44	94	33	36	96.5	82.5	89.5
8-Sep	Tuesday	4:00 PM	46	64	33	26	92.0	89.5	90.8
9-Sep	Wednesday	3:00 PM	47	49	25	25	95.0	90.5	92.8
9-Sep	Wednesday	5:00 PM	48	46	44	43	95.0	91.0	93.0
11-Sep	Friday	4:45 PM	49	84	62	59	97.0	100.0	98.5
11-Sep	Friday	6:45 PM	50	43	66	61	94.5	94.0	94.3
15-Sep	Tuesday	7:00 PM	52	50	19	16	83.0	74.5	78.8
17-Sep	Thursday	3:00 PM	56	46	28	34	93.5	90.5	92.0
18-Sep	Friday	4:00 PM	58	61	17	14	100.5	98.5	99.5
21-Sep	Monday	5:00 PM	60	78	20	22	97.0	94.0	95.5
22-Sep	Tuesday	4:00 PM	61	50	65	62	100.5	101.0	100.8
22-Sep	Tuesday	6:00 PM	62	39	71	62	96.5	95.0	95.8
23-Sep	Wednesday	5:00 PM	63	126	15	20	98.5	94.5	96.5
23-Sep	Wednesday	7:00 PM	64	98	18	16	95.0	84.0	89.5
24-Sep	Thursday	6:00 PM	65	48	62	55	96.0	87.0	91.5
25-Sep	Friday	7:00 PM	66	45	58	45	92.5	84.5	88.5
28-Sep	Monday	2:08 PM	68	80	25	28	97.0	71.0	84.0

Table 5-3 shows the details of the scheduled events that were dropped from the analysis. Five of the events were dropped because they occurred during the first week of testing when the control programming and system operating systems were being tested and revised to ensure proper program operation. The remaining events were dropped because insufficient numbers of DLC devices responded in both the pre-event and event time periods. Inspecting the table, it is apparent that most of these tests took place when the ambient temperatures were too low (i.e., less than 90 degrees F) in the testing areas. In two cases, events were dropped from the analysis because only the PCTs were operated and insufficient numbers of these devices were represented in the testing sample to detect a difference in the response rates of the devices.

Table 5-3: Events Excluded from Final Signal Latency Estimates

Events with sample size under 30 - Dropped								
Event Date	Event Day	Event Time	Latency	Pre-Event Count	Event Count	Fresno Temperature (F)	Fairfield / Antioch Temperature (F)	Weighted Average Temperature (F)
4-Aug	Tuesday	1:00 PM	131	12	16	89.5	80.5	85.0
5-Aug	Wednesday	2:00 PM	125	12	17	92.0	78.5	85.3
6-Aug	Thursday	3:00 PM	Not Detected	9	10	81.5	73.0	77.3
25-Aug	Tuesday	12:00 PM	Not Detected	7	6	87.0	77.0	82.0
25-Aug	Tuesday	2:00 PM	53	14	15	93.5	83.0	88.3
8-Sep	Tuesday	2:00 PM	363	13	13	90.5	86.5	88.5
14-Sep	Monday	6:00 PM	219	12	8	77.0	71.5	74.3
16-Sep	Wednesday	12:00 PM	Not Detected	4	4	85.5	82.0	83.8
16-Sep	Wednesday	2:00 PM	243	13	12	89.0	87.0	88.0
17-Sep	Thursday	1:00 PM	59	15	12	89.5	85.0	87.3
18-Sep	Friday	2:00 PM	Not Detected	7	12	97.0	97.5	97.3
21-Sep	Monday	3:00 PM	Not Detected	10	13	97.0	97.0	97.0
28-Sep	Monday	12:00 PM	122	16	7	92.5	71.5	82.0
29-Sep	Tuesday	1:00 PM	Not Detected	1	1	73.0	71.5	72.3
29-Sep	Tuesday	3:00 PM	Not Detected	0	1	72.5	71.5	72.0
30-Sep	Wednesday	2:00 PM	Not Detected	0	0	74.5	74.5	74.5
30-Sep	Wednesday	4:00 PM	Not Detected	0	1	76.0	76.0	76.0
1-Oct	Thursday	3:00 PM	Not Detected	2	3	NA	NA	NA
1-Oct	Thursday	5:00 PM	Not Detected	8	5	NA	NA	NA
2-Oct	Friday	4:00 PM	Not Detected	5	5	NA	NA	NA
2-Oct	Friday	6:00 PM	Not Detected	8	8	NA	NA	NA

Early events - Dropped								
Event Date	Event Day	Event Time	Latency	Pre-Event Count	Event Count	Fresno Temperature (F)	Fairfield / Antioch Temperature (F)	Weighted Average Temperature (F)
4-Aug	Tuesday	3:00 PM	66	27	22	93.5	84.5	89.0
5-Aug	Wednesday	4:00 PM	61	34	35	95.5	78.0	86.8
6-Aug	Thursday	5:00 PM	58	17	20	81.0	72.0	76.5
7-Aug	Friday	4:00 PM	87	16	17	99.5	79.5	90.3
7-Aug	Friday	6:00 PM	57	24	22	96.5	76.5	87.3

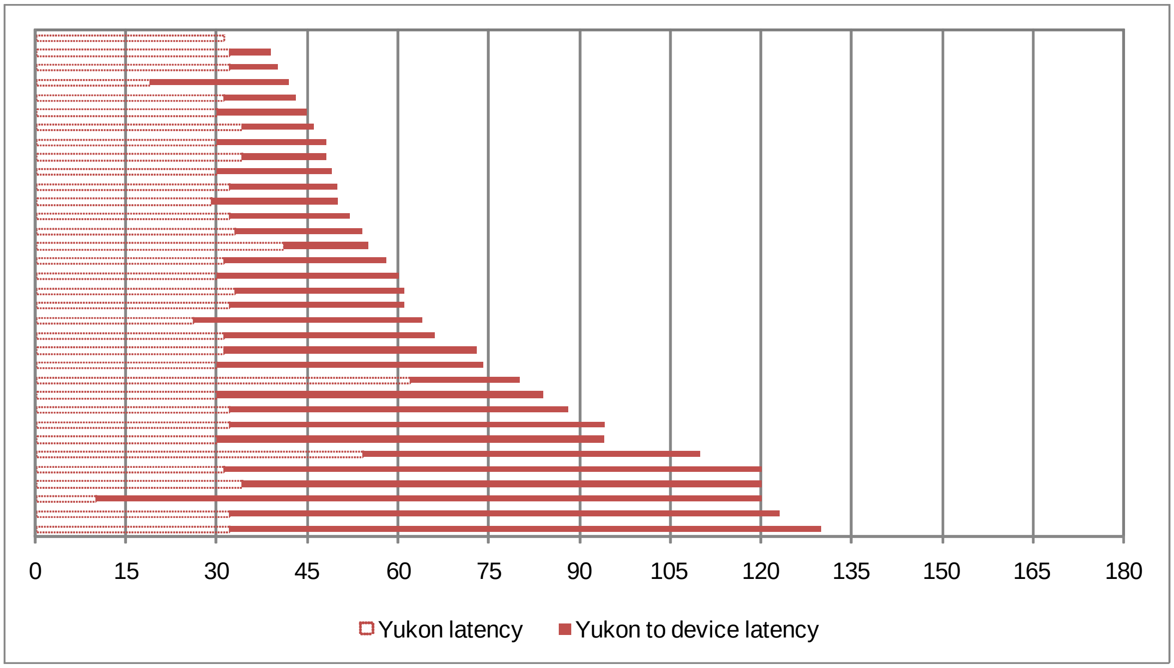
For a subset of 34 of the test events, communications logs were obtained from the Yukon control computer that described the time required for that system to assemble the load contol message and transmit them to the paging companies.[6] On average, about 30 seconds are required to assemble and transmit the load control messages to the paging systems. Most of the time this process occurrs within plus or minus ten seconds of the average time. The variation in this stage of the signal processing results from several factors:

1. Load on the Yukon system varies with the number of load control operations that are underway at any point in time – the more load control operations that are scheduled, the longer it takes to process the control messages.
2. Outbound load control messages are transmitted through a limited number of telephone line modems. When load control signals for several programs are being sent, messages must queue up for outbound transmission and this can introduce delay.
3. The paging systems are publicly available transmission facilities whose signal processing loads vary. During times of high volume traffic on the paging systems, load control signals must queue up along with all the other signals being processed by the paging system for transmission to the control devices. Traffic volumes on the system vary.

Comparison of the signal latencies arising from processes in the Yukon system and the paging systems are displayed in Figure 5-9. On average, 53.5 percent of the latency in initial device response occurs after the signals have left the Yukon system. It is apparent that the latency arising in the Yukon system is relatively constant at about 30 seconds. The latency arising in the paging systems is much more variable – ranging from very short times (a few seconds) to more than 1.5 minutes.

[6] System operations logs for the first 17 days of load control operations were erased by the Yukon system as part of their normal operating procedures before this practice was discovered. Therefore records for only a subset of the operations were obtained for this stage of the communications process.

Figure 5-9: Signal Latency by Source



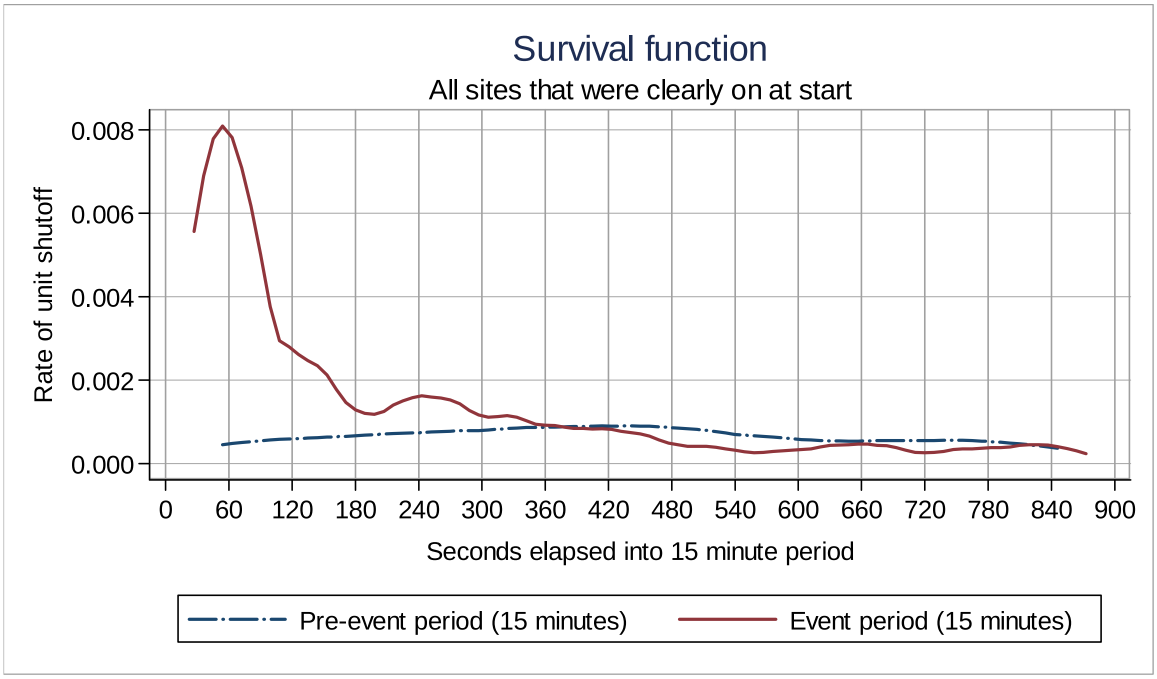
5.3.1. Full Device Response

Gaining a thorough understanding of initial device response time at the event level is essential before demand response can be established as a reliable source of ancillary services. However, it is also useful to understand how long into an event devices stop responding. In other words, how long does it take until all the devices that are going to respond have responded? In order to pinpoint the end of device response, a different approach is necessary.

The two curves presented in Figure 5-10 compare the rate of AC shutoffs (per second) for the 15 minute pre-event and event periods (hazard curves).[7] The two curves diverge because the during events the rate at which devices naturally shutt off is altered. During AS Pilot events, starting at the point of initial device response, signals cause devices to shut off at a much higher rate than the naturally ocurring shutoff rate. In contrast, the naturally occurring shut off rate for pre-event period shutoff rate is unperturbed and relatively constant (over a short enough time period that external conditions vary minimally).

[7] The curves are known as hazard curves and are the derivative of the survival functions presented earlier. They depict the instantaneous shut off rate over time rather than the cumulative share of AC units that remain on.

Figure 5-10: Example Survival Rates for Pre-Event Periods and Event Periods



The event period shutoff rate is very high at the beginning of the event as devices receive signals. Then it decreases, falling below the naturally occurring rate. Over time signal receptions begin to taper off and the shutoff rate begins to fall, eventually sinking below the naturally ocurring shutoff rate because the pool of devices to potentially shutoff for the remainder of the event has been drastically reduced by event response. The point at which the two curves intersect is the point at which the event period exhibits a naturally occurring shutoff rate. This is the point during events at which there is full signal response. Across all events, this occurs just after six minutes have elapsed.

5.3.2. Analysis of Drivers of Latency

An effort was also made to determine whether response latency varied by weather, day of the week or hour of the day. To test for the impacts of these variables on signal latency, a regression model was used. Before running regressions, graphs can be used to shed light on any potential statistical relationships. The specification for the multivariate regression model is discussed below. Before discussing the regression model results, it is useful to consider the bivariate relationships observed between latency and the independent variables of interest.

Figure 5-11 displays the relationship between signal latency and weather. In the figure it is apparent that there is no relationship between the ambient temperature at the time of the test and signal latency.

Figure 5-11: Impact of Ambient Temperature on Latency

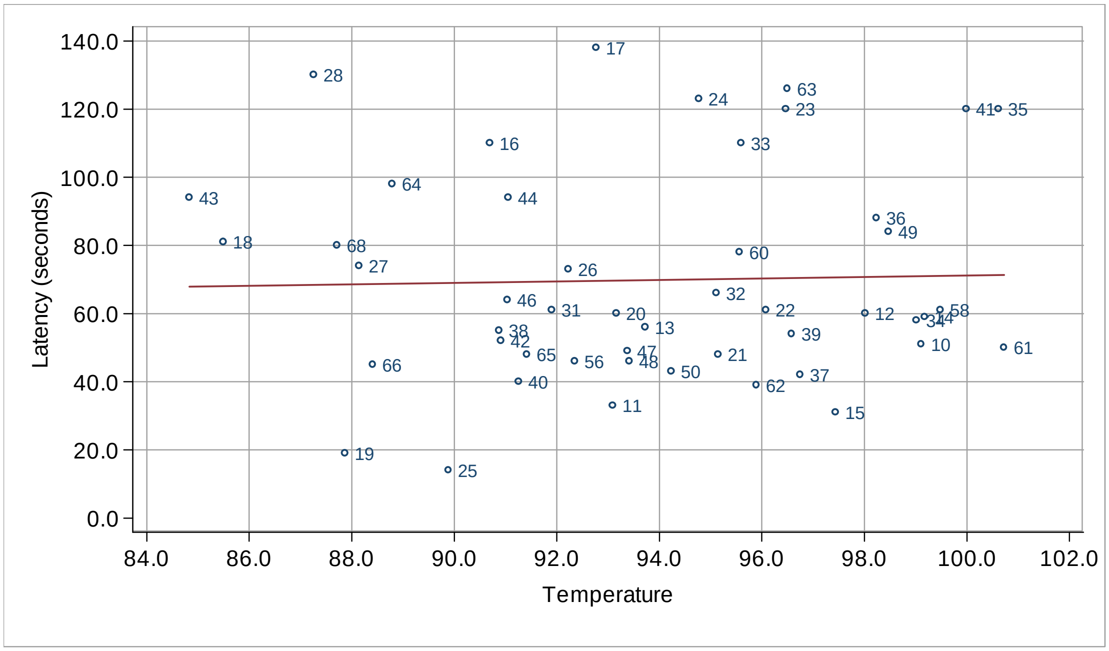


Figure 5-12: Impact of Hour of the Day on Latency

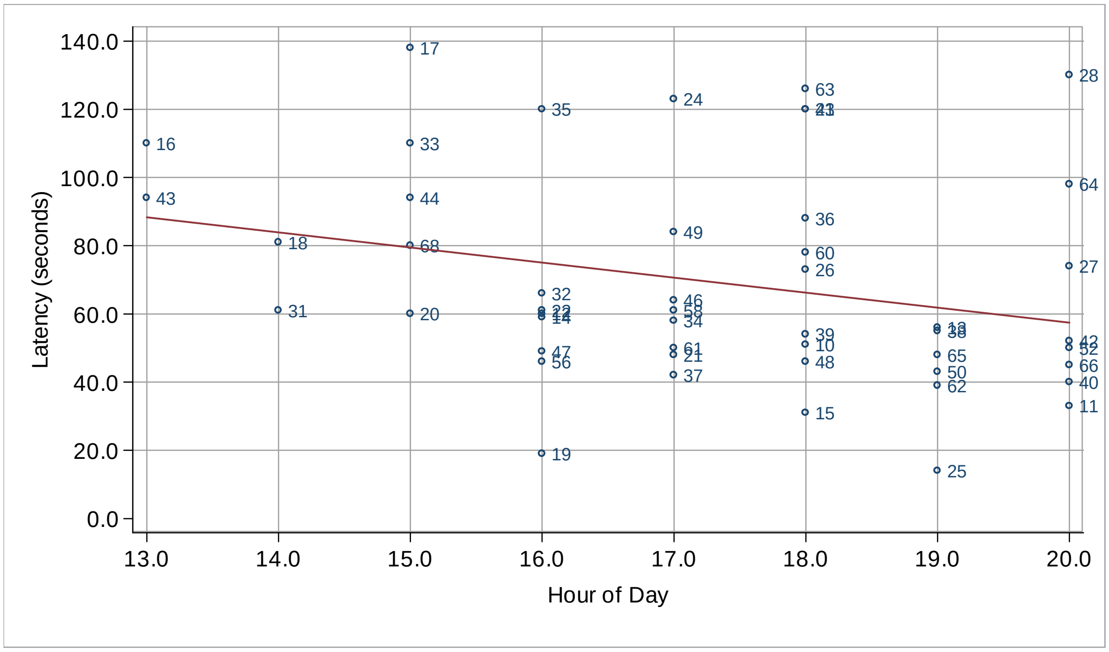


Figure 5-13: Impact of Day of Week on Latency

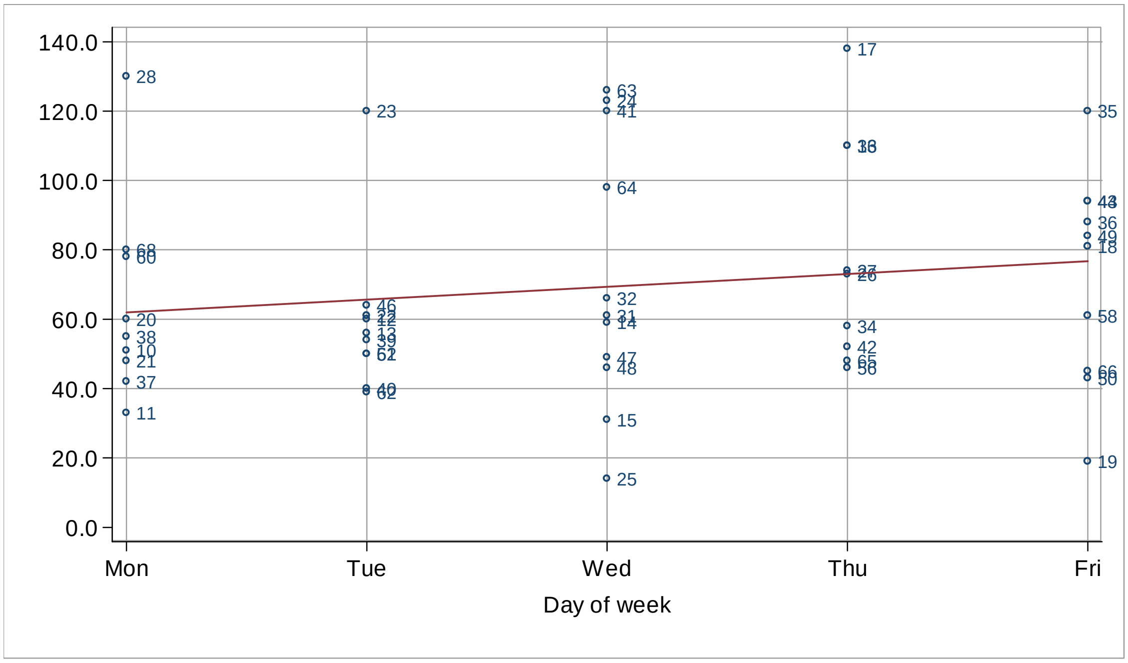


Figure 5-12 and Figure 5-13 display the relationship between hour of the day and latency and day of week and latency. There appear to be weak relationships between signal latency and these operating conditions.

A regression model was used to quantify the impacts of these control variables on latency. Day of the week and hour of day were included in the model as dummy variables and temperature was included using cooling degree hours with a base of 65 degrees (F). Cooling degree hours reflect the number of degrees above 65 for a given hour.

This simple regression model explains about 30 percent of the variation in signal latency. The relationship between latency and ambient temperature was not statistically significant; and when the other variables were added into the equation, the effects of day of the week are not significant. So these variables do not influence latency. However, the results suggest that signal latency is related to hour of the day.[8] Latency is higher for events that took place earlier in the day. This may be related to paging system traffic levels. Table 5-4 shows the regression parameters. The regression controls the effects of the other variables, in essence isolating the effects of each hour on latency. In general, the results indicate that latency is relatively high before 3:00 pm and then drops off as the afternoon progresses into early evening.

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[8] It is not possible to conclude the relationship is robust because the statistical significance of the model and parameters depends on the regression technique employed. Using robust standard error or clustering standards error for the event date leads to narrower standard errors and a statistically significant regression model (based on the F-test). This is atypical and is related to the correlation between the explanatory variables and the error magnitude. In contrast, uncorrected standard errors produce wider confidence bands and a regression model that is not statistically significant.

Table 5-4: Latency Drivers Regression Output

Linear Regression: Latency

Number of obs	**49**
F(12,	**7.39**
Prob > F	**0.000**
R-squared	**0.310**
Root MSE	**29.606**

Dependent Variable: Latency	Coef.	Std. Err.	T	P>t	95% Confidence Interval	
1:00 - 2:00 PM	-33.41	14.94	-2.24	0.032	-63.72	-3.11
2:00 - 3:00 PM	-6.57	13.06	-0.50	0.618	-33.06	19.93
3:00 - 4:00 PM	-51.83	14.17	-3.66	0.001	-80.56	-23.10
4:00 - 5:00 PM	-44.05	16.11	-2.74	0.010	-76.72	-11.39
5:00 - 6:00 PM	-32.71	14.44	-2.27	0.030	-61.99	-3.43
6:00 - 7:00 PM	-62.55	11.66	-5.36	0.000	-86.21	-38.90
7:00 - 8:00 PM	-33.16	13.10	-2.53	0.016	-59.72	-6.59
Tuesday	6.39	15.29	0.42	0.679	-24.61	37.39
Wednesday	14.98	18.33	0.82	0.419	-22.18	52.15
Thursday	12.75	14.30	0.89	0.378	-16.24	41.75
Friday	12.41	14.26	0.87	0.390	-16.51	41.32
CDH 65	1.39	1.23	1.13	0.267	-1.11	3.89
Constant	64.75	26.07	2.48	0.018	11.87	117.63

6. EVENT LOAD IMPACTS

The fundamental question addressed by the AS Pilot is whether it is technically and financially feasible for demand-side resources to act as a Participating Load resources in the CAISO market. A basic difference between residential AC load control and larger C&I load is that residential programs rely on the aggregation of mutliple individual loads to provide predictable and reliable load reductions. Several factors associated with load impacts and predictive models are critical to the feasibility of using a central AC control program as Participating Load. This section addresses the following:

- The load impacts delivered for test events.
- The distribution of load impacts observed over the course of testing.
- How load impacts of AC load control vary with environmental conditions (i.e., hour, day of week and ambient temperature).
- The variation in load impact between PCT and DLC devices and the variation in load reduction by region.
- The ability to build DR AS resources by geographical location (e.g., local capacity areas).

As previously discussed, load impacts for ancillary services operations were systematically tested on different days of the week, under varying weather conditions and at different times of the day. In total 71 events were called. The information from test events and AC load patterns was employed not only to estimate load impacts, but to assess systematic drivers of variation in load impacts and to develop and validate predictive models.

The remainder of this chapter presents the methodology, results, and implications of the ex-post load impact estimation.

6.1. Methodology

Calculating load impacts at the one minute or five minute level raises several issues that are not common with estimation at 15, 30, or hourly intervals:

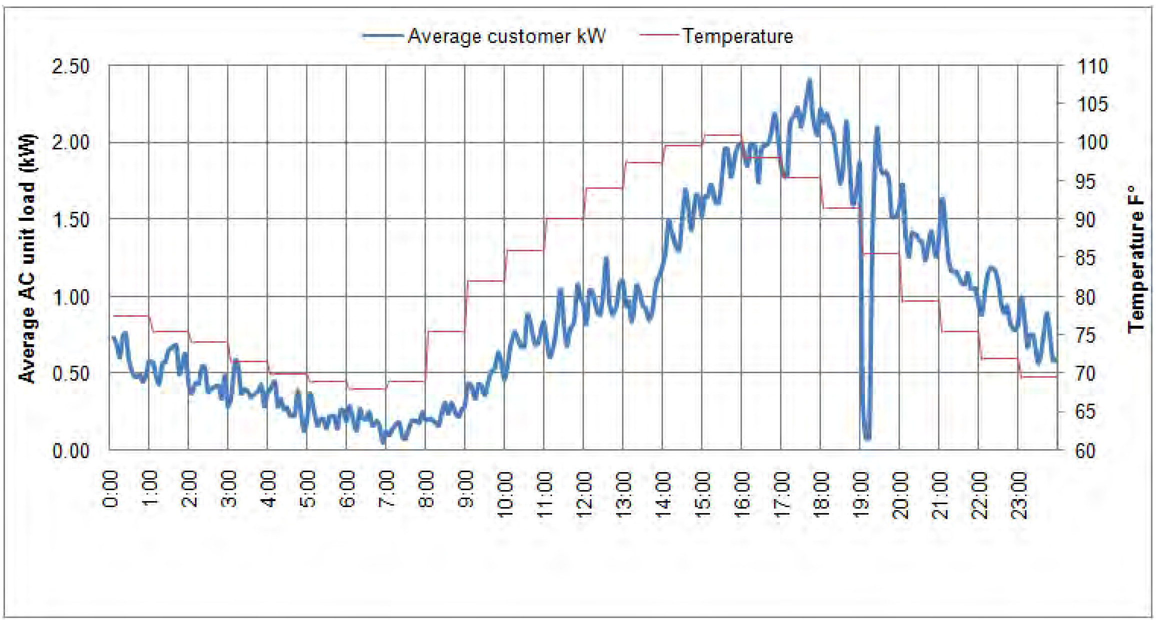
- Even with aggregation across multiple customers, there is significantly more random variation with one minute or five minute interval data due to AC units coming on or shutting down.
- The primary explanatory variable for AC load patterns is weather which is typically recorded on an hourly or half hourly basis, limiting the ability to explain variation in load patterns at a more granular level.
- At a very granular level, AC load has unusually distributed data. The load is tri-modal, with clusters at zero, the fan load, and full connected load, and several, less frequent values between the load clusters.
- For the AS Pilot analysis, the primary goal was to estimate impacts for each event interval by feeder and devices. Put differently, the focus was not on average effects but on very granular and specific effects. A technical but important issue is that any variable designed to capture effects for a single period is estimating the difference between that particular period and expected normal load patterns. As a consequence, the regression will attribute any unexplained

variation or bias in the estimates to the control event. In other words, the impacts will incorporate any systematic errors.

- The multiple daily events – 71 in total – lead to a high volume of variables designed to model the event load reductions and the snapback.

Figure 6-1 illustrates the random variation in AC load measured at the five minute interval. The example depicts the 5 minute load intervals for a single day, September 3, 2009, and reflects the average AC load across 105 AC loggers measuring AC loads on the Antioch feeder. The sharp drop in the average customer load occuring at 7:00 pm is the load drop associated with the load control test that occurred on that hour. While the load drop is quite dramatic, there is substantial random variation in the AC loads occuring within the hours. Unfortunately, the most powerful predictor of AC load is temperature and this variable is measured on an hourly basis and thus cannot explain the variation in load within hours. For this reason standard regression modeling techniques are not likely to be useful in estimating the load impacts resulting from these short duration operations.

Figure 6-1: Example Average Customer AC Loads at Five Minute Intervals Antioch Feeder– Sep 3, 2009



Instead a simpler approach was used. It is possible to use the appliance loads shortly before and after each event to estimate the load that would have occurred if the load control event had not occurred. The regressions developed were designed to produce the best estimate of load in the absence of events by using data on usage patterns before and after the events, and additional weather related explanatory variables. The impacts were calculated as the difference between the estimated load in the absence of a control event and the observed load.

The AC load data was aggregated for each feeder and device type and regressions were conducted on the aggregated data. The segments were selected in order to allow for development of separate estimates by region and device type. In total, eight regressions were estimated for the following segments:

- Antioch DLC switch devices
- Antioch PCTs
- Fairfield DLC switch devices
- Fairfield PCTs
- Fresno 1 DLC switch devices
- Fresno PCTs
- Fresno 2 DLC switch devices
- Fresno 2 PCTs

The dependent variable for each regresssion was the average five minute interval AC load for the average customer. The 15 minute event and post-event periods were treated as missing observations in order to allow the estimation to focus on naturally occurring, unperturbed load patterns. The post-event period was excluded to avoid confusing AC snapback after curtailment with unperturbed load patterns. The model included both loads observed before and after the event as explanatory variables and weather variables.

Mathematically, the regressions can be expressed by:

$$
\begin{aligned}
kW_t = {} & a_i + \sum_{i=3}^{6} b^{i-x} KW_{t-i} + \sum_{x=6}^{8} b^{i+x} KW_{i+x} \\
& + \sum_{i=1}^{24} b^{HR_i} (CDH \times \mathrm{HR}_i) + \sum_{i=1}^{24} b^{HR_i} (CDH \times HR_i)^2 + \sum_{i=1}^{24} b^{HR_i} (CDH \times HR_i)^3 \\
& + \sum_{i=0}^{6} b^{DOW_i} (CDH \times DOW_i) + \sum_{i=0}^{6} b^{DOW_i} (CDH \times DOW_i)^2 + \sum_{i=0}^{6} b^{DOW_i} (CDH \times DOW_i)^3 \\
& + e_t
\end{aligned}
$$

Where

b’s	Regression parameters
t	5 minute time intervals
kW	Average demand over the interval
CDH	Cooling degree hours (base 70 F)
HR	Hour of day (1-24)
DOW	Day of week (1-7)

6.1.1. Model Accuracy and Validity

The three key elements to assessing the quality of regression models are accuracy (or lack of bias), explanatory power, and precision.

The accuracy of the regression models was assessed by comparing regression predicted load with actual load and estimating the mean error and relative mean error for conditions under which an AC direct load control program would operate. Figure 6-2 compares the average hourly actual load and regression predicted load for days where temperatures exceeded 100 F°. Figure 6-3 compares the average hourly actual and regression predicted load for days were daily maximum temperatures were in the 95-100 F° range.

The regression model does a good job of predicting load under various weather conditions and for each hour of the day. Indeed, the difference between actual and predicted load is hardly visible, with the difference in each hour typically occurring only in the second or third decimal point. In addition, Figure 6-2 and Figure 6-3 present the mean error and relative error, which are systematic measures of bias. The mean error reflects the magnitude and direction of the error. A positive error means the regression overestimates load and a negative error means it underestimates load. The relative mean error allows for comparison by normalizing for customer load. It is simply the mean error divided by the mean load. In other words, it is the percent error.

Figure 6-2: Comparison of Average Hourly Actual and Predicted Load Days with Daily Maximum Temperatures in Excess of 100 F° (Weighted)

Hour	Actual kW	Predicted kW	Mean Error	% Error
1:00	0.19	0.19	0.00	0.3%
2:00	0.13	0.13	0.00	-0.2%
3:00	0.08	0.08	0.00	-1.8%
4:00	0.05	0.05	0.00	1.2%
5:00	0.03	0.03	0.00	6.7%
6:00	0.04	0.04	0.00	4.1%
7:00	0.04	0.04	0.00	-0.4%
8:00	0.06	0.06	-0.01	-8.4%
9:00	0.04	0.04	0.00	0.6%
10:00	0.08	0.08	0.00	3.0%
11:00	0.16	0.16	0.00	-1.3%
12:00	0.34	0.34	0.00	1.1%
13:00	0.64	0.64	0.00	0.2%
14:00	1.00	1.00	0.00	-0.3%
15:00	1.33	1.36	0.03	2.1%
16:00	1.68	1.69	0.01	0.4%
17:00	2.00	2.00	0.01	0.3%
18:00	2.12	2.07	-0.04	-2.1%
19:00	1.92	1.93	0.01	0.4%
20:00	1.51	1.51	0.01	0.5%
21:00	1.14	1.15	0.01	0.8%
22:00	0.84	0.82	-0.02	-2.1%
23:00	0.50	0.52	0.02	4.4%
0:00	0.33	0.33	0.00	0.5%
Total	0.59	0.59	0.00	0.2%
2-6 pm	1.78	1.78	0.00	-0.1%

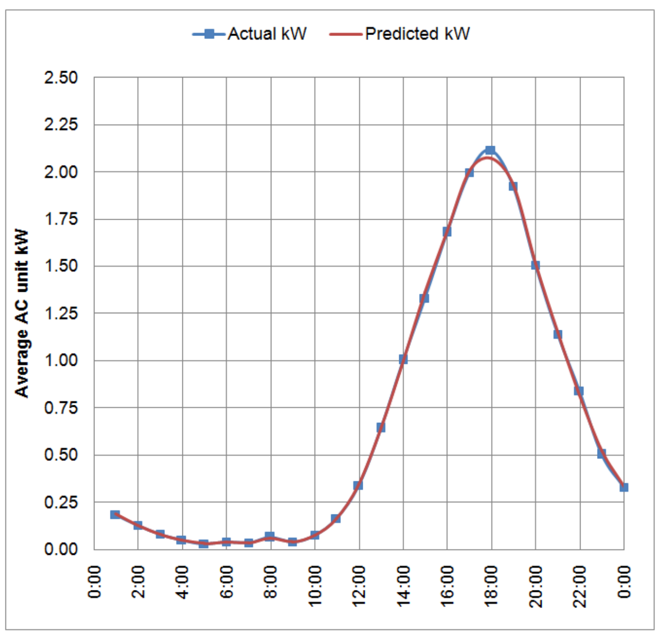


Figure 6-3: Comparison of Average Hourly Actual and Predicted Load Days with Daily Maximum Temperatures within 95-100 F° (Weighted)

Hour	Actual kW	Predicted kW	Mean Error	% Error
1:00	0.16	0.16	0.00	-0.6%
2:00	0.11	0.11	0.00	-2.1%
3:00	0.07	0.07	0.00	2.5%
4:00	0.05	0.05	0.00	-1.0%
5:00	0.03	0.03	0.00	3.3%
6:00	0.04	0.04	0.00	-2.2%
7:00	0.03	0.03	0.00	13.7%
8:00	0.05	0.05	-0.01	-11.0%
9:00	0.03	0.03	0.00	13.0%
10:00	0.04	0.05	0.00	2.0%
11:00	0.07	0.08	0.01	7.5%
12:00	0.20	0.20	0.00	1.1%
13:00	0.40	0.40	0.00	0.2%
14:00	0.67	0.68	0.00	0.7%
15:00	1.09	1.08	0.00	-0.3%
16:00	1.36	1.36	0.00	-0.2%
17:00	1.54	1.56	0.02	1.5%
18:00	1.66	1.64	-0.02	-1.5%
19:00	1.60	1.59	-0.01	-0.8%
20:00	1.26	1.26	0.00	0.2%
21:00	0.95	0.96	0.01	0.8%
22:00	0.70	0.69	-0.01	-1.9%
23:00	0.45	0.46	0.01	1.3%
0:00	0.26	0.27	0.00	0.7%
Total	0.47	0.47	0.00	0.0%
2-6 pm	1.41	1.41	0.00	-0.2%

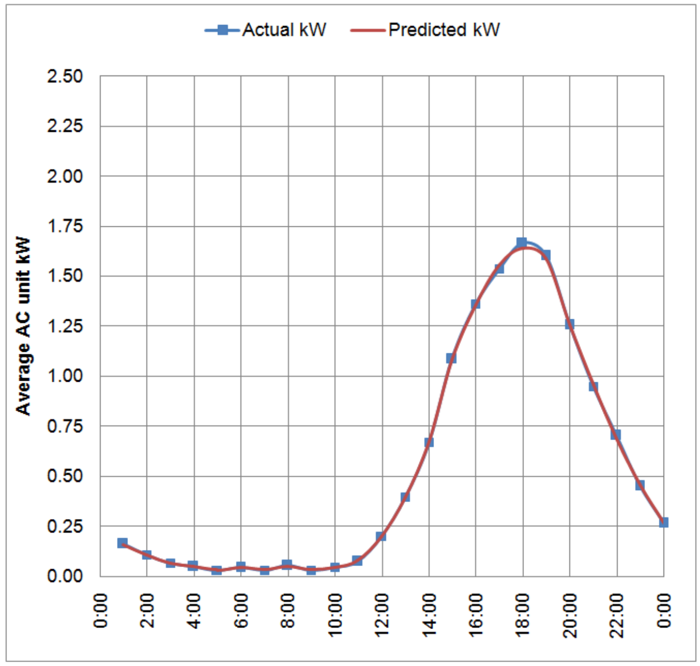
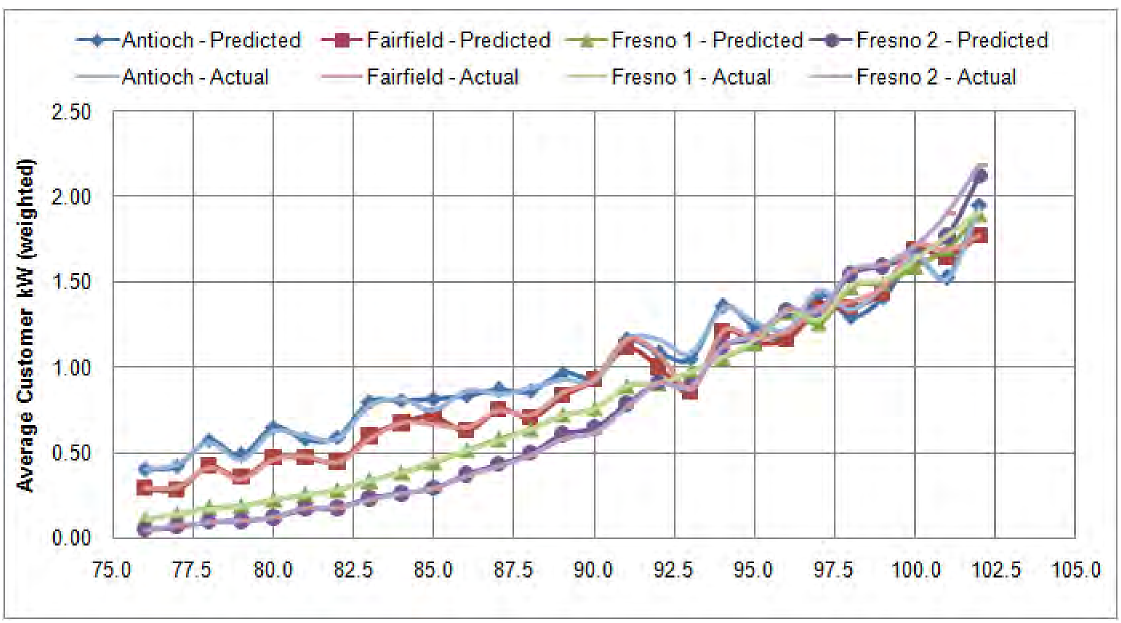


Figure 6-4 shows the average actual and predicted average values across the relevant temperature spectrum by feeder.

Figure 6-4: Comparison of Average Hourly Actual and Predicted Load by Temperature and Feeder (Weighted)



As seen, the model does an excellent job of predicting load at each temperature for each feeder, including extreme values. The figure also highlights two facts; first is the variation in AC load use patterns across different regions. Antioch and Fairfield AC usage is higher at lower temperatures than on the Fresno feeders. Second, the relationship between temperature and AC consumption is non-linear – a five degree change from 95 to 100 F° is associated with an increase in load levels in excess of 40% for Fairfield, Fresno 1 and Fresno 2.

6.1.1. Goodness of Fit Measures

From a policy standpoint, the location of AS resource matters and it is important to understand how well the load impact estimates and predictive models perform for specific customer segments at specific locations. Table 6-1 summarizes the amount of variation explained by the regression models by feeder location and device type as well as the aggregate explanatory power.

Table 6-1: Load Impact Regression R-squared Values by Segment

Feeder	DLC	T-STAT	Total
Antioch	0.976	0.950	0.963
Fairfield	0.985	0.930	0.956
Fresno 2	0.982	0.961	0.971
Fresno 1	0.971	0.959	0.965
Total	0.978	0.953	**0.965**

The R-squared is a measure of goodness-of-fit that assesses the explanatory power of the regression. In the aggregate, the model explains 96.5 percent of the variation in energy use. Put another way, only about 3.5 percent of the variation around the mean energy use is explained by factors that are not included in the model. In addition, the regression model explains the variation at the feeder and device level relative well, although the variation for the DLC switches is modeled slightly better than that of PCTs due likely to differences in the sample size and the associated volatility in the data.

6.2. Load Impact Results

AC load and load impacts vary substantially due to differences in weather conditions and time of day. AC load can range from zero to over 4 kW per unit and, by connection, load impacts vary substantially. Importantly, the relationship between AC load and temperature is non-linear, with load increasing rapidly when temperatures exceed 90 F°.

Figure 6-5 illustrates the variation in AC load and associated variation in load impacts. It presents actual and predicted loads for three days in September with daily maximum temperatures of 86 F°, 91 F°, and 100 F°. The AC load for the 91 F° day is more than double the AC load in the 86 F° day and the AC load for the 100 F° is almost three and half times larger. In addition, on all three days, the AC load varies substantially by hour. As a result, the AC load impacts depend on the weather conditions and the time of day when the load control event is activated. While the AC load and load drops vary substantially, they are highly predictable and generally more load reduction is available for extreme weather events that drive system load peaks.

Figure 6-5: Example of AC Load Profiles and Impacts by Daily Maximum Temperature and Time of Day

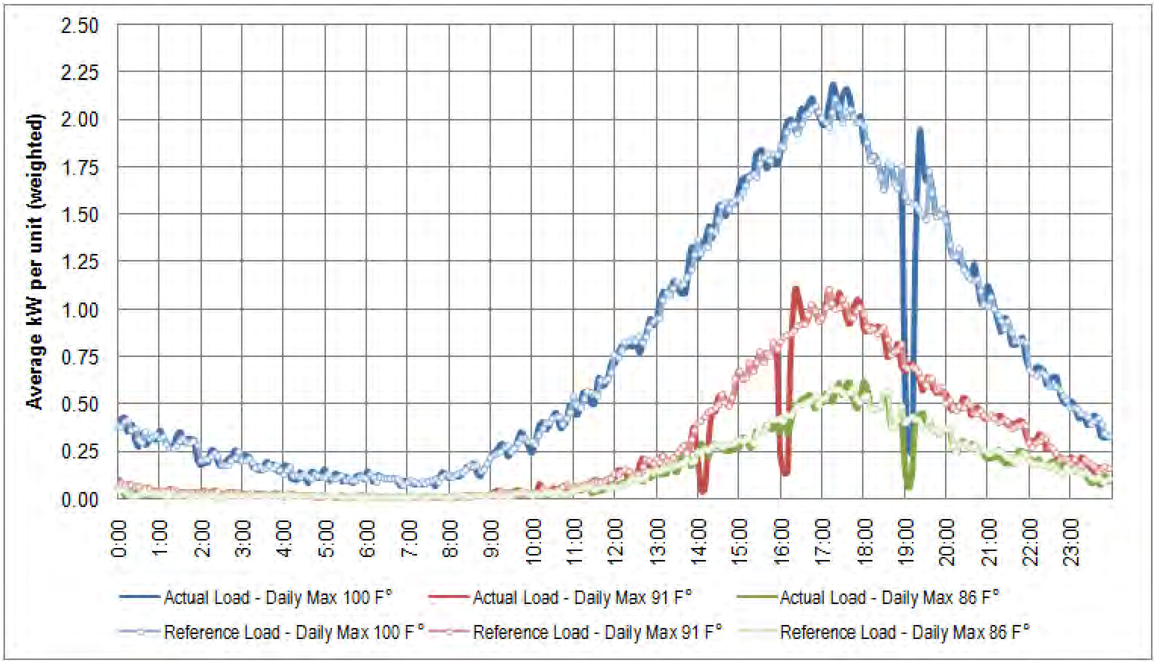


Table 6-2 presents data on AC load and load impacts by temperature ranges and device type for each of the four feeders in the AS Pilot. AC loads in the 95-100 F temperature range are typically more than 50 percent higher than load in the 90-95 F range. As a result, the load impact reduction potential from AC load varies substantially but also coincides with system peaking conditions.

The results in Table 6-2 also reflect differences across regions in AC usage patterns and in the load reduction from PCTs and DLC switches. In the milder regions (relative to Fresno) of Antioch and Fairfield, participants tend to use more AC load at lower temperatures while Fresno participants typically ramped AC consumption more quickly when temperatures exceed 90 F°.

The magnitude of difference in load impacts between DLC switches and PCTs is not uniform across feeders. Load reductions from PCTs in Antioch and Fairfield are relatively similar to DLC switch impacts. However, load reductions from PCTs are substantially lower than for DLC switches on the Fresno feeders, particularly Fresno 2. This pattern was identified via the real time monitoring system shortly after operations started and was investigated. Both DLC switches and PCTs were operated on shed mode and, in theory, should produce similar load impacts. The difference in the load impacts is due to weaker signals from the paging system in specific regions. DLC switch devices are typically situated outside homes and can more easily receive and respond to weaker paging signals. On the other hand, PCTs are inside homes and are less likely to receive and respond to weaker paging signals. Although the SmartAC signal was sent over two paging systems to ensure robust coverage, the paging signals for the Fresno feeders were still substantially weaker.

Table 6-2: Summary of AC Load and Load Impacts by Feeder, Type of Device, and Temperature Range

Feeder	Temp (F°)	# of events	DLC switches Estimated AC Load (kW)	DLC switches Estimated Impact (kW)	PCTs Estimated AC Load (kW)	PCTs Estimated Impact (kW)	OVERALL Estimated AC Load (kW)	OVERALL Estimated Impact (kW)
Antioch	75 or less	11	0.30	-0.26	0.37	-0.31	0.31	-0.27
	75-80 F°	10	0.40	-0.26	0.44	-0.26	0.41	-0.26
	80-85 F°	12	0.53	-0.45	0.64	-0.44	0.56	-0.45
	85-90 F°	11	0.91	-0.75	0.93	-0.73	0.92	-0.75
	90-95 F°	12	1.11	-0.98	1.27	-0.84	1.15	-0.93
	95-100 F°	10	1.70	-1.35	1.53	-0.96	1.65	-1.21
	Above 100 F°	2	1.49	-1.24	1.58	-1.36	1.51	-1.27
	Overall	**68**	**0.79**	**-0.65**	**0.88**	**-0.61**	**0.81**	**-0.64**
Fairfield	75 or less	11	0.24	-0.21	0.33	-0.22	0.26	-0.21
	75-80 F°	10	0.30	-0.21	0.36	-0.19	0.31	-0.21
	80-85 F°	12	0.45	-0.39	0.61	-0.37	0.48	-0.39
	85-90 F°	11	0.85	-0.69	0.89	-0.72	0.85	-0.70
	90-95 F°	12	1.16	-1.01	1.22	-0.82	1.17	-0.98
	95-100 F°	10	1.63	-1.39	1.60	-1.02	1.62	-1.31
	Above 100 F°	2	1.74	-1.43	1.72	-1.50	1.74	-1.44
	Overall	**68**	**0.75**	**-0.63**	**0.86**	**-0.58**	**0.77**	**-0.62**
Fresno 1	75 or less	3	0.06	-0.04	0.09	-0.08	0.06	-0.05
	75-80 F°	2	0.13	-0.09	0.15	-0.09	0.13	-0.09
	80-85 F°	3	0.41	-0.26	0.69	-0.31	0.47	-0.28
	85-90 F°	6	0.52	-0.30	0.58	-0.23	0.53	-0.28
	90-95 F°	21	1.01	-0.71	1.17	-0.53	1.04	-0.64
	95-100 F°	26	1.45	-1.01	1.64	-0.57	1.49	-0.82
	Above 100 F°	7	1.79	-1.38	1.94	-0.77	1.82	-1.13
	Overall	**68**	**1.09**	**-0.77**	**1.28**	**-0.50**	**1.13**	**-0.66**
Fresno 2	75 or less	3	0.01	0.00	0.01	-0.01	0.01	-0.01
	75-80 F°	2	0.05	-0.04	0.06	-0.02	0.05	-0.03
	80-85 F°	3	0.31	-0.27	0.31	-0.04	0.31	-0.18
	85-90 F°	6	0.32	-0.12	0.26	-0.07	0.31	-0.10
	90-95 F°	21	0.94	-0.71	0.91	-0.28	0.93	-0.54
	95-100 F°	26	1.57	-1.21	1.50	-0.39	1.56	-0.85
	Above 100 F°	7	2.08	-1.67	1.90	-0.54	2.04	-1.18
	Overall	**68**	**1.11**	**-0.85**	**1.09**	**-0.30**	**1.11**	**-0.62**

Appendix B details the aggregate load impacts for each event and each feeder. Appendix C details the load impacts per device for each event, 5 minute interval, feeder, and device type. Appendix D presents the actual load profiles and estimated reference load for each event day during the test period of August and September of 2009.

Figure 6-6 presents the distribution of aggregate load impacts for all event periods in the study. Figure 6-7 present the distribution of per device impacts for all event periods.

Figure 6-6: Distribution of Aggregate Load Impacts for Each Event Period

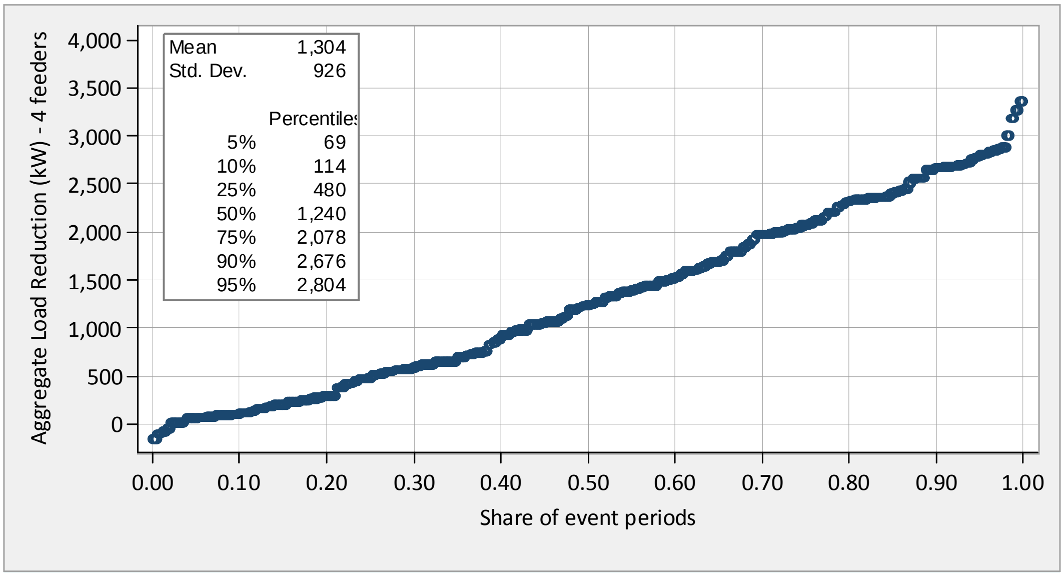
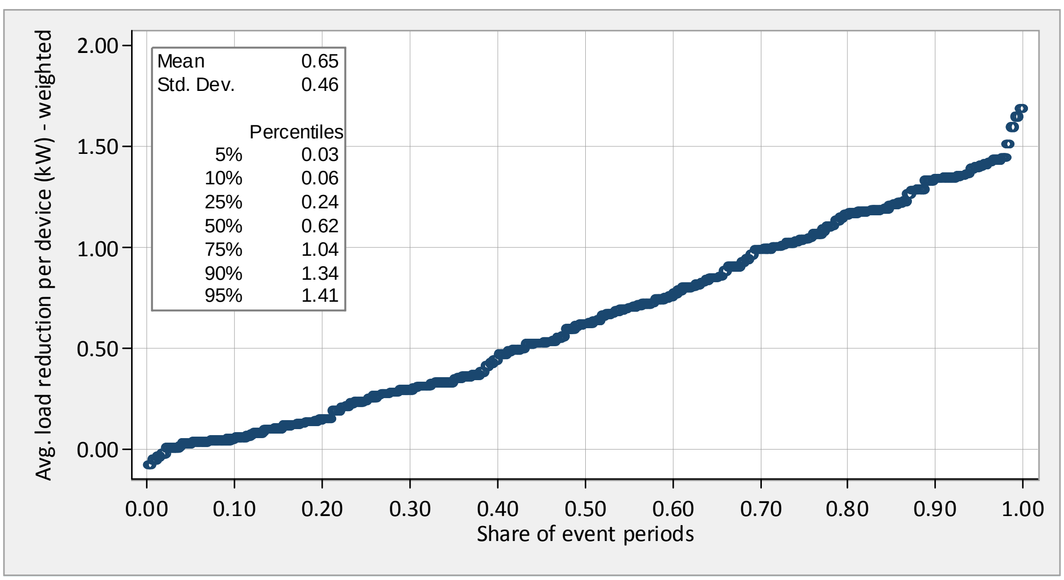


Figure 6-7: Distribution of Average Load Impacts per Device for Each Event Period



At its peak, the total load reductions for the four feeders exceed 3.3 MW, and load reduction exceeded 1.2 MW for more than 50 percent of events. Although the overall feeder impacts are interesting on their own, the load reductions per device are more relevant in assessing the potential for AC load control as an ancillary service resource. PG&E has over 135,000 DLC devices among active participants. The four feeders where ancillary service operations were tested have almost 2,000 customers, or approximately

1.5% of devices. Because the pilot controlled load twice a day on most of the weekdays during the test period, it provides a realistic measure of the load reductions the program could bid in as Participating Load on a per device basis given the variation in the weather conditions and AC loads.

The average load reduction per device across all events was 0.65 kW per device. For over 25 percent of events, load reductions per device exceeded one kW. Though the feeder participants do not represent the entire SmartAC participant population, they do reflect the geographical diversity in the PG&E territory. With the current available AC load control participants and a full scale use of participants for ancillary services, SmartAC could provide approximately 80 MW of load reduction for ancillary services for most summer days, and upwards of 180 MW for system peaking conditions. The program-wide AS load reduction capability could be further refined through a sample representative of the SmartAC population rather than a feeder specific pilot. There are several additional operational considerations that need to be addressed for a full scale deployment.

7. EFFECT OF LOAD CURTAILMENTS ON COMFORT AND SATISFACTION

To assess the effects of ancillary services operations on customers, a post-season customer survey was used to measure the differences between customers whose loads were controlled 71 times during the AS Pilot and other SmartAC participants who were operated one time during the test period. Overall, 814 customers were selected for the survey.[9] Of the customers selected, 314 were on feeders where ancillary service operations were simulated by shutting down AC compressors for 15 minutes at a time, twice daily. The remaining 500 customers were selected from the SmartAC participant population on feeders that were not part of AS Pilot and were designed to serve as a control group.

The remainder of this section:

- Describes the sample design and in particular the method used to draw the control groups sample (i.e., propensity score matching).
- Compares the demographics of the AS Pilot feeder participants that responded to the survey to control group survey respondents.
- Presents results regarding the differences in customer comfort and satisfaction between customers in the AS Pilot and control group customers.

7.1. Methodology - Sample Design and Control Group Selection

The AS Pilot feeder group customers were selected using proportional random sampling. The eligible population was divided into strata based on feeder and type of control device (DLC switch or PCT), and the same proportion of units was drawn from each cell. The approach ensures the sample is representative of the population and that it is random for key categories.

The control group was selected from the remaining SmartAC population who were not on the AS Pilot feeders based on two primary steps. First, the eligible match population was narrowed to customers assigned to the same weather stations as the AS Pilot feeder population and in the same primary city area (as defined by the three digit zip code). Second, because there can be substantial variation within cities, the match group was selected using propensity score matching -- a technique designed to ensure control group members are as similar as possible as those who received actual choices. This technique requires estimation of the probability customers were part of the AS Pilot feeder population using as many known predictors of selection as are available. The predictors included:

- climate region

[9] Three filters were employed prior to drawing the sample. Customers without valid phone contact information or who were part of the SmartAC measurement and evaluation sample were removed from the sampling frame. In addition, customers who were not active or moved during the AS Pilot were removed.

- CARE enrollment status
- whether the household had received energy efficiency rebates in the past five years
- annual electricity consumption (kWh)
- annual electricity bill
- median neighborhood income (census block group data)
- median neighborhood age (census block group data)
- median head of household age (census block group data)
- control device type (DLC or PCT)
- number of AC units
- tons per AC unit
- correlation between monthly consumption and heat intensity (as defined by monthly cooling degree days)
- ratio of summer bill to annual bill, and
- marketing persona clusters.

The propensity model was developed using probit regression. The probit regression produced propensity scores reflecting the likelihood participants would be part of the AS Pilot feeder group – given known characteristics With propensity score matching, it is generally preferable to include as many explanatory variables as are available because the potential cost of an omission error, or bias, is greater than the cost for including too many variables, resulting in larger standard errors. First, a linear model was specified to identify the key drivers. Subsequently, the key drivers were interacted with climate region to assess whether such interactions were statistically significant. The final model divided the key variables into deciles to address potential non-linear relationships. The final model was used to predict propensity scores and the match group was selected from the supported range using a nearest neighbor matching algorithm.

Table 7-1 compares the AS Pilot feeder customers with the control group customers on key customer characteristics. The differences between the AS Pilot customer group and the control group are not statistically significant except for one variable. The homes in the control group are about one year older than those in the AS Pilot test group. This difference, while statistically significant, is minor and not substantively interesting.

Table 7-1: Pre-Survey Comparison of AS Pilot Feeder Participants to Control Group

Characteristic	AS Pilot feeder participants	Match group	t value	Probability
Energy efficiency rebate in past 5 years	0.98	0.98	0.16	0.88
CARE status	0.2	0.21	-0.65	0.52
Thermostat device	0.24	0.26	-0.99	0.32
Number of AC units	1.13	1.12	0.73	0.46
Tons per AC unit	2.75	2.68	0.92	0.36
Correlation between monthly consumption and heat intensity	0.43	0.44	-0.42	0.67
Ratio of summer to annual bill	0.11	0.11	-0.93	0.35
Climate region (S=1 R=0)	0.56	0.54	0.72	0.47
Neighborhood average household members	3.43	3.44	-0.69	0.49
Neighborhood ,median head of household age	48.6	48.6	0	1
Neighborhood median year home built	1988.5	1987.7	2.15	0.03
Neighborhood median income	84,869.00	84,596.00	0.24	0.81
Annual cooling degree days (heat intensity)	1,622.90	1,621.30	0.05	0.96
Annual consumption (kWh)	24,924.00	23,971.00	1.31	0.19
Annual PG&E bill	3,827.00	3,640.00	1.2	0.23

Appendix F provides the regression results for the probit model used to develop propensity scores.

7.2. Comparison of AS Pilot Feeder and Control Group Customers

Of the 814 survey attempts, 454 SmartAC customers responded, producing a net response rate of 55.8%. Of the 454 respondents, 180 were participants in the AS Pilot and 274 were in the control group.

The control group had an average of 0.07 other kinds of heaters in their house, while the AS Pilot had an average of 0.02 other kinds of heaters in their house (t=2.49 p=0.01). Because these numbers are so small and because the number of other heat sources is unlikely to influence their satisfaction with PG&E or the SmartAC program, this difference is not problematic.

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unlikely to influence their satisfaction with PG&E or the SmartAC program, this difference is not problematic.

Table 7-2 summarizes how the AS Pilot feeder respondents compare with control group respondents. The variables that are plausibly related to customer comfort such as the number of AC units, heat intensity, and AC tonnage are not statistically different. All but one of the differences between the control and AS Pilot feeder respondents are statistically insignificant (at a 95% confidence level).

The control group had an average of 0.07 other kinds of heaters in their house, while the AS Pilot had an average of 0.02 other kinds of heaters in their house (t=2.49 p=0.01). Because these numbers are so small and because the number of other heat sources is unlikely to influence their satisfaction with PG&E or the SmartAC program, this difference is not problematic.

Table 7-2: Post Survey Comparison of AS Pilot Survey Population to Control Group

Characteristic	Control Group	AS Pilot Group	t value	Probability
Energy efficiency rebate in past 5 years	0.99	0.98	0.38	0.71
CARE status	0.14	0.17	-0.67	0.50
Thermostat device	0.30	0.27	0.56	0.58
Number of AC units	1.19	1.14	1.27	0.20
Tons per AC unit	2.56	2.73	-1.12	0.26
Correlation between monthly consumption and heat intensity	0.40	0.45	-1.03	0.30
Ratio of summer to annual bill	0.11	0.11	0.44	0.66
Climate region (S=1 R=0)	0.50	0.52	-0.58	0.56
Average census block group household members	3.42	3.36	1.56	0.12
Median CBG head of household age	48.77	49.45	-1.17	0.24
Median CBG year home built	1987.87	1987.81	0.10	0.92
Median CBG income	84095.43	85792.09	-0.78	0.44
Annual cooling degree days (heat intensity)	1682.25	1667.96	0.23	0.82
Annual consumption (kWh)	24615.53	23004.1	1.11	0.27
Annual PG&E bill	3887.66	3576.33	1.01	0.31
Years of residency	14.83	13.67	1.19	0.23
Home square footage	2114.94	2072.41	0.58	0.56
Home bedrooms	3.47	3.48	-0.10	0.92
Number of central gas heaters	0.91	0.91	0.14	0.89
Number of room gas heaters	0.55	0.46	1.49	0.14
Number of wood fireplaces	0.45	0.53	-1.71	0.09
Number of other heaters	0.07	0.02	2.49	0.01
Household size	1.17	1.13	0.80	0.42
Number of people in household over 65	1.27	1.25	0.48	0.63
Number of people in household 18-24	0.87	0.86	0.43	0.67
Number of people in household 5-17	0.76	0.80	-0.89	0.37
Number of people in household under 5	11.62	12.59	-1.25	0.21
Age of respondent	2.90	2.73	1.23	0.22

7.3. Results - Impact of Operations on Customer Comfort and Satisfaction

There were no statistically significant differences between the control group and the AS Pilot group in terms of their satisfaction with PG&E, their satisfaction with the SmartAC program, or how many events they noticed throughout the summer. Furthermore, there was no statistically significant difference in their weekday evening, weekend afternoon, and weekend evening thermostat settings, which could have influenced comfort levels caused by the AS Pilot. Neither group had significant differences in their typical afternoon or evening AC use, another variable which could have influenced comfort levels caused by the AS Pilot. The only variable that was significantly different between the control group and the AS Pilot group was the typical weekday afternoon thermostat settings. While this result is statistically significant, (t=2.28 p=0.02), the actual difference in the thermostat setting between the two groups is small: 73.76°F for the control group and 71.91°F for the AS Pilot group. This might indicate that the AS Pilot caused customers to turn down their thermostats an average of 1.85°F on weekday afternoons, but this difference could also be attributed to chance.

Table 7-3 compares the AS Pilot feeder and control group responses to questions about satisfaction, events, thermostat setting and AC use.

Table 7-3: Comparison of Satisfaction, Thermostat Settings, and AC Use Between the AS Pilot Group and a Control Group of Similar SmartAC Customers

Question	Control Group	AS Pilot Group	t value	Prob.
Are you satisfied with PG&E (1=yes)	0.91	0.87	1.28	0.20
How satisfied are you with the SAC program? (1=very dissatisfied, 10=very satisfied)	7.84	7.64	0.92	0.36
Did you notice PG&E turning down your AC this summer?(1=yes)	0.17	0.17	0.01	1.00
How many times did you notice this?	3.23	2.79	0.67	0.51
Are you familiar with the SAC program?	0.82	0.87	-1.35	0.18
Do you understand the SAC program?	0.91	1.00	-1.58	0.12
What is your typical weekday afternoon thermostat setting?	73.76	71.92	2.28	0.02
What is your typical weekday evening thermostat setting?	73.14	72.27	1.03	0.30
What is your typical weekend afternoon thermostat setting?	73.71	73.22	0.30	0.76
What is your typical weekend evening thermostat setting?	74.95	71.45	1.51	0.14
How often do you typically use your AC in the afternoon?	2.32	2.33	-0.04	0.97
How often do you typically use your AC in the evening?	2.26	2.35	-0.61	0.54

Among respondents, 91% of the control group and 87% of the AS Pilot group were satisfied with their relationship with PG&E this summer. On average, the control group rated the SmartAC program as 7.84 out of 10, and the AS Pilot group rated the SmartAC program as a 7.64 out of 10, with the majority of both groups reporting that they were overall satisfied with the SmartAC program.

About 17% of both the control group and the AS Pilot customer sample reported that PG&E had turned down their AC during the summer. PG&E turned down the AC units of the control group customers only once during the summer, while customers on the AS Pilot were turned off twice every weekday during the months of August and September – a total of 71 times. Both AS Pilot and control group customers, on average, reported the same number of control events. Customers in the control group (who experienced one event) reported on average 3.23 events throughout the summer, while customers in the AS Pilot group (who experienced 71 events) reported an average of 2.79 events throughout the summer. Figure 4 describes in more detail the number of AC control events reported by both groups. However, the primary finding is that the differences are not statistically significant, regardless of whether the mean number of events or the distribution of reported events is compared.

The survey results did not indicate any statistically significant difference in customer comfort or satisfaction attributable to the AS Pilot control events.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. Latency

On average PG&E's SmartAC program reduced customer AC loads within 70.1 seconds of the start of operations. This is about 10 seconds longer than CAISO's current requirement of one minute. About half of the time, load reductions were present within the one minute requirement. The test results also showed that on 95% of test occasions load reductions began within 126 seconds – about six seconds longer than a two minute requirement that has been discussed by CAISO and parties; on all tests, load reductions began within 133 seconds.

The system never failed to operate during a test and was always fully operational within 10 minutes. The appliances in the tests responded very quickly to the load control signals. Virtually all of the load reduction obtainable from the control system happened within the first three minutes of operation and all of it is available within six minutes.

The latencies are slightly longer than CAISO's current or anticipated requirement (two minutes). By redesigning the communications interface between the Yukon system and the paging companies (eliminating the modem dialing process) which is involved in the final stage of the signal transmission, the latency can be shortened by 10 to 15 seconds. This change would bring the system into compliance with the CAISO operating requirement (one minute) on the average and within an operating requirement of two minutes; the system would be compliant 95% of the time. Also, giving ancillary service operations precedence in the Yukon system could shorten signal latencies because they would receive priority status when other program operations are scheduled. This would eliminate the longer latencies that were observed when other load control operations (e.g., system level load control operations) were taking place.

Both of the above modifications should be undertaken in the event that PG&E decides to participate in the ancillary services market.

8.2. Load Impacts

The load impacts observed during the pilot were sometimes substantial. However, the magnitude of these impacts depended heavily on ambient temperature and time of day. When ambient temperatures were below 80 degrees F in the Central Valley and east of the Coastal Range (Northern California's hot climate zone), load impacts per device were relatively low (i.e. about .2 kW per installed unit). This is because only a small fraction of the AC units were operating when the temperature was this low. When average temperatures were between 90 and 100 degrees F (the typical summer afternoon) the load impacts were much higher (between .54 kW and 1.4 kW depending on temperature and location). When temperatures were in excess of 100 degrees F, the load impacts were between .62 kW and 1.44 kW per unit depending on location and device type. The temperature rises quite dramatically throughout the afternoon on summer days in the areas were SmartAC is operating, and this has a predictable effect on the load impacts that are obtained from SmartAC. Much higher load reductions were observed between 2:00 pm and 6:00 pm than at other times of the day.

Aggregation of the average load impacts obtained from ancillary services operations can produce large and predictable load reductions. Just under 2,000 AC units were controlled in the AS Pilot. The load reductions from this small population ranged from almost no impacts when temperatures were cool (i.e., less than 75 degrees) to upwards of 3.3 MW. These load impacts are small in comparison to the load of the PG&E area. However, the feeders involved in the pilot comprise only 1.5% of the loads controllable using the SmartAC system. While the AS pilot was not a representative sample of the AC units under control in the SmartAC system, it was geographically diverse and provides an indication of the ancillary service load reduction potential from SmartAC. The results obtained from the pilot suggest that load reductions obtainable from the SmartAC population in ancillary services operations could be relatively large – over 80 MW of load reduction for most summer days, and upwards of 180 MW for system peaking conditions. Using this resource for ancillary services operations would require less than a month to re-commission the control devices to respond to ancillary services calls. In other words, the current pilot population could be expanded by a factor of approximately 60 with limited cost.

The load impacts of the SmartAC system vary with weather and time of day. However, the effects of these factors on load impacts are predictable using multiple regression techniques. Regression models relying solely on temperature, time of day and day of week explain about 86% of the variation in the AC loads observed during the AS Pilot tests and accurately predict AC loads for days with daily maximum temperatures above 90 F°. Using projected weather by hour for the locations for which ancillary services will be called, it is possible to forecast day-ahead load impacts by hour and hour ahead load impacts. There is, of course, some prediction error to be expected resulting from error in weather forecasts, but this error should not be problematic from an operational perspective.

In a competitive market, the reliability of the load relief offered by its AC load control system is the responsibility of PG&E (the bidder). It is a risk management problem. The bidder has to account for the risk associated with failing to meet contractual ancillary service resources. It can do this by bidding into the market only the quantity of ancillary service load reduction that it is virtually certain (95%) will occur based on its recent experience with the accuracy of weather forecasts.

The load impacts observed in the AS Pilot tests are conservative. Two reasons underlie this conclusion. First, the tests were conducted during the last two months of the summer (August and September). They did not include observations from the month of July. Since many of the hottest days in summer occur in July, the test results probably underestimate the maximum load reductions that could be obtained from the systems under consideration.

Second, the paging system signals for the north Fresno area where the two Fresno feeders were located are weaker than in other regions. The problem can address through negotiation with the paging companies to bolster signal strength in the area. Under similar weather conditions, a 40 to 60 percent difference was observed in the load impacts observed for Fresno PCTs relative to PCTs in the other two areas under study (Antioch and Fairfield).

Close inspection of the differences in load impacts for the Fresno feeders and the feeders located in Antioch and Fairfield indicates that the average appliance loads at high temperatures are about the same (about 2 kW on average) for all of the areas. However, substantially fewer PCTs in Fresno, which are located inside buildings, were responding to load control signals. PCTs The evidence suggests that the signals from the paging systems serving the Fresno feeders are not strong enough to control the PCTs. Communication tests performed by Cooper Power Systems indicate that this problem is not widespread. Moreover, PCTs in Antioch and Fairfield provided load reductions similar to DLC switches. If the problem is not widespread, then it is likely that the impacts measured on the Fresno feeders are lower than should be expected for other hot Central Valley locations.

8.3. Impacts on Customers

Ancillary services operations lasting up to 15 minutes have no impacts on customers. Customers are not aware of these operations and the satisfaction of customers with PG&E service in general and with the SmartAC program are not affected at all.

Since the tests did not last longer than 30 minutes, it is impossible to say how much impact longer operations might have on customers. Additional testing will be required to determine whether these longer operations cause negative customer reactions. This testing could easily be completed in 2010 by operating a sample of SmartAC customers in simulated ancillary services operations at varying temperatures and observing their reactions. This test would not require metering so it could be conducted inexpensively. This test is recommended before PG&E goes forward with telemetry investments required to participate in the ancillary services market.

8.4. Performance of Telemetry

The telemetry system used in the study measured customer AC loads in real time throughout the months of August and September. As explained in prior sections, each minute during the load control test periods, the data loggers installed on the customer AC units transmitted load measurements (kW, AMPS, Volts) that had been observed at the end of the previous minute to a central computer. The central computer then displayed the results from the previous minute on a web page accessible by the CAISO, the project team and others who were interested in the project (i.e., PG&E management). The displays were updated each minute with the results transmitted during the previous minute. The effect of this design is that users who are viewing the load impacts through the system see the response of the system about one minute after the actual response has taken place. That is, there is a one minute delay in the observation of load impacts in real time using this approach to telemetry.

The clocks on Yukon's central load data management computer and data loggers are set to Coordinated Universal Time every 24 hours so that reported load measurements are in real time. Since the system always responds in full (i.e., provides all available load reduction) in less than six minutes, this delay has no effect on the ability of the system operator to confirm the effect of the program within the 10-minute interval required by WECC. However, the system operator may find the one minute time delay in the load impact display unacceptable for confirming that the load control system has started on command. This problem can be overcome by instructing the Yukon system to <u>directly</u> inform CAISO that it has transmitted the load control signals to the paging system at the time that it does so <u>in real time</u>. Using this design, CAISO will be informed that the load control system has been started within five seconds of the real time of start of an operation. Given the response time of the Yukon system (about 30 seconds on average) the operator can confirm the start of load control system operations about 35 seconds after the operation is requested.

8.5. Scalability

The size of the AC load control capability (i.e., the number of AC units under control) can be scaled up quickly and with limited expense. The AC units that would participate in AC load control operations in the ancillary services market are already program participants and load control devices have already been installed at these customer locations.

There are 135 thousand air conditioners participating in the program at this time; and the number is growing as PG&E continues to market the program. Modifications to the control computer required to control these AC units for purposes of providing ancillary services has already been written and tested as part of the AS Pilot and only minor modifications would be required to implement it on a full scale market basis. Commissioning the entire SmartAC population to respond to ancillary services operations requires programming through Yukon; creating the notch test control strategy as an option.

The existing telemetry system can be scaled up quickly, but some work will undoubtedly be required to create an acceptable interface between the telemetry system used in the pilot and the CAISO operations control systems. The load data management system operated by EICT can accommodate tens of thousands of telemeters. In other words, there is no technical barrier to expanding the current telecommunications design to accommodate a large sample of telemeters.

If the telemetry system used in the AS Pilot is acceptable in principle to the CAISO, then the first cost to scale up the existing system to manage the load impacts obtained for the entire SmartAC program is approximately $1.2 million. This system would consist of 500 telemeters installed on a representative sample of participating air conditioning units in the PG&E service territory. The annual operating cost of the telemetry system would be approximately $300,000 per year thereafter. If additional resolution is required by CAISO at the LCA level, additional meters would be required in each LCA to bring the number of load measurement devices up to 500 within each LCA. This would result in increased cost, but the per unit costs for these additional telemeters decline as the number of installations increases. Assuming 1,000 total telemeters are required to support ancillary services operations, the initial installation cost of the system would be about $2 million and the annual operating cost would be approximately $500,000.

APPENDIX A: EVENT INFORMATION

Event Date	Event Day	Event Time	Fresno Temperature (F)	Fairfield / Antioch Temperature (F)	Weighted Average Temperature (F)	Number of DLC Devices Instructed to Shed Load
4-Aug	Tuesday	1:00 PM	89.5	80.5	85.0	1,994
4-Aug	Tuesday	3:00 PM	93.5	84.5	89.0	1,994
5-Aug	Wednesday	2:00 PM	92.0	78.5	85.3	1,994
5-Aug	Wednesday	4:00 PM	95.5	78.0	86.8	1,994
6-Aug	Thursday	3:00 PM	81.5	73.0	77.3	1,994
6-Aug	Thursday	5:00 PM	81.0	72.0	76.5	1,994
7-Aug	Friday	4:00 PM	99.5	79.5	90.3	1,994
7-Aug	Friday	6:00 PM	96.5	76.5	87.3	1,994
10-Aug	Monday	5:00 PM	100.5	98.0	99.3	1,994
10-Aug	Monday	7:00 PM	98.0	88.5	93.3	1,994
11-Aug	Tuesday	3:00 PM	101.5	86.0	93.8	1,994
11-Aug	Tuesday	6:00 PM	96.5	77.0	87.5	1,994
12-Aug	Wednesday	3:00 PM	98.5	100.0	99.3	1,994
12-Aug	Wednesday	5:00 PM	99.5	95.5	97.5	1,994
13-Aug	Thursday	12:00 PM	92.0	89.5	90.8	1,994
13-Aug	Thursday	2:00 PM	96.0	90.5	93.3	1,994
14-Aug	Friday	1:00 PM	90.5	78.0	84.3	1,994
14-Aug	Friday	3:15 PM	94.0	77.5	85.8	1,994
17-Aug	Monday	2:00 PM	97.5	86.5	92.0	1,994
17-Aug	Monday	4:00 PM	98.5	91.5	95.0	1,994
18-Aug	Tuesday	3:00 PM	100.0	88.5	94.3	1,994
18-Aug	Tuesday	5:00 PM	100.5	90.5	95.5	1,994
19-Aug	Wednesday	4:00 PM	101.0	81.5	91.3	1,994
19-Aug	Wednesday	6:00 PM	99.5	71.5	85.5	1,994
20-Aug	Thursday	5:00 PM	98.0	80.0	89.0	1,994
20-Aug	Thursday	7:00 PM	93.0	70.5	81.8	1,994
24-Aug	Monday	7:00 PM	91.5	68.5	80.0	1,994
25-Aug	Tuesday	12:00 PM	87.0	77.0	82.0	1,994
25-Aug	Tuesday	2:00 PM	93.5	83.0	88.3	1,994
26-Aug	Wednesday	1:00 PM	95.0	82.0	88.5	1,994
26-Aug	Wednesday	3:00 PM	98.5	87.0	92.8	1,994
27-Aug	Thursday	2:00 PM	96.5	93.5	95.0	1,994
27-Aug	Thursday	4:25 PM	100.0	97.5	98.8	1,994
28-Aug	Friday	3:15 PM	99.5	101.5	100.5	1,994
28-Aug	Friday	5:15 PM	97.5	99.0	98.3	1,994
31-Aug	Monday	4:00 PM	100.5	83.0	91.8	1,994
31-Aug	Monday	6:00 PM	94.5	78.0	86.3	1,994
1-Sep	Tuesday	5:00 PM	99.5	92.0	95.8	1,994

Event Date	Event Day	Event Time	Fresno Temperature (F)	Fairfield / Antioch Temperature (F)	Weighted Average Temperature (F)	Number of DLC Devices Instructed to Shed Load
1-Sep	Tuesday	7:00 PM	95.0	84.0	89.5	1,994
2-Sep	Wednesday	5:55 PM	100.0	97.0	98.5	1,994
3-Sep	Thursday	7:00 PM	96.5	85.5	91.0	1,994
4-Sep	Friday	12:00 PM	91.5	79.5	85.5	1,994
4-Sep	Friday	2:00 PM	96.5	82.5	89.5	1,994
8-Sep	Tuesday	2:00 PM	90.5	86.5	88.5	1,994
8-Sep	Tuesday	4:00 PM	92.0	89.5	90.8	1,994
9-Sep	Wednesday	3:00 PM	95.0	90.5	92.8	1,994
9-Sep	Wednesday	5:00 PM	95.0	91.0	93.0	1,994
11-Sep	Friday	4:45 PM	97.0	100.0	98.5	1,994
11-Sep	Friday	6:45 PM	94.5	94.0	94.3	1,994
14-Sep	Monday	6:00 PM	77.0	71.5	74.3	1,994
15-Sep	Tuesday	7:00 PM	83.0	74.5	78.8	1,994
16-Sep	Wednesday	12:00 PM	85.5	82.0	83.8	1,994
16-Sep	Wednesday	2:00 PM	89.0	87.0	88.0	1,994
17-Sep	Thursday	1:00 PM	89.5	85.0	87.3	1,994
17-Sep	Thursday	3:00 PM	93.5	90.5	92.0	1,994
18-Sep	Friday	2:00 PM	97.0	97.5	97.3	389
18-Sep	Friday	4:00 PM	100.5	98.5	99.5	389
21-Sep	Monday	3:00 PM	97.0	97.0	97.0	389
21-Sep	Monday	5:00 PM	97.0	94.0	95.5	389
22-Sep	Tuesday	4:00 PM	100.5	101.0	100.8	1,994
22-Sep	Tuesday	6:00 PM	96.5	95.0	95.8	1,994
23-Sep	Wednesday	5:00 PM	98.5	94.5	96.5	389
23-Sep	Wednesday	7:00 PM	95.0	84.0	89.5	389
24-Sep	Thursday	6:00 PM	96.0	87.0	91.5	1,994
25-Sep	Friday	7:00 PM	92.5	84.5	88.5	1,994
28-Sep	Monday	12:00 PM	92.5	71.5	82.0	1,994
28-Sep	Monday	2:08 PM	97.0	71.0	84.0	1,994
29-Sep	Tuesday	1:00 PM	73.0	71.5	72.3	1,994
29-Sep	Tuesday	3:00 PM	72.5	71.5	72.0	1,994
30-Sep	Wednesday	2:00 PM	74.5	74.5	74.5	1,994
30-Sep	Wednesday	4:00 PM	76.0	76.0	76.0	1,994

APPENDIX B: AGGREGATE LOAD IMPACTS BY EVENT AND FEEDER

	Date	Start time	Temp F°	Aggregate load reduction (kW)					Percent load reduction				
				Antioch	Fairfield	Fresno 1	Fresno 2	Total	Antioch	Fairfield	Fresno 1	Fresno 2	Total
1	04-Aug-10	13:00	89.5	26	53	169	156	404	57.2%	84.5%	73.7%	80.9%	76.2%
2	04-Aug-10	15:00	93.5	47	90	218	302	658	48.5%	69.0%	56.7%	77.1%	65.4%
3	05-Aug-10	14:00	92.0	86	66	215	184	552	82.9%	83.4%	61.8%	68.9%	69.1%
4	05-Aug-10	16:00	95.5	113	103	333	372	921	85.5%	79.8%	63.4%	72.2%	70.8%
5	06-Aug-10	15:00	81.5	36	21	53	72	182	92.8%	44.2%	39.0%	78.4%	57.9%
6	06-Aug-10	17:00	81.0	57	58	102	130	347	79.5%	81.2%	49.4%	73.3%	65.8%
7	07-Aug-10	16:00	99.5	130	121	99	105	455	96.6%	78.3%	63.9%	72.9%	77.4%
8	07-Aug-10	18:00	96.5	144	119	158	153	574	94.5%	82.2%	69.8%	68.0%	76.7%
9	10-Aug-10	17:00	100.5	723	772	476	589	2,560	86.2%	91.6%	68.8%	75.5%	81.2%
10	10-Aug-10	19:00	98.0	596	643	406	571	2,216	82.3%	88.9%	60.6%	80.4%	78.4%
11	11-Aug-10	15:00	101.5	274	234	551	587	1,646	70.6%	88.5%	73.1%	75.9%	75.5%
12	11-Aug-10	18:00	96.5	451	259	544	590	1,845	76.9%	86.5%	71.0%	69.1%	73.6%
13	12-Aug-10	15:00	98.5	396	393	380	372	1,542	71.2%	82.5%	64.2%	69.4%	71.3%
14	12-Aug-10	17:00	99.5	605	538	421	598	2,162	79.2%	85.5%	61.4%	76.5%	75.6%
15	13-Aug-10	12:00	92.0	206	273	201	118	799	57.4%	82.4%	65.9%	62.5%	67.4%
16	13-Aug-10	14:00	96.0	365	435	286	302	1,389	78.6%	79.5%	55.4%	69.1%	70.6%
17	14-Aug-10	13:00	90.5	150	146	214	145	655	81.1%	81.9%	66.7%	82.0%	76.1%
18	14-Aug-10	15:15	94.0	243	174	217	303	937	83.8%	86.2%	48.3%	76.7%	70.1%
19	17-Aug-10	14:00	97.5	320	217	295	297	1,129	90.6%	87.0%	70.4%	72.5%	78.9%
20	17-Aug-10	16:00	98.5	492	462	491	455	1,900	85.8%	92.6%	74.3%	73.4%	80.7%
21	18-Aug-10	15:00	100.0	319	253	413	479	1,463	87.7%	83.4%	57.9%	71.2%	71.3%
22	18-Aug-10	17:00	100.5	592	448	519	589	2,148	83.4%	87.4%	68.9%	68.3%	75.7%
23	19-Aug-10	16:00	101.0	379	354	544	547	1,824	88.8%	92.7%	67.2%	71.0%	76.4%
24	19-Aug-10	18:00	99.5	453	337	563	606	1,959	86.5%	92.2%	68.3%	72.1%	76.7%
25	20-Aug-10	17:00	98.0	295	264	417	499	1,476	80.3%	90.4%	64.6%	73.8%	74.4%

	Date	Start time	Temp F°	Aggregate load reduction (kW)					Percent load reduction				
				Antioch	Fairfield	Fresno 1	Fresno 2	Total	Antioch	Fairfield	Fresno 1	Fresno 2	Total
26	20-Aug-10	19:00	93.0	213	162	457	386	1,218	81.7%	84.8%	72.5%	70.9%	74.9%
27	24-Aug-10	19:00	91.5	102	67	359	360	887	85.8%	64.0%	63.5%	74.7%	69.9%
28	25-Aug-10	12:00	87.0	17	20	91	54	182	87.4%	76.7%	77.8%	71.3%	76.4%
29	25-Aug-10	14:00	93.5	78	56	219	173	526	86.7%	79.5%	60.5%	70.1%	68.4%
30	26-Aug-10	13:00	95.0	58	51	223	94	427	74.7%	71.0%	67.3%	68.9%	69.0%
31	26-Aug-10	15:00	98.5	133	89	308	232	763	81.0%	41.2%	56.0%	52.1%	55.4%
32	27-Aug-10	14:00	96.5	186	118	164	121	590	82.1%	56.7%	43.5%	37.7%	52.0%
33	27-Aug-10	16:25	100.0	351	390	376	407	1,524	72.0%	86.4%	49.7%	67.7%	66.3%
34	28-Aug-10	15:15	99.5	487	569	252	331	1,639	76.8%	80.4%	44.0%	70.8%	68.8%
35	28-Aug-10	17:15	97.5	614	556	333	206	1,709	75.8%	78.0%	51.7%	37.3%	62.8%
36	31-Aug-10	16:00	100.5	184	113	502	503	1,303	63.7%	85.4%	68.2%	70.7%	69.7%
37	31-Aug-10	18:00	94.5	229	136	368	475	1,208	72.3%	85.9%	65.3%	71.9%	71.1%
38	01-Sep-10	17:00	99.5	330	349	471	550	1,700	72.0%	86.3%	69.2%	72.8%	74.0%
39	01-Sep-10	19:00	95.0	389	320	377	445	1,530	86.8%	85.1%	62.0%	67.7%	73.3%
40	02-Sep-10	17:55	100.0	510	629	572	548	2,260	76.0%	89.0%	74.0%	73.7%	78.1%
41	03-Sep-10	19:00	96.5	621	525	391	480	2,017	87.7%	86.9%	69.8%	73.5%	79.9%
42	04-Sep-10	12:00	91.5	138	64	190	103	493	78.8%	68.1%	77.5%	79.1%	76.8%
43	04-Sep-10	14:00	96.5	315	189	329	257	1,089	86.0%	79.7%	67.7%	63.4%	72.9%
44	08-Sep-10	14:00	90.5	75	93	241	117	526	88.4%	66.4%	77.4%	86.9%	78.4%
45	08-Sep-10	16:00	92.0	215	284	316	276	1,092	94.2%	84.9%	72.0%	76.6%	80.1%
46	09-Sep-10	15:00	95.0	193	252	318	203	967	96.2%	83.5%	67.8%	71.3%	76.9%
47	09-Sep-10	17:00	95.0	344	462	356	335	1,496	89.4%	90.4%	65.0%	70.4%	78.0%
48	11-Sep-10	16:45	97.0	569	581	322	289	1,762	81.6%	76.4%	54.5%	53.2%	68.0%
49	11-Sep-10	18:45	94.5	632	581	427	316	1,957	94.2%	90.0%	73.4%	72.9%	83.9%
50	14-Sep-10	18:00	77.0	56	52	47	28	183	79.1%	75.4%	63.9%	75.1%	73.0%
51	15-Sep-10	19:00	83.0	113	111	157	89	471	95.7%	81.4%	73.5%	78.3%	80.8%
52	16-Sep-10	12:00	85.5	28	37	75	19	159	85.3%	60.0%	69.8%	97.2%	71.8%
53	16-Sep-10	14:00	89.0	99	97	193	73	463	83.9%	56.8%	65.7%	89.5%	69.5%

	Date	Start time	Temp F°	Aggregate load reduction (kW)					Percent load reduction				
				Antioch	Fairfield	Fresno 1	Fresno 2	Total	Antioch	Fairfield	Fresno 1	Fresno 2	Total
54	17-Sep-10	13:00	89.5	128	126	192	64	510	97.9%	87.8%	73.3%	75.1%	82.1%
55	17-Sep-10	15:00	93.5	234	282	302	157	975	94.1%	87.0%	72.2%	57.1%	77.0%
56	18-Sep-10	14:00	97.0	36	68	23	2	128	31.2%	45.4%	17.0%	2.3%	27.4%
57	18-Sep-10	16:00	100.5	56	2	31	7	96	34.9%	0.8%	16.9%	5.8%	14.6%
58	21-Sep-10	15:00	97.0	54	32	0	16	103	43.3%	27.6%	0.0%	16.6%	21.5%
59	21-Sep-10	17:00	97.0	58	30	0	20	107	31.6%	16.3%	0.0%	12.6%	15.2%
60	22-Sep-10	16:00	100.5	577	629	480	434	2,121	90.8%	86.2%	65.7%	66.9%	77.2%
61	22-Sep-10	18:00	96.5	592	584	452	411	2,039	86.7%	87.3%	66.0%	68.9%	77.4%
62	23-Sep-10	17:00	98.5	61	68	10	28	167	32.1%	40.5%	5.1%	17.3%	23.4%
63	23-Sep-10	19:00	95.0	66	25	48	14	153	39.1%	18.7%	34.1%	11.4%	27.1%
64	24-Sep-10	18:00	96.0	531	369	406	414	1,720	80.6%	84.9%	68.0%	77.3%	77.3%
65	25-Sep-10	19:00	92.5	400	325	329	261	1,315	88.0%	81.1%	69.3%	66.8%	76.4%
66	28-Sep-10	12:00	92.5	96	27	169	40	332	93.8%	71.3%	73.7%	47.3%	73.1%
67	28-Sep-10	14:08	97.0	90	36	247	193	566	48.4%	45.7%	51.7%	55.8%	52.0%
68	29-Sep-10	13:00	73.0	4	3	1	0	8	87.4%	39.7%	18.5%	0.0%	42.2%
69	29-Sep-10	15:00	72.5	13	20	6	4	44	90.9%	72.7%	48.7%	48.9%	68.6%
70	30-Sep-10	14:00	74.5	-3	7	6	9	20	0.0%	58.1%	45.0%	94.4%	54.7%
71	30-Sep-10	16:00	76.0	25	22	10	7	64	93.0%	81.3%	59.8%	92.9%	81.8%
	TOTALS			**17,796**	**16,443**	**19,437**	**18,675**	**72,352**	**79.9%**	**80.7%**	**62.9%**	**68.5%**	**71.8%**

APPENDIX C: LOAD IMPACTS PER EVENT, FEEDER, DEVICE AND 5 MINUTE INTERVALS

Table C-1: Antioch Load Impact Estimates by Event and Device Type

Average Load Reduction Per Device (kW)

Event	Date	Start time	Temp (F°)	Switch (n=71, N=413)				Thermostat (n=28, N=102)			
				5 min	10 min	15 min	Total	5 min	10 min	15 min	Total
1	4-Aug	1:00 PM	80.5	-0.06	-0.02	-0.04	-0.04	-0.11	-0.17	-0.18	-0.15
2	4-Aug	3:00 PM	84.5	-0.02	-0.08	-0.17	-0.09	-0.10	-0.15	-0.36	-0.20
3	5-Aug	2:00 PM	78.5	-0.17	-0.23	-0.20	-0.20	-0.15	-0.28	-0.33	-0.25
4	5-Aug	4:00 PM	78.0	-0.17	-0.28	-0.28	-0.24	-0.30	-0.47	-0.41	-0.40
5	6-Aug	3:00 PM	73.0	-0.03	-0.04	-0.06	-0.05	-0.20	-0.29	-0.27	-0.25
6	6-Aug	5:00 PM	72.0	-0.13	-0.08	-0.14	-0.12	-0.21	-0.25	-0.21	-0.22
7	7-Aug	4:00 PM	79.5	-0.29	-0.31	-0.30	-0.30	-0.32	-0.41	-0.38	-0.37
8	7-Aug	6:00 PM	76.5	-0.34	-0.35	-0.31	-0.33	-0.36	-0.45	-0.45	-0.42
9	10-Aug	5:00 PM	98.0	-1.66	-1.81	-1.93	-1.80	-1.44	-1.60	-1.59	-1.54
10	10-Aug	7:00 PM	88.5	-1.27	-1.53	-1.66	-1.49	-1.01	-1.32	-1.48	-1.27
11	11-Aug	3:00 PM	86.0	-0.60	-0.69	-0.68	-0.66	-0.51	-0.74	-0.81	-0.69
12	11-Aug	6:00 PM	77.0	-0.95	-1.15	-1.27	-1.12	-0.75	-1.00	-1.13	-0.96
13	12-Aug	3:00 PM	100.0	-0.58	-1.12	-1.23	-0.98	-0.23	-1.19	-1.23	-0.88
14	12-Aug	5:00 PM	95.5	-1.20	-1.64	-1.55	-1.46	-1.03	-1.71	-1.71	-1.48
15	13-Aug	12:00 PM	89.5	-0.12	-0.68	-0.78	-0.53	-0.05	-0.49	-0.63	-0.39
16	13-Aug	2:00 PM	90.5	-0.55	-1.04	-1.17	-0.92	-0.56	-0.87	-0.84	-0.76
17	14-Aug	1:00 PM	78.0	-0.20	-0.42	-0.48	-0.37	-0.19	-0.41	-0.45	-0.35
18	14-Aug	3:15 PM	77.5	-0.42	-0.62	-0.64	-0.56	-0.46	-0.76	-0.94	-0.72
19	17-Aug	2:00 PM	86.5	-0.65	-0.79	-0.85	-0.76	-0.68	-0.89	-0.91	-0.83
20	17-Aug	4:00 PM	91.5	-1.04	-1.28	-1.29	-1.21	-0.82	-1.18	-1.41	-1.14
21	18-Aug	3:00 PM	88.5	-0.60	-0.79	-0.79	-0.73	-0.79	-0.99	-1.05	-0.94
22	18-Aug	5:00 PM	90.5	-1.52	-1.49	-1.44	-1.48	-1.18	-1.27	-1.27	-1.24
23	19-Aug	4:00 PM	81.5	-0.79	-0.97	-0.92	-0.89	-0.86	-1.11	-1.10	-1.02
24	19-Aug	6:00 PM	71.5	-0.90	-1.24	-1.17	-1.10	-0.92	-1.09	-1.21	-1.07
25	20-Aug	5:00 PM	80.0	-0.63	-0.75	-0.75	-0.71	-0.63	-0.73	-0.82	-0.73
26	20-Aug	7:00 PM	70.5	-0.48	-0.54	-0.53	-0.52	-0.49	-0.58	-0.46	-0.51
27	24-Aug	7:00 PM	68.5	-0.25	-0.26	-0.26	-0.26	-0.16	-0.20	-0.24	-0.20
28	25-Aug	12:00 PM	77.0	-0.01	-0.05	-0.08	-0.04	-0.04	-0.02	-0.02	-0.03
29	25-Aug	2:00 PM	83.0	-0.11	-0.21	-0.23	-0.18	-0.18	-0.24	-0.22	-0.22
30	26-Aug	1:00 PM	82.0	-0.03	-0.17	-0.20	-0.13	-0.04	-0.26	-0.24	-0.18
31	26-Aug	3:00 PM	87.0	-0.23	-0.34	-0.33	-0.30	-0.34	-0.47	-0.43	-0.41
32	27-Aug	2:00 PM	93.5	-0.31	-0.50	-0.53	-0.45	-0.21	-0.60	-0.59	-0.47
33	27-Aug	4:25 PM	97.5	-0.70	-0.99	-0.99	-0.89	-0.54	-0.76	-0.74	-0.68
34	28-Aug	3:15 PM	101.5	-0.82	-1.39	-1.29	-1.17	-0.85	-1.42	-1.43	-1.23
35	28-Aug	5:15 PM	99.0	-0.98	-1.92	-1.88	-1.59	-0.61	-1.31	-1.24	-1.06
36	31-Aug	4:00 PM	83.0	-0.29	-0.50	-0.55	-0.45	-0.24	-0.54	-0.55	-0.44

37	31-Aug	6:00 PM	78.0	-0.51	-0.55	-0.60	-0.55	-0.53	-0.61	-0.52	-0.55
38	1-Sep	5:00 PM	92.0	-0.83	-0.85	-0.87	-0.85	-0.49	-0.65	-0.63	-0.59
39	1-Sep	7:00 PM	84.0	-0.94	-1.12	-1.12	-1.06	-0.43	-0.50	-0.45	-0.46
40	2-Sep	5:55 PM	97.0	-1.07	-1.18	-1.39	-1.21	-1.10	-1.32	-1.54	-1.32
41	3-Sep	7:00 PM	85.5	-1.44	-1.61	-1.61	-1.55	-1.04	-1.42	-1.46	-1.31
42	4-Sep	12:00 PM	79.5	-0.16	-0.45	-0.49	-0.37	0.00	-0.28	-0.32	-0.20
43	4-Sep	2:00 PM	82.5	-0.57	-0.81	-0.87	-0.75	-0.63	-0.93	-0.88	-0.81
44	8-Sep	2:00 PM	86.5	-0.08	-0.14	-0.20	-0.14	-0.24	-0.38	-0.41	-0.34
45	8-Sep	4:00 PM	89.5	-0.37	-0.50	-0.54	-0.47	-0.57	-0.78	-0.86	-0.74
46	9-Sep	3:00 PM	90.5	-0.39	-0.52	-0.53	-0.48	-0.35	-0.42	-0.44	-0.41
47	9-Sep	5:00 PM	91.0	-0.72	-0.90	-0.95	-0.86	-0.62	-0.74	-0.82	-0.72
48	11-Sep	4:45 PM	100.0	-0.91	-1.68	-1.70	-1.43	-0.74	-1.27	-1.53	-1.18
49	11-Sep	6:45 PM	94.0	-1.50	-1.59	-1.55	-1.55	-1.45	-1.49	-1.48	-1.47
50	14-Sep	6:00 PM	71.5	-0.07	-0.14	-0.16	-0.12	-0.03	-0.27	-0.25	-0.18
51	15-Sep	7:00 PM	74.5	-0.27	-0.29	-0.27	-0.28	-0.21	-0.26	-0.30	-0.25
52	16-Sep	12:00 PM	82.0	-0.03	-0.07	-0.11	-0.07	-0.05	-0.07	-0.05	-0.06
53	16-Sep	2:00 PM	87.0	-0.20	-0.29	-0.28	-0.26	-0.06	-0.26	-0.17	-0.17
54	17-Sep	1:00 PM	85.0	-0.31	-0.32	-0.32	-0.32	-0.22	-0.28	-0.36	-0.29
55	17-Sep	3:00 PM	90.5	-0.47	-0.54	-0.59	-0.53	-0.56	-0.74	-0.81	-0.70
56	18-Sep	2:00 PM	97.5	NA	NA	NA	NA	0.05	-0.49	-0.60	-0.35
57	18-Sep	4:00 PM	98.5	NA	NA	NA	NA	-0.45	-0.50	-0.70	-0.55
58	21-Sep	3:00 PM	97.0	NA	NA	NA	NA	-0.46	-0.68	-0.45	-0.53
59	21-Sep	5:00 PM	94.0	NA	NA	NA	NA	-0.31	-0.76	-0.62	-0.56
60	22-Sep	4:00 PM	101.0	-1.20	-1.52	-1.50	-1.41	-1.09	-1.49	-1.47	-1.35
61	22-Sep	6:00 PM	95.0	-1.30	-1.43	-1.55	-1.42	-1.26	-1.53	-1.61	-1.47
62	23-Sep	5:00 PM	94.5	NA	NA	NA	NA	-0.66	-0.70	-0.43	-0.60
63	23-Sep	7:00 PM	84.0	NA	NA	NA	NA	-0.77	-0.53	-0.66	-0.65
64	24-Sep	6:00 PM	87.0	-1.10	-1.39	-1.37	-1.29	-1.05	-1.45	-1.33	-1.28
65	25-Sep	7:00 PM	84.5	-0.92	-0.95	-1.01	-0.96	-0.81	-1.11	-1.09	-1.00
66	28-Sep	12:00 PM	71.5	-0.19	-0.21	-0.24	-0.22	-0.15	-0.36	-0.36	-0.29
67	28-Sep	2:08 PM	71.0	-0.39	-0.37	0.17	-0.19	-0.63	-0.56	-0.09	-0.43
68	29-Sep	1:00 PM	71.5	-0.02	-0.01	-0.01	-0.01	0.01	0.01	0.02	0.01
69	29-Sep	3:00 PM	71.5	-0.04	-0.04	-0.04	-0.04	0.00	0.00	-0.01	0.00
70	30-Sep	2:00 PM	74.5	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00
71	30-Sep	4:00 PM	76.0	-0.06	-0.05	-0.05	-0.05	-0.10	-0.09	-0.09	-0.09
	Average		**85.1**	**-0.54**	**-0.70**	**-0.72**	**-0.65**	**-0.49**	**-0.69**	**-0.71**	**-0.63**

NA Not activated

NP Not Possible - due to 5 minute interval data

N Number of feeder SmartAC devices

n Number of feeder sample points

Table C-2: Fairfield Load Impact Estimates by Event and Device Type

Average Load Reduction Per Device (kW)

Event	Date	Start time	Temp (F°)	Switch (n=85, N=406)				Thermostat (n=14, N=96)			
				5 min	10 min	15 min	Total	5 min	10 min	15 min	Total
1	4-Aug	1:00 PM	80.5	-0.11	-0.16	-0.19	-0.15	-0.01	-0.03	-0.05	-0.03
2	4-Aug	3:00 PM	84.5	-0.17	-0.23	-0.31	-0.24	0.02	-0.26	-0.23	-0.16
3	5-Aug	2:00 PM	78.5	-0.15	-0.17	-0.15	-0.16	-0.17	-0.21	-0.19	-0.19
4	5-Aug	4:00 PM	78.0	-0.23	-0.24	-0.25	-0.24	-0.30	-0.30	-0.31	-0.30
5	6-Aug	3:00 PM	73.0	-0.03	-0.05	-0.04	-0.04	-0.07	-0.14	-0.13	-0.11
6	6-Aug	5:00 PM	72.0	-0.12	-0.13	-0.13	-0.12	-0.20	-0.23	-0.22	-0.22
7	7-Aug	4:00 PM	79.5	-0.25	-0.28	-0.28	-0.27	-0.34	-0.56	-0.37	-0.43
8	7-Aug	6:00 PM	76.5	-0.24	-0.27	-0.25	-0.25	-0.44	-0.47	-0.48	-0.47
9	10-Aug	5:00 PM	98.0	-1.84	-1.96	-1.96	-1.92	-1.87	-1.90	-1.76	-1.84
10	10-Aug	7:00 PM	88.5	-1.53	-1.63	-1.56	-1.57	-1.69	-1.60	-1.58	-1.62
11	11-Aug	3:00 PM	86.0	-0.50	-0.59	-0.63	-0.57	-0.40	-0.71	-0.68	-0.60
12	11-Aug	6:00 PM	77.0	-0.61	-0.62	-0.59	-0.60	-0.73	-0.74	-0.88	-0.78
13	12-Aug	3:00 PM	100.0	-0.91	-1.13	-1.12	-1.05	-0.22	-0.76	-0.86	-0.62
14	12-Aug	5:00 PM	95.5	-1.21	-1.42	-1.42	-1.35	-1.01	-1.33	-1.36	-1.24
15	13-Aug	12:00 PM	89.5	-0.51	-0.74	-0.73	-0.66	-0.60	-0.87	-0.72	-0.73
16	13-Aug	2:00 PM	90.5	-0.78	-1.27	-1.31	-1.12	-0.76	-1.03	-0.83	-0.88
17	14-Aug	1:00 PM	78.0	-0.29	-0.41	-0.41	-0.37	-0.24	-0.34	-0.37	-0.32
18	14-Aug	3:15 PM	77.5	-0.38	-0.43	-0.42	-0.41	-0.44	-0.58	-0.50	-0.51
19	17-Aug	2:00 PM	86.5	-0.44	-0.48	-0.51	-0.48	-0.67	-0.82	-0.84	-0.78
20	17-Aug	4:00 PM	91.5	-0.91	-1.09	-1.14	-1.05	-1.50	-1.61	-1.45	-1.52
21	18-Aug	3:00 PM	88.5	-0.57	-0.66	-0.64	-0.62	-0.58	-0.74	-0.54	-0.62
22	18-Aug	5:00 PM	90.5	-1.08	-1.18	-1.23	-1.16	-0.82	-0.81	-0.94	-0.86
23	19-Aug	4:00 PM	81.5	-0.81	-0.92	-0.95	-0.89	-0.94	-0.71	-0.70	-0.78
24	19-Aug	6:00 PM	71.5	-0.87	-0.90	-0.83	-0.86	-0.76	-0.63	-0.66	-0.68
25	20-Aug	5:00 PM	80.0	-0.67	-0.71	-0.72	-0.70	-0.43	-0.41	-0.48	-0.44
26	20-Aug	7:00 PM	70.5	-0.43	-0.41	-0.41	-0.42	-0.37	-0.26	-0.37	-0.34
27	24-Aug	7:00 PM	68.5	-0.19	-0.21	-0.20	-0.20	0.09	-0.10	-0.08	-0.03
28	25-Aug	12:00 PM	77.0	-0.04	-0.06	-0.07	-0.06	0.00	-0.01	-0.04	-0.02
29	25-Aug	2:00 PM	83.0	-0.09	-0.13	-0.17	-0.13	-0.19	-0.08	-0.24	-0.17
30	26-Aug	1:00 PM	82.0	-0.13	-0.14	-0.17	-0.15	0.03	-0.07	-0.08	-0.04
31	26-Aug	3:00 PM	87.0	-0.09	-0.21	-0.20	-0.17	-0.42	-0.48	-0.44	-0.45
32	27-Aug	2:00 PM	93.5	-0.08	-0.38	-0.38	-0.28	-0.06	-0.35	-0.55	-0.32
33	27-Aug	4:25 PM	97.5	-0.90	-1.02	-1.04	-0.99	-0.72	-0.92	-0.88	-0.84
34	28-Aug	3:15 PM	101.5	-1.00	-1.53	-1.56	-1.36	-1.26	-1.74	-1.73	-1.58
35	28-Aug	5:15 PM	99.0	-0.92	-1.61	-1.59	-1.37	-1.04	-1.52	-1.52	-1.36
36	31-Aug	4:00 PM	83.0	-0.26	-0.30	-0.28	-0.28	-0.28	-0.29	-0.26	-0.28
37	31-Aug	6:00 PM	78.0	-0.30	-0.35	-0.34	-0.33	-0.24	-0.38	-0.44	-0.35
38	1-Sep	5:00 PM	92.0	-0.88	-0.95	-0.94	-0.92	-0.48	-0.58	-0.74	-0.60
39	1-Sep	7:00 PM	84.0	-0.65	-0.80	-0.77	-0.74	-0.93	-0.99	-1.07	-1.00

40	2-Sep	5:55 PM	97.0	-1.48	-1.61	-1.63	-1.57	-1.27	-1.48	-1.59	-1.45
41	3-Sep	7:00 PM	85.5	-1.17	-1.28	-1.26	-1.23	-1.39	-1.53	-1.70	-1.54
42	4-Sep	12:00 PM	79.5	-0.09	-0.19	-0.20	-0.16	-0.10	-0.13	-0.17	-0.13
43	4-Sep	2:00 PM	82.5	-0.40	-0.47	-0.44	-0.44	-0.50	-0.64	-0.62	-0.59
44	8-Sep	2:00 PM	86.5	-0.13	-0.27	-0.30	-0.23	-0.17	-0.26	-0.18	-0.21
45	8-Sep	4:00 PM	89.5	-0.71	-0.76	-0.78	-0.75	-0.37	-0.50	-0.60	-0.49
46	9-Sep	3:00 PM	90.5	-0.56	-0.64	-0.72	-0.64	-0.51	-0.62	-0.49	-0.54
47	9-Sep	5:00 PM	91.0	-1.04	-1.17	-1.19	-1.13	-1.12	-1.14	-1.20	-1.15
48	11-Sep	4:45 PM	100.0	-0.83	-1.74	-1.76	-1.44	-0.90	-1.59	-1.64	-1.38
49	11-Sep	6:45 PM	94.0	-1.32	-1.56	-1.56	-1.48	-1.10	-1.28	-1.29	-1.22
50	14-Sep	6:00 PM	71.5	-0.05	-0.13	-0.16	-0.11	-0.08	-0.27	-0.23	-0.20
51	15-Sep	7:00 PM	74.5	-0.23	-0.26	-0.26	-0.25	-0.28	-0.44	-0.40	-0.37
52	16-Sep	12:00 PM	82.0	-0.04	-0.14	-0.13	-0.10	-0.07	0.03	-0.09	-0.04
53	16-Sep	2:00 PM	87.0	0.03	-0.30	-0.40	-0.22	-0.33	-0.33	-0.31	-0.32
54	17-Sep	1:00 PM	85.0	-0.30	-0.34	-0.35	-0.33	-0.14	-0.19	-0.33	-0.22
55	17-Sep	3:00 PM	90.5	-0.53	-0.67	-0.82	-0.67	-0.78	-0.79	-0.82	-0.80
56	18-Sep	2:00 PM	97.5	NA	NA	NA	NA	-0.59	-0.71	-0.82	-0.71
57	18-Sep	4:00 PM	98.5	NA	NA	NA	NA	-0.14	0.01	0.08	-0.02
58	21-Sep	3:00 PM	97.0	NA	NA	NA	NA	-0.20	-0.33	-0.48	-0.34
59	21-Sep	5:00 PM	94.0	NA	NA	NA	NA	-0.20	-0.29	-0.43	-0.31
60	22-Sep	4:00 PM	101.0	-1.48	-1.58	-1.57	-1.54	-1.52	-1.60	-1.60	-1.57
61	22-Sep	6:00 PM	95.0	-1.47	-1.53	-1.53	-1.51	-1.10	-1.18	-1.16	-1.14
62	23-Sep	5:00 PM	94.5	NA	NA	NA	NA	-0.39	-0.64	-1.11	-0.71
63	23-Sep	7:00 PM	84.0	NA	NA	NA	NA	-0.31	-0.26	-0.21	-0.26
64	24-Sep	6:00 PM	87.0	-0.80	-0.85	-0.89	-0.85	-1.09	-1.29	-1.10	-1.16
65	25-Sep	7:00 PM	84.5	-0.76	-0.83	-0.82	-0.80	-0.67	-0.88	-0.82	-0.79
66	28-Sep	12:00 PM	71.5	-0.06	-0.07	-0.06	-0.07	-0.16	-0.08	0.01	-0.08
67	28-Sep	2:08 PM	71.0	NP	-0.09	-0.11	NP	NP	-0.30	-0.21	NP
68	29-Sep	1:00 PM	71.5	0.00	0.00	0.00	0.00	-0.03	-0.03	-0.04	-0.03
69	29-Sep	3:00 PM	71.5	-0.04	-0.06	-0.05	-0.05	-0.03	-0.05	-0.07	-0.05
70	30-Sep	2:00 PM	74.5	0.00	0.00	0.00	0.00	-0.08	-0.08	-0.09	-0.08
71	30-Sep	4:00 PM	76.0	-0.04	-0.05	-0.06	-0.05	-0.07	-0.08	-0.08	-0.08
	Average		**85.1**	**-0.53**	**-0.65**	**-0.66**	**-0.61**	**-0.52**	**-0.63**	**-0.64**	**-0.60**

NA Not activated

NP Not Possible - due to 5 minute interval data

N Number of feeder SmartAC devices

n Number of feeder sample points

Table C-3: Fresno 1 Load Impact Estimates by Event and Device Type

Average Load Reduction Per Device (kW)

Event	Date	Start time	Temp (F°)	Switch (n=68, N=420)				Thermostat (n=40, N=105)			
				5 min	10 min	15 min	Total	5 min	10 min	15 min	Total
1	4-Aug	1:00 PM	89.5	-0.36	-0.47	-0.43	-0.42	-0.22	-0.30	-0.49	-0.33
2	4-Aug	3:00 PM	93.5	-0.50	-0.55	-0.56	-0.53	-0.49	-0.46	-0.44	-0.46
3	5-Aug	2:00 PM	92.0	-0.47	-0.56	-0.53	-0.52	-0.25	-0.47	-0.68	-0.47
4	5-Aug	4:00 PM	95.5	-0.84	-0.87	-0.90	-0.87	-0.51	-0.43	-0.53	-0.49
5	6-Aug	3:00 PM	81.5	-0.07	-0.06	-0.09	-0.07	-0.32	-0.40	-0.31	-0.34
6	6-Aug	5:00 PM	81.0	-0.16	-0.20	-0.27	-0.21	-0.31	-0.42	-0.38	-0.37
7	7-Aug	4:00 PM	85.0	-0.17	-0.22	-0.28	-0.22	-0.21	-0.15	-0.51	-0.29
8	7-Aug	6:00 PM	84.0	-0.39	-0.40	-0.45	-0.41	-0.22	-0.26	-0.21	-0.23
9	10-Aug	5:00 PM	100.5	-1.13	-1.19	-1.26	-1.19	-0.93	-0.83	-0.93	-0.90
10	10-Aug	7:00 PM	98.0	-0.97	-1.06	-1.05	-1.02	-0.42	-0.83	-0.96	-0.74
11	11-Aug	3:00 PM	101.5	-1.31	-1.46	-1.42	-1.40	-0.90	-1.16	-0.85	-0.97
12	11-Aug	6:00 PM	100.5	-1.15	-1.39	-1.42	-1.32	-1.12	-1.37	-1.13	-1.21
13	12-Aug	3:00 PM	98.5	-0.86	-0.96	-1.00	-0.94	-0.65	-0.81	-0.88	-0.78
14	12-Aug	5:00 PM	99.5	-0.97	-1.13	-1.12	-1.07	-0.62	-0.75	-0.78	-0.72
15	13-Aug	12:00 PM	92.0	-0.43	-0.62	-0.62	-0.56	0.07	-0.24	-0.35	-0.17
16	13-Aug	2:00 PM	96.0	-0.51	-0.83	-0.88	-0.74	-0.37	-0.37	-0.58	-0.44
17	14-Aug	1:00 PM	90.5	-0.41	-0.61	-0.62	-0.55	-0.19	-0.44	-0.46	-0.37
18	14-Aug	3:15 PM	94.0	0.01	-0.82	-0.91	-0.58	-0.04	-0.34	-0.46	-0.28
19	17-Aug	2:00 PM	97.5	-0.67	-0.78	-0.84	-0.76	-0.50	-0.35	-0.52	-0.46
20	17-Aug	4:00 PM	98.5	-1.17	-1.30	-1.30	-1.26	-0.86	-0.74	-0.83	-0.81
21	18-Aug	3:00 PM	100.0	-0.87	-1.17	-1.20	-1.08	-0.35	-0.48	-0.92	-0.58
22	18-Aug	5:00 PM	100.5	-1.23	-1.40	-1.36	-1.33	-0.83	-0.80	-0.95	-0.86
23	19-Aug	4:00 PM	101.0	-1.31	-1.52	-1.47	-1.43	-0.53	-0.83	-0.91	-0.75
24	19-Aug	6:00 PM	99.5	-1.46	-1.46	-1.46	-1.46	-0.80	-1.00	-0.80	-0.87
25	20-Aug	5:00 PM	98.0	-0.98	-1.07	-1.10	-1.05	-0.90	-0.78	-0.66	-0.78
26	20-Aug	7:00 PM	93.0	-1.04	-1.10	-1.10	-1.08	-1.08	-1.26	-1.03	-1.12
27	24-Aug	7:00 PM	91.5	-0.95	-1.04	-0.99	-0.99	-0.10	-0.21	-0.62	-0.31
28	25-Aug	12:00 PM	87.0	-0.17	-0.23	-0.25	-0.22	-0.14	-0.20	-0.28	-0.21
29	25-Aug	2:00 PM	93.5	-0.54	-0.62	-0.63	-0.59	-0.16	-0.08	-0.46	-0.23
30	26-Aug	1:00 PM	95.0	-0.46	-0.62	-0.64	-0.57	-0.22	-0.34	-0.53	-0.36
31	26-Aug	3:00 PM	98.5	-0.76	-0.82	-0.85	-0.81	-0.37	-0.41	-0.53	-0.43
32	27-Aug	2:00 PM	96.5	-0.07	-0.49	-0.59	-0.38	0.05	-0.66	-0.66	-0.42
33	27-Aug	4:25 PM	100.0	-0.95	-1.05	-1.00	-1.00	-0.49	-0.36	-0.57	-0.47
34	28-Aug	3:15 PM	99.5	-0.41	-0.70	-0.67	-0.60	-0.26	-0.75	-0.84	-0.62
35	28-Aug	5:15 PM	97.5	-0.49	-1.00	-0.96	-0.82	-0.53	-0.99	-0.60	-0.71
36	31-Aug	4:00 PM	100.5	-1.29	-1.31	-1.24	-1.28	-0.82	-0.88	-0.87	-0.86
37	31-Aug	6:00 PM	94.5	-0.90	-0.90	-0.91	-0.90	-0.75	-0.81	-0.77	-0.78
38	1-Sep	5:00 PM	99.5	-1.07	-1.24	-1.22	-1.18	-1.00	-0.87	-0.82	-0.90
39	1-Sep	7:00 PM	95.0	-0.73	-1.03	-1.03	-0.93	-0.63	-0.97	-0.66	-0.76
40	2-Sep	5:55 PM	100.0	-1.37	-1.51	-1.52	-1.47	-0.88	-0.98	-0.98	-0.95

41	3-Sep	7:00 PM	96.5	-0.80	-1.03	-1.07	-0.97	-0.68	-0.85	-0.85	-0.79
42	4-Sep	12:00 PM	91.5	-0.41	-0.52	-0.57	-0.50	-0.17	-0.29	-0.29	-0.25
43	4-Sep	2:00 PM	96.5	-0.81	-0.82	-0.80	-0.81	-0.71	-0.67	-0.65	-0.68
44	8-Sep	2:00 PM	90.5	-0.46	-0.67	-0.66	-0.60	-0.34	-0.58	-0.51	-0.48
45	8-Sep	4:00 PM	92.0	-0.67	-0.79	-0.80	-0.75	-0.60	-0.89	-0.76	-0.75
46	9-Sep	3:00 PM	95.0	-0.65	-0.83	-0.89	-0.79	-0.52	-0.47	-0.85	-0.61
47	9-Sep	5:00 PM	95.0	-0.77	-0.91	-0.98	-0.89	-0.65	-0.60	-0.79	-0.68
48	11-Sep	4:45 PM	97.0	-0.13	-1.10	-1.10	-0.78	-0.36	-1.02	-0.80	-0.73
49	11-Sep	6:45 PM	94.5	-1.13	-1.12	-1.01	-1.09	-0.67	-0.74	-0.81	-0.74
50	14-Sep	6:00 PM	77.0	-0.10	-0.12	-0.08	-0.10	-0.08	-0.13	-0.24	-0.15
51	15-Sep	7:00 PM	83.0	-0.31	-0.37	-0.39	-0.35	-0.38	-0.60	-0.38	-0.45
52	16-Sep	12:00 PM	85.5	-0.19	-0.19	-0.20	-0.19	-0.16	-0.13	-0.07	-0.12
53	16-Sep	2:00 PM	89.0	-0.34	-0.52	-0.59	-0.48	-0.19	-0.43	-0.49	-0.37
54	17-Sep	1:00 PM	89.5	-0.52	-0.53	-0.52	-0.52	-0.27	-0.30	-0.05	-0.21
55	17-Sep	3:00 PM	93.5	-0.69	-0.82	-0.82	-0.78	-0.38	-0.50	-0.59	-0.49
56	18-Sep	2:00 PM	97.0	NA	NA	NA	NA	-0.31	-0.24	-0.11	-0.22
57	18-Sep	4:00 PM	100.5	NA	NA	NA	NA	-0.19	-0.37	-0.34	-0.30
58	21-Sep	3:00 PM	97.0	NA	NA	NA	NA	-0.04	-0.06	0.11	0.00
59	21-Sep	5:00 PM	97.0	NA	NA	NA	NA	-0.14	0.00	0.21	0.02
60	22-Sep	4:00 PM	100.5	-1.04	-1.29	-1.31	-1.21	-0.73	-0.89	-0.99	-0.87
61	22-Sep	6:00 PM	96.5	-1.03	-1.15	-1.21	-1.13	-0.93	-0.75	-0.90	-0.86
62	23-Sep	5:00 PM	98.5	NA	NA	NA	NA	0.09	-0.23	-0.14	-0.09
63	23-Sep	7:00 PM	95.0	NA	NA	NA	NA	-0.33	-0.73	-0.31	-0.46
64	24-Sep	6:00 PM	96.0	-0.97	-1.14	-1.13	-1.08	-0.40	-0.50	-0.64	-0.51
65	25-Sep	7:00 PM	92.5	-0.76	-0.83	-0.79	-0.79	-0.53	-0.93	-0.81	-0.76
66	28-Sep	12:00 PM	92.5	-0.34	-0.41	-0.45	-0.40	-0.26	-0.46	-0.50	-0.41
67	28-Sep	2:08 PM	97.0	NP	-0.93	-0.84	NP	NP	-0.55	-0.71	NP
68	29-Sep	1:00 PM	73.0	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.01
69	29-Sep	3:00 PM	72.5	0.00	0.00	0.01	0.00	-0.06	-0.09	-0.09	-0.08
70	30-Sep	2:00 PM	74.5	0.00	-0.01	-0.01	-0.01	-0.06	-0.05	-0.05	-0.05
71	30-Sep	4:00 PM	76.0	-0.01	-0.01	-0.01	-0.01	-0.06	-0.09	-0.10	-0.08
	Average		**93.4**	**-0.66**	**-0.80**	**-0.79**	**-0.75**	**-0.43**	**-0.55**	**-0.56**	**-0.51**

NA Not activated

NP Not Possible - due to 5 minute interval data

N Number of feeder SmartAC devices

n Number of feeder sample points

Table C-4: Fresno 2 Load Impact Estimates by Event and Device Type

Average Load Reduction Per Device (kW)

Event	Date	Start time	Temp (F°)	Switch (n=60, N=366)				Thermostat (n=40, N=86)			
				5 min	10 min	15 min	Total	5 min	10 min	15 min	Total
1	4-Aug	1:00 PM	89.5	-0.44	-0.50	-0.50	-0.48	-0.15	-0.21	-0.21	-0.19
2	4-Aug	3:00 PM	93.5	-0.89	-1.01	-1.01	-0.97	-0.08	-0.12	-0.42	-0.21
3	5-Aug	2:00 PM	92.0	-0.52	-0.60	-0.62	-0.58	-0.09	-0.15	-0.29	-0.18
4	5-Aug	4:00 PM	95.5	-1.09	-1.21	-1.20	-1.17	-0.29	-0.28	-0.56	-0.38
5	6-Aug	3:00 PM	81.5	-0.21	-0.24	-0.23	-0.23	-0.05	-0.09	-0.08	-0.07
6	6-Aug	5:00 PM	81.0	-0.39	-0.44	-0.43	-0.42	-0.03	0.02	-0.22	-0.07
7	7-Aug	4:00 PM	85.0	-0.32	-0.37	-0.36	-0.35	-0.09	0.04	0.02	-0.01
8	7-Aug	6:00 PM	84.0	-0.48	-0.54	-0.54	-0.52	0.09	0.06	-0.05	0.03
9	10-Aug	5:00 PM	100.5	-1.74	-1.79	-1.74	-1.76	-1.01	-1.04	-0.91	-0.99
10	10-Aug	7:00 PM	98.0	-1.68	-1.77	-1.76	-1.74	-0.82	-0.76	-0.83	-0.80
11	11-Aug	3:00 PM	101.5	-1.71	-1.82	-1.91	-1.82	-0.71	-0.64	-0.76	-0.70
12	11-Aug	6:00 PM	100.5	-1.70	-1.91	-1.95	-1.85	-0.37	-0.32	-1.09	-0.59
13	12-Aug	3:00 PM	98.5	-0.97	-1.13	-1.15	-1.08	-0.63	-0.84	-0.74	-0.74
14	12-Aug	5:00 PM	99.5	-1.81	-1.94	-1.88	-1.88	-0.68	-0.39	-0.71	-0.59
15	13-Aug	12:00 PM	92.0	-0.33	-0.40	-0.43	-0.39	-0.20	0.10	-0.06	-0.05
16	13-Aug	2:00 PM	96.0	-0.53	-1.12	-1.15	-0.93	-0.17	-0.58	-0.38	-0.38
17	14-Aug	1:00 PM	90.5	-0.36	-0.47	-0.44	-0.42	-0.20	-0.28	-0.36	-0.28
18	14-Aug	3:15 PM	94.0	-0.87	-0.90	-0.98	-0.92	-0.49	-0.56	-0.28	-0.44
19	17-Aug	2:00 PM	97.5	-0.97	-0.97	-0.84	-0.93	-0.22	-0.32	-0.41	-0.32
20	17-Aug	4:00 PM	98.5	-1.33	-1.51	-1.56	-1.47	-0.38	-0.29	-0.19	-0.28
21	18-Aug	3:00 PM	100.0	-1.14	-1.59	-1.67	-1.47	-0.20	-0.59	-1.08	-0.62
22	18-Aug	5:00 PM	100.5	-1.90	-1.86	-1.88	-1.88	-0.30	-0.51	-0.55	-0.45
23	19-Aug	4:00 PM	101.0	-1.61	-1.68	-1.83	-1.71	-0.73	-0.77	-0.29	-0.60
24	19-Aug	6:00 PM	99.5	-1.95	-1.97	-1.78	-1.90	-0.24	-0.63	-0.99	-0.62
25	20-Aug	5:00 PM	98.0	-1.39	-1.58	-1.52	-1.50	-0.95	-0.78	-0.61	-0.78
26	20-Aug	7:00 PM	93.0	-1.10	-1.21	-1.20	-1.17	-0.35	-0.65	-0.69	-0.56
27	24-Aug	7:00 PM	91.5	-1.11	-1.12	-1.11	-1.11	-0.60	-0.40	-0.28	-0.42
28	25-Aug	12:00 PM	87.0	-0.20	-0.16	-0.14	-0.17	-0.09	-0.05	-0.08	-0.07
29	25-Aug	2:00 PM	93.5	-0.41	-0.47	-0.62	-0.50	-0.42	-0.33	-0.36	-0.37
30	26-Aug	1:00 PM	95.0	-0.15	-0.20	-0.33	-0.23	-0.37	-0.40	-0.41	-0.39
31	26-Aug	3:00 PM	98.5	-0.67	-0.69	-0.75	-0.70	-0.44	-0.40	-0.16	-0.34
32	27-Aug	2:00 PM	96.5	-0.12	-0.43	-0.53	-0.36	0.06	-0.36	-0.30	-0.20
33	27-Aug	4:25 PM	100.0	-1.31	-1.27	-1.31	-1.29	-0.42	-0.15	-0.44	-0.34
34	28-Aug	3:15 PM	99.5	-0.87	-1.13	-1.14	-1.05	-0.18	-0.29	-0.43	-0.30
35	28-Aug	5:15 PM	97.5	-0.52	-0.76	-0.66	-0.64	-0.30	-0.13	-0.21	-0.21
36	31-Aug	4:00 PM	100.5	-1.48	-1.65	-1.68	-1.60	-0.35	-0.45	-0.42	-0.40
37	31-Aug	6:00 PM	94.5	-1.43	-1.56	-1.52	-1.50	-0.35	-0.46	-0.43	-0.42
38	1-Sep	5:00 PM	99.5	-1.72	-1.82	-1.76	-1.77	-0.58	-0.42	-0.10	-0.37
39	1-Sep	7:00 PM	95.0	-1.20	-1.43	-1.46	-1.36	-0.66	-0.52	-0.64	-0.60
40	2-Sep	5:55 PM	100.0	-1.63	-1.64	-1.65	-1.64	-0.88	-0.84	-0.98	-0.90

41	3-Sep	7:00 PM	96.5	-1.45	-1.58	-1.48	-1.50	-0.28	-0.59	-0.60	-0.49
42	4-Sep	12:00 PM	91.5	-0.26	-0.34	-0.35	-0.32	-0.24	-0.12	-0.03	-0.13
43	4-Sep	2:00 PM	96.5	-0.60	-0.94	-0.97	-0.84	-0.10	-0.20	-0.09	-0.13
44	8-Sep	2:00 PM	90.5	-0.25	-0.39	-0.41	-0.35	-0.10	-0.24	-0.26	-0.20
45	8-Sep	4:00 PM	92.0	-0.85	-0.99	-0.93	-0.92	-0.01	-0.10	-0.04	-0.05
46	9-Sep	3:00 PM	95.0	-0.57	-0.67	-0.71	-0.65	0.10	-0.14	-0.41	-0.15
47	9-Sep	5:00 PM	95.0	-0.79	-1.12	-1.11	-1.01	-0.48	-0.61	-0.49	-0.52
48	11-Sep	4:45 PM	97.0	-0.11	-1.29	-1.33	-0.91	-0.36	-0.45	-0.04	-0.28
49	11-Sep	6:45 PM	94.5	-0.89	-1.01	-1.01	-0.97	-0.25	-0.42	-0.57	-0.41
50	14-Sep	6:00 PM	77.0	-0.07	-0.11	-0.11	-0.10	-0.01	0.03	0.00	0.01
51	15-Sep	7:00 PM	83.0	-0.21	-0.29	-0.30	-0.26	-0.17	-0.22	-0.05	-0.15
52	16-Sep	12:00 PM	85.5	-0.05	-0.06	-0.06	-0.06	-0.03	-0.03	-0.03	-0.03
53	16-Sep	2:00 PM	89.0	-0.17	-0.21	-0.24	-0.20	-0.14	-0.20	-0.22	-0.19
54	17-Sep	1:00 PM	89.5	-0.17	-0.22	-0.25	-0.21	-0.07	0.07	-0.03	-0.01
55	17-Sep	3:00 PM	93.5	-0.45	-0.48	-0.45	-0.46	-0.16	-0.40	-0.35	-0.30
56	18-Sep	2:00 PM	97.0	NA	NA	NA	NA	-0.09	-0.10	0.13	-0.02
57	18-Sep	4:00 PM	100.5	NA	NA	NA	NA	-0.12	0.09	-0.21	-0.08
58	21-Sep	3:00 PM	97.0	NA	NA	NA	NA	-0.13	-0.21	-0.23	-0.19
59	21-Sep	5:00 PM	97.0	NA	NA	NA	NA	-0.27	-0.30	-0.12	-0.23
60	22-Sep	4:00 PM	100.5	-1.24	-1.39	-1.35	-1.32	-0.58	-0.62	-0.59	-0.60
61	22-Sep	6:00 PM	96.5	-1.18	-1.35	-1.55	-1.36	-0.15	-0.06	-0.15	-0.12
62	23-Sep	5:00 PM	98.5	NA	NA	NA	NA	-0.17	-0.43	-0.38	-0.33
63	23-Sep	7:00 PM	95.0	NA	NA	NA	NA	-0.50	-0.24	0.26	-0.16
64	24-Sep	6:00 PM	96.0	-1.30	-1.30	-1.33	-1.31	-0.05	-0.43	-0.64	-0.37
65	25-Sep	7:00 PM	92.5	-0.79	-0.82	-0.85	-0.82	-0.42	-0.38	0.01	-0.26
66	28-Sep	12:00 PM	92.5	-0.10	-0.15	-0.14	-0.13	-0.05	-0.06	0.10	0.00
67	28-Sep	2:08 PM	97.0	NP	-0.94	-0.79	NP	NP	-0.38	-0.33	NP
68	29-Sep	1:00 PM	73.0	0.02	0.02	0.03	0.02	-0.01	0.00	0.00	0.00
69	29-Sep	3:00 PM	72.5	0.00	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01
70	30-Sep	2:00 PM	74.5	-0.03	-0.02	-0.02	-0.03	-0.03	-0.02	-0.02	-0.02
71	30-Sep	4:00 PM	76.0	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03
	Average		**93.4**	**-0.81**	**-0.93**	**-0.92**	**-0.89**	**-0.28**	**-0.32**	**-0.33**	**-0.31**

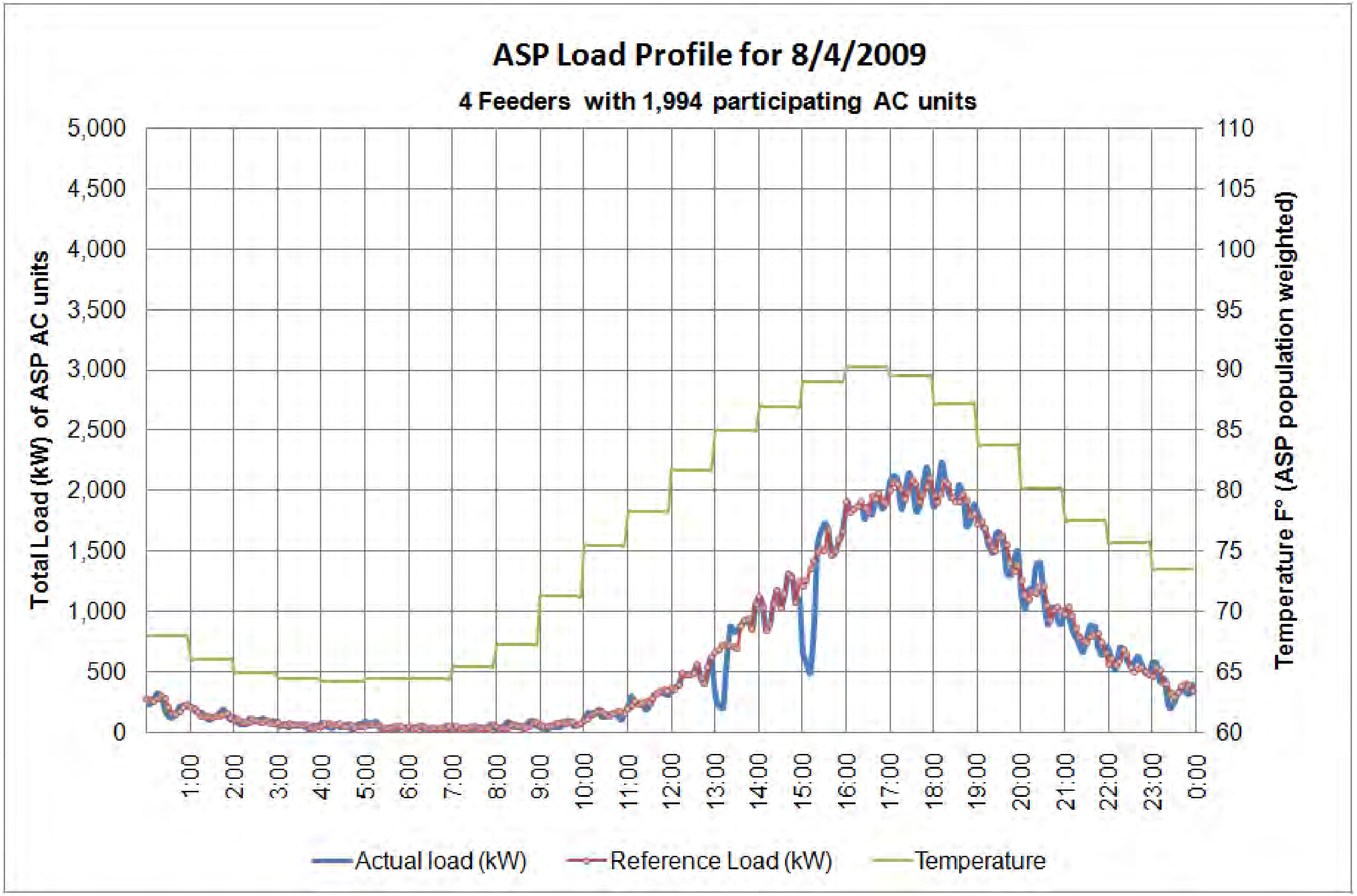
NA Not activated

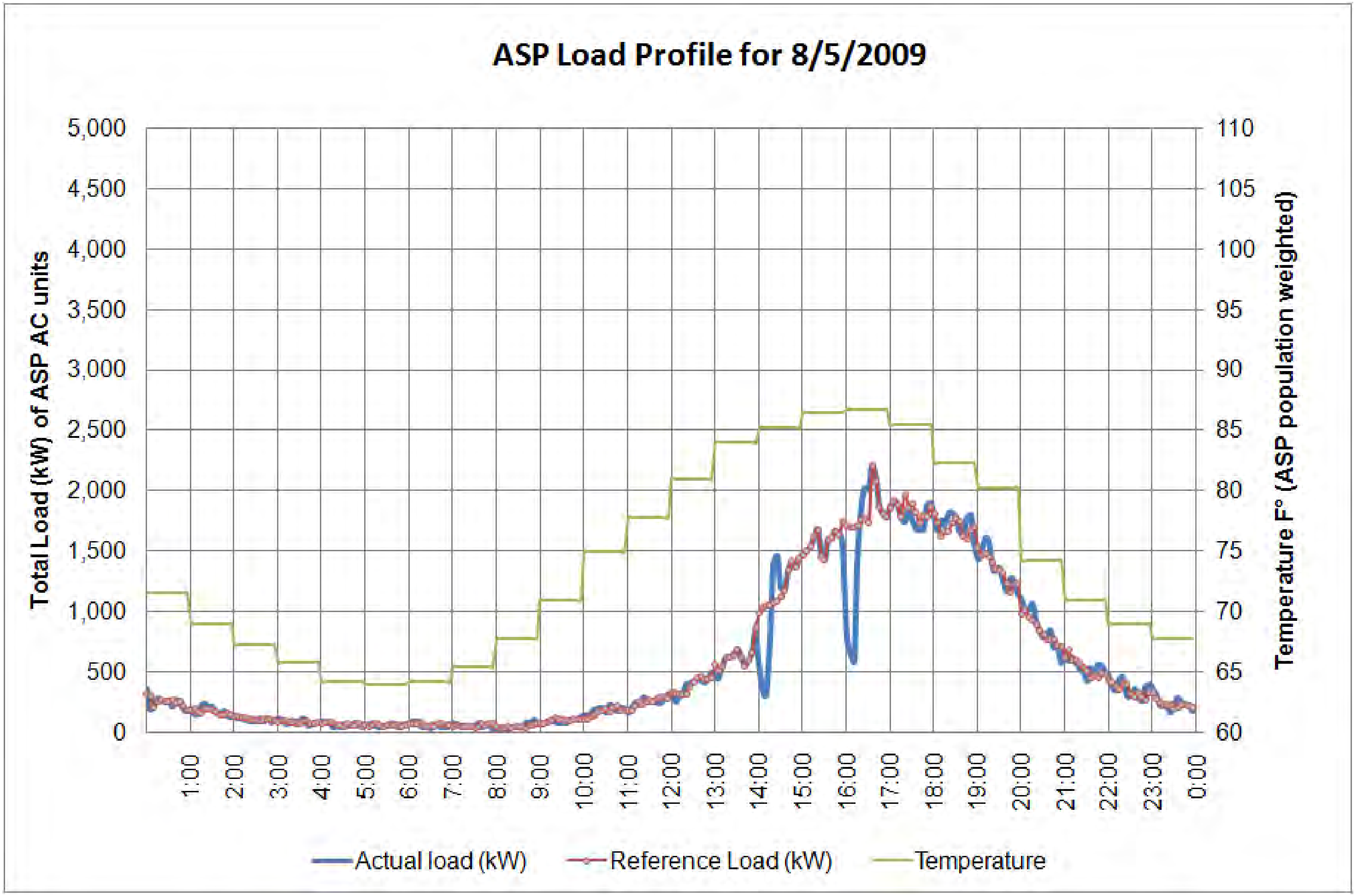
NP Not Possible - due to 5 minute interval data

N Number of feeder SmartAC devices

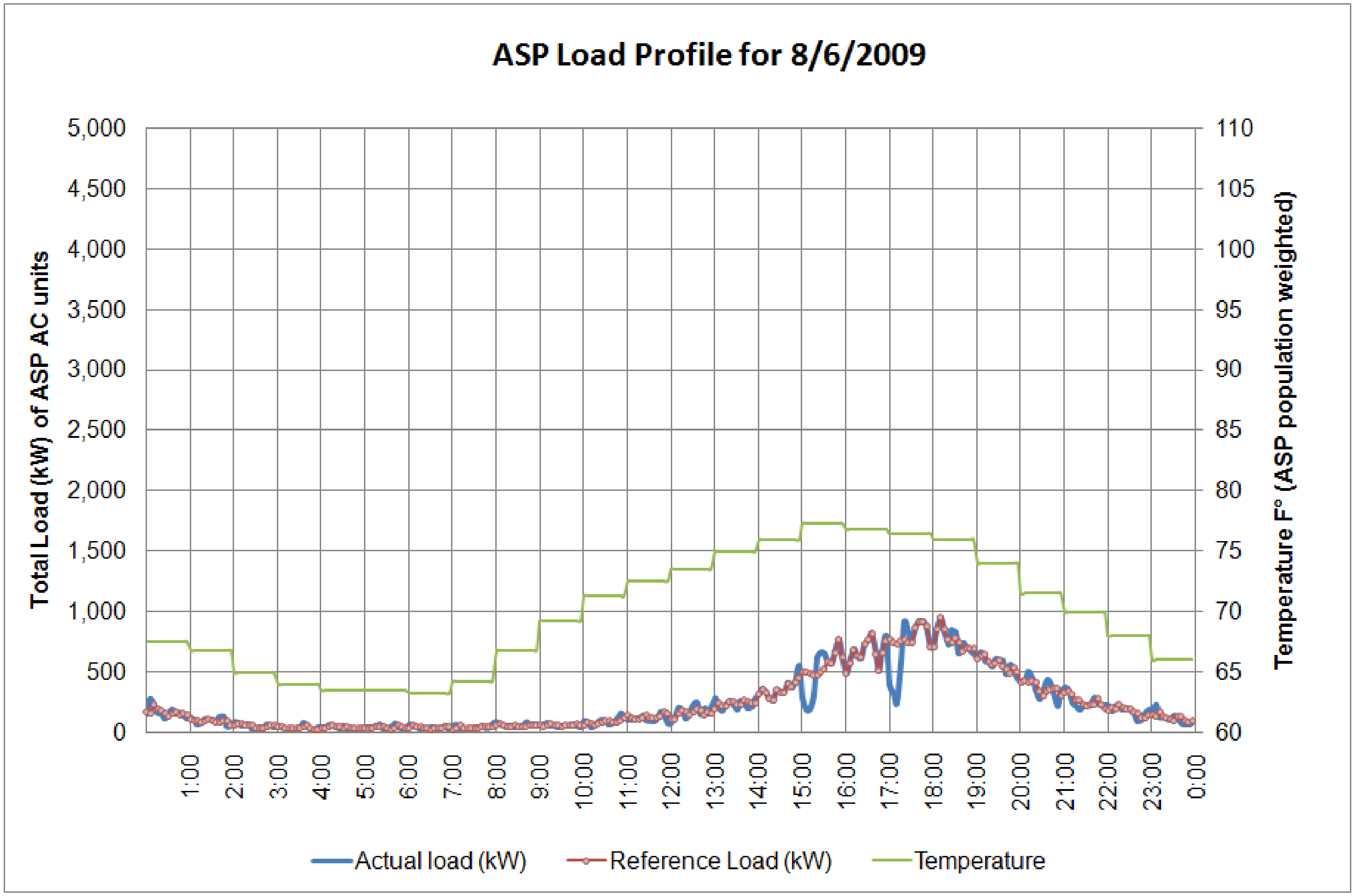
n Number of feeder sample points

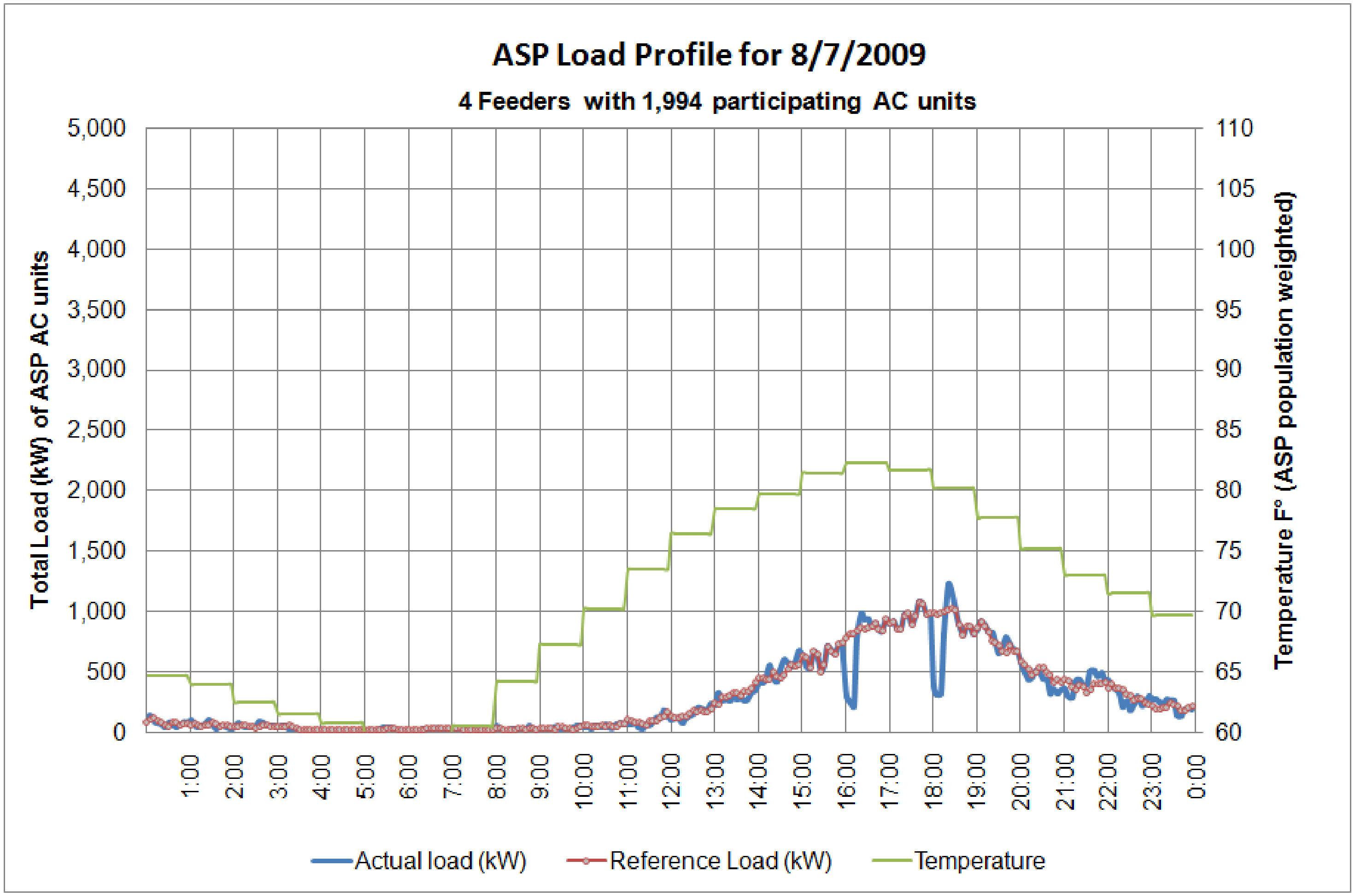
APPENDIX D: LOAD PROFILES FOR EVENT DAYS

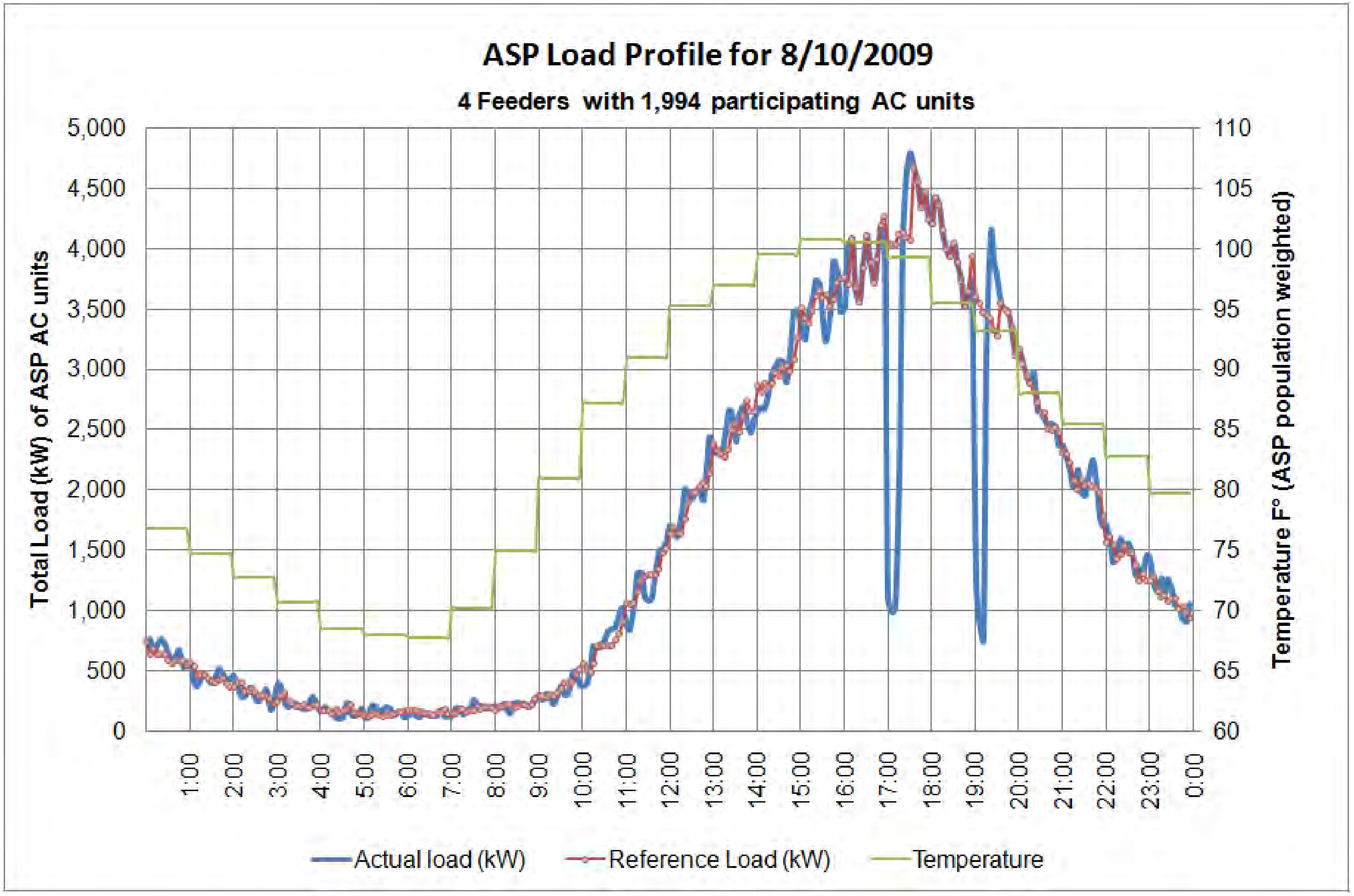


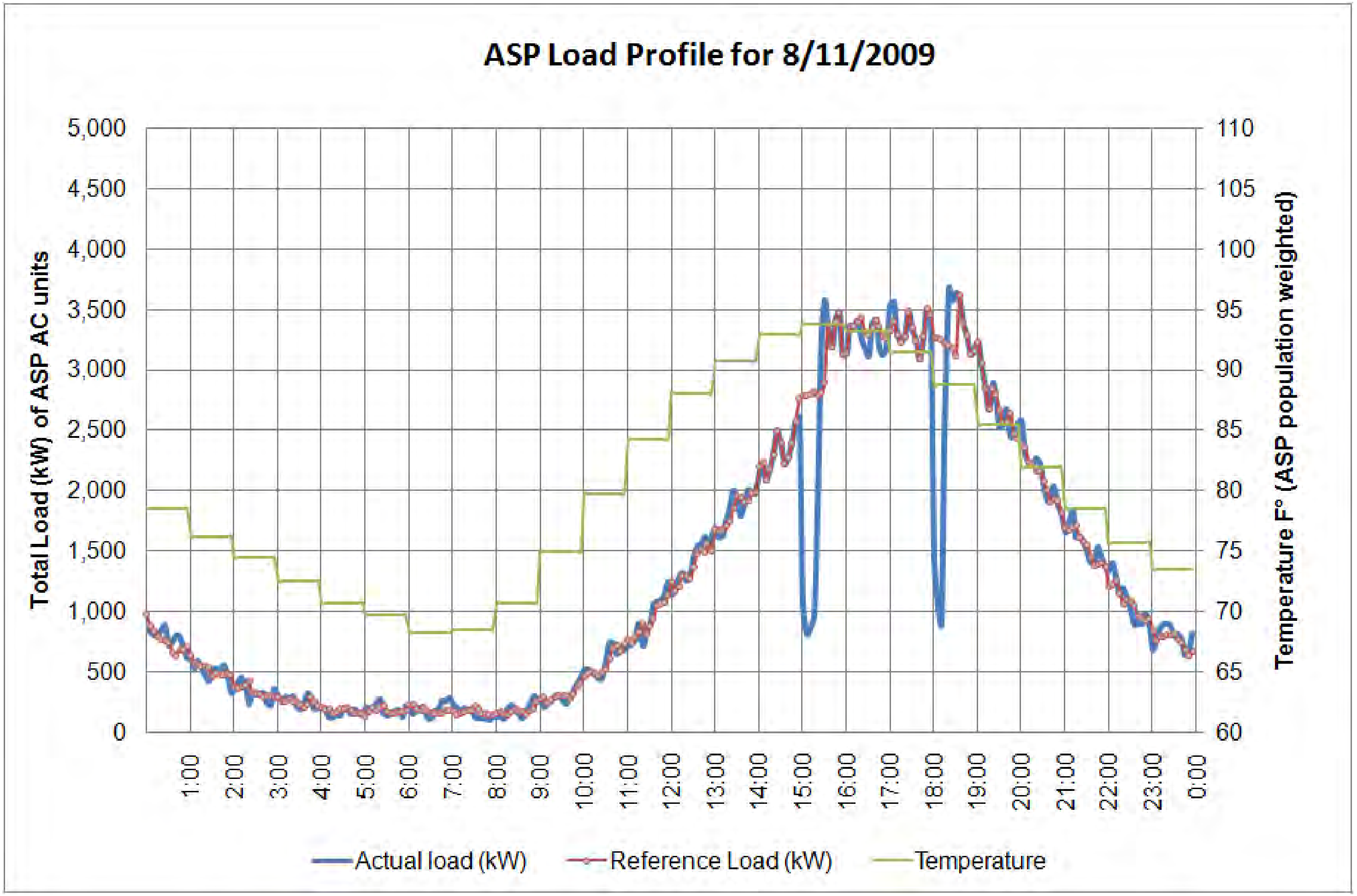


ASP Load Profile for 8/5/2009
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

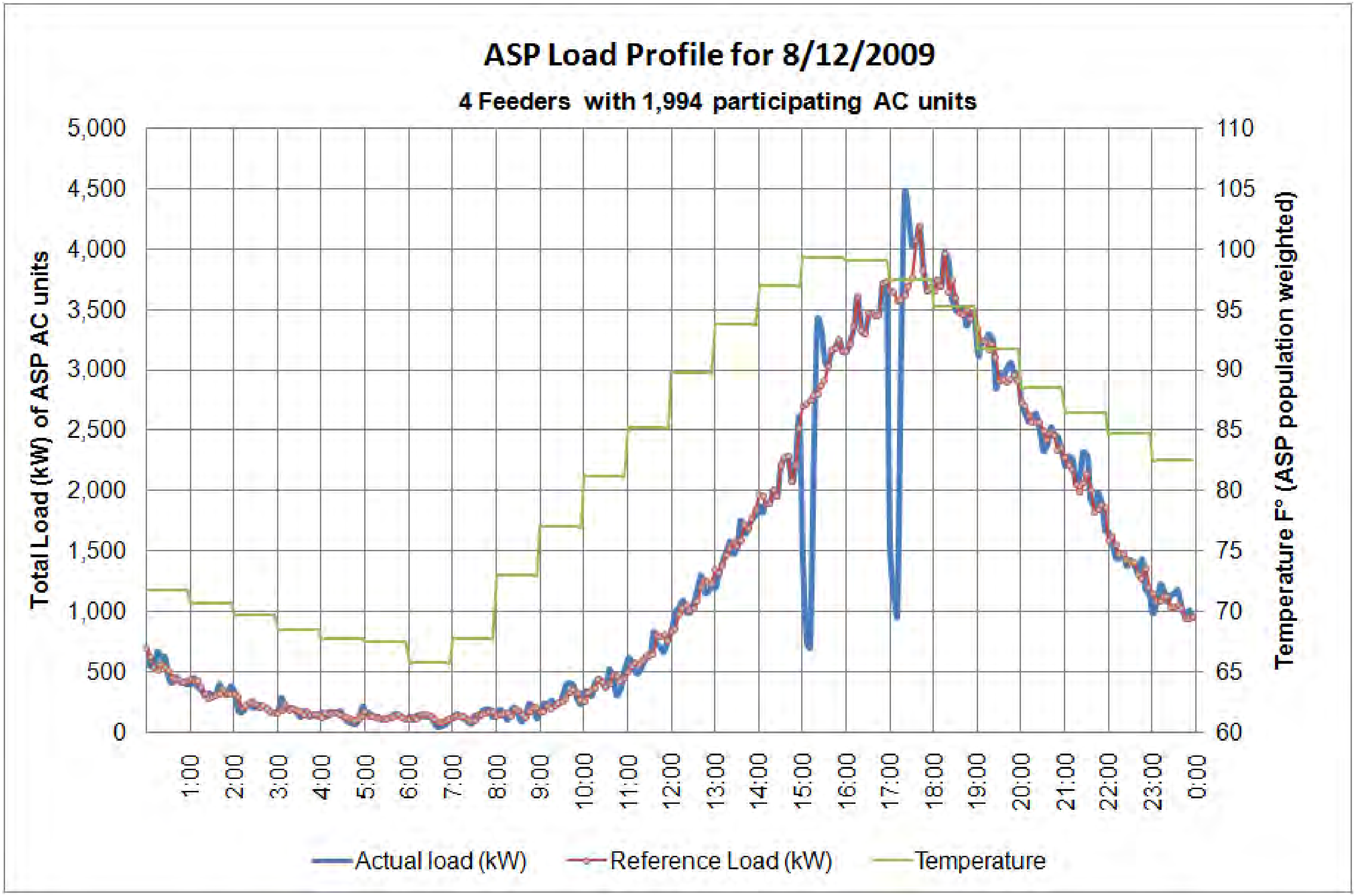

ASP Load Profile for 8/6/2009
Total Load (kW) of ASP AC units
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Temperature F° (ASP population weighted)
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

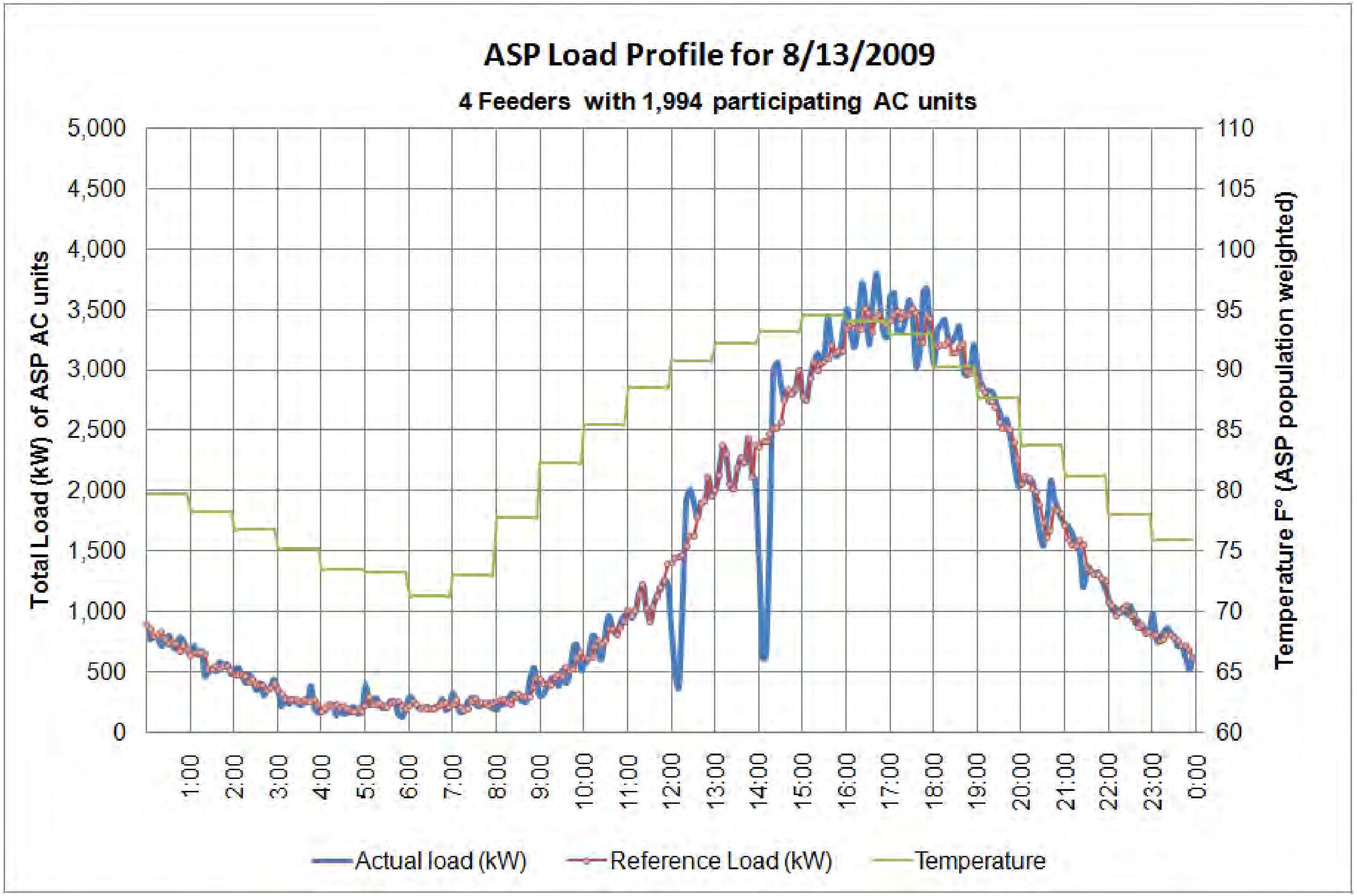

ASP Load Profile for 8/7/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature


ASP Load Profile for 8/10/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

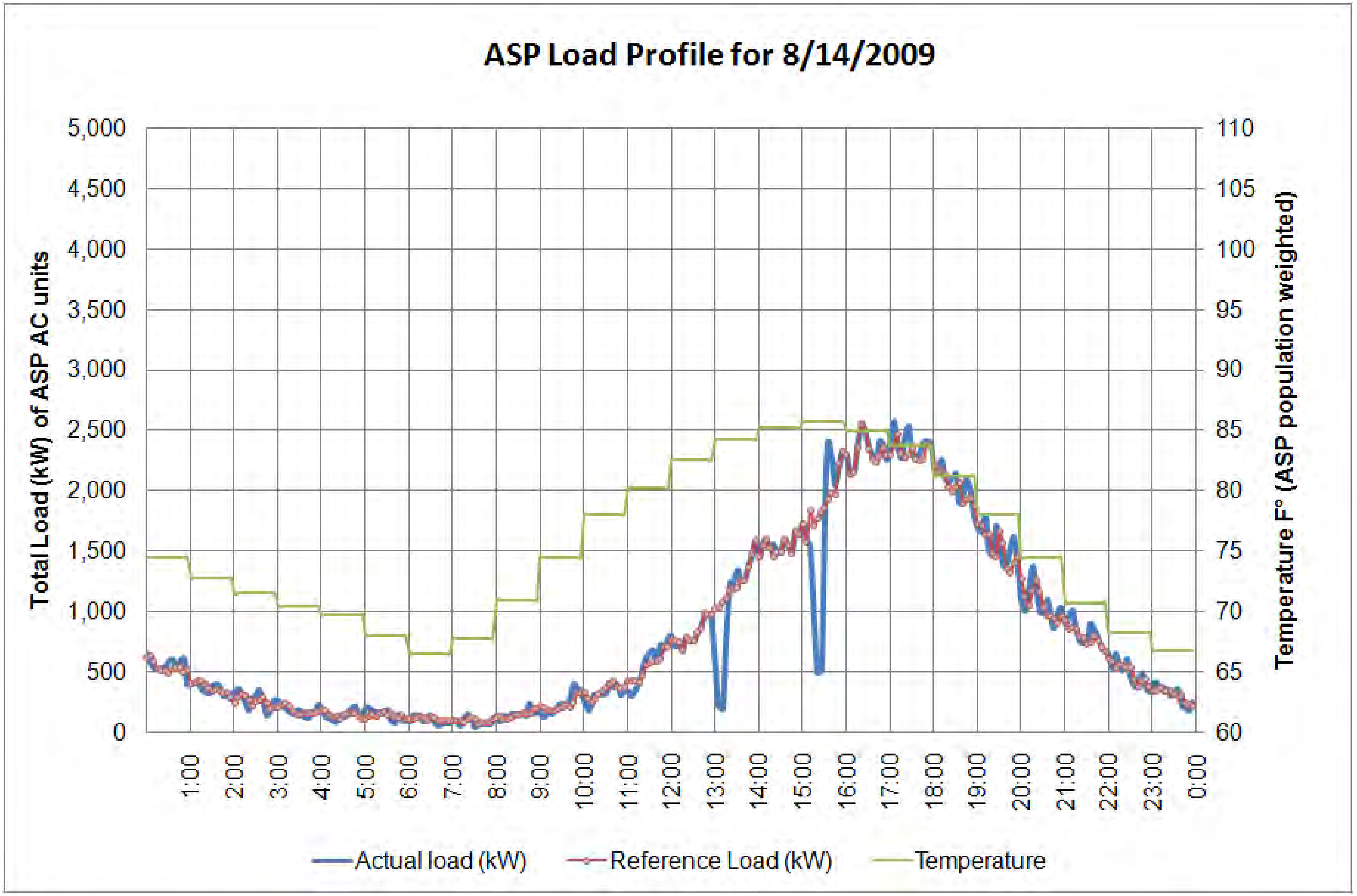


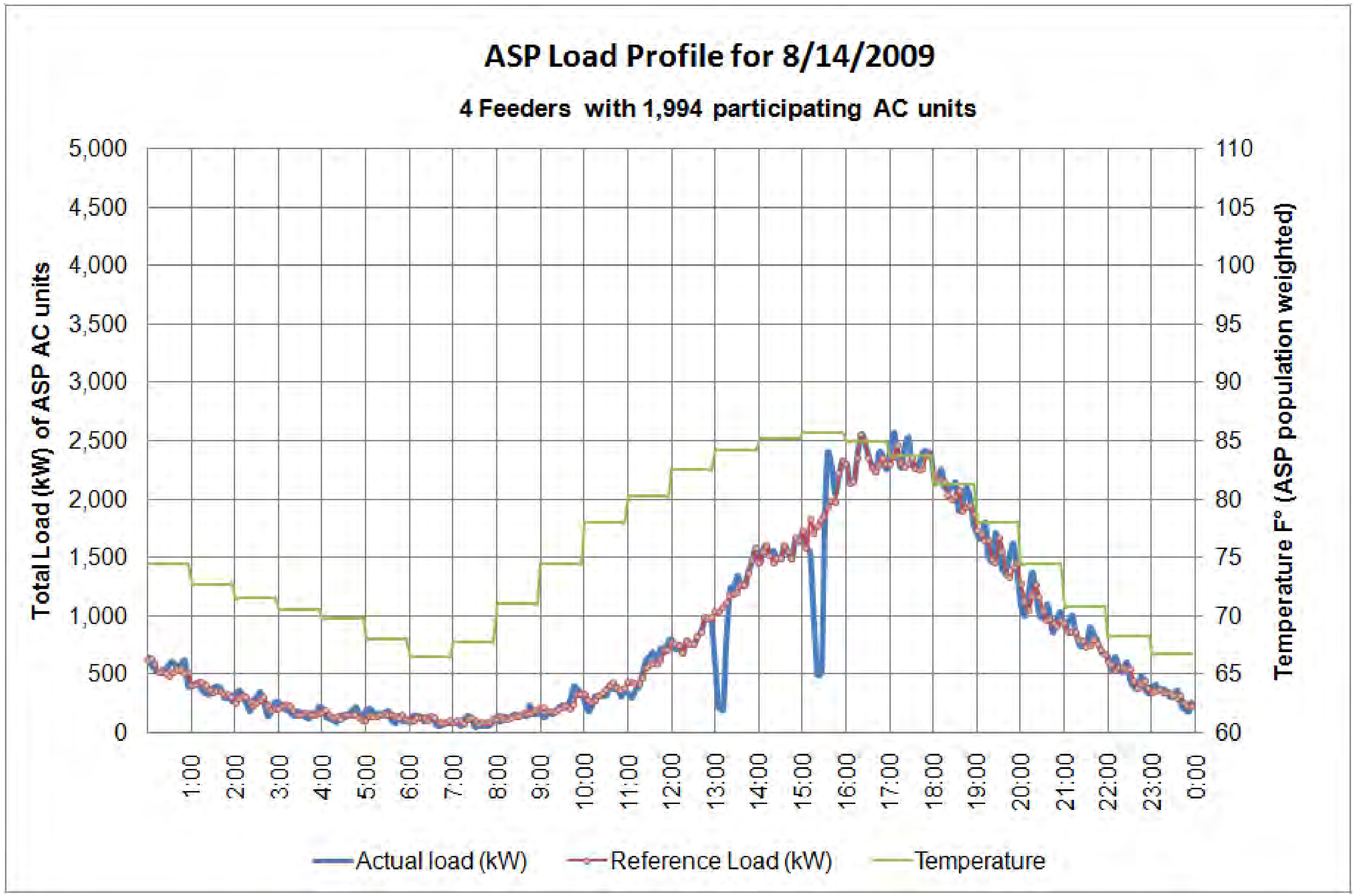
ASP Load Profile for 8/11/2009
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature


ASP Load Profile for 8/12/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

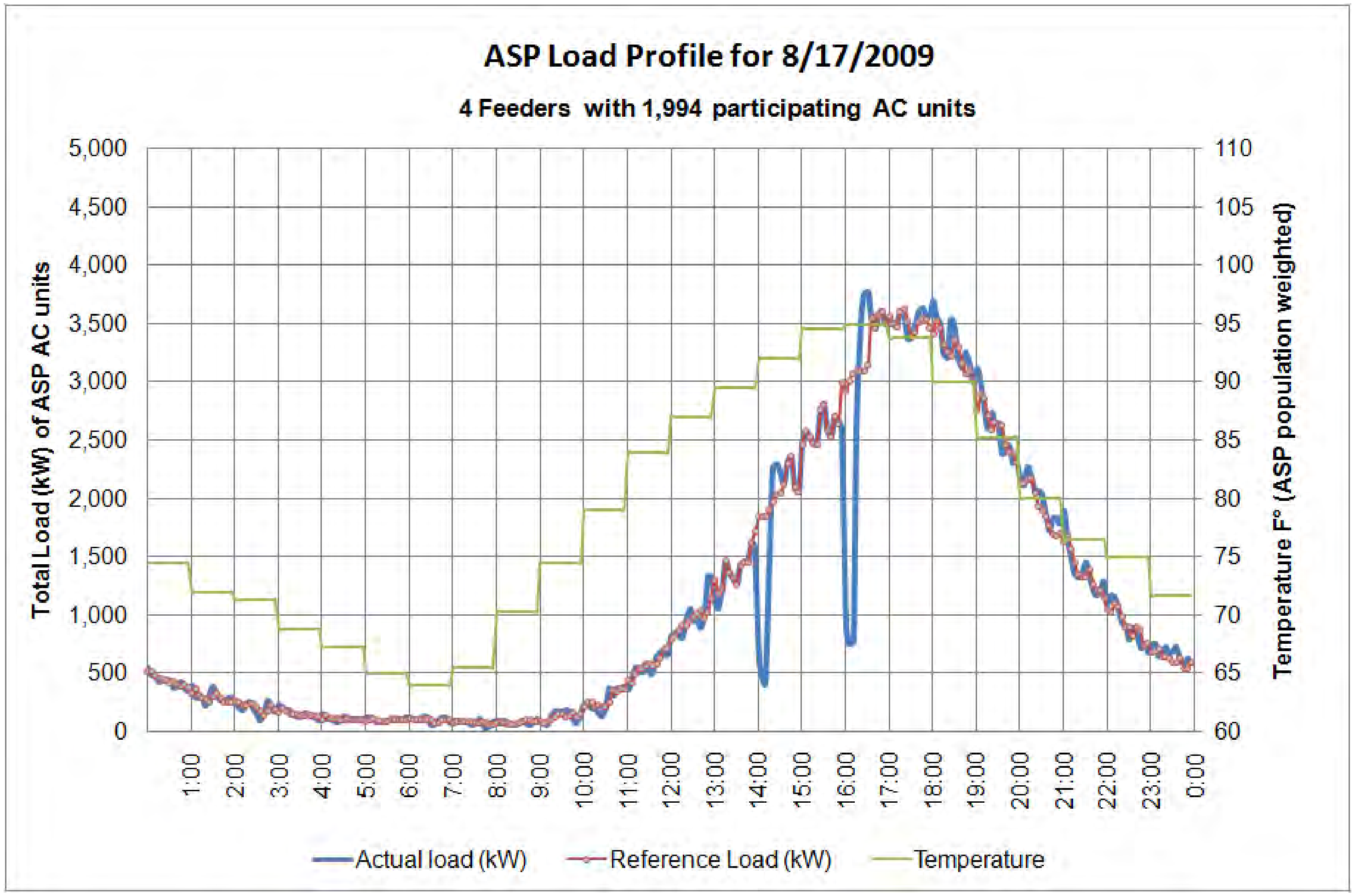


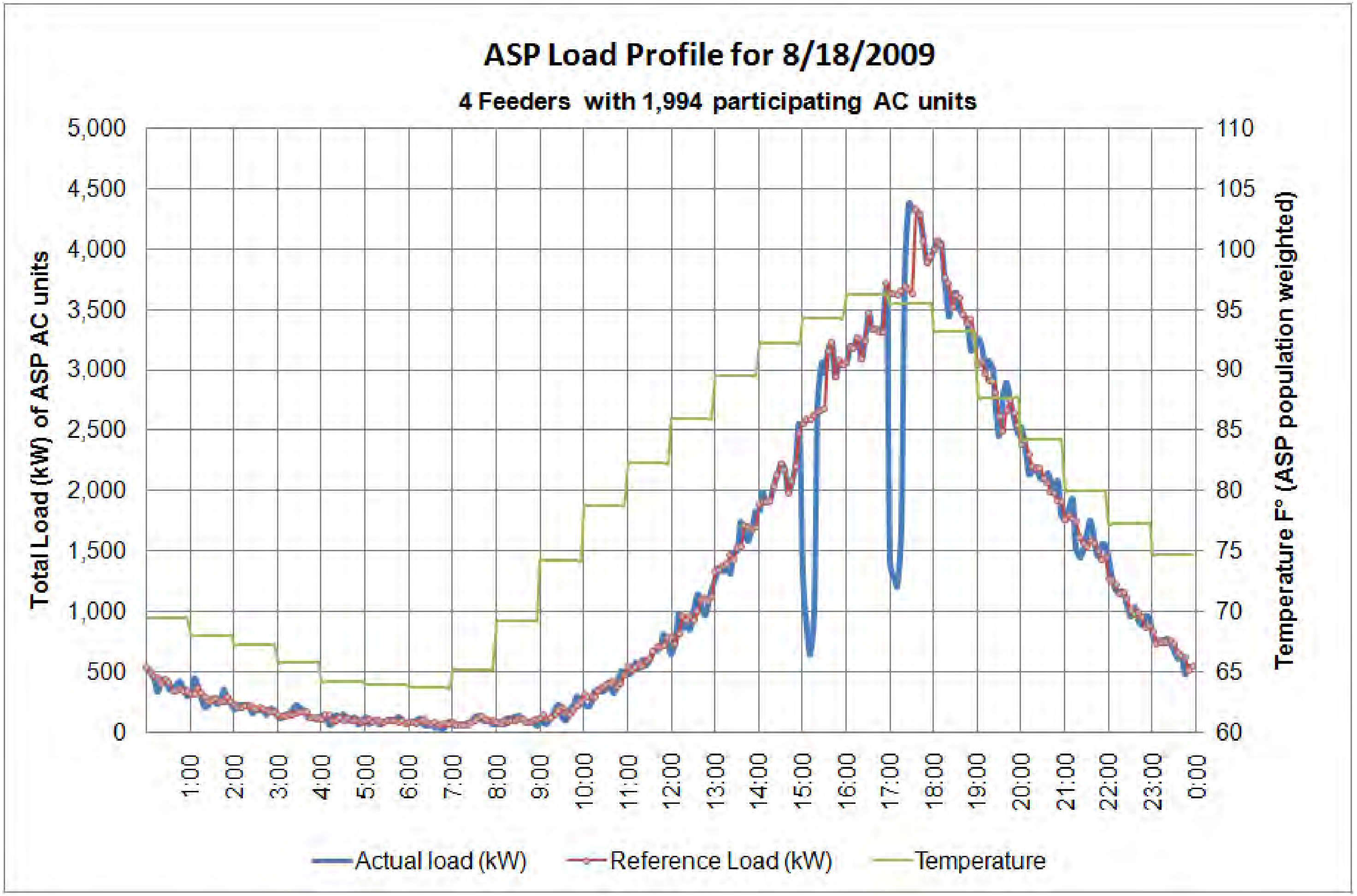
ASP Load Profile for 8/13/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Temperature F° (ASP population weighted)
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature


ASP Load Profile for 8/14/2009
Total Load (kW) of ASP AC units
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
Temperature F° (ASP population weighted)
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

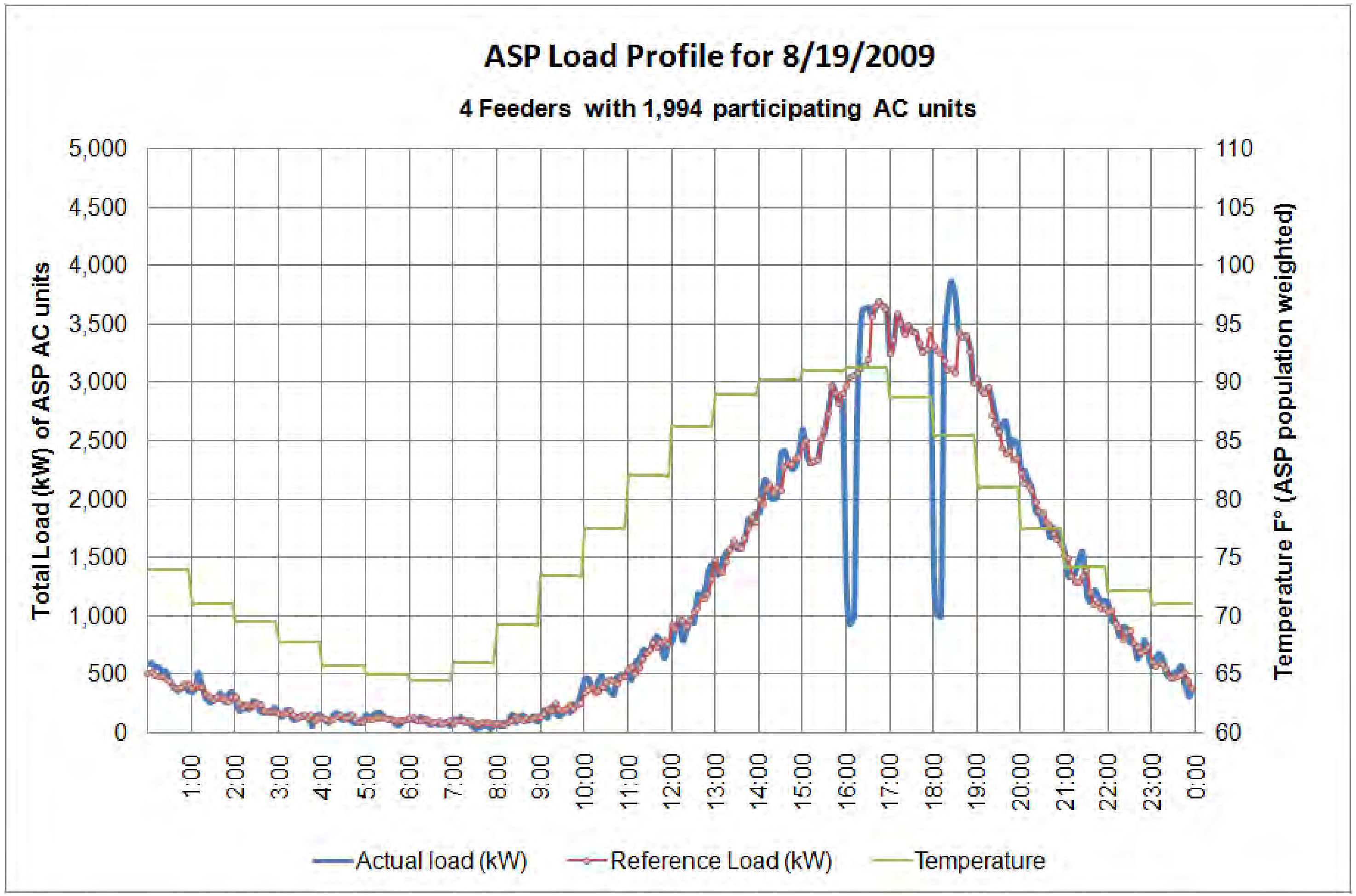


ASP Load Profile for 8/14/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

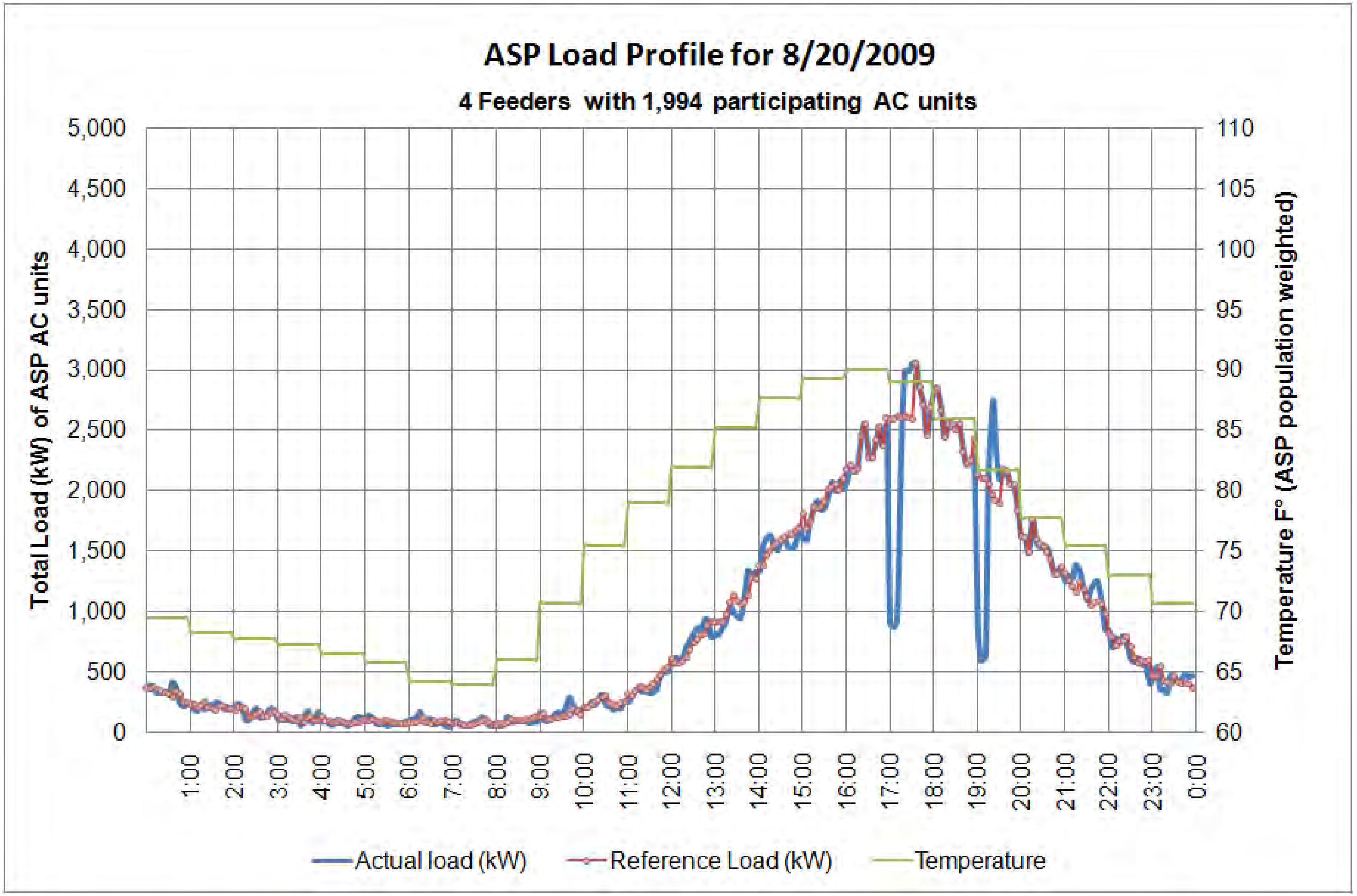

ASP Load Profile for 8/17/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

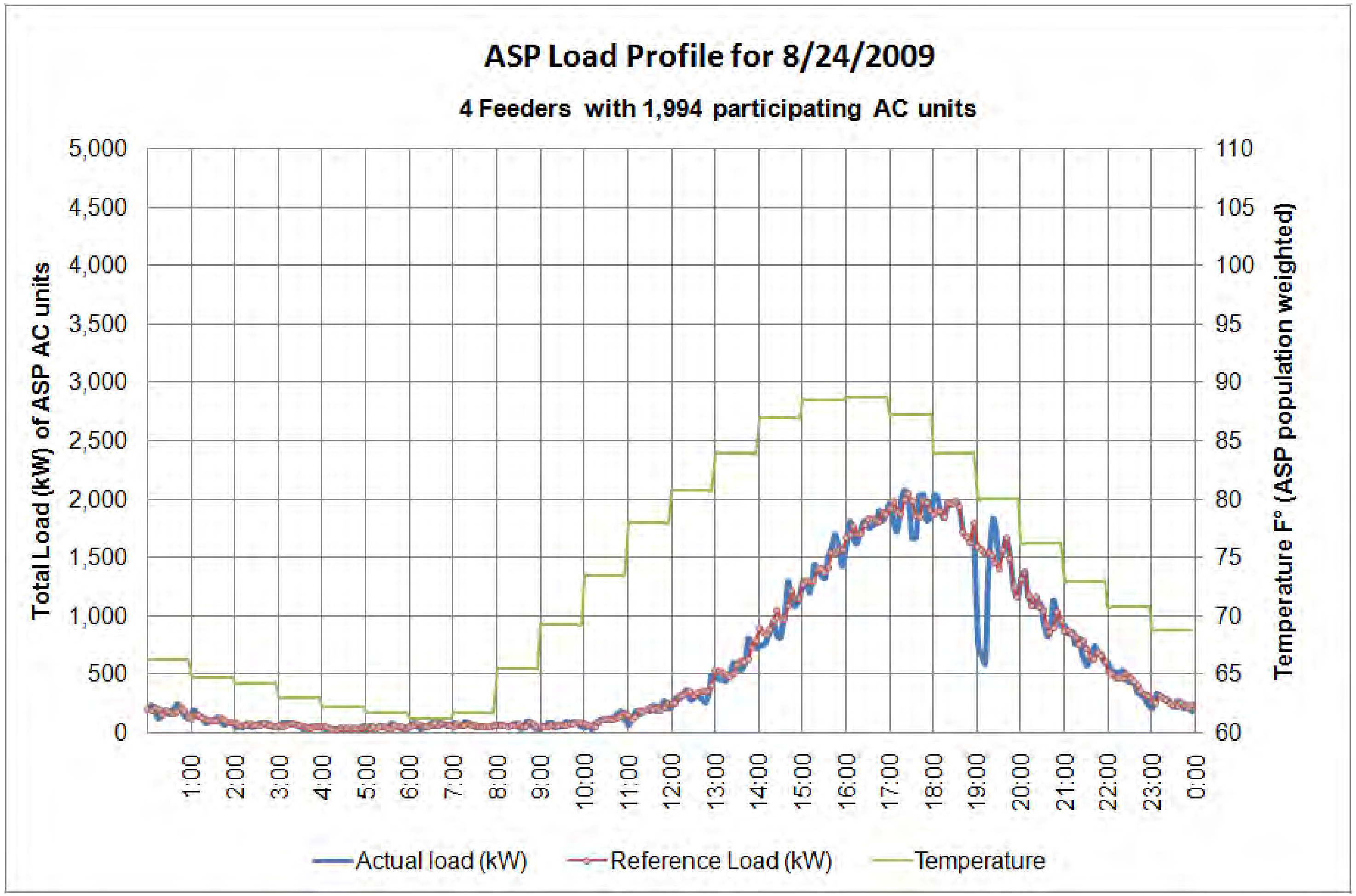


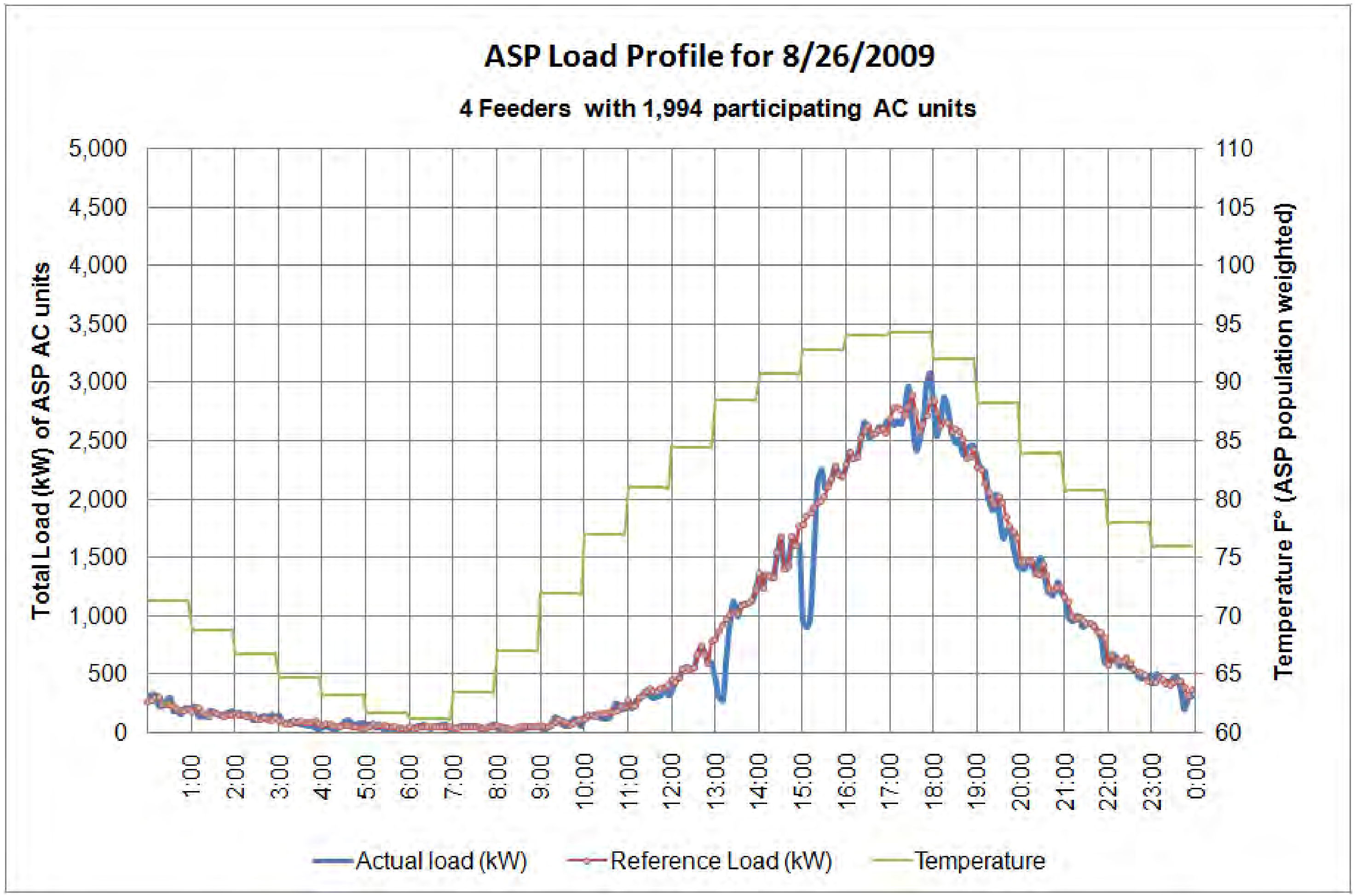
ASP Load Profile for 8/18/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature



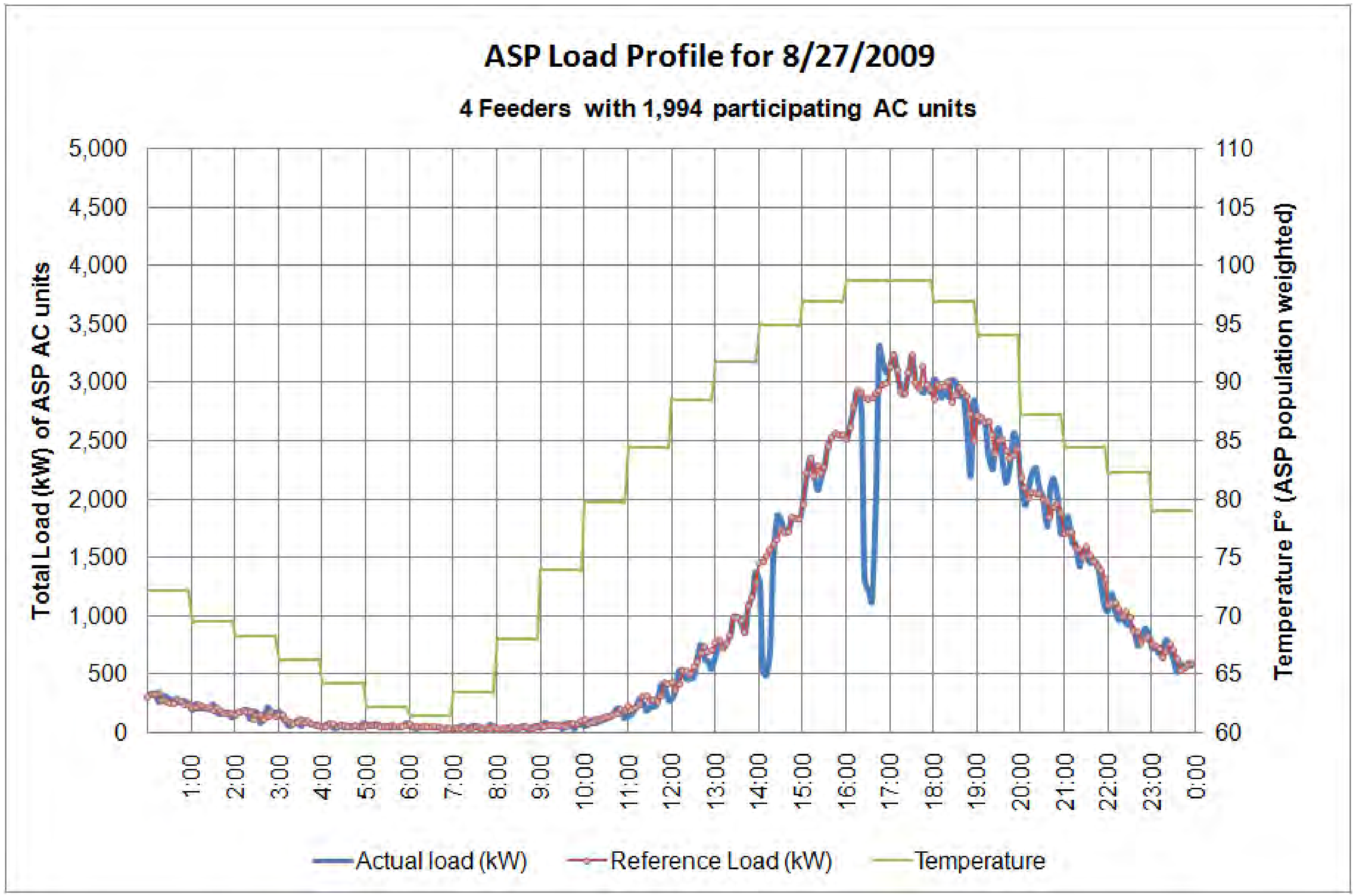
ASP Load Profile for 8/19/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature


ASP Load Profile for 8/20/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

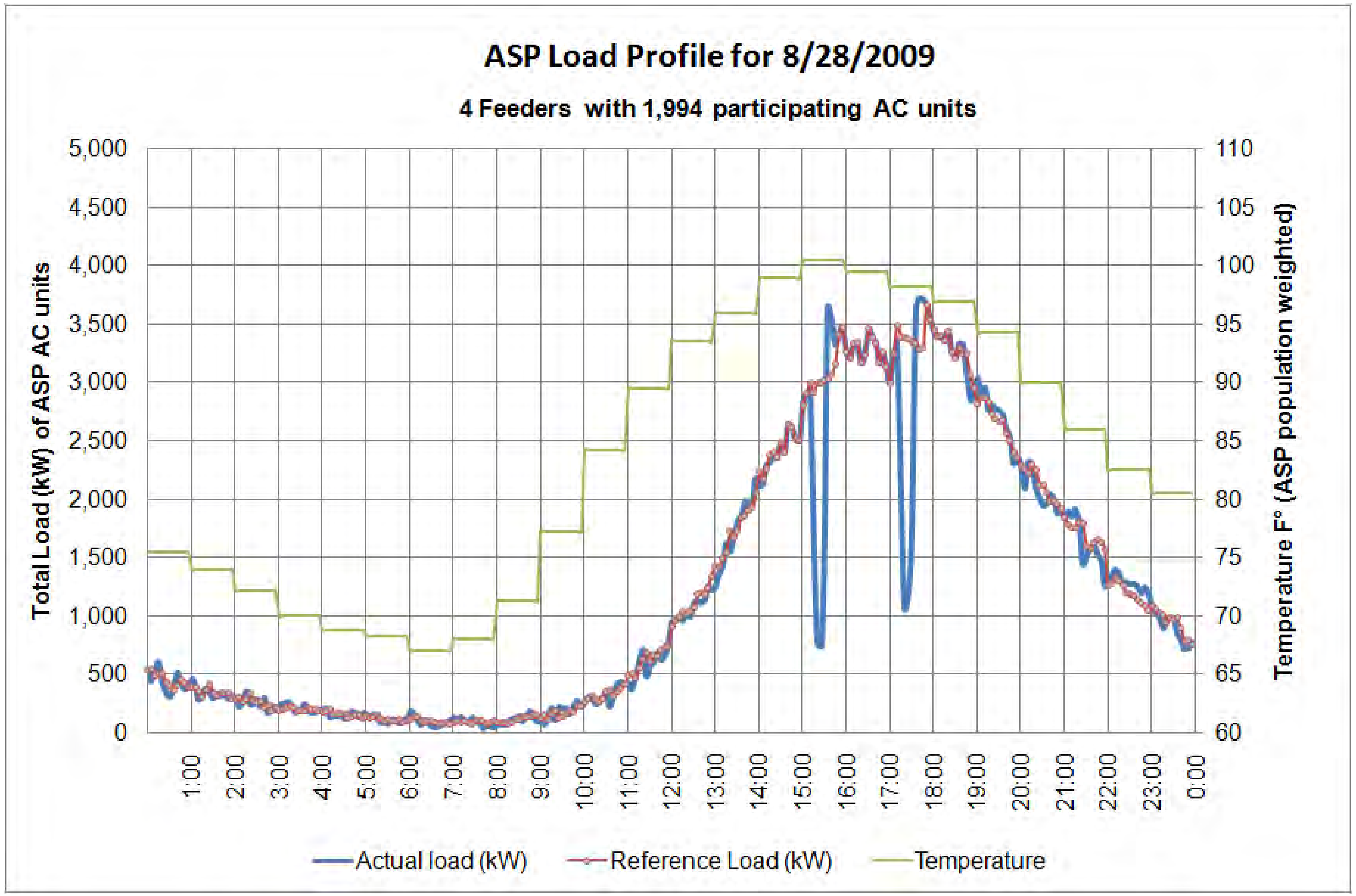

ASP Load Profile for 8/24/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature



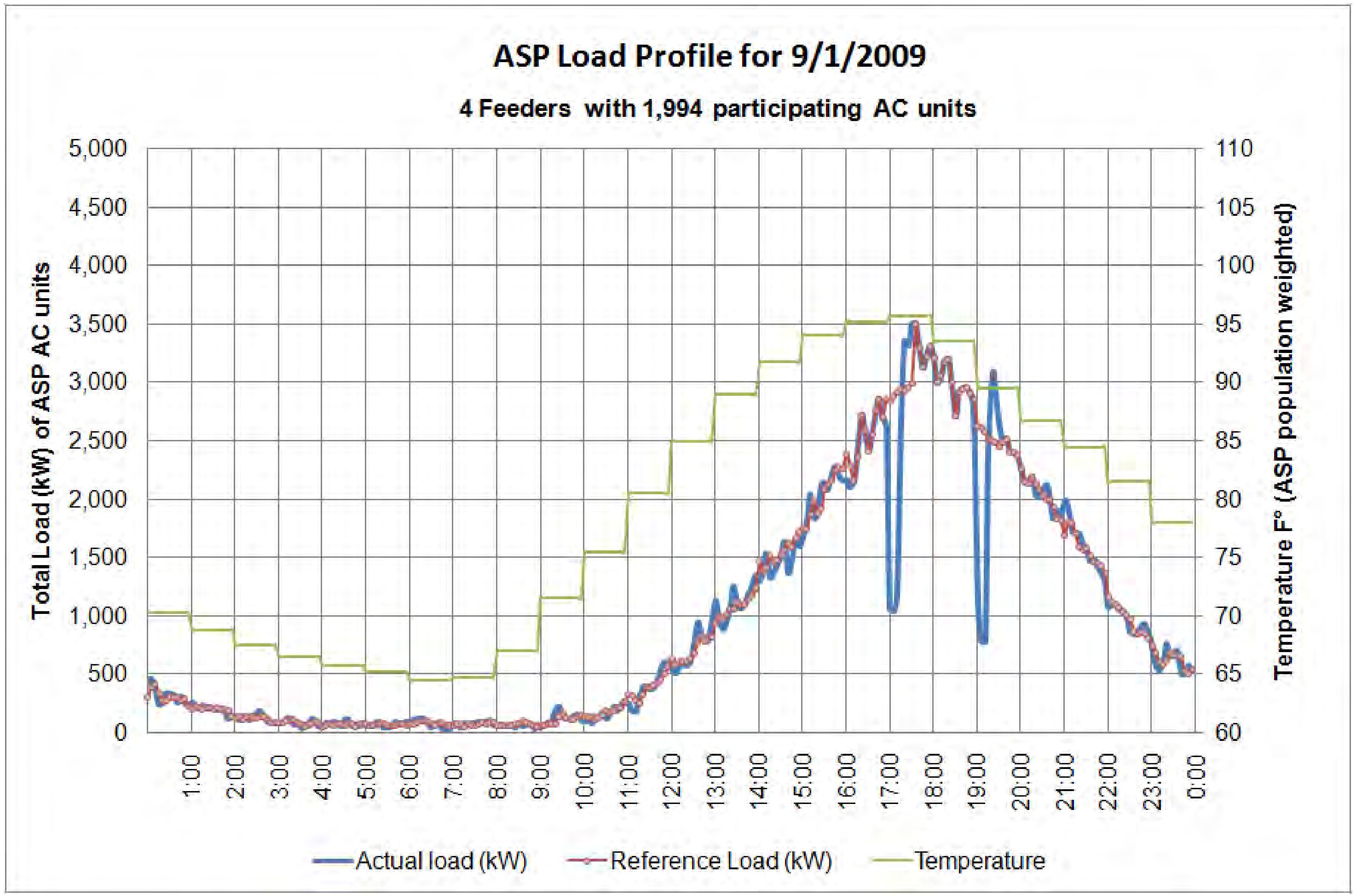
ASP Load Profile for 8/26/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

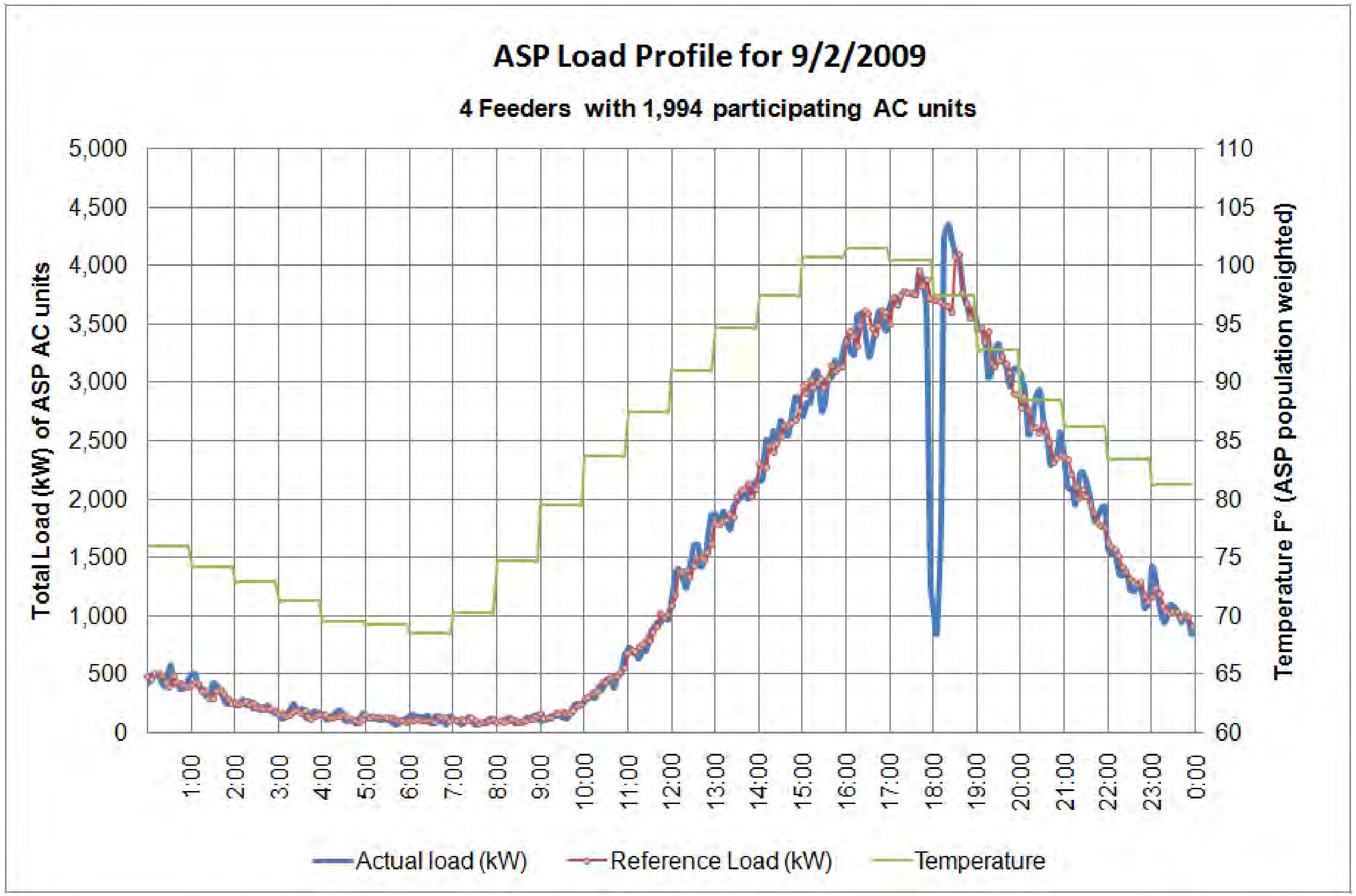


ASP Load Profile for 8/27/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

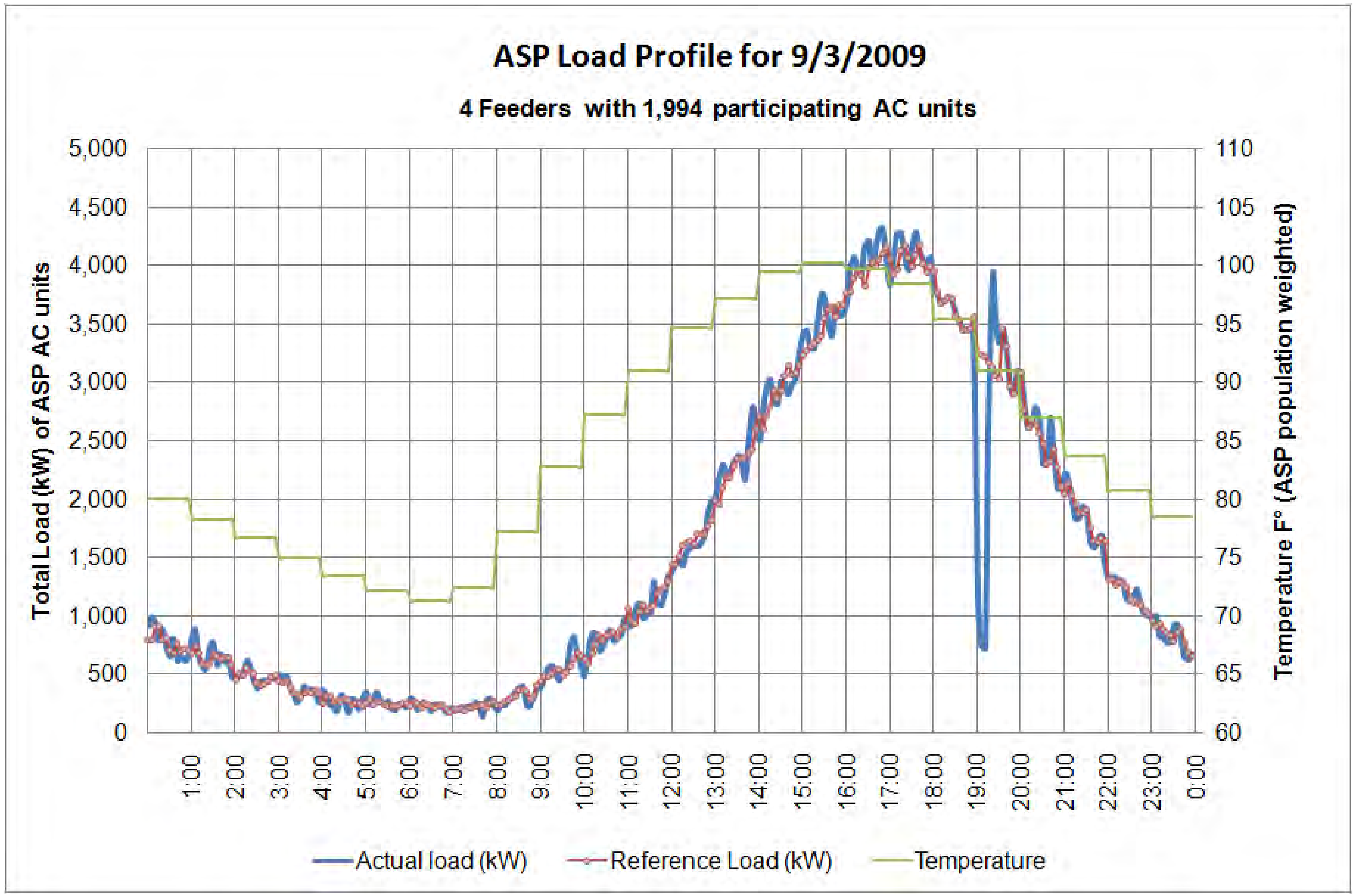


ASP Load Profile for 8/28/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

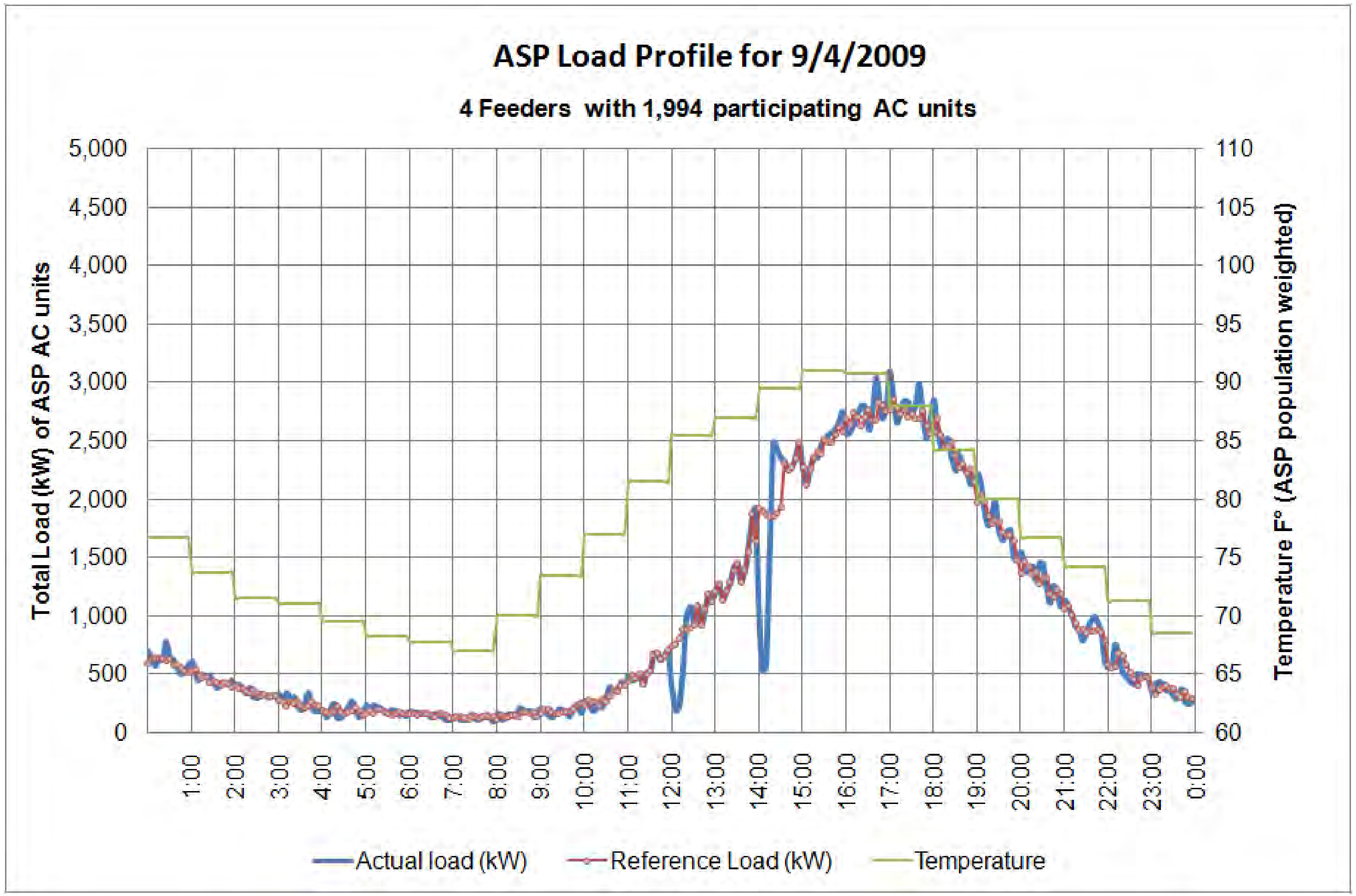

ASP Load Profile for 9/1/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

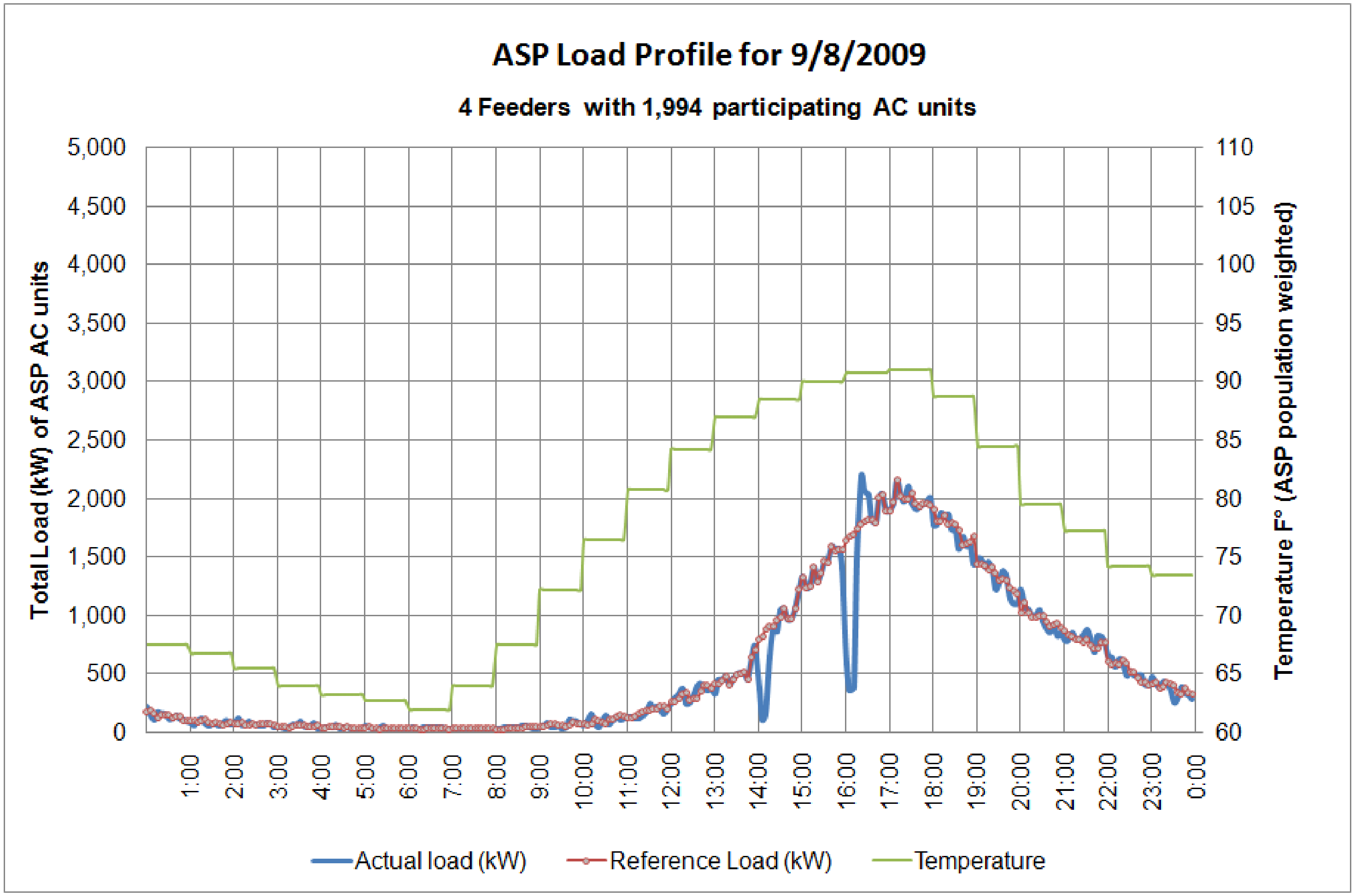


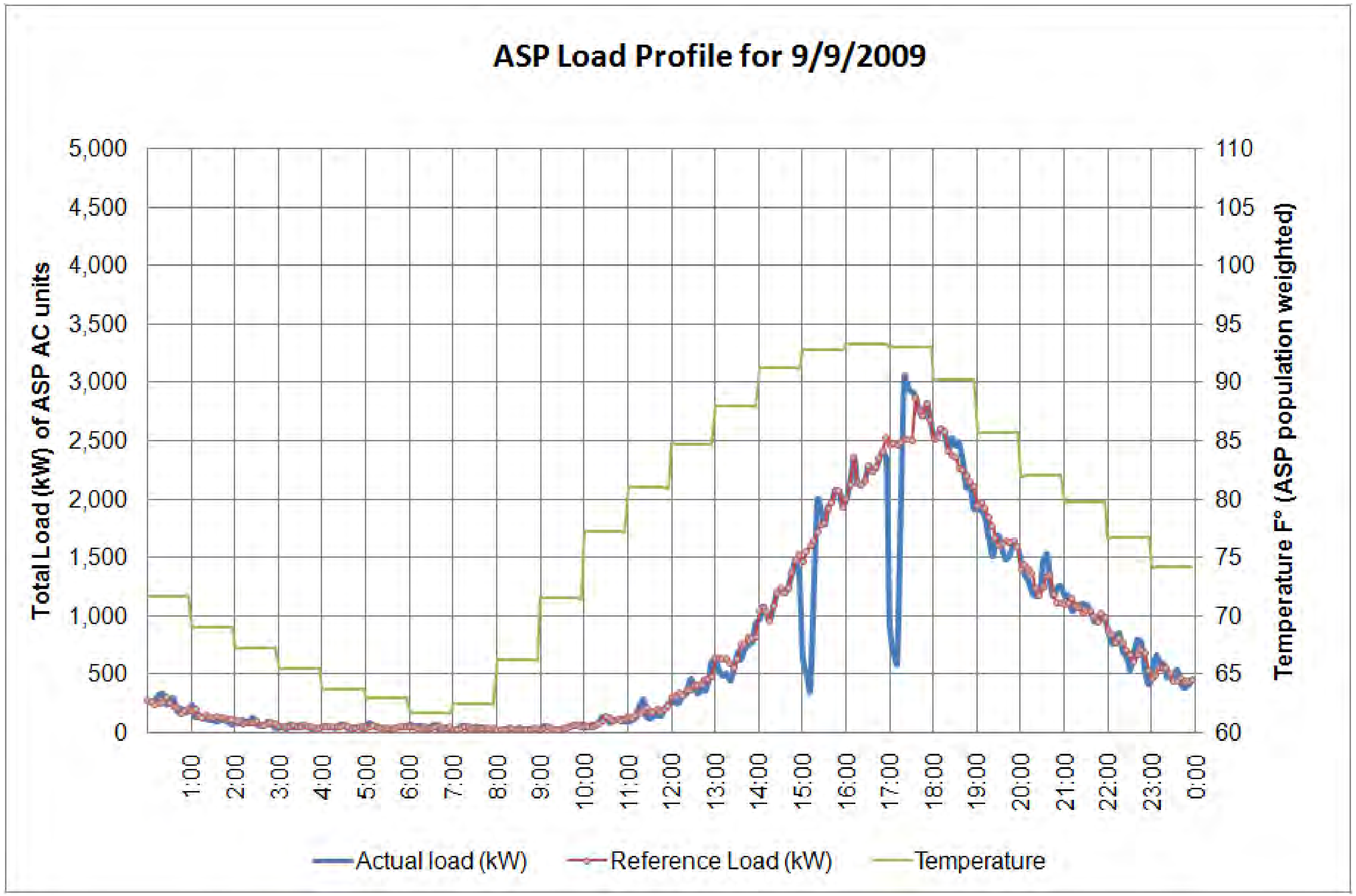
ASP Load Profile for 9/2/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Actual load (kW)
Reference Load (kW)
Temperature

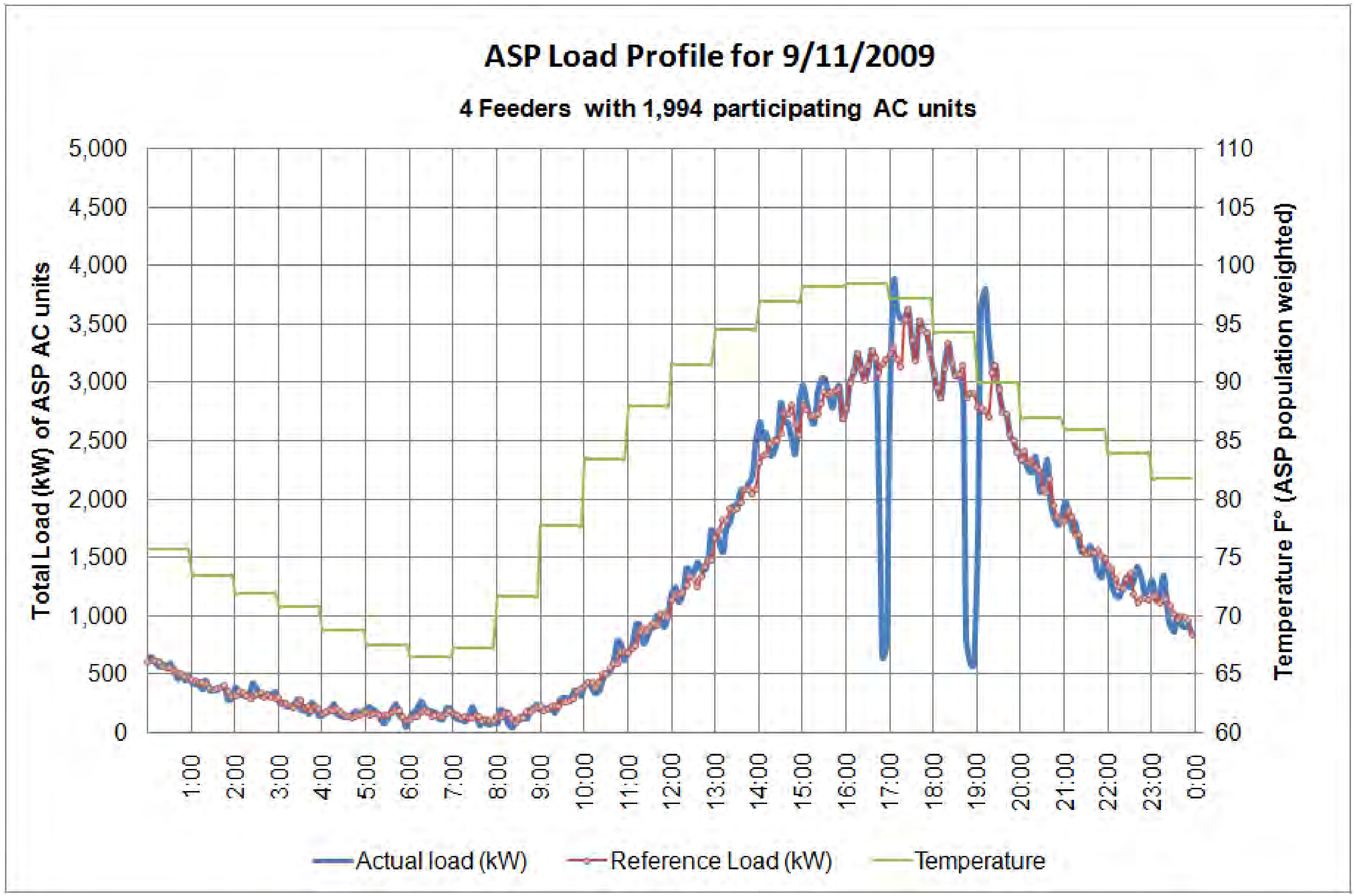


ASP Load Profile for 9/3/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

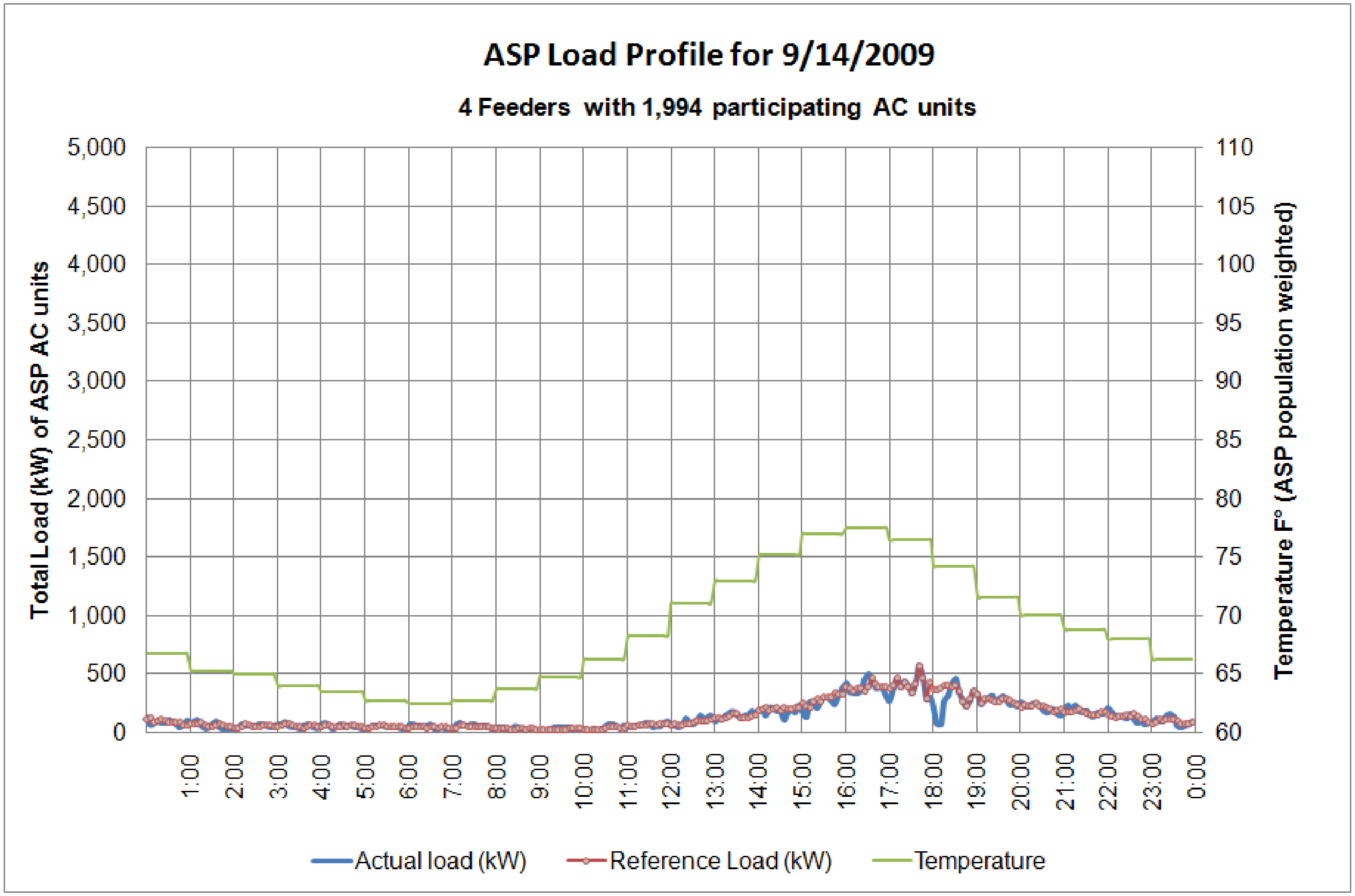

ASP Load Profile for 9/4/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature


ASP Load Profile for 9/8/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

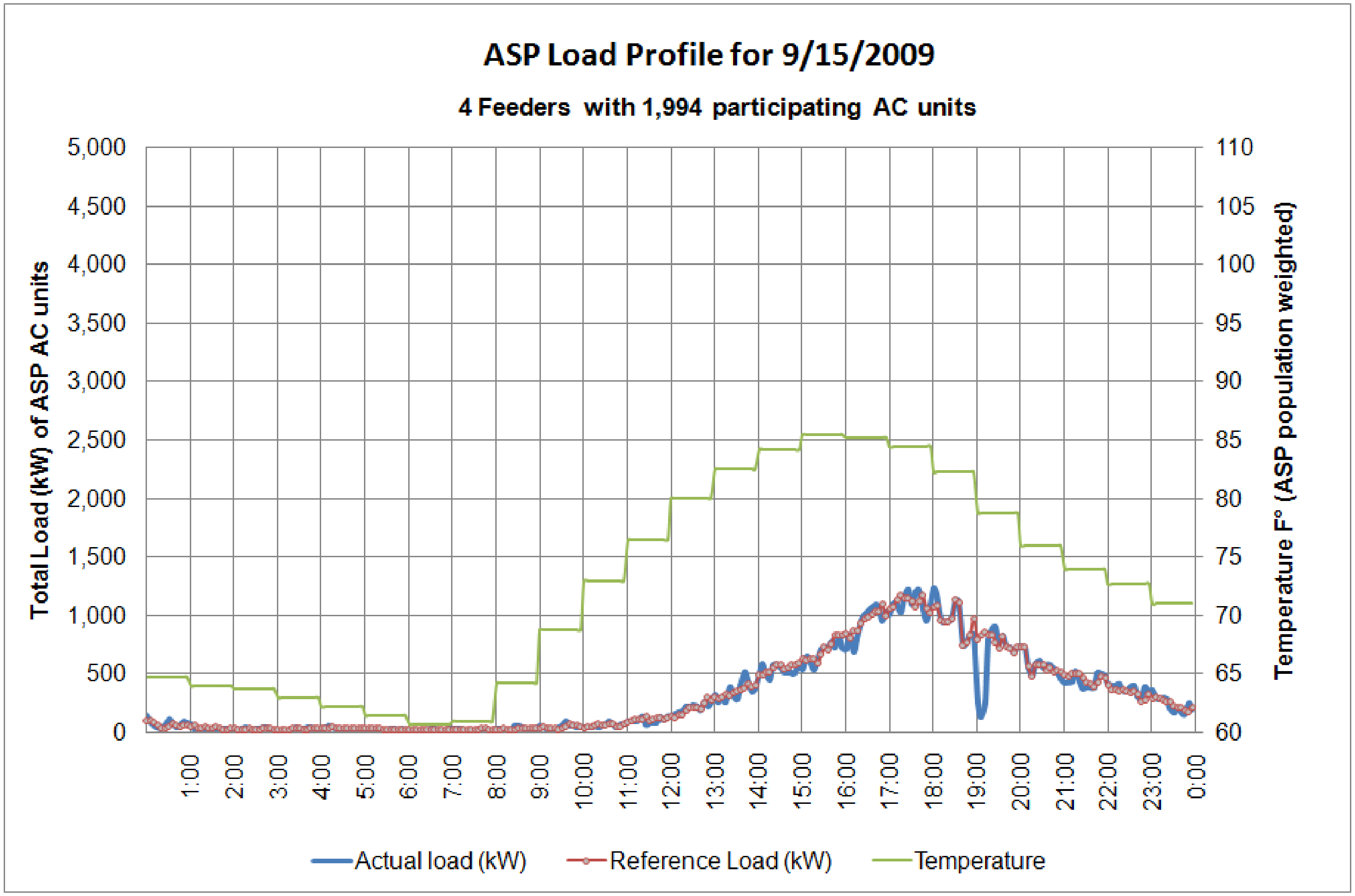

ASP Load Profile for 9/9/2009
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature



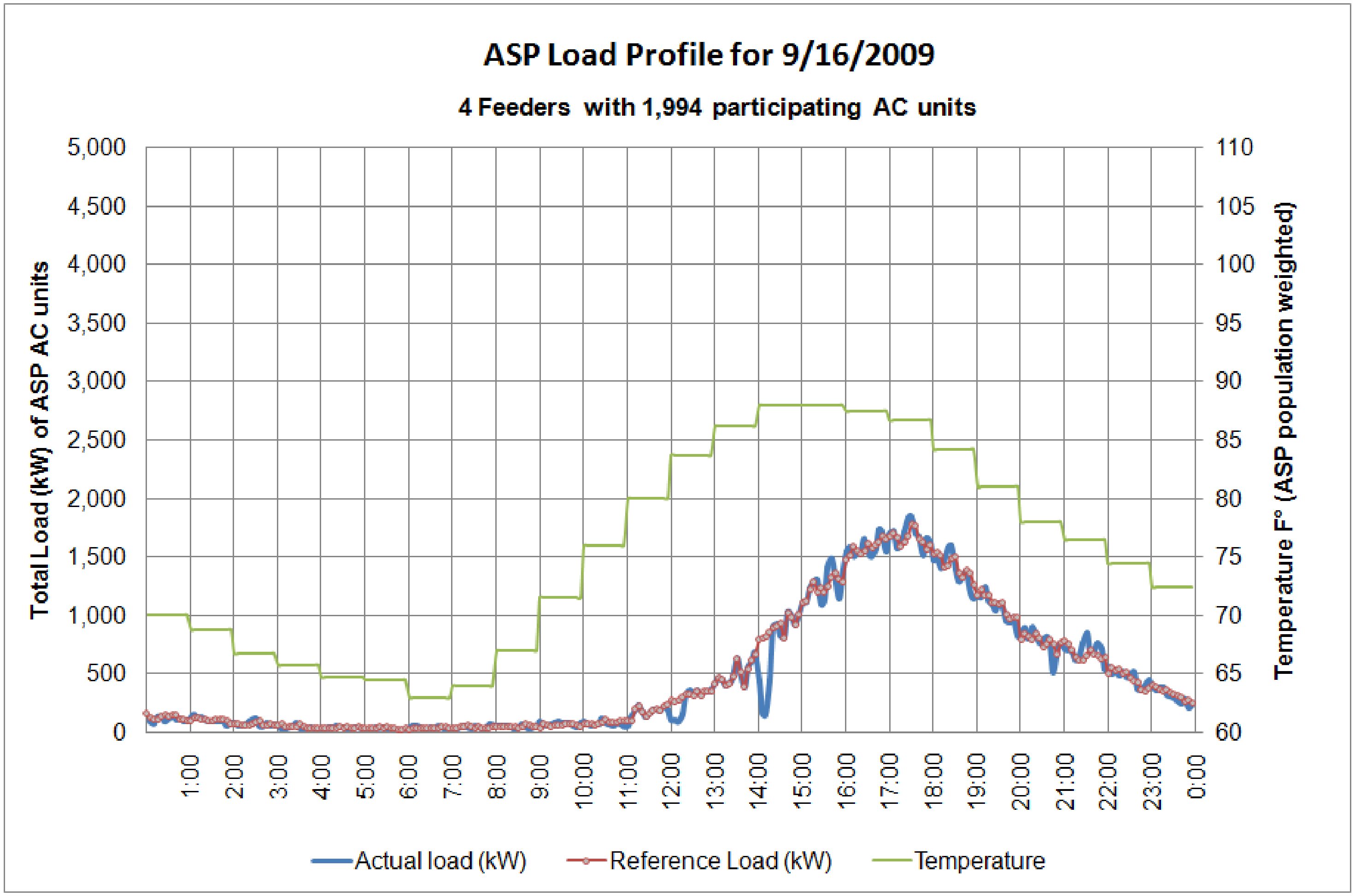
ASP Load Profile for 9/11/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature



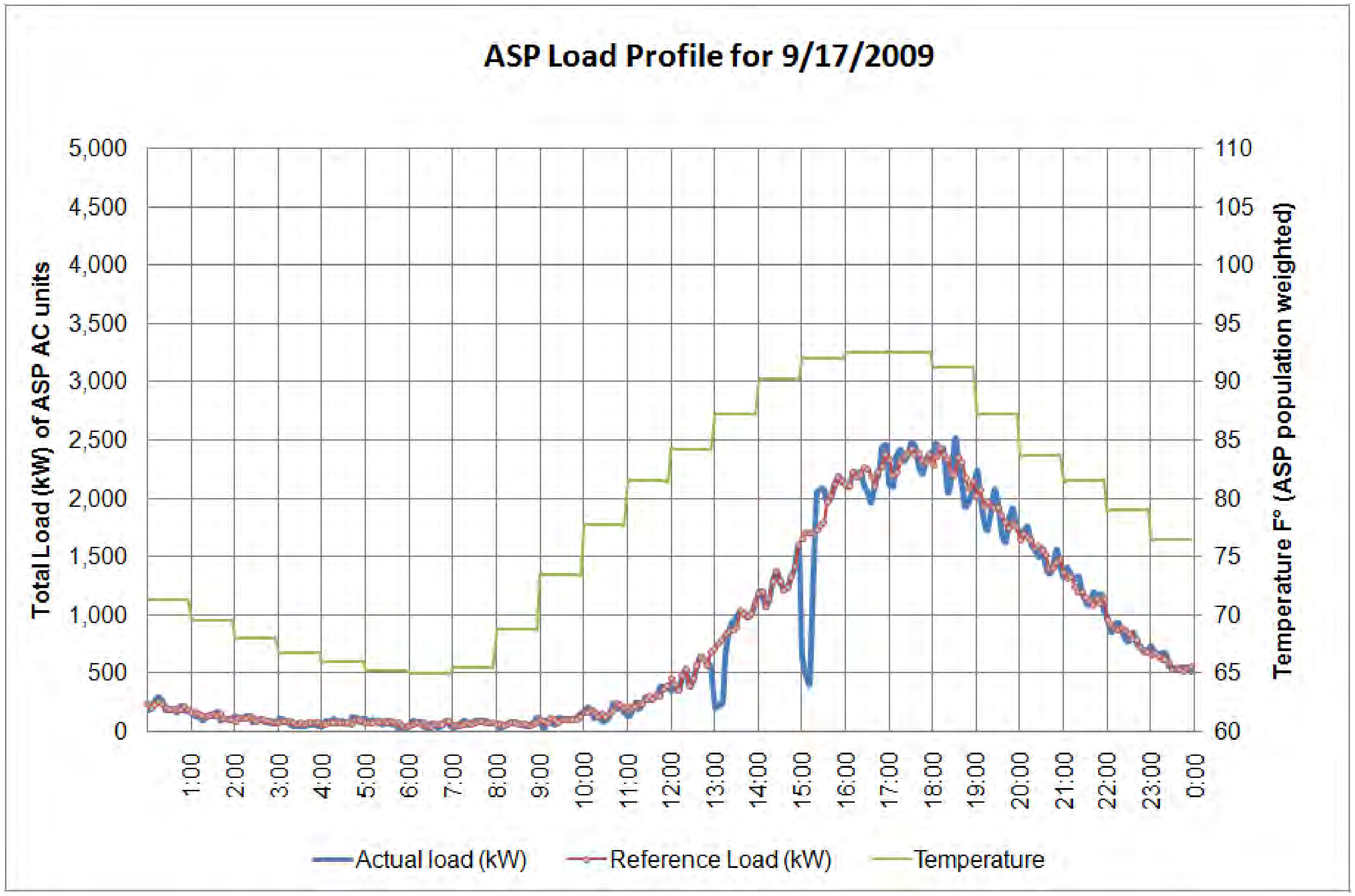
ASP Load Profile for 9/14/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

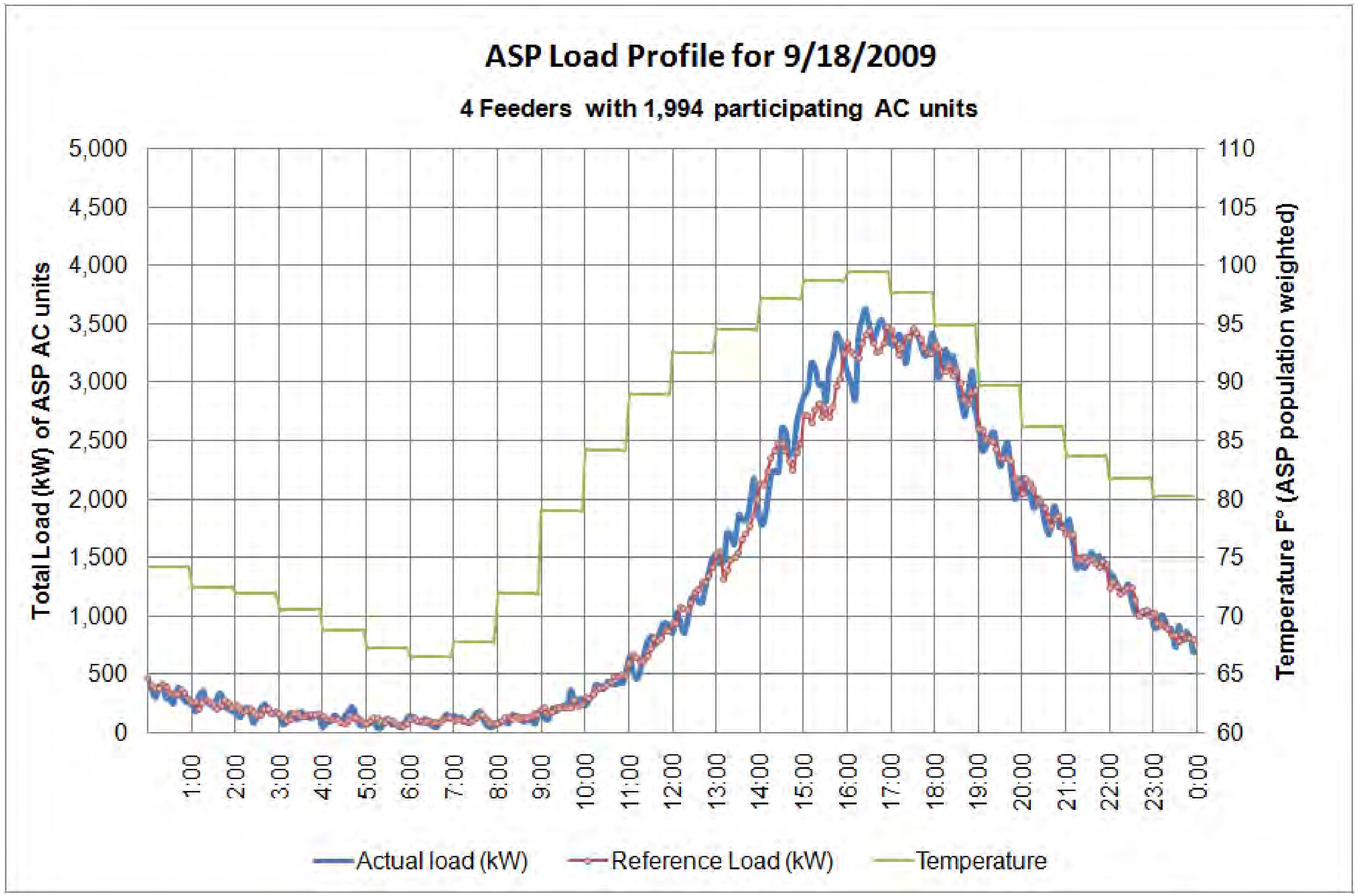


ASP Load Profile for 9/15/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

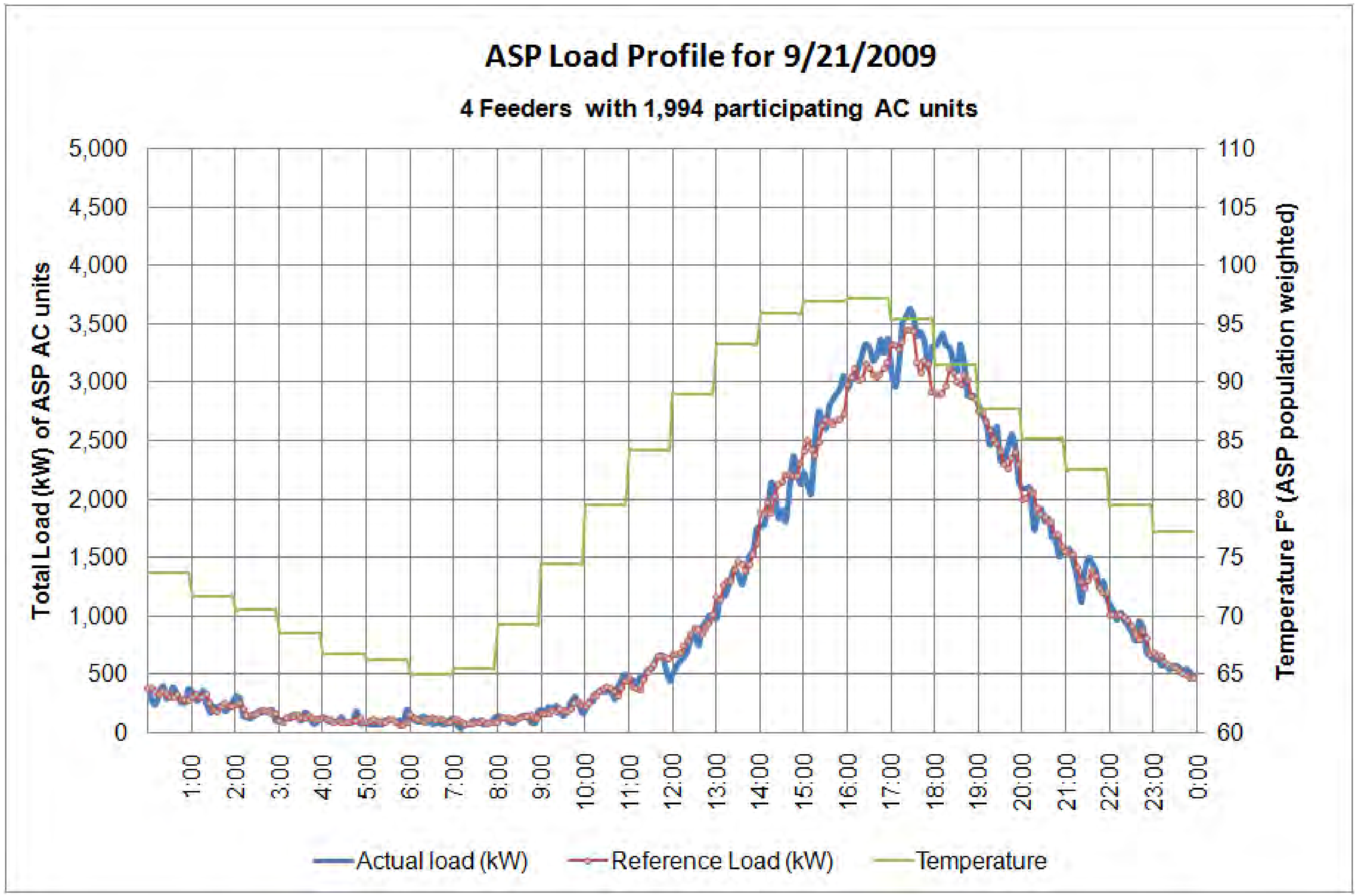


ASP Load Profile for 9/16/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Actual load (kW)
Reference Load (kW)
Temperature

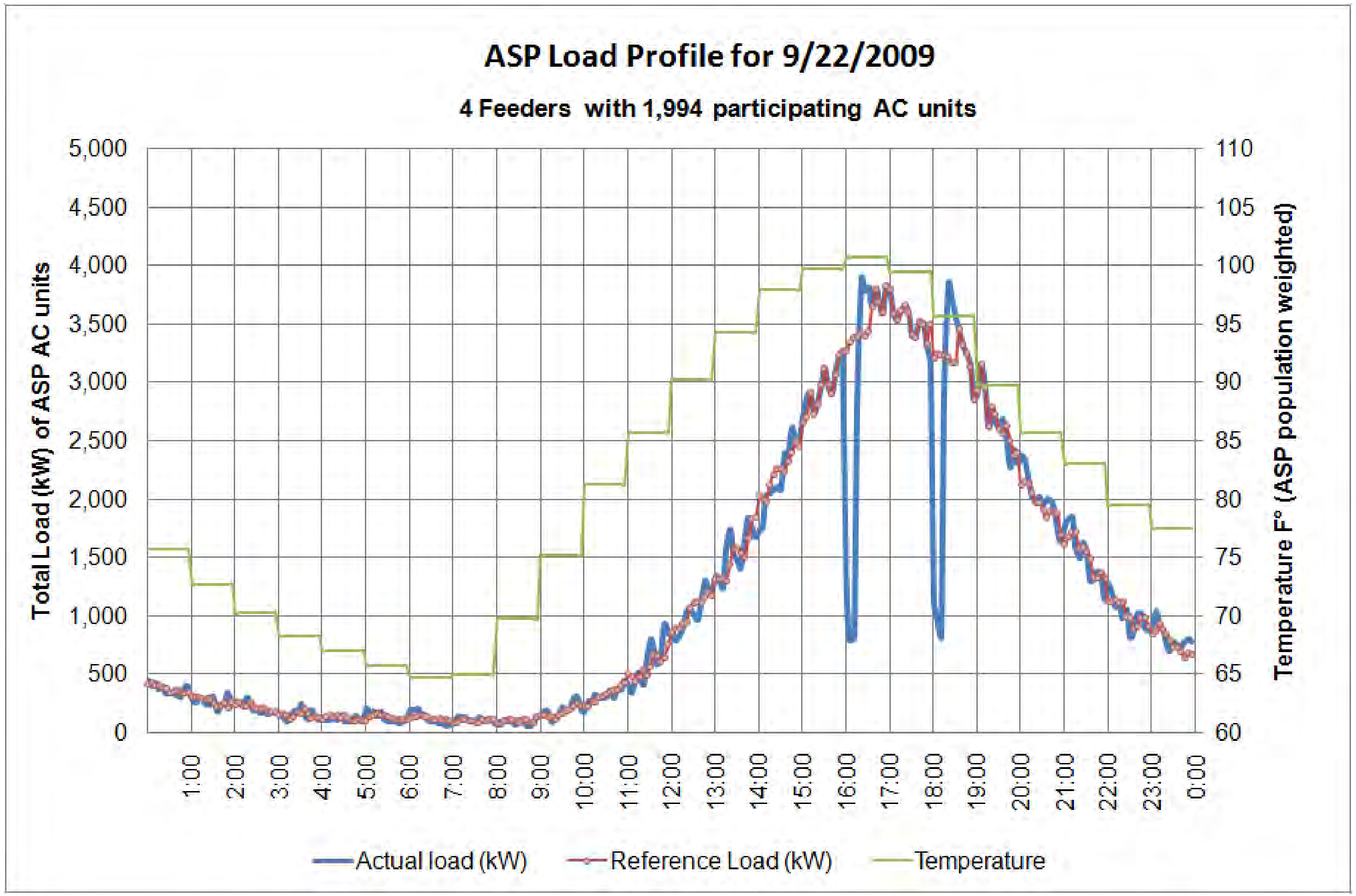

ASP Load Profile for 9/17/2009
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature



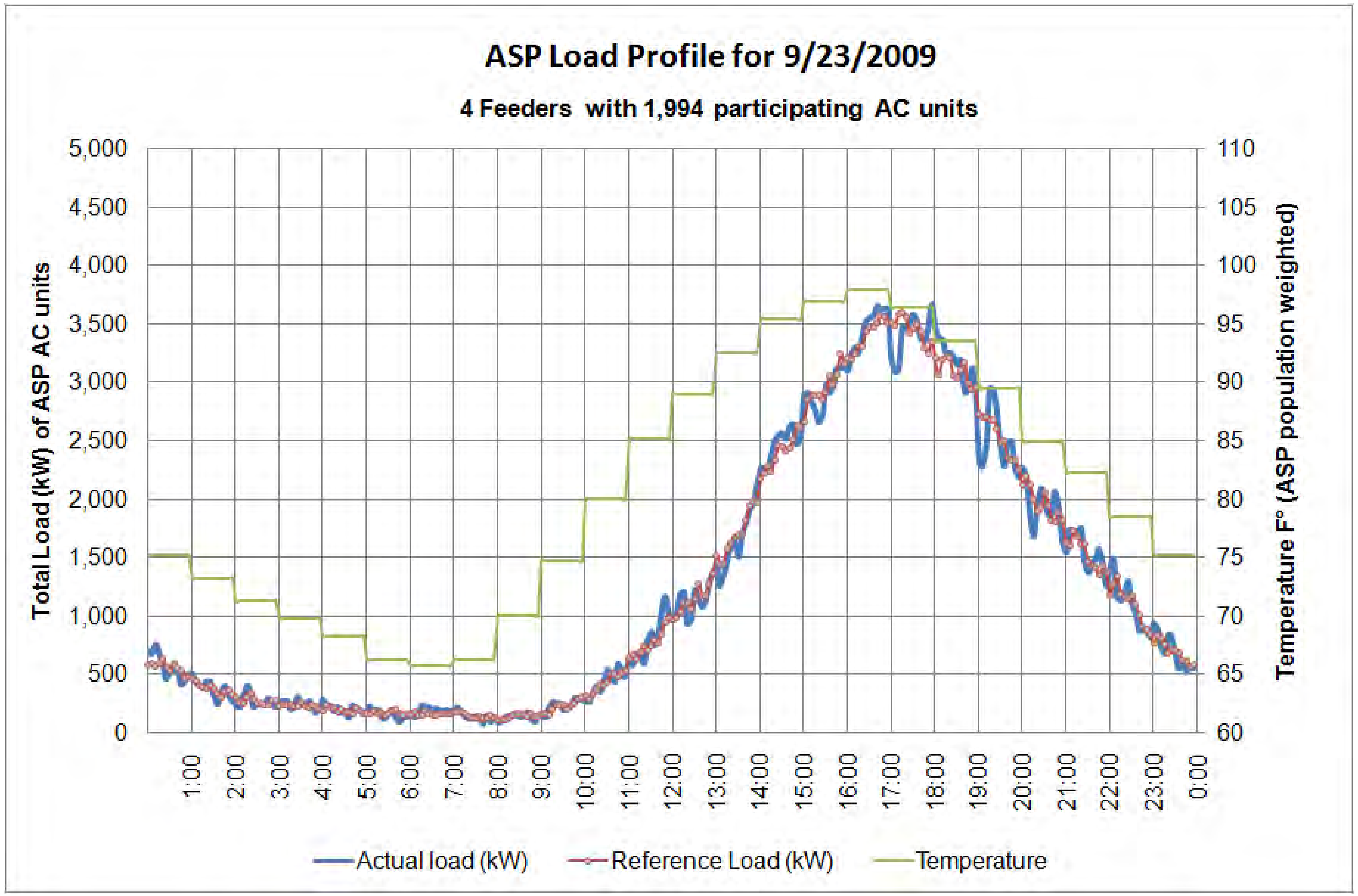
Only PCTs were controlled for this event. A total of 389 PCTs, or 19.5 percent of the total devices, were controlled.



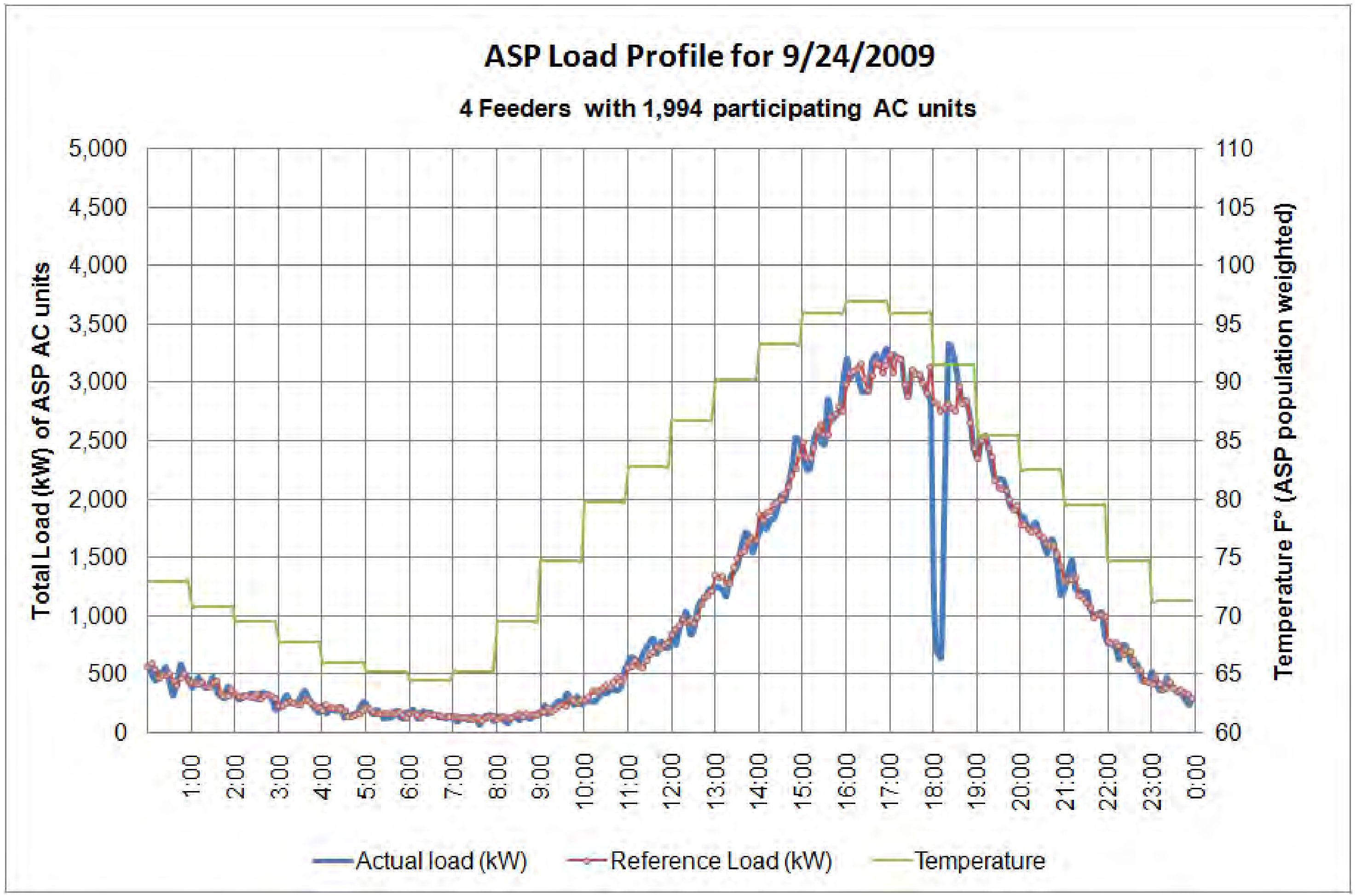
Only PCTs were controlled for this event. A total of 389 PCTs, or 19.5 percent of the total devices, were controlled.

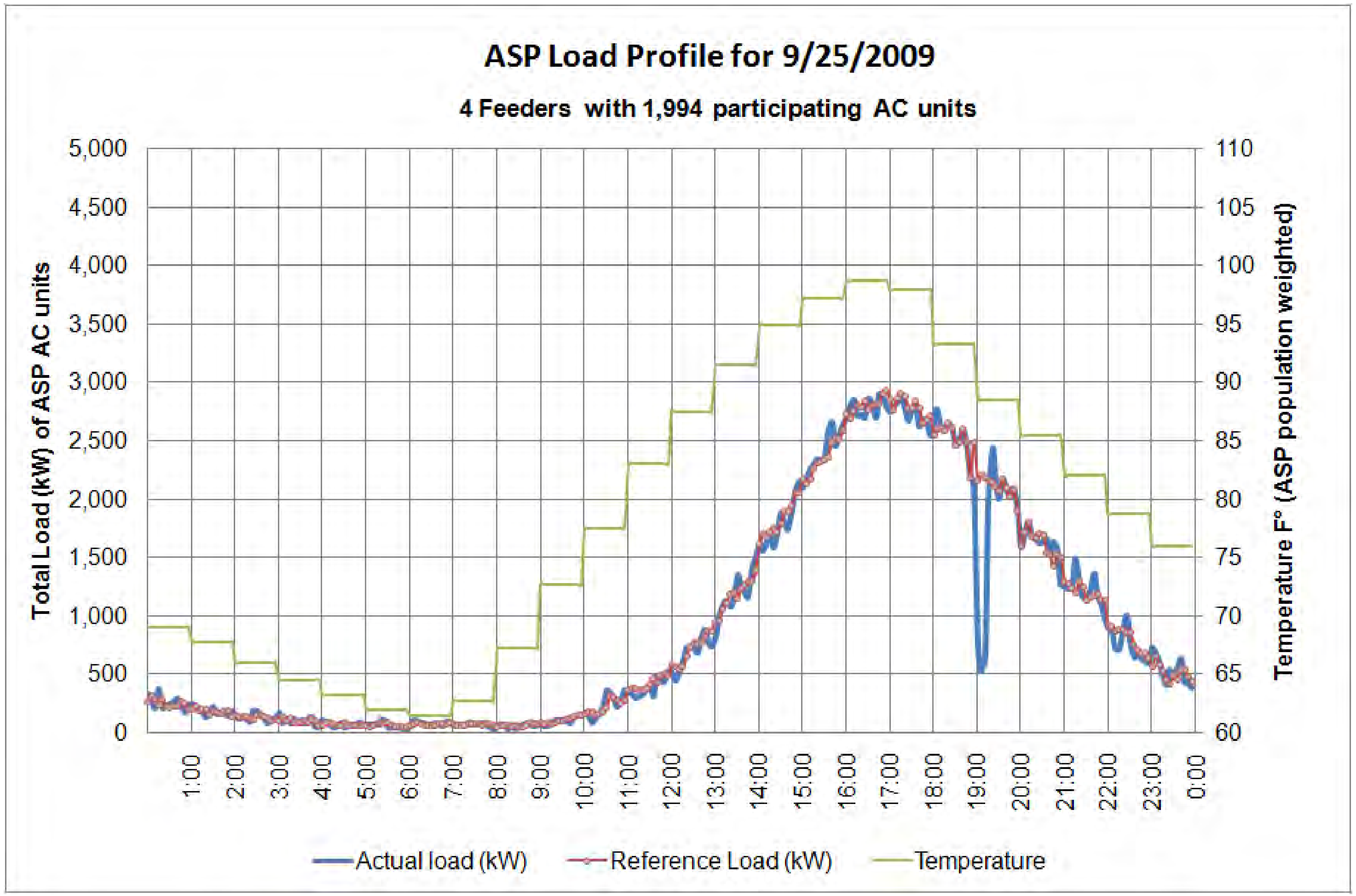


ASP Load Profile for 9/22/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Actual load (kW)
Reference Load (kW)
Temperature

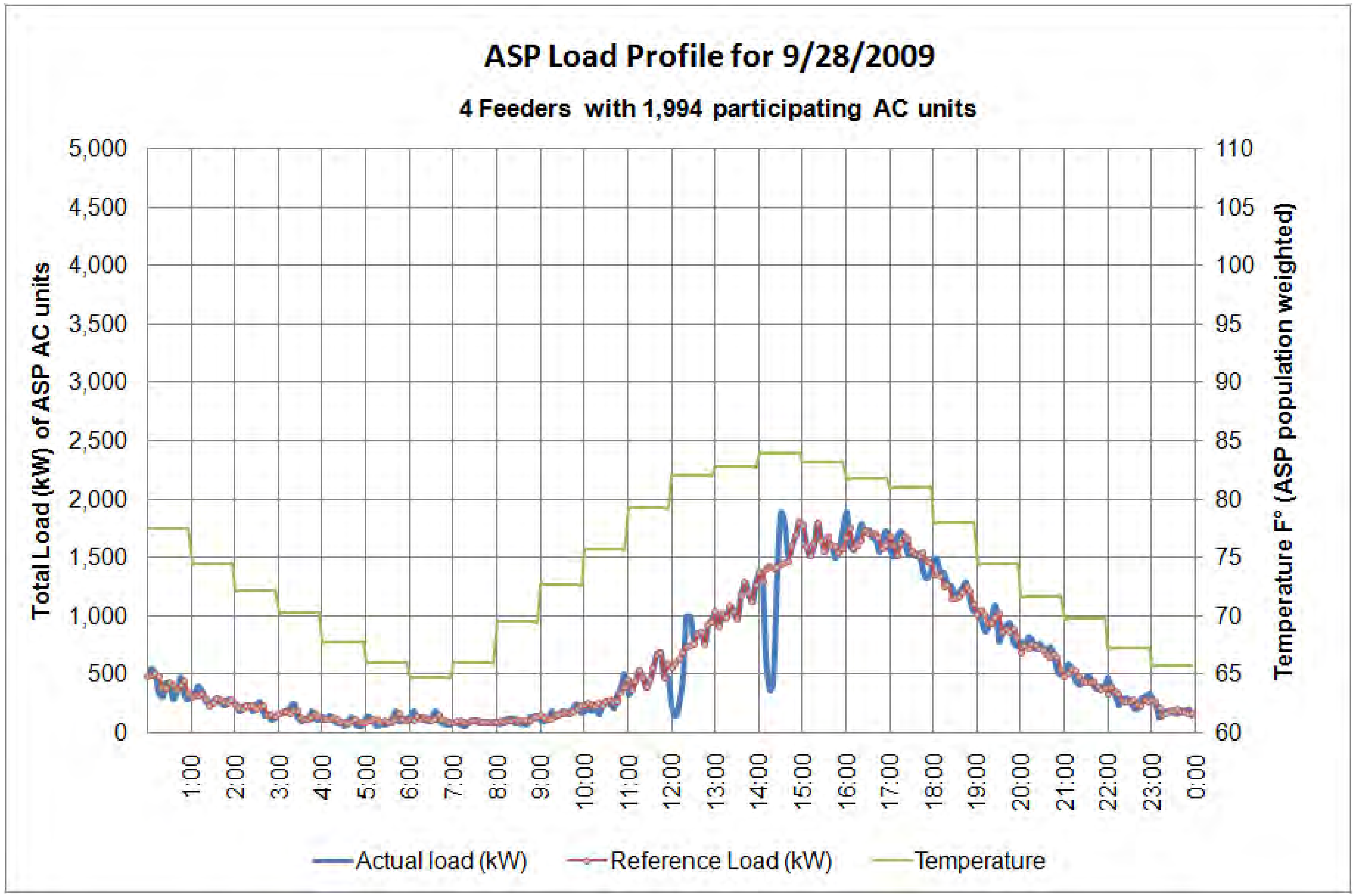


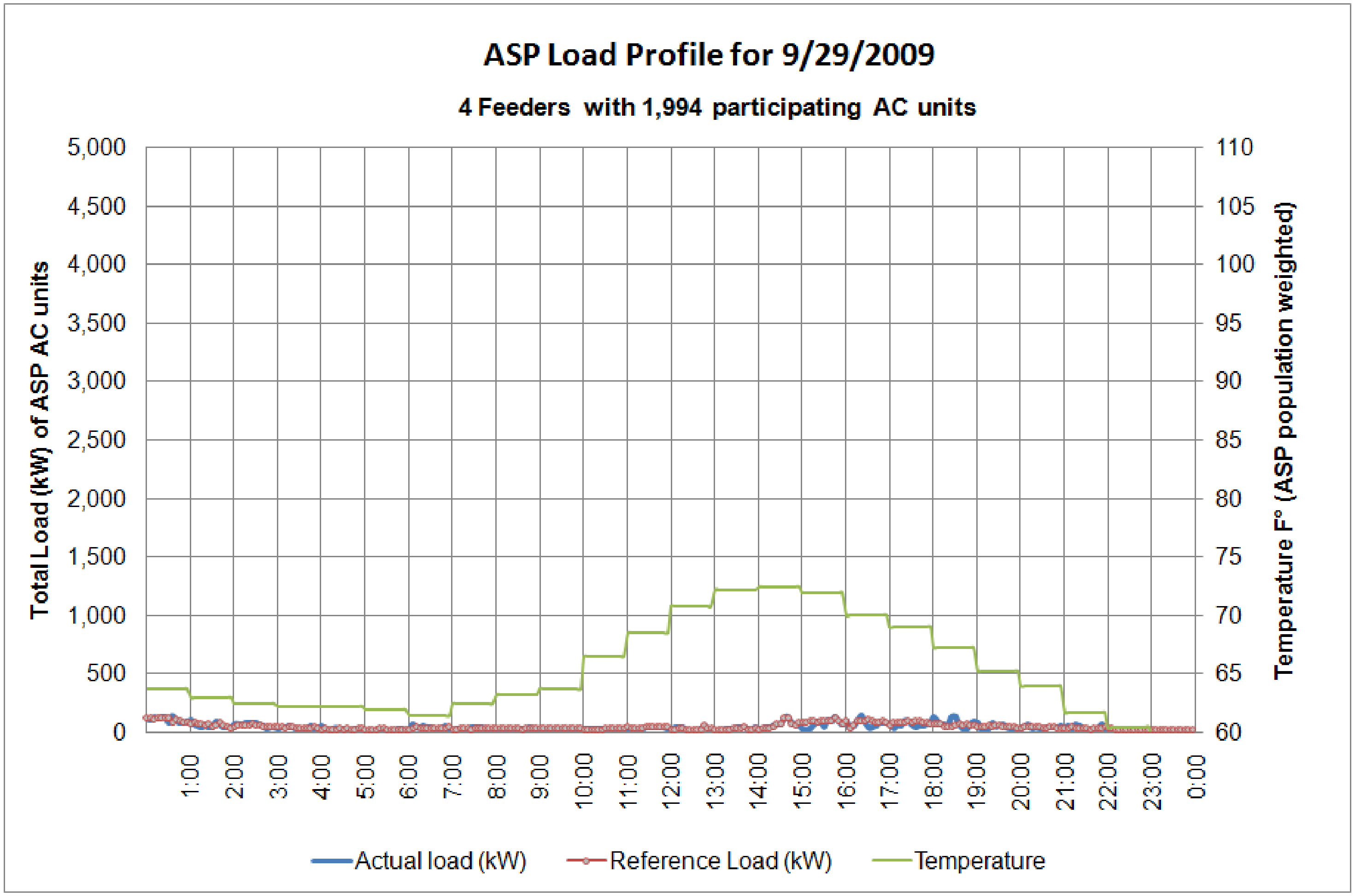
Only PCTs were controlled for this event. A total of 389 PCTs, or 19.5 percent of the total devices, were controlled.


ASP Load Profile for 9/24/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

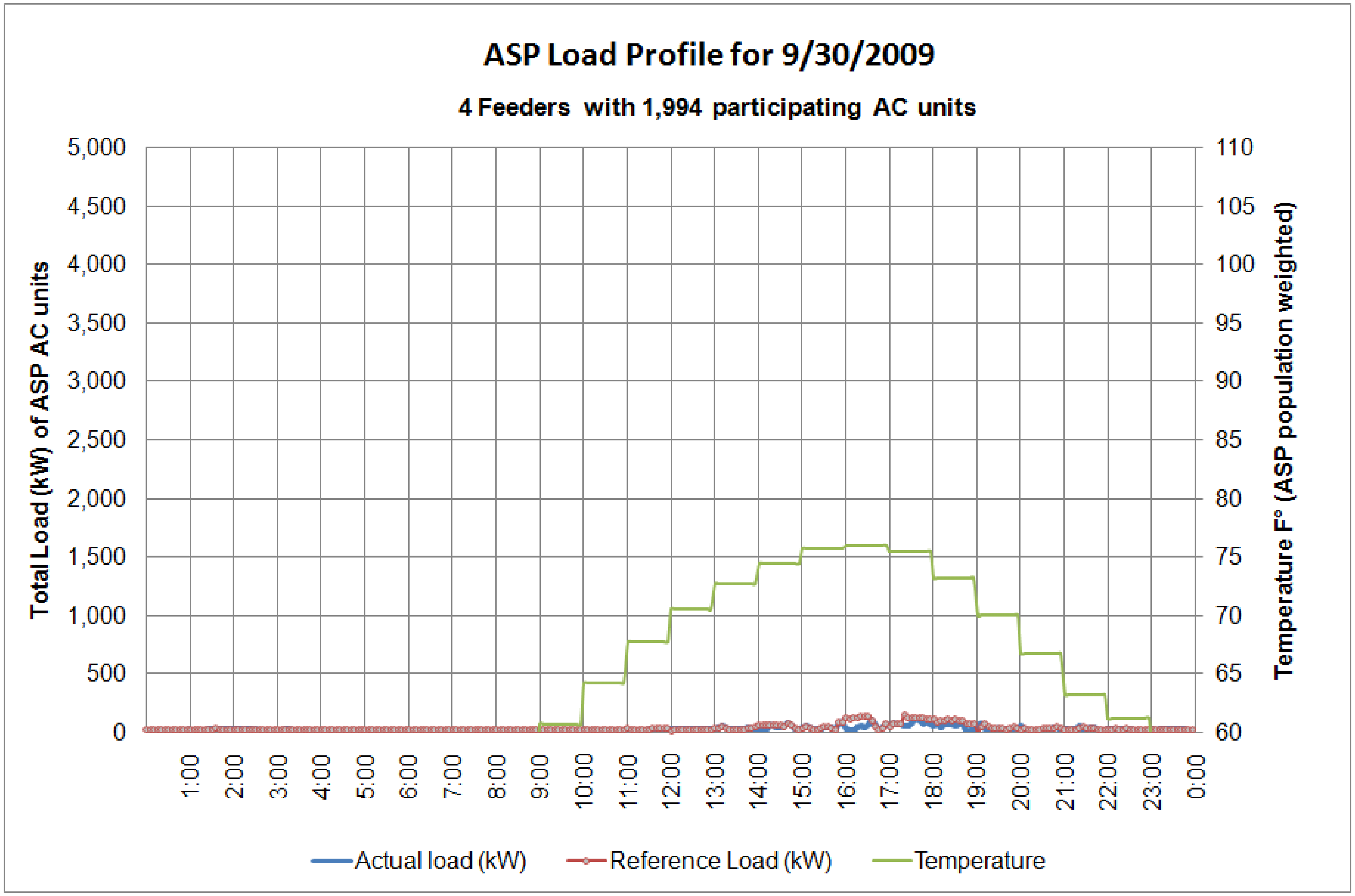


ASP Load Profile for 9/25/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature


ASP Load Profile for 9/28/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature



ASP Load Profile for 9/29/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature


ASP Load Profile for 9/30/2009
4 Feeders with 1,994 participating AC units
Total Load (kW) of ASP AC units
Temperature F° (ASP population weighted)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
110
105
100
95
90
85
80
75
70
65
60
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Actual load (kW)
Reference Load (kW)
Temperature

APPENDIX E: LOAD IMPACT REFERENCE LOAD REGRESSIONS

ARIMA REGRESSION - Antioch DLC switches

		Number of obs	16035
		Wald chi2(102)	177784.88
Log likelihood =	18666.06	Prob > chi2	0.000

Depent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Avg kW - 35 min lag	0.0598	0.0057	10.48	0.000	0.0486	0.0710
Avg kW - 40 min lag	0.1044	0.0058	18.10	0.000	0.0931	0.1157
Avg kW - 45 min lag	0.1884	0.0058	32.75	0.000	0.1771	0.1997
Avg kW - 50 min lag	0.1219	0.0056	21.78	0.000	0.1109	0.1328
Avg kW - 35 min lead	0.0572	0.0058	9.91	0.000	0.0459	0.0685
Avg kW - 40 min lead	0.1071	0.0058	18.35	0.000	0.0956	0.1185
Avg kW - 45 min lead	0.1870	0.0060	31.32	0.000	0.1753	0.1987
Avg kW - 50 min lead	0.1173	0.0057	20.58	0.000	0.1061	0.1284
CDH	0.0041	0.0035	1.15	0.249	-0.0028	0.0110
CDH - squared	-0.0001	0.0003	-0.39	0.700	-0.0007	0.0004
CDH - cubed	0.0000	0.0000	0.59	0.556	0.0000	0.0000
CDH x Hour 1	0.0032	0.0092	0.34	0.732	-0.0149	0.0212
CDH x Hour 2	0.0084	0.0129	0.65	0.516	-0.0170	0.0338
CDH x Hour 3	0.0058	0.0205	0.28	0.776	-0.0343	0.0459
CDH x Hour 4	0.0115	0.0327	0.35	0.724	-0.0526	0.0757
CDH x Hour 5	0.0163	0.0533	0.31	0.760	-0.0882	0.1208
CDH x Hour 6	-0.0018	0.0728	-0.03	0.980	-0.1446	0.1409
CDH x Hour 7	-0.0237	0.2075	-0.11	0.909	-0.4305	0.3830
CDH x Hour 8	0.0051	0.0580	0.09	0.930	-0.1085	0.1187
CDH x Hour 9	-0.0013	0.0177	-0.07	0.944	-0.0359	0.0334
CDH x Hour 10	0.0008	0.0068	0.12	0.902	-0.0125	0.0142
CDH x Hour 11	-0.0010	0.0047	-0.20	0.838	-0.0103	0.0083
CDH x Hour 12	0.0015	0.0044	0.34	0.733	-0.0071	0.0100
CDH x Hour 13	-0.0016	0.0042	-0.39	0.699	-0.0099	0.0067
CDH x Hour 14	0.0031	0.0041	0.76	0.444	-0.0049	0.0111
CDH x Hour 15	-0.0062	0.0041	-1.51	0.132	-0.0143	0.0019
CDH x Hour 16	0.0024	0.0036	0.66	0.512	-0.0047	0.0095
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	0.0003	0.0034	0.08	0.940	-0.0064	0.0069
CDH x Hour 19	0.0081	0.0036	2.27	0.024	0.0011	0.0152
CDH x Hour 20	0.0008	0.0041	0.19	0.853	-0.0072	0.0087
CDH x Hour 21	-0.0069	0.0048	-1.43	0.154	-0.0163	0.0026
CDH x Hour 22	0.0116	0.0057	2.04	0.042	0.0004	0.0227
CDH x Hour 23	0.0087	0.0065	1.35	0.178	-0.0040	0.0214
CDH x Hour 24	0.0068	0.0082	0.83	0.408	-0.0093	0.0229
CDH x Hour 1 - squared	-0.0013	0.0020	-0.65	0.516	-0.0051	0.0026
CDH x Hour 2 - squared	-0.0024	0.0033	-0.72	0.472	-0.0088	0.0041
CDH x Hour 3 - squared	-0.0012	0.0073	-0.16	0.874	-0.0155	0.0132
CDH x Hour 4 - squared	-0.0071	0.0191	-0.38	0.708	-0.0445	0.0302
CDH x Hour 5 - squared	-0.0090	0.0344	-0.26	0.794	-0.0764	0.0584
CDH x Hour 6 - squared	-0.0044	0.0330	-0.13	0.893	-0.0690	0.0602
CDH x Hour 7 - squared	0.0134	0.1111	0.12	0.904	-0.2044	0.2312
CDH x Hour 8 - squared	-0.0043	0.0188	-0.23	0.820	-0.0411	0.0325

ARIMA REGRESSION - Antioch DLC switches

		Number of obs	16035
		Wald chi2(102)	177784.88
Log likelihood =	18666.06	Prob > chi2	0.000

Depent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Hour 9 - squared	-0.0005	0.0043	-0.11	0.911	-0.0089	0.0079
CDH x Hour 10 - squared	-0.0007	0.0009	-0.71	0.479	-0.0025	0.0012
CDH x Hour 11 - squared	-0.0002	0.0005	-0.36	0.721	-0.0011	0.0008
CDH x Hour 12 - squared	-0.0004	0.0004	-1.10	0.271	-0.0012	0.0003
CDH x Hour 13 - squared	-0.0002	0.0004	-0.47	0.638	-0.0009	0.0005
CDH x Hour 14 - squared	-0.0005	0.0003	-1.54	0.123	-0.0011	0.0001
CDH x Hour 15 - squared	0.0003	0.0003	1.03	0.302	-0.0003	0.0010
CDH x Hour 16 - squared	-0.0005	0.0003	-1.88	0.061	-0.0010	0.0000
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	0.0002	0.0003	0.75	0.452	-0.0003	0.0007
CDH x Hour 19 - squared	-0.0006	0.0003	-1.94	0.052	-0.0011	0.0000
CDH x Hour 20 - squared	-0.0001	0.0004	-0.34	0.734	-0.0008	0.0006
CDH x Hour 21 - squared	0.0008	0.0005	1.66	0.096	-0.0001	0.0018
CDH x Hour 22 - squared	-0.0018	0.0007	-2.42	0.016	-0.0032	-0.0003
CDH x Hour 23 - squared	-0.0012	0.0010	-1.27	0.203	-0.0031	0.0007
CDH x Hour 24 - squared	-0.0018	0.0015	-1.14	0.253	-0.0048	0.0013
CDH x Hour 1 - cubed	0.0001	0.0001	0.77	0.439	-0.0001	0.0003
CDH x Hour 2 - cubed	0.0002	0.0002	0.74	0.456	-0.0003	0.0006
CDH x Hour 3 - cubed	0.0000	0.0006	0.03	0.980	-0.0012	0.0012
CDH x Hour 4 - cubed	0.0008	0.0023	0.36	0.719	-0.0036078	0.0052
CDH x Hour 5 - cubed	0.0010	0.0048	0.20	0.841	-0.0084087	0
CDH x Hour 6 - cubed	0.0010	0.0037	0.26	0.793	-0.0063346	0
CDH x Hour 7 - cubed	-0.0020	0.0140	-0.14	0.889	-0.0293446	0.025
CDH x Hour 8 - cubed	0.0005	0.0014	0.31	0.754	-0.0023793	0.0032853
CDH x Hour 9 - cubed	0.0000	0.0002	0.09	0.926	-0.0004	0.0005
CDH x Hour 10 - cubed	0.0000	0.0000	0.75	0.455	0.0000	0.0001
CDH x Hour 11 - cubed	0.0000	0.0000	0.44	0.656	0.0000	0.0000
CDH x Hour 12 - cubed	0.0000	0.0000	1.12	0.262	0.0000	0.0000
CDH x Hour 13 - cubed	0.0000	0.0000	0.62	0.536	0.0000	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	1.71	0.088	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	-0.95	0.344	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	2.49	0.013	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	-1.31	0.190	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	1.86	0.063	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	0.37	0.713	0.0000	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	-2.09	0.037	-0.0001	0.0000
CDH x Hour 22 - cubed	0.0001	0.0000	2.75	0.006	0.0000	0.0001
CDH x Hour 23 - cubed	0.0000	0.0000	1.09	0.275	0.0000	0.0001
CDH x Hour 24 - cubed	0.0001	0.0001	1.27	0.203	0.0000	0.0002
CDH x Sep	-0.0008	0.0014	-0.61	0.544	-0.0036	0.0019
CDH x Sep - squared	0.0001	0.0001	0.53	0.594	-0.0002	0.0003
CDH x Sep - cubed	0.0000	0.0000	-0.50	0.620	0.0000	0.0000
CDH x Sun	-0.0032	0.0026	-1.24	0.216	-0.0083	0.0019
CDH x Sun - squared	0.0004	0.0002	1.71	0.088	-0.0001	0.0008
CDH x Sun - cubed	0.0000	0.0000	-1.86	0.063	0.0000	0.0000
CDH x Mon	-0.0065	0.0027	-2.38	0.017	-0.0119	-0.0012
CDH x Mon - squared	0.0007	0.0002	3.10	0.002	0.0003	0.0012
CDH x Mon - cubed	0.0000	0.0000	-3.48	0.000	0.0000	0.0000
CDH x Tue	-0.0048	0.0028	-1.71	0.088	-0.0102	0.0007

ARIMA REGRESSION - Antioch DLC switches

					Number of obs	16035
					Wald chi2(102)	177784.88
Log	likelihood	=		18666.06	Prob > chi2	0.000

Depent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Tue - squared	0.0005	0.0002	2.05	0.041	0.0000	0.0010
CDH x Tue - cubed	0.0000	0.0000	-2.40	0.016	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						
CDH x Wed - cubed (Base omitted)						
CDH x Thu	-0.0048	0.0026	-1.83	0.068	-0.0099	0.0004
CDH x Thu - squared	0.0006	0.0002	2.70	0.007	0.0002	0.0010
CDH x Thu - cubed	0.0000	0.0000	-3.21	0.001	0.0000	0.0000
CDH x Fri	-0.0012	0.0027	-0.44	0.663	-0.0064	0.0041
CDH x Fri - squared	0.0001	0.0002	0.56	0.576	-0.0003	0.0006
CDH x Fri - cubed	0.0000	0.0000	-0.68	0.496	0.0000	0.0000
CDH x Sat	-0.0001	0.0024	-0.03	0.973	-0.0049	0.0047
CDH x Sat - squared	0.0000	0.0002	0.19	0.851	-0.0004	0.0004
CDH x Sat - cubed	0.0000	0.0000	-0.20	0.839	0.0000	0.0000
Constant	0.0018	0.0042	0.44	0.662	-0.0063	0.0100
ARMA						
ar						
L1.	0.5842	0.0047	123.91	0.000	0.5749987	0.5935
/sigma	0.0754	0.0003	269.31	0.000	0.0748318	0.0759

ARIMA REGRESSSION - Fairfield DLC Switches

			Number of obs	16035
			Wald chi2(102)	279519.34
Log	likelihood =	23718.27	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Avg kW - 35 min lag	0.1094	0.0049	22.27	0.000	0.0998	0.1191
Avg kW - 40 min lag	0.1085	0.0053	20.66	0.000	0.0982	0.1187
Avg kW - 45 min lag	0.1200	0.0053	22.81	0.000	0.1097	0.1303
Avg kW - 50 min lag	0.1095	0.0048	22.86	0.000	0.1001	0.1189
Avg kW - 35 min lead	0.1048	0.0049	21.29	0.000	0.0952	0.1145
Avg kW - 40 min lead	0.1115	0.0053	20.86	0.000	0.1010	0.1220
Avg kW - 45 min lead	0.1237	0.0052	23.58	0.000	0.1134	0.1340
Avg kW - 50 min lead	0.1090	0.0050	21.63	0.000	0.0991	0.1188
CDH	0.0038	0.0029	1.32	0.188	-0.0019	0.0095
CDH - squared	0.0000	0.0002	0.05	0.958	-0.0004	0.0004
CDH - cubed	0.0000	0.0000	0.46	0.646	0.0000	0.0000
CDH x Hour 1	0.0008	0.0101	0.08	0.940	-0.0190	0.0206
CDH x Hour 2	-0.0015	0.0132	-0.12	0.906	-0.0274	0.0243
CDH x Hour 3	-0.0033	0.0231	-0.14	0.888	-0.0485	0.0420
CDH x Hour 4	-0.0179	0.0405	-0.44	0.658	-0.0974	0.0615
CDH x Hour 5	-0.0106	0.0756	-0.14	0.888	-0.1587	0.1375
CDH x Hour 6	-0.0063	0.1018	-0.06	0.951	-0.2059	0.1933
CDH x Hour 7	-0.0045	0.2198	-0.02	0.984	-0.4353	0.4263
CDH x Hour 8	0.0121	0.0431	0.28	0.779	-0.0724	0.0965
CDH x Hour 9	-0.0157	0.0158	-0.99	0.320	-0.0467	0.0153
CDH x Hour 10	-0.0033	0.0067	-0.49	0.623	-0.0165	0.0099
CDH x Hour 11	-0.0038	0.0048	-0.78	0.433	-0.0131	0.0056
CDH x Hour 12	-0.0033	0.0041	-0.81	0.419	-0.0114	0.0048
CDH x Hour 13	-0.0055	0.0036	-1.51	0.131	-0.0127	0.0016
CDH x Hour 14	-0.0053	0.0034	-1.57	0.116	-0.0119	0.0013
CDH x Hour 15	-0.0079	0.0033	-2.38	0.018	-0.0144	-0.0014
CDH x Hour 16	-0.0024	0.0026	-0.92	0.357	-0.0075	0.0027
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	-0.0026	0.0025	-1.07	0.286	-0.0074	0.0022
CDH x Hour 19	0.0004	0.0026	0.14	0.889	-0.0047	0.0055
CDH x Hour 20	-0.0033	0.0033	-1.01	0.314	-0.0098	0.0031
CDH x Hour 21	0.0003	0.0039	0.09	0.932	-0.0074	0.0081
CDH x Hour 22	-0.0017	0.0053	-0.33	0.742	-0.0121	0.0086
CDH x Hour 23	0.0088	0.0058	1.50	0.133	-0.0027	0.0202
CDH x Hour 24	-0.0025	0.0074	-0.34	0.736	-0.0170	0.0120
CDH x Hour 1 - squared	-0.0016	0.0022	-0.71	0.476	-0.0059	0.0028
CDH x Hour 2 - squared	-0.0008	0.0035	-0.23	0.816	-0.0076	0.0060
CDH x Hour 3 - squared	-0.0004	0.0084	-0.05	0.961	-0.0168	0.0160
CDH x Hour 4 - squared	0.0082	0.0261	0.31	0.754	-0.0430	0.0594
CDH x Hour 5 - squared	0.0103	0.0515	0.20	0.841	-0.0906	0.1113
CDH x Hour 6 - squared	0.0002	0.0512	0.00	0.997	-0.1001	0.1004
CDH x Hour 7 - squared	0.0068	0.1181	0.06	0.954	-0.2246	0.2383
CDH x Hour 8 - squared	-0.0068	0.0157	-0.43	0.665	-0.0375	0.0239
CDH x Hour 9 - squared	0.0030	0.0037	0.83	0.407	-0.0042	0.0103

ARIA REGRESSSION - Fairfield DLC Switches

			Number of obs	16035
			Wald chi2(102)	279519.34
Log	likelihood =	23718.27	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Hour 10 - squared	-0.0003	0.0009	-0.31	0.756	-0.0021	0.0016
CDH x Hour 11 - squared	-0.0001	0.0005	-0.20	0.838	-0.0011	0.0009
CDH x Hour 12 - squared	-0.0002	0.0004	-0.42	0.675	-0.0009	0.0006
CDH x Hour 13 - squared	0.0002	0.0003	0.54	0.589	-0.0004	0.0007
CDH x Hour 14 - squared	0.0002	0.0003	0.67	0.500	-0.0003	0.0007
CDH x Hour 15 - squared	0.0004	0.0002	1.65	0.100	-0.0001	0.0009
CDH x Hour 16 - squared	0.0000	0.0002	-0.06	0.956	-0.0004	0.0004
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	0.0004	0.0002	1.93	0.054	0.0000	0.0007
CDH x Hour 19 - squared	0.0001	0.0002	0.67	0.502	-0.0003	0.0005
CDH x Hour 20 - squared	0.0005	0.0003	1.82	0.070	0.0000	0.0011
CDH x Hour 21 - squared	-0.0003	0.0004	-0.65	0.518	-0.0011	0.0006
CDH x Hour 22 - squared	0.0003	0.0007	0.46	0.649	-0.0010	0.0017
CDH x Hour 23 - squared	-0.0016	0.0009	-1.79	0.074	-0.0034	0.0002
CDH x Hour 24 - squared	0.0002	0.0014	0.11	0.911	-0.0026	0.0030
CDH x Hour 1 - cubed	0.0001	0.0001	0.79	0.431	-0.0001	0.0003
CDH x Hour 2 - cubed	0.0001	0.0002	0.35	0.724	-0.0004	0.0005
CDH x Hour 3 - cubed	0.0001	0.0007	0.10	0.918	-0.0013	0.0014
CDH x Hour 4 - cubed	-0.0009	0.0032	-0.30	0.765	-0.0071239	0.0052
CDH x Hour 5 - cubed	-0.0016	0.0073	-0.22	0.825	-0.0158232	0
CDH x Hour 6 - cubed	0.0000	0.0064	0.00	1.000	-0.012468	0
CDH x Hour 7 - cubed	-0.0016	0.0150	-0.11	0.914	-0.0310573	0.028
CDH x Hour 8 - cubed	0.0006	0.0013	0.46	0.645	-0.0019566	0.0031615
CDH x Hour 9 - cubed	-0.0002	0.0002	-0.87	0.387	-0.0006	0.0002
CDH x Hour 10 - cubed	0.0000	0.0000	0.32	0.750	-0.0001	0.0001
CDH x Hour 11 - cubed	0.0000	0.0000	0.29	0.773	0.0000	0.0000
CDH x Hour 12 - cubed	0.0000	0.0000	0.79	0.429	0.0000	0.0000
CDH x Hour 13 - cubed	0.0000	0.0000	-0.46	0.648	0.0000	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	-0.69	0.491	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	-1.51	0.130	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	0.41	0.680	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	-2.39	0.017	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	-1.15	0.251	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	-2.16	0.030	0.0000	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	1.22	0.224	0.0000	0.0000
CDH x Hour 22 - cubed	0.0000	0.0000	-0.49	0.621	-0.0001	0.0000
CDH x Hour 23 - cubed	0.0001	0.0000	1.80	0.071	0.0000	0.0001
CDH x Hour 24 - cubed	0.0000	0.0001	-0.07	0.943	-0.0001	0.0001
CDH x Sep	-0.0023	0.0013	-1.79	0.073	-0.0047	0.0002
CDH x Sep - squared	0.0002	0.0001	2.33	0.020	0.0000	0.0004
CDH x Sep - cubed	0.0000	0.0000	-2.72	0.007	0.0000	0.0000
CDH x Sun	0.0025	0.0025	1.01	0.312	-0.0024	0.0074
CDH x Sun - squared	-0.0002	0.0002	-0.98	0.327	-0.0006	0.0002
CDH x Sun - cubed	0.0000	0.0000	0.87	0.385	0.0000	0.0000
CDH x Mon	0.0010	0.0024	0.40	0.691	-0.0038	0.0057

ARIMA REGRESSSION - Fairfield DLC Switches

					Number of obs	16035
					Wald chi2(102)	279519.34
Log	likelihood	=	23718.27		Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Mon - squared	-0.0001	0.0002	-0.43	0.666	-0.0005	0.0003
CDH x Mon - cubed	0.0000	0.0000	0.44	0.662	0.0000	0.0000
CDH x Tue	0.0037	0.0024	1.53	0.125	-0.0010	0.0085
CDH x Tue - squared	-0.0004	0.0002	-2.10	0.036	-0.0008	0.0000
CDH x Tue - cubed	0.0000	0.0000	2.43	0.015	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						
CDH x Wed - cubed (Base omitted)						
CDH x Thu	-0.0024	0.0023	-1.04	0.298	-0.0070	0.0021
CDH x Thu - squared	0.0003	0.0002	1.82	0.069	0.0000	0.0007
CDH x Thu - cubed	0.0000	0.0000	-2.41	0.016	0.0000	0.0000
CDH x Fri	0.0056	0.0024	2.38	0.017	0.0010	0.0103
CDH x Fri - squared	-0.0005	0.0002	-2.85	0.004	-0.0009	-0.0002
CDH x Fri - cubed	0.0000	0.0000	3.07	0.002	0.0000	0.0000
CDH x Sat	0.0023	0.0023	1.03	0.301	-0.0021	0.0068
CDH x Sat - squared	-0.0002	0.0002	-1.28	0.200	-0.0006	0.0001
CDH x Sat - cubed	0.0000	0.0000	1.46	0.146	0.0000	0.0000
Constant	0.0021	0.0050	0.42	0.672	-0.0077	0.0120
ARMA						
ar						
L1.	0.6736	0.0034	195.87	0.000	0.6668104	0.6803
/sigma	0.0550	0.0002	344.07	0.000	0.0546413	0.0553

ARIMA REGRESSION - Fresno 1 DLC switches

		Number of obs	16035
		Wald chi2(102)	122254.26
Log likelihood =	20789.06	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Avg kW - 35 min lag	0.1261	0.0054	23.19	0.000	0.1155	0.1368
Avg kW - 40 min lag	0.1143	0.0061	18.78	0.000	0.1023	0.1262
Avg kW - 45 min lag	0.0672	0.0056	11.91	0.000	0.0561	0.0783
Avg kW - 50 min lag	0.0554	0.0054	10.35	0.000	0.0449	0.0659
Avg kW - 35 min lead	0.1231	0.0056	21.98	0.000	0.1121	0.1341
Avg kW - 40 min lead	0.1170	0.0058	20.09	0.000	0.1056	0.1285
Avg kW - 45 min lead	0.0651	0.0058	11.27	0.000	0.0538	0.0764
Avg kW - 50 min lead	0.0596	0.0057	10.47	0.000	0.0484	0.0707
CDH	-0.0048	0.0094	-0.51	0.610	-0.0231	0.0136
CDH - squared	0.0007	0.0005	1.43	0.154	-0.0003	0.0018
CDH - cubed	0.0000	0.0000	-0.73	0.466	0.0000	0.0000
CDH x Hour 1	0.0090	0.0164	0.55	0.582	-0.0231	0.0412
CDH x Hour 2	0.0036	0.0207	0.18	0.861	-0.0369	0.0441
CDH x Hour 3	-0.0002	0.0247	-0.01	0.994	-0.0487	0.0483
CDH x Hour 4	0.0034	0.0319	0.11	0.915	-0.0591	0.0659
CDH x Hour 5	0.0057	0.0345	0.16	0.869	-0.0620	0.0734
CDH x Hour 6	0.0042	0.0386	0.11	0.913	-0.0714	0.0799
CDH x Hour 7	0.0001	0.0426	0.00	0.998	-0.0833	0.0836
CDH x Hour 8	0.0056	0.0428	0.13	0.896	-0.0784	0.0896
CDH x Hour 9	0.0054	0.0273	0.20	0.843	-0.0481	0.0589
CDH x Hour 10	0.0089	0.0185	0.48	0.632	-0.0274	0.0451
CDH x Hour 11	0.0017	0.0156	0.11	0.914	-0.0288	0.0322
CDH x Hour 12	0.0000	0.0134	0.00	0.999	-0.0263	0.0263
CDH x Hour 13	0.0037	0.0110	0.34	0.738	-0.0179	0.0253
CDH x Hour 14	0.0012	0.0099	0.12	0.907	-0.0183	0.0206
CDH x Hour 15	0.0006	0.0088	0.07	0.945	-0.0166	0.0178
CDH x Hour 16	-0.0017	0.0060	-0.29	0.770	-0.0135	0.0100
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	0.0008	0.0075	0.10	0.919	-0.0139	0.0154
CDH x Hour 19	0.0117	0.0089	1.31	0.190	-0.0058	0.0291
CDH x Hour 20	0.0027	0.0088	0.30	0.762	-0.0145	0.0198
CDH x Hour 21	0.0005	0.0098	0.05	0.960	-0.0187	0.0197
CDH x Hour 22	-0.0011	0.0115	-0.09	0.925	-0.0236	0.0214
CDH x Hour 23	0.0118	0.0116	1.01	0.311	-0.0110	0.0345
CDH x Hour 24	0.0095	0.0151	0.63	0.531	-0.0202	0.0392
CDH x Hour 1 - squared	-0.0011	0.0020	-0.56	0.578	-0.0050	0.0028
CDH x Hour 2 - squared	-0.0004	0.0029	-0.13	0.900	-0.0061	0.0054
CDH x Hour 3 - squared	0.0004	0.0039	0.10	0.924	-0.0073	0.0081
CDH x Hour 4 - squared	-0.0004	0.0060	-0.07	0.947	-0.0122	0.0114
CDH x Hour 5 - squared	-0.0007	0.0069	-0.11	0.916	-0.0143	0.0128
CDH x Hour 6 - squared	-0.0002	0.0083	-0.03	0.980	-0.0165	0.0161
CDH x Hour 7 - squared	0.0010	0.0103	0.10	0.922	-0.0191	0.0211
CDH x Hour 8 - squared	-0.0008	0.0099	-0.08	0.939	-0.0201	0.0186
CDH x Hour 9 - squared	-0.0009	0.0046	-0.20	0.841	-0.0099	0.0080

ARIMA REGRESSION - Fresno 1 DLC switches

		Number of obs	16035
		Wald chi2(102)	122254.26
Log	likelihood =	20789.06 Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Hour 10 - squared	-0.0016	0.0022	-0.72	0.474	-0.0058	0.0027
CDH x Hour 11 - squared	-0.0003	0.0015	-0.20	0.844	-0.0032	0.0026
CDH x Hour 12 - squared	-0.0001	0.0011	-0.13	0.898	-0.0024	0.0021
CDH x Hour 13 - squared	-0.0006	0.0008	-0.66	0.508	-0.0022	0.0011
CDH x Hour 14 - squared	-0.0002	0.0007	-0.30	0.762	-0.0016	0.0012
CDH x Hour 15 - squared	-0.0001	0.0006	-0.14	0.887	-0.0013	0.0011
CDH x Hour 16 - squared	0.0001	0.0004	0.25	0.804	-0.0007	0.0009
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	0.0001	0.0005	0.12	0.904	-0.0009	0.0010
CDH x Hour 19 - squared	-0.0009	0.0006	-1.44	0.150	-0.0020	0.0003
CDH x Hour 20 - squared	0.0000	0.0006	0.02	0.986	-0.0012	0.0012
CDH x Hour 21 - squared	0.0001	0.0007	0.07	0.944	-0.0014	0.0015
CDH x Hour 22 - squared	0.0003	0.0010	0.30	0.765	-0.0016	0.0022
CDH x Hour 23 - squared	-0.0010	0.0011	-0.88	0.377	-0.0031	0.0012
CDH x Hour 24 - squared	-0.0010	0.0017	-0.59	0.556	-0.0043	0.0023
CDH x Hour 1 - cubed	0.0000	0.0001	0.38	0.704	-0.0001	0.0001
CDH x Hour 2 - cubed	0.0000	0.0001	0.00	0.999	-0.0002	0.0002
CDH x Hour 3 - cubed	0.0000	0.0002	-0.24	0.809	-0.0004	0.0003
CDH x Hour 4 - cubed	0.0000	0.0003	0.00	0.997	-0.0005629	0.0006
CDH x Hour 5 - cubed	0.0000	0.0004	0.01	0.990	-0.0006843	0
CDH x Hour 6 - cubed	0.0000	0.0004	-0.08	0.938	-0.0009055	0
CDH x Hour 7 - cubed	-0.0001	0.0006	-0.20	0.842	-0.0013412	0.001
CDH x Hour 8 - cubed	0.0000	0.0006	0.02	0.986	-0.0011178	0.0011385
CDH x Hour 9 - cubed	0.0000	0.0002	0.10	0.918	-0.0004	0.0004
CDH x Hour 10 - cubed	0.0001	0.0001	0.77	0.441	-0.0001	0.0002
CDH x Hour 11 - cubed	0.0000	0.0000	0.00	0.997	-0.0001	0.0001
CDH x Hour 12 - cubed	0.0000	0.0000	-0.07	0.948	0.0000	0.0000
CDH x Hour 13 - cubed	0.0000	0.0000	0.63	0.530	0.0000	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	0.18	0.855	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	0.00	0.998	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	-0.45	0.652	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	-0.39	0.699	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	1.53	0.126	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	-0.34	0.737	0.0000	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	-0.30	0.760	0.0000	0.0000
CDH x Hour 22 - cubed	0.0000	0.0000	-0.50	0.620	-0.0001	0.0000
CDH x Hour 23 - cubed	0.0000	0.0000	0.52	0.604	0.0000	0.0001
CDH x Hour 24 - cubed	0.0000	0.0000	0.41	0.684	-0.0001	0.0001
CDH x Sep	0.0007	0.0027	0.27	0.786	-0.0045	0.0060
CDH x Sep - squared	-0.0001	0.0002	-0.36	0.722	-0.0005	0.0003
CDH x Sep - cubed	0.0000	0.0000	0.33	0.744	0.0000	0.0000
CDH x Sun	0.0014	0.0045	0.32	0.751	-0.0073	0.0102
CDH x Sun - squared	-0.0001	0.0003	-0.25	0.804	-0.0007	0.0006
CDH x Sun - cubed	0.0000	0.0000	0.21	0.834	0.0000	0.0000
CDH x Mon	0.0029	0.0046	0.63	0.526	-0.0062	0.0120

ARIMA REGRESSION - Fresno 1 DLC switches

		Number of obs	16035
		Wald chi2(102)	122254.26
Log likelihood	= 20789.06	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Mon - squared	-0.0003	0.0003	-0.74	0.462	-0.0009	0.0004
CDH x Mon - cubed	0.0000	0.0000	0.67	0.501	0.0000	0.0000
CDH x Tue	0.0011	0.0048	0.23	0.817	-0.0083	0.0105
CDH x Tue - squared	-0.0002	0.0004	-0.44	0.662	-0.0009	0.0005
CDH x Tue - cubed	0.0000	0.0000	0.65	0.516	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						
CDH x Wed - cubed (Base omitted)						
CDH x Thu	0.0018	0.0046	0.39	0.696	-0.0072	0.0108
CDH x Thu - squared	-0.0001	0.0003	-0.40	0.690	-0.0008	0.0005
CDH x Thu - cubed	0.0000	0.0000	0.34	0.734	0.0000	0.0000
CDH x Fri	-0.0015	0.0048	-0.31	0.760	-0.0108	0.0079
CDH x Fri - squared	0.0002	0.0004	0.51	0.607	-0.0005	0.0009
CDH x Fri - cubed	0.0000	0.0000	-0.73	0.464	0.0000	0.0000
CDH x Sat	0.0035	0.0045	0.78	0.437	-0.0054	0.0124
CDH x Sat - squared	-0.0002	0.0003	-0.71	0.475	-0.0009	0.0004
CDH x Sat - cubed	0.0000	0.0000	0.53	0.599	0.0000	0.0000
Constant	0.0055	0.0542	0.10	0.919	-0.1006	0.1117
ARMA						
ar						
L1.	0.7736	0.0037	211.68	0.000	0.7664773	0.7808
/sigma	0.0659	0.0002	304.95	0.000	0.065443	0.0663

ARIMA REGRESSION - Fresno 2 DLC switches

		Number of obs	16035
		Wald chi2(102)	131187.22
Log likelihood =	14,675.7000	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Avg kW - 35 min lag	0.0742	0.0052	14.29	0.000	0.0640	0.0843
Avg kW - 40 min lag	0.1192	0.0056	21.16	0.000	0.1082	0.1302
Avg kW - 45 min lag	0.1192	0.0055	21.73	0.000	0.1085	0.1300
Avg kW - 50 min lag	0.0620	0.0052	11.97	0.000	0.0519	0.0722
Avg kW - 35 min lead	0.0688	0.0051	13.45	0.000	0.0587	0.0788
Avg kW - 40 min lead	0.1280	0.0054	23.70	0.000	0.1174	0.1386
Avg kW - 45 min lead	0.1280	0.0055	23.46	0.000	0.1173	0.1387
Avg kW - 50 min lead	0.0677	0.0052	12.98	0.000	0.0575	0.0779
CDH	0.0005	0.0140	0.04	0.971	-0.0269	0.0280
CDH - squared	0.0001	0.0007	0.09	0.929	-0.0014	0.0015
CDH - cubed	0.0000	0.0000	0.91	0.363	0.0000	0.0000
CDH x Hour 1	0.0062	0.0252	0.25	0.805	-0.0432	0.0556
CDH x Hour 2	0.0046	0.0316	0.15	0.883	-0.0573	0.0665
CDH x Hour 3	0.0014	0.0416	0.03	0.974	-0.0802	0.0829
CDH x Hour 4	0.0059	0.0671	0.09	0.930	-0.1257	0.1375
CDH x Hour 5	0.0033	0.0800	0.04	0.967	-0.1534	0.1601
CDH x Hour 6	0.0032	0.0766	0.04	0.967	-0.1470	0.1533
CDH x Hour 7	0.0010	0.0737	0.01	0.989	-0.1434	0.1454
CDH x Hour 8	0.0057	0.0997	0.06	0.954	-0.1896	0.2010
CDH x Hour 9	0.0029	0.0533	0.06	0.956	-0.1015	0.1074
CDH x Hour 10	0.0026	0.0349	0.08	0.940	-0.0657	0.0710
CDH x Hour 11	0.0100	0.0285	0.35	0.726	-0.0458	0.0658
CDH x Hour 12	0.0108	0.0238	0.45	0.650	-0.0359	0.0575
CDH x Hour 13	-0.0031	0.0182	-0.17	0.867	-0.0388	0.0327
CDH x Hour 14	-0.0063	0.0163	-0.39	0.700	-0.0381	0.0256
CDH x Hour 15	0.0061	0.0137	0.45	0.655	-0.0207	0.0329
CDH x Hour 16	0.0011	0.0117	0.09	0.927	-0.0219	0.0240
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	-0.0045	0.0101	-0.45	0.654	-0.0243	0.0153
CDH x Hour 19	0.0062	0.0115	0.54	0.592	-0.0164	0.0288
CDH x Hour 20	-0.0070	0.0121	-0.58	0.561	-0.0308	0.0167
CDH x Hour 21	0.0082	0.0128	0.63	0.526	-0.0170	0.0333
CDH x Hour 22	0.0084	0.0141	0.60	0.551	-0.0193	0.0362
CDH x Hour 23	0.0012	0.0172	0.07	0.944	-0.0325	0.0349
CDH x Hour 24	0.0063	0.0201	0.31	0.754	-0.0331	0.0457
CDH x Hour 1 - squared	-0.0007	0.0030	-0.24	0.811	-0.0066	0.0051
CDH x Hour 2 - squared	-0.0008	0.0044	-0.19	0.852	-0.0094	0.0078
CDH x Hour 3 - squared	0.0001	0.0065	0.02	0.984	-0.0127	0.0130
CDH x Hour 4 - squared	-0.0011	0.0130	-0.08	0.936	-0.0266	0.0245
CDH x Hour 5 - squared	-0.0005	0.0169	-0.03	0.975	-0.0336	0.0325
CDH x Hour 6 - squared	-0.0003	0.0177	-0.01	0.989	-0.0349	0.0343
CDH x Hour 7 - squared	0.0006	0.0166	0.04	0.971	-0.0320	0.0332
CDH x Hour 8 - squared	-0.0013	0.0208	-0.06	0.948	-0.0422	0.0395
CDH x Hour 9 - squared	-0.0003	0.0090	-0.04	0.971	-0.0180	0.0174

ARIMA REGRESSION - Fresno 2 DLC switches

		Number of obs	16035
		Wald chi2(102)	131187.22
Log likelihood =	14,675.7000	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Hour 10 - squared	-0.0004	0.0041	-0.09	0.925	-0.0083	0.0076
CDH x Hour 11 - squared	-0.0014	0.0027	-0.53	0.594	-0.0066	0.0038
CDH x Hour 12 - squared	-0.0014	0.0019	-0.75	0.455	-0.0052	0.0023
CDH x Hour 13 - squared	0.0000	0.0013	0.02	0.983	-0.0026	0.0026
CDH x Hour 14 - squared	0.0003	0.0011	0.28	0.780	-0.0019	0.0025
CDH x Hour 15 - squared	-0.0008	0.0009	-0.90	0.366	-0.0026	0.0010
CDH x Hour 16 - squared	-0.0003	0.0008	-0.35	0.727	-0.0018	0.0012
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	0.0005	0.0006	0.72	0.468	-0.0008	0.0017
CDH x Hour 19 - squared	-0.0002	0.0008	-0.31	0.756	-0.0017	0.0013
CDH x Hour 20 - squared	0.0007	0.0008	0.82	0.412	-0.0009	0.0023
CDH x Hour 21 - squared	-0.0009	0.0009	-0.93	0.353	-0.0027	0.0010
CDH x Hour 22 - squared	-0.0009	0.0011	-0.75	0.451	-0.0031	0.0014
CDH x Hour 23 - squared	0.0000	0.0016	0.03	0.978	-0.0031	0.0031
CDH x Hour 24 - squared	-0.0008	0.0021	-0.37	0.710	-0.0049	0.0033
CDH x Hour 1 - cubed	0.0000	0.0001	0.11	0.912	-0.0002	0.0002
CDH x Hour 2 - cubed	0.0000	0.0002	0.15	0.879	-0.0003	0.0003
CDH x Hour 3 - cubed	0.0000	0.0003	-0.12	0.908	-0.0005	0.0005
CDH x Hour 4 - cubed	0.0000	0.0006	0.05	0.962	-0.0011927	0.0013
CDH x Hour 5 - cubed	0.0000	0.0009	0.01	0.990	-0.0017214	0
CDH x Hour 6 - cubed	0.0000	0.0010	-0.01	0.988	-0.0019934	0
CDH x Hour 7 - cubed	-0.0001	0.0010	-0.09	0.930	-0.001962	0.002
CDH x Hour 8 - cubed	0.0001	0.0011	0.06	0.951	-0.0020309	0.0021624
CDH x Hour 9 - cubed	0.0000	0.0004	-0.02	0.981	-0.0008	0.0008
CDH x Hour 10 - cubed	0.0000	0.0001	-0.02	0.985	-0.0002	0.0002
CDH x Hour 11 - cubed	0.0000	0.0001	0.52	0.604	-0.0001	0.0002
CDH x Hour 12 - cubed	0.0000	0.0000	0.79	0.430	0.0000	0.0001
CDH x Hour 13 - cubed	0.0000	0.0000	-0.22	0.828	-0.0001	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	-0.50	0.617	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	1.04	0.300	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	0.42	0.673	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	-0.96	0.338	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	0.14	0.892	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	-1.04	0.298	0.0000	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	1.20	0.231	0.0000	0.0001
CDH x Hour 22 - cubed	0.0000	0.0000	0.78	0.434	0.0000	0.0001
CDH x Hour 23 - cubed	0.0000	0.0000	-0.28	0.780	-0.0001	0.0001
CDH x Hour 24 - cubed	0.0000	0.0001	0.26	0.798	-0.0001	0.0001
CDH x Sep	-0.0008	0.0033	-0.23	0.817	-0.0072	0.0057
CDH x Sep - squared	0.0001	0.0002	0.29	0.771	-0.0004	0.0005
CDH x Sep - cubed	0.0000	0.0000	-0.63	0.529	0.0000	0.0000
CDH x Sun	-0.0040	0.0054	-0.74	0.459	-0.0145	0.0066
CDH x Sun - squared	0.0004	0.0004	1.15	0.249	-0.0003	0.0012
CDH x Sun - cubed	0.0000	0.0000	-1.51	0.132	0.0000	0.0000
CDH x Mon	-0.0037	0.0060	-0.62	0.534	-0.0155	0.0080

ARIMA REGRESSION - Fresno 2 DLC switches

		Number of obs	16035
		Wald chi2(102)	131187.22
Log likelihood =	14,675.7000	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Mon - squared	0.0004	0.0004	0.88	0.379	-0.0005	0.0013
CDH x Mon - cubed	0.0000	0.0000	-1.05	0.294	0.0000	0.0000
CDH x Tue	-0.0023	0.0060	-0.39	0.700	-0.0140	0.0094
CDH x Tue - squared	0.0002	0.0004	0.48	0.630	-0.0006	0.0011
CDH x Tue - cubed	0.0000	0.0000	-0.47	0.638	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						
CDH x Wed - cubed (Base omitted)						
CDH x Thu	-0.0040	0.0058	-0.68	0.496	-0.0154	0.0074
CDH x Thu - squared	0.0005	0.0004	1.06	0.287	-0.0004	0.0013
CDH x Thu - cubed	0.0000	0.0000	-1.40	0.160	0.0000	0.0000
CDH x Fri	-0.0049	0.0060	-0.82	0.413	-0.0166	0.0068
CDH x Fri - squared	0.0006	0.0004	1.34	0.179	-0.0003	0.0015
CDH x Fri - cubed	0.0000	0.0000	-1.82	0.069	0.0000	0.0000
CDH x Sat	-0.0042	0.0057	-0.74	0.462	-0.0154	0.0070
CDH x Sat - squared	0.0005	0.0004	1.19	0.233	-0.0003	0.0013
CDH x Sat - cubed	0.0000	0.0000	-1.64	0.101	0.0000	0.0000
Constant	0.0004	0.0894	0.00	0.996	-0.1748	0.1757
ARMA						
ar						
L1.	0.6502	0.0037	175.97	0.000	0.6429592	0.6574
/sigma	0.0966	0.0003	338.88	0.000	0.0960543	0.0972

ARIMA REGRESSION - Antioch PCTs

Number of obs	15897
Wald Chi2	146764.63
Prob > chi2	0.000

Log likelihood = 11893.29

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Avg kW - 35 min lag	0.0934	0.0056	16.55	0.000	0.0824	0.1045
Avg kW - 40 min lag	0.0939	0.0063	15.01	0.000	0.0816	0.1061
Avg kW - 45 min lag	0.1423	0.0062	22.84	0.000	0.1301	0.1545
Avg kW - 50 min lag	0.1461	0.0056	26.11	0.000	0.1351	0.1571
Avg kW - 35 min lead	0.0901	0.0056	15.98	0.000	0.0790	0.1011
Avg kW - 40 min lead	0.0960	0.0062	15.58	0.000	0.0839	0.1081
Avg kW - 45 min lead	0.1455	0.0062	23.37	0.000	0.1333	0.1577
Avg kW - 50 min lead	0.1390	0.0057	24.51	0.000	0.1279	0.1501
CDH	0.0017	0.0043	0.39	0.694	-0.0068	0.0102
CDH - squared	0.0004	0.0003	1.18	0.236	-0.0003	0.0010
CDH - cubed	0.0000	0.0000	-1.55	0.122	0.0000	0.0000
CDH x Hour 1	-0.0005	0.0139	-0.04	0.971	-0.0278	0.0268
CDH x Hour 2	-0.0132	0.0173	-0.76	0.446	-0.0470	0.0207
CDH x Hour 3	0.0027	0.0258	0.10	0.917	-0.0479	0.0532
CDH x Hour 4	0.0181	0.0417	0.43	0.664	-0.0637	0.0999
CDH x Hour 5	-0.0289	0.0781	-0.37	0.711	-0.1819	0.1241
CDH x Hour 6	0.0415	0.0852	0.49	0.627	-0.1255	0.2084
CDH x Hour 7	0.0094	0.2427	0.04	0.969	-0.4663	0.4852
CDH x Hour 8	-0.0337	0.0512	-0.66	0.510	-0.1340	0.0666
CDH x Hour 9	-0.0014	0.0165	-0.08	0.933	-0.0338	0.0310
CDH x Hour 10	-0.0066	0.0072	-0.92	0.360	-0.0208	0.0076
CDH x Hour 11	-0.0049	0.0058	-0.85	0.396	-0.0162	0.0064
CDH x Hour 12	0.0003	0.0053	0.06	0.950	-0.0100	0.0107
CDH x Hour 13	-0.0018	0.0051	-0.35	0.724	-0.0118	0.0082
CDH x Hour 14	-0.0070	0.0047	-1.49	0.137	-0.0163	0.0022
CDH x Hour 15	-0.0061	0.0045	-1.35	0.178	-0.0150	0.0028
CDH x Hour 16	-0.0053	0.0043	-1.24	0.213	-0.0138	0.0031
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	-0.0018	0.0043	-0.43	0.670	-0.0103	0.0066
CDH x Hour 19	0.0092	0.0044	2.08	0.038	0.0005	0.0178
CDH x Hour 20	-0.0094	0.0052	-1.82	0.069	-0.0196	0.0007
CDH x Hour 21	-0.0067	0.0063	-1.05	0.292	-0.0191	0.0057
CDH x Hour 22	0.0041	0.0084	0.49	0.625	-0.0124	0.0206
CDH x Hour 23	-0.0260	0.0102	-2.55	0.011	-0.0460	-0.0060
CDH x Hour 24	0.0123	0.0105	1.17	0.244	-0.0084	0.0329
CDH x Hour 1 - squared	-0.0018	0.0030	-0.58	0.560	-0.0076	0.0041
CDH x Hour 2 - squared	0.0031	0.0045	0.69	0.492	-0.0057	0.0119
CDH x Hour 3 - squared	-0.0016	0.0095	-0.16	0.869	-0.0202	0.0171
CDH x Hour 4 - squared	-0.0101	0.0251	-0.40	0.689	-0.0592	0.0391
CDH x Hour 5 - squared	0.0176	0.0536	0.33	0.742	-0.0873	0.1226
CDH x Hour 6 - squared	-0.0301	0.0404	-0.74	0.457	-0.1092	0.0491
CDH x Hour 7 - squared	-0.0101	0.1331	-0.08	0.940	-0.2710	0.2509
CDH x Hour 8 - squared	0.0120	0.0188	0.64	0.523	-0.0248	0.0488
CDH x Hour 9 - squared	-0.0004	0.0036	-0.12	0.905	-0.0075	0.0066
CDH x Hour 10 - squared	0.0004	0.0009	0.38	0.702	-0.0015	0.0022

ARIMA REGRESSION - Antioch PCTs

Number of obs	15897
Wald Chi2	146764.63
Prob > chi2	0.000

Log likelihood = 11893.29

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Hour 11 - squared	-0.0002	0.0006	-0.33	0.740	-0.0014	0.0010
CDH x Hour 12 - squared	-0.0006	0.0005	-1.30	0.193	-0.0015	0.0003
CDH x Hour 13 - squared	-0.0005	0.0004	-1.33	0.182	-0.0013	0.0003
CDH x Hour 14 - squared	0.0001	0.0004	0.36	0.716	-0.0006	0.0008
CDH x Hour 15 - squared	0.0002	0.0003	0.53	0.595	-0.0005	0.0008
CDH x Hour 16 - squared	0.0000	0.0003	-0.05	0.960	-0.0006	0.0006
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	0.0001	0.0003	0.40	0.692	-0.0005	0.0008
CDH x Hour 19 - squared	-0.0006	0.0003	-1.84	0.066	-0.0013	0.0000
CDH x Hour 20 - squared	0.0008	0.0005	1.72	0.085	-0.0001	0.0017
CDH x Hour 21 - squared	0.0001	0.0007	0.19	0.849	-0.0012	0.0014
CDH x Hour 22 - squared	-0.0011	0.0011	-0.97	0.331	-0.0032	0.0011
CDH x Hour 23 - squared	0.0026	0.0016	1.61	0.108	-0.0006	0.0057
CDH x Hour 24 - squared	-0.0016	0.0020	-0.80	0.422	-0.0056	0.0023
CDH x Hour 1 - cubed	0.0001	0.0002	0.79	0.431	-0.0002	0.0004
CDH x Hour 2 - cubed	-0.0002	0.0003	-0.81	0.415	-0.0008	0.0003
CDH x Hour 3 - cubed	0.0001	0.0008	0.13	0.895	-0.0015	0.0017
CDH x Hour 4 - cubed	0.0010	0.0030	0.33	0.744	-0.0048773	0.0068
CDH x Hour 5 - cubed	-0.0028	0.0074	-0.38	0.706	-0.0172477	0
CDH x Hour 6 - cubed	0.0043	0.0048	0.91	0.364	-0.0050076	0
CDH x Hour 7 - cubed	0.0013	0.0172	0.08	0.938	-0.0323246	0.035
CDH x Hour 8 - cubed	-0.0010	0.0016	-0.66	0.512	-0.0041091	0.0020473
CDH x Hour 9 - cubed	0.0000	0.0002	0.09	0.924	-0.0004	0.0004
CDH x Hour 10 - cubed	0.0000	0.0000	-0.42	0.673	-0.0001	0.0000
CDH x Hour 11 - cubed	0.0000	0.0000	0.51	0.607	0.0000	0.0000
CDH x Hour 12 - cubed	0.0000	0.0000	1.69	0.090	0.0000	0.0000
CDH x Hour 13 - cubed	0.0000	0.0000	2.12	0.034	0.0000	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	0.15	0.879	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	-0.29	0.775	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	0.95	0.341	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	-0.51	0.613	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	1.77	0.077	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	-1.66	0.096	0.0000	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	0.36	0.719	0.0000	0.0000
CDH x Hour 22 - cubed	0.0000	0.0000	1.11	0.265	0.0000	0.0001
CDH x Hour 23 - cubed	-0.0001	0.0001	-1.48	0.138	-0.0002	0.0000
CDH x Hour 24 - cubed	0.0001	0.0001	0.56	0.576	-0.0001	0.0002
CDH x Sep	-0.0001	0.0017	-0.08	0.938	-0.0034	0.0031
CDH x Sep - squared	0.0000	0.0001	-0.24	0.809	-0.0003	0.0002
CDH x Sep - cubed	0.0000	0.0000	0.49	0.625	0.0000	0.0000
CDH x Sun	0.0019	0.0032	0.60	0.550	-0.0044	0.0082
CDH x Sun - squared	-0.0001	0.0003	-0.39	0.700	-0.0006	0.0004
CDH x Sun - cubed	0.0000	0.0000	0.26	0.799	0.0000	0.0000
CDH x Mon	0.0008	0.0035	0.22	0.822	-0.0060	0.0076
CDH x Mon - squared	-0.0001	0.0003	-0.36	0.721	-0.0007	0.0005

ARIMA REGRESSION - Antioch PCTs

Number of obs	15897
Wald Chi2	146764.63
Prob > chi2	0.000

Log likelihood = 11893.29

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Mon - cubed	0.0000	0.0000	0.30	0.762	0.0000	0.0000
CDH x Tue	0.0018	0.0037	0.49	0.623	-0.0054	0.0091
CDH x Tue - squared	-0.0002	0.0003	-0.77	0.439	-0.0009	0.0004
CDH x Tue - cubed	0.0000	0.0000	0.76	0.445	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						
CDH x Wed - cubed (Base omitted)						
CDH x Thu	0.0035	0.0033	1.05	0.292	-0.0030	0.0100
CDH x Thu - squared	-0.0002	0.0003	-0.84	0.402	-0.0008	0.0003
CDH x Thu - cubed	0.0000	0.0000	0.43	0.670	0.0000	0.0000
CDH x Fri	0.0052	0.0033	1.58	0.115	-0.0013	0.0118
CDH x Fri - squared	-0.0005	0.0003	-1.58	0.113	-0.0010	0.0001
CDH x Fri - cubed	0.0000	0.0000	1.37	0.171	0.0000	0.0000
CDH x Sat	0.0066	0.0031	2.15	0.031	0.0006	0.0126
CDH x Sat - squared	-0.0006	0.0003	-2.32	0.020	-0.0011	-0.0001
CDH x Sat - cubed	0.0000	0.0000	2.29	0.022	0.0000	0.0000
Constant	0.0014	0.0048	0.29	0.774	-0.0081	0.0108
ARMA						
ar						
L1.	0.4409	0.0050	88.60	0.000	0.4311266	0.4506
/sigma	0.1144	0.0004	279.64	0.000	0.1135669	0.1152

ARIMA REGRESSSION - Fairfield PCTs

		Number of obs	15897
		Wald chi2(114)	85915.24
Log likelihood =	10133.03	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Avg kW - 35 min lag	0.0648	0.0051	12.76	0.000	0.0548	0.0747
Avg kW - 40 min lag	0.0516	0.0054	9.61	0.000	0.0411	0.0621
Avg kW - 45 min lag	0.1183	0.0054	22.03	0.000	0.1077	0.1288
Avg kW - 50 min lag	0.1516	0.0050	30.32	0.000	0.1418	0.1614
Avg kW - 35 min lead	0.0575	0.0050	11.53	0.000	0.0477	0.0673
Avg kW - 40 min lead	0.0447	0.0054	8.32	0.000	0.0342	0.0553
Avg kW - 45 min lead	0.1130	0.0054	20.91	0.000	0.1024	0.1236
Avg kW - 50 min lead	0.1403	0.0052	27.16	0.000	0.1302	0.1505
CDH	0.0007	0.0050	0.13	0.893	-0.0092	0.0105
CDH - squared	0.0006	0.0004	1.63	0.103	-0.0001	0.0014
CDH - cubed	0.0000	0.0000	-1.42	0.154	0.0000	0.0000
CDH x Hour 1	0.0149	0.0174	0.86	0.391	-0.0192	0.0490
CDH x Hour 2	0.0027	0.0233	0.12	0.908	-0.0430	0.0484
CDH x Hour 3	0.0028	0.0433	0.06	0.949	-0.0821	0.0876
CDH x Hour 4	0.0153	0.0694	0.22	0.825	-0.1206	0.1513
CDH x Hour 5	-0.0282	0.1414	-0.20	0.842	-0.3054	0.2491
CDH x Hour 6	0.1128	0.2476	0.46	0.649	-0.3724	0.5980
CDH x Hour 7	0.0124	1.6270	0.01	0.994	-3.1765	3.2012
CDH x Hour 8	-0.0019	0.1744	-0.01	0.991	-0.3438	0.3399
CDH x Hour 9	-0.0112	0.0329	-0.34	0.734	-0.0756	0.0533
CDH x Hour 10	-0.0064	0.0164	-0.39	0.694	-0.0385	0.0256
CDH x Hour 11	-0.0073	0.0087	-0.84	0.403	-0.0244	0.0098
CDH x Hour 12	-0.0060	0.0068	-0.88	0.380	-0.0194	0.0074
CDH x Hour 13	-0.0073	0.0061	-1.20	0.232	-0.0193	0.0047
CDH x Hour 14	-0.0025	0.0056	-0.44	0.659	-0.0134	0.0085
CDH x Hour 15	0.0091	0.0049	1.84	0.066	-0.0006	0.0187
CDH x Hour 16	-0.0015	0.0046	-0.33	0.743	-0.0105	0.0075
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	0.0035	0.0043	0.81	0.420	-0.0050	0.0119
CDH x Hour 19	0.0097	0.0048	2.00	0.046	0.0002	0.0192
CDH x Hour 20	-0.0051	0.0059	-0.86	0.387	-0.0166	0.0064
CDH x Hour 21	0.0018	0.0071	0.25	0.800	-0.0121	0.0157
CDH x Hour 22	0.0078	0.0092	0.84	0.400	-0.0103	0.0258
CDH x Hour 23	-0.0196	0.0119	-1.65	0.100	-0.0430	0.0037
CDH x Hour 24	0.0317	0.0147	2.15	0.031	0.0028	0.0605
CDH x Hour 1 - squared	-0.0016	0.0038	-0.42	0.671	-0.0090	0.0058
CDH x Hour 2 - squared	-0.0014	0.0059	-0.23	0.815	-0.0130	0.0102
CDH x Hour 3 - squared	-0.0023	0.0141	-0.17	0.868	-0.0301	0.0254
CDH x Hour 4 - squared	-0.0099	0.0411	-0.24	0.810	-0.0904	0.0707
CDH x Hour 5 - squared	0.0284	0.0941	0.30	0.763	-0.1561	0.2129
CDH x Hour 6 - squared	-0.0469	0.1124	-0.42	0.676	-0.2671	0.1733
CDH x Hour 7 - squared	-0.0122	0.8705	-0.01	0.989	-1.7184	1.6940
CDH x Hour 8 - squared	-0.0022	0.0716	-0.03	0.975	-0.1425	0.1381
CDH x Hour 9 - squared	0.0005	0.0080	0.07	0.948	-0.0151	0.0161

ARIMA REGRESSSION - Fairfield PCTs

				Number of obs	15897
				Wald chi2(114)	85915.24
Log	likelihood	=	10133.03	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Hour 10 - squared	-0.0003	0.0022	-0.14	0.886	-0.0046	0.0039
CDH x Hour 11 - squared	-0.0001	0.0009	-0.07	0.942	-0.0018	0.0017
CDH x Hour 12 - squared	-0.0002	0.0006	-0.26	0.793	-0.0013	0.0010
CDH x Hour 13 - squared	0.0001	0.0005	0.18	0.855	-0.0009	0.0011
CDH x Hour 14 - squared	-0.0003	0.0004	-0.80	0.425	-0.0012	0.0005
CDH x Hour 15 - squared	-0.0009	0.0004	-2.50	0.012	-0.0016	-0.0002
CDH x Hour 16 - squared	-0.0001	0.0003	-0.35	0.723	-0.0008	0.0006
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	0.0003	0.0003	0.91	0.364	-0.0004	0.0010
CDH x Hour 19 - squared	-0.0003	0.0004	-0.70	0.484	-0.0011	0.0005
CDH x Hour 20 - squared	0.0011	0.0005	2.13	0.033	0.0001	0.0022
CDH x Hour 21 - squared	-0.0001	0.0008	-0.17	0.864	-0.0016	0.0014
CDH x Hour 22 - squared	0.0003	0.0012	0.24	0.814	-0.0021	0.0026
CDH x Hour 23 - squared	0.0042	0.0018	2.33	0.020	0.0007	0.0078
CDH x Hour 24 - squared	-0.0068	0.0028	-2.39	0.017	-0.0124	-0.0012
CDH x Hour 1 - cubed	0.0000	0.0002	0.22	0.823	-0.0003	0.0004
CDH x Hour 2 - cubed	0.0001	0.0004	0.33	0.740	-0.0006	0.0008
CDH x Hour 3 - cubed	0.0002	0.0011	0.20	0.840	-0.0019	0.0024
CDH x Hour 4 - cubed	0.0011	0.0049	0.22	0.824	-0.0085383	0.0107
CDH x Hour 5 - cubed	-0.0045	0.0130	-0.34	0.730	-0.0300211	0
CDH x Hour 6 - cubed	0.0049	0.0127	0.39	0.700	-0.0199597	0
CDH x Hour 7 - cubed	0.0012	0.1097	0.01	0.991	-0.213775	0.216
CDH x Hour 8 - cubed	0.0002	0.0062	0.03	0.979	-0.0119835	0.0123043
CDH x Hour 9 - cubed	0.0000	0.0004	-0.02	0.980	-0.0009	0.0008
CDH x Hour 10 - cubed	0.0000	0.0001	0.14	0.888	-0.0001	0.0001
CDH x Hour 11 - cubed	0.0000	0.0000	0.03	0.980	0.0000	0.0000
CDH x Hour 12 - cubed	0.0000	0.0000	0.42	0.673	0.0000	0.0000
CDH x Hour 13 - cubed	0.0000	0.0000	-0.03	0.975	0.0000	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	1.34	0.182	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	2.72	0.006	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	0.53	0.593	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	-1.78	0.076	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	0.19	0.849	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	-2.86	0.004	-0.0001	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	0.50	0.614	0.0000	0.0001
CDH x Hour 22 - cubed	0.0000	0.0000	-0.82	0.410	-0.0001	0.0000
CDH x Hour 23 - cubed	-0.0002	0.0001	-2.75	0.006	-0.0003	-0.0001
CDH x Hour 24 - cubed	0.0003	0.0001	2.52	0.012	0.0001	0.0006
CDH x Sep	-0.0021	0.0022	-0.96	0.338	-0.0063	0.0022
CDH x Sep - squared	0.0004	0.0002	2.07	0.038	0.0000	0.0007
CDH x Sep - cubed	0.0000	0.0000	-2.46	0.014	0.0000	0.0000
CDH x Sun	0.0067	0.0042	1.61	0.108	-0.0015	0.0149
CDH x Sun - squared	-0.0007	0.0003	-2.06	0.039	-0.0014	0.0000
CDH x Sun - cubed	0.0000	0.0000	2.55	0.011	0.0000	0.0000
CDH x Mon	0.0024	0.0044	0.56	0.579	-0.0061	0.0110

ARIMA REGRESSSION - Fairfield PCTs

				Number of obs	15897
				Wald chi2(114)	85915.24
Log	likelihood	=	10133.03	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Mon - squared	-0.0002	0.0004	-0.58	0.564	-0.0009	0.0005
CDH x Mon - cubed	0.0000	0.0000	1.05	0.294	0.0000	0.0000
CDH x Tue	0.0124	0.0045	2.75	0.006	0.0036	0.0212
CDH x Tue - squared	-0.0014	0.0004	-3.62	0.000	-0.0021	-0.0006
CDH x Tue - cubed	0.0000	0.0000	3.93	0.000	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						
CDH x Wed - cubed (Base omitted)						
CDH x Thu	0.0053	0.0043	1.22	0.221	-0.0032	0.0138
CDH x Thu - squared	-0.0004	0.0004	-1.07	0.286	-0.0011	0.0003
CDH x Thu - cubed	0.0000	0.0000	1.06	0.290	0.0000	0.0000
CDH x Fri	0.0131	0.0042	3.11	0.002	0.0048	0.0213
CDH x Fri - squared	-0.0012	0.0004	-3.30	0.001	-0.0018	-0.0005
CDH x Fri - cubed	0.0000	0.0000	3.44	0.001	0.0000	0.0000
CDH x Sat	0.0070	0.0039	1.80	0.072	-0.0006	0.0146
CDH x Sat - squared	-0.0008	0.0003	-2.35	0.019	-0.0014	-0.0001
CDH x Sat - cubed	0.0000	0.0000	3.16	0.002	0.0000	0.0000
Constant	0.0204	0.0092	2.22	0.026	0.0024	0.0384
ARMA						
ar						
L1.	0.5221	0.0043	120.22	0.000	0.5135899	0.5306
/sigma	0.1277	0.0004	323.35	0.000	0.1269166	0.1285

ARIMA REGRESSION - Fresno 1 PCTs

					Number of obs	15897
					Wald chi2(114)	126345.29
Log	likelihood	=		12102.26	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Avg kW - 35 min lag	0.0361	0.0063	5.74	0.000	0.0238	0.0484
Avg kW - 40 min lag	0.1355	0.0064	21.05	0.000	0.1228	0.1481
Avg kW - 45 min lag	0.1366	0.0066	20.56	0.000	0.1236	0.1496
Avg kW - 50 min lag	0.1182	0.0063	18.88	0.000	0.1059	0.1305
Avg kW - 35 min lead	0.0352	0.0063	5.55	0.000	0.0228	0.0476
Avg kW - 40 min lead	0.1297	0.0065	19.96	0.000	0.1170	0.1424
Avg kW - 45 min lead	0.1347	0.0066	20.33	0.000	0.1217	0.1476
Avg kW - 50 min lead	0.1119	0.0063	17.82	0.000	0.0996	0.1242
CDH	0.0055	0.0087	0.64	0.524	-0.0115	0.0225
CDH - squared	0.0000	0.0006	-0.03	0.979	-0.0011	0.0011
CDH - cubed	0.0000	0.0000	0.47	0.640	0.0000	0.0000
CDH x Hour 1	0.0037	0.0131	0.28	0.776	-0.0219	0.0293
CDH x Hour 2	-0.0094	0.0153	-0.61	0.539	-0.0393	0.0205
CDH x Hour 3	0.0015	0.0165	0.09	0.926	-0.0307	0.0338
CDH x Hour 4	-0.0088	0.0203	-0.43	0.665	-0.0486	0.0310
CDH x Hour 5	0.0000	0.0237	0.00	0.999	-0.0464	0.0465
CDH x Hour 6	-0.0119	0.0248	-0.48	0.630	-0.0606	0.0367
CDH x Hour 7	0.0159	0.0211	0.76	0.450	-0.0254	0.0573
CDH x Hour 8	-0.0110	0.0258	-0.43	0.669	-0.0616	0.0396
CDH x Hour 9	-0.0098	0.0218	-0.45	0.653	-0.0525	0.0329
CDH x Hour 10	-0.0037	0.0195	-0.19	0.851	-0.0419	0.0345
CDH x Hour 11	-0.0113	0.0144	-0.79	0.432	-0.0396	0.0169
CDH x Hour 12	0.0057	0.0126	0.45	0.652	-0.0190	0.0303
CDH x Hour 13	-0.0038	0.0116	-0.32	0.745	-0.0265	0.0190
CDH x Hour 14	-0.0031	0.0117	-0.27	0.788	-0.0260	0.0198
CDH x Hour 15	0.0035	0.0106	0.33	0.744	-0.0173	0.0242
CDH x Hour 16	0.0043	0.0107	0.40	0.691	-0.0167	0.0253
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	0.0029	0.0087	0.33	0.738	-0.0142	0.0201
CDH x Hour 19	-0.0049	0.0096	-0.51	0.609	-0.0237	0.0139
CDH x Hour 20	-0.0103	0.0106	-0.98	0.329	-0.0310	0.0104
CDH x Hour 21	0.0045	0.0105	0.43	0.671	-0.0162	0.0251
CDH x Hour 22	-0.0065	0.0111	-0.59	0.558	-0.0282	0.0152
CDH x Hour 23	-0.0051	0.0111	-0.46	0.647	-0.0268	0.0167
CDH x Hour 24	-0.0059	0.0117	-0.51	0.612	-0.0289	0.0170
CDH x Hour 1 - squared	-0.0010	0.0015	-0.68	0.498	-0.0039	0.0019
CDH x Hour 2 - squared	0.0010	0.0020	0.49	0.626	-0.0030	0.0050
CDH x Hour 3 - squared	-0.0010	0.0025	-0.40	0.692	-0.0058	0.0039
CDH x Hour 4 - squared	0.0009	0.0038	0.25	0.801	-0.0064	0.0083
CDH x Hour 5 - squared	-0.0014	0.0051	-0.28	0.783	-0.0114	0.0086
CDH x Hour 6 - squared	0.0007	0.0056	0.12	0.908	-0.0104	0.0117
CDH x Hour 7 - squared	-0.0036	0.0046	-0.78	0.434	-0.0127	0.0054
CDH x Hour 8 - squared	0.0015	0.0056	0.26	0.791	-0.0095	0.0124
CDH x Hour 9 - squared	0.0011	0.0038	0.28	0.779	-0.0063	0.0084

ARIMA REGRESSION - Fresno 1 PCTs

					Number of obs	15897
					Wald chi2(114)	126345.29
Log	likelihood	=	12102.26		Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Hour 10 - squared	-0.0003	0.0025	-0.13	0.894	-0.0052	0.0045
CDH x Hour 11 - squared	0.0007	0.0014	0.54	0.587	-0.0019	0.0034
CDH x Hour 12 - squared	-0.0013	0.0010	-1.28	0.202	-0.0033	0.0007
CDH x Hour 13 - squared	0.0000	0.0009	0.00	0.998	-0.0017	0.0017
CDH x Hour 14 - squared	-0.0002	0.0008	-0.27	0.789	-0.0019	0.0014
CDH x Hour 15 - squared	-0.0005	0.0007	-0.64	0.522	-0.0019	0.0010
CDH x Hour 16 - squared	-0.0006	0.0007	-0.80	0.422	-0.0020	0.0008
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	-0.0003	0.0006	-0.53	0.598	-0.0014	0.0008
CDH x Hour 19 - squared	0.0003	0.0006	0.47	0.638	-0.0010	0.0016
CDH x Hour 20 - squared	0.0009	0.0007	1.21	0.228	-0.0006	0.0024
CDH x Hour 21 - squared	-0.0007	0.0008	-0.88	0.377	-0.0022	0.0008
CDH x Hour 22 - squared	0.0005	0.0009	0.56	0.574	-0.0013	0.0023
CDH x Hour 23 - squared	0.0001	0.0010	0.13	0.897	-0.0018	0.0021
CDH x Hour 24 - squared	0.0005	0.0012	0.38	0.702	-0.0019	0.0028
CDH x Hour 1 - cubed	0.0000	0.0000	0.68	0.500	-0.0001	0.0001
CDH x Hour 2 - cubed	0.0000	0.0001	-0.60	0.550	-0.0002	0.0001
CDH x Hour 3 - cubed	0.0000	0.0001	0.44	0.661	-0.0002	0.0002
CDH x Hour 4 - cubed	0.0000	0.0002	-0.26	0.793	-0.0003999	0.0003
CDH x Hour 5 - cubed	0.0001	0.0003	0.32	0.749	-0.0004573	0
CDH x Hour 6 - cubed	0.0000	0.0003	-0.05	0.961	-0.0006482	0
CDH x Hour 7 - cubed	0.0002	0.0003	0.69	0.490	-0.0003363	0.001
CDH x Hour 8 - cubed	-0.0001	0.0003	-0.26	0.798	-0.0006842	0.0005259
CDH x Hour 9 - cubed	-0.0001	0.0002	-0.36	0.717	-0.0004	0.0003
CDH x Hour 10 - cubed	0.0000	0.0001	0.12	0.906	-0.0001	0.0002
CDH x Hour 11 - cubed	0.0000	0.0000	-0.66	0.510	-0.0001	0.0000
CDH x Hour 12 - cubed	0.0000	0.0000	1.74	0.081	0.0000	0.0001
CDH x Hour 13 - cubed	0.0000	0.0000	0.01	0.992	0.0000	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	0.49	0.621	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	0.77	0.439	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	1.03	0.304	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	0.67	0.503	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	-0.45	0.649	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	-1.53	0.126	0.0000	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	1.27	0.204	0.0000	0.0000
CDH x Hour 22 - cubed	0.0000	0.0000	-0.67	0.501	-0.0001	0.0000
CDH x Hour 23 - cubed	0.0000	0.0000	-0.13	0.896	-0.0001	0.0000
CDH x Hour 24 - cubed	0.0000	0.0000	-0.42	0.674	-0.0001	0.0001
CDH x Sep	-0.0003	0.0019	-0.16	0.870	-0.0041	0.0035
CDH x Sep - squared	0.0000	0.0002	0.14	0.891	-0.0003	0.0003
CDH x Sep - cubed	0.0000	0.0000	-0.47	0.635	0.0000	0.0000
CDH x Sun	0.0001	0.0035	0.04	0.971	-0.0068	0.0071
CDH x Sun - squared	0.0001	0.0003	0.37	0.713	-0.0004	0.0006
CDH x Sun - cubed	0.0000	0.0000	-0.58	0.565	0.0000	0.0000
CDH x Mon	0.0012	0.0037	0.32	0.746	-0.0061	0.0085

ARIMA REGRESSION - Fresno 1 PCTs

					Number of obs	15897
					Wald chi2(114)	126345.29
Log	likelihood	=		12102.26	Prob > chi2	0.000

Dependent Variable - Avg. kW	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
CDH x Mon - squared	-0.0001	0.0003	-0.35	0.728	-0.0007	0.0005
CDH x Mon - cubed	0.0000	0.0000	0.40	0.692	0.0000	0.0000
CDH x Tue	-0.0010	0.0038	-0.26	0.792	-0.0085	0.0065
CDH x Tue - squared	0.0002	0.0003	0.53	0.599	-0.0004	0.0008
CDH x Tue - cubed	0.0000	0.0000	-0.61	0.545	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						
CDH x Wed - cubed (Base omitted)						
CDH x Thu	0.0015	0.0038	0.39	0.699	-0.0060	0.0090
CDH x Thu - squared	-0.0001	0.0003	-0.31	0.755	-0.0007	0.0005
CDH x Thu - cubed	0.0000	0.0000	0.33	0.745	0.0000	0.0000
CDH x Fri	-0.0004	0.0037	-0.12	0.908	-0.0076	0.0067
CDH x Fri - squared	0.0001	0.0003	0.25	0.806	-0.0005	0.0006
CDH x Fri - cubed	0.0000	0.0000	-0.23	0.816	0.0000	0.0000
CDH x Sat	0.0003	0.0036	0.10	0.923	-0.0067	0.0074
CDH x Sat - squared	0.0001	0.0003	0.19	0.849	-0.0005	0.0006
CDH x Sat - cubed	0.0000	0.0000	-0.39	0.695	0.0000	0.0000
Constant	0.0029	0.0262	0.11	0.911	-0.0484	0.0542
ARMA						
ar						
L1.	0.4585	0.0058	79.10	0.000	0.4471365	0.4699
/sigma	0.1128	0.0005	240.66	0.000	0.1119182	0.1138

ARIMA REGRESSION - Fresno 2 PCTs

		Number of obs	15897
		Wald chi2(114)	151391.35
Log	likelihood =	12168.58	Prob > chi2	0.000

Dependent Variable - Avg. kW	Std. Err.	z	P>z	[95% Conf.	Interval]	
Avg kW - 35 min lag	0.0830	0.0055	15.08	0.000	0.0722	0.0937
Avg kW - 40 min lag	0.0942	0.0056	16.81	0.000	0.0832	0.1052
Avg kW - 45 min lag	0.1069	0.0055	19.29	0.000	0.0960	0.1177
Avg kW - 50 min lag	0.1095	0.0054	20.17	0.000	0.0989	0.1202
Avg kW - 35 min lead	0.0995	0.0054	18.43	0.000	0.0889	0.1101
Avg kW - 40 min lead	0.0961	0.0056	17.03	0.000	0.0850	0.1071
Avg kW - 45 min lead	0.1139	0.0057	19.99	0.000	0.1028	0.1251
Avg kW - 50 min lead	0.1214	0.0056	21.57	0.000	0.1104	0.1325
CDH	0.0037	0.0105	0.36	0.721	-0.0168	0.0242
CDH - squared	-0.0002	0.0006	-0.34	0.735	-0.0014	0.0010
CDH - cubed	0.0000	0.0000	1.10	0.273	0.0000	0.0000
CDH x Hour 1	-0.0070	0.0177	-0.40	0.690	-0.0416	0.0276
CDH x Hour 2	-0.0034	0.0204	-0.17	0.869	-0.0434	0.0367
CDH x Hour 3	-0.0032	0.0261	-0.12	0.903	-0.0543	0.0479
CDH x Hour 4	-0.0017	0.0329	-0.05	0.960	-0.0661	0.0628
CDH x Hour 5	-0.0033	0.0358	-0.09	0.927	-0.0735	0.0670
CDH x Hour 6	-0.0022	0.0371	-0.06	0.952	-0.0751	0.0706
CDH x Hour 7	-0.0082	0.0371	-0.22	0.825	-0.0808	0.0645
CDH x Hour 8	0.0031	0.0403	0.08	0.938	-0.0758	0.0821
CDH x Hour 9	-0.0060	0.0389	-0.15	0.877	-0.0822	0.0702
CDH x Hour 10	-0.0007	0.0290	-0.03	0.980	-0.0575	0.0560
CDH x Hour 11	0.0007	0.0214	0.03	0.975	-0.0412	0.0425
CDH x Hour 12	-0.0005	0.0192	-0.03	0.979	-0.0382	0.0372
CDH x Hour 13	-0.0116	0.0165	-0.70	0.483	-0.0439	0.0207
CDH x Hour 14	-0.0024	0.0154	-0.16	0.875	-0.0325	0.0277
CDH x Hour 15	-0.0045	0.0122	-0.37	0.710	-0.0285	0.0194
CDH x Hour 16	-0.0035	0.0114	-0.31	0.757	-0.0259	0.0188
CDH x Hour 17 (Base omitted)						
CDH x Hour 18	-0.0062	0.0095	-0.65	0.516	-0.0248	0.0125
CDH x Hour 19	-0.0105	0.0100	-1.05	0.294	-0.0300	0.0091
CDH x Hour 20	0.0039	0.0103	0.38	0.702	-0.0163	0.0242
CDH x Hour 21	-0.0034	0.0110	-0.31	0.759	-0.0250	0.0182
CDH x Hour 22	0.0039	0.0122	0.32	0.749	-0.0201	0.0279
CDH x Hour 23	-0.0110	0.0132	-0.83	0.405	-0.0367	0.0148
CDH x Hour 24	-0.0063	0.0160	-0.39	0.695	-0.0376	0.0251
CDH x Hour 1 - squared	0.0008	0.0021	0.41	0.685	-0.0032	0.0049
CDH x Hour 2 - squared	0.0004	0.0028	0.13	0.899	-0.0051	0.0059
CDH x Hour 3 - squared	-0.0001	0.0042	-0.01	0.988	-0.0082	0.0081
CDH x Hour 4 - squared	-0.0001	0.0062	-0.01	0.993	-0.0121	0.0120
CDH x Hour 5 - squared	-0.0002	0.0076	-0.02	0.980	-0.0151	0.0147
CDH x Hour 6 - squared	0.0002	0.0084	0.03	0.978	-0.0161	0.0166
CDH x Hour 7 - squared	0.0009	0.0077	0.12	0.905	-0.0142	0.0161
CDH x Hour 8 - squared	0.0003	0.0088	0.03	0.973	-0.0169	0.0175
CDH x Hour 9 - squared	0.0004	0.0065	0.06	0.951	-0.0124	0.0132
CDH x Hour 10 - squared	-0.0004	0.0036	-0.11	0.912	-0.0074	0.0066

CDH x Hour 11 - squared	-0.0004	0.0021	-0.17	0.863	-0.0044	0.0037
CDH x Hour 12 - squared	-0.0002	0.0016	-0.14	0.892	-0.0033	0.0029
CDH x Hour 13 - squared	0.0008	0.0012	0.68	0.494	-0.0015	0.0032
CDH x Hour 14 - squared	-0.0002	0.0011	-0.17	0.865	-0.0023	0.0019
CDH x Hour 15 - squared	0.0003	0.0008	0.40	0.688	-0.0013	0.0019
CDH x Hour 16 - squared	0.0003	0.0007	0.34	0.735	-0.0012	0.0017
CDH x Hour 17 - squared (Base omitted)						
CDH x Hour 18 - squared	0.0006	0.0006	0.91	0.361	-0.0006	0.0017
CDH x Hour 19 - squared	0.0009	0.0007	1.30	0.192	-0.0004	0.0021
CDH x Hour 20 - squared	-0.0001	0.0007	-0.08	0.938	-0.0015	0.0013
CDH x Hour 21 - squared	0.0003	0.0008	0.42	0.673	-0.0012	0.0019
CDH x Hour 22 - squared	-0.0003	0.0010	-0.30	0.762	-0.0023	0.0017
CDH x Hour 23 - squared	0.0014	0.0012	1.20	0.231	-0.0009	0.0037
CDH x Hour 24 - squared	0.0007	0.0017	0.40	0.686	-0.0026	0.0040
CDH x Hour 1 - cubed	0.0000	0.0001	-0.48	0.631	-0.0002	0.0001
CDH x Hour 2 - cubed	0.0000	0.0001	-0.17	0.867	-0.0002	0.0002
CDH x Hour 3 - cubed	0.0000	0.0002	0.09	0.926	-0.0003	0.0004
CDH x Hour 4 - cubed	0.0000	0.0003	0.00	0.998	-0.0005698	0.0006
CDH x Hour 5 - cubed	0.0000	0.0004	0.03	0.973	-0.0007892	0
CDH x Hour 6 - cubed	0.0000	0.0005	-0.05	0.963	-0.0009689	0
CDH x Hour 7 - cubed	0.0000	0.0004	-0.05	0.963	-0.0008165	0.001
CDH x Hour 8 - cubed	-0.0001	0.0005	-0.16	0.873	-0.0010182	0.0008642
CDH x Hour 9 - cubed	0.0000	0.0003	-0.04	0.967	-0.0006	0.0005
CDH x Hour 10 - cubed	0.0000	0.0001	0.14	0.891	-0.0002	0.0002
CDH x Hour 11 - cubed	0.0000	0.0001	0.14	0.891	-0.0001	0.0001
CDH x Hour 12 - cubed	0.0000	0.0000	0.12	0.904	-0.0001	0.0001
CDH x Hour 13 - cubed	0.0000	0.0000	-0.84	0.402	-0.0001	0.0000
CDH x Hour 14 - cubed	0.0000	0.0000	0.32	0.750	0.0000	0.0000
CDH x Hour 15 - cubed	0.0000	0.0000	-0.50	0.614	0.0000	0.0000
CDH x Hour 16 - cubed	0.0000	0.0000	-0.39	0.697	0.0000	0.0000
CDH x Hour 17 - cubed (Base omitted)						
CDH x Hour 18 - cubed	0.0000	0.0000	-0.85	0.396	0.0000	0.0000
CDH x Hour 19 - cubed	0.0000	0.0000	-1.28	0.200	0.0000	0.0000
CDH x Hour 20 - cubed	0.0000	0.0000	-0.05	0.963	0.0000	0.0000
CDH x Hour 21 - cubed	0.0000	0.0000	-0.37	0.710	0.0000	0.0000
CDH x Hour 22 - cubed	0.0000	0.0000	0.42	0.676	0.0000	0.0001
CDH x Hour 23 - cubed	0.0000	0.0000	-1.57	0.117	-0.0001	0.0000
CDH x Hour 24 - cubed	0.0000	0.0000	-0.45	0.656	-0.0001	0.0001
CDH x Sep	0.0008	0.0023	0.33	0.738	-0.0038	0.0053
CDH x Sep - squared	-0.0001	0.0002	-0.38	0.704	-0.0004	0.0003
CDH x Sep - cubed	0.0000	0.0000	0.02	0.981	0.0000	0.0000
CDH x Sun	0.0026	0.0040	0.65	0.519	-0.0053	0.0105
CDH x Sun - squared	-0.0002	0.0003	-0.76	0.449	-0.0008	0.0004
CDH x Sun - cubed	0.0000	0.0000	0.90	0.366	0.0000	0.0000
CDH x Mon	0.0018	0.0045	0.40	0.692	-0.0071	0.0107
CDH x Mon - squared	-0.0002	0.0003	-0.59	0.554	-0.0009	0.0005
CDH x Mon - cubed	0.0000	0.0000	0.75	0.455	0.0000	0.0000
CDH x Tue	0.0009	0.0045	0.20	0.843	-0.0079	0.0096
CDH x Tue - squared	-0.0001	0.0003	-0.37	0.710	-0.0008	0.0005
CDH x Tue - cubed	0.0000	0.0000	0.51	0.612	0.0000	0.0000
CDH x Wed (Base omitted)						
CDH x Wed - squared (Base omitted)						

CDH x Wed - cubed (Base omitted)						
CDH x Thu	-0.0006	0.0045	-0.12	0.902	-0.0094	0.0083
CDH x Thu - squared	0.0001	0.0003	0.25	0.799	-0.0006	0.0008
CDH x Thu - cubed	0.0000	0.0000	-0.39	0.698	0.0000	0.0000
CDH x Fri	-0.0006	0.0044	-0.14	0.890	-0.0092	0.0080
CDH x Fri - squared	0.0001	0.0003	0.41	0.685	-0.0005	0.0008
CDH x Fri - cubed	0.0000	0.0000	-0.70	0.484	0.0000	0.0000
CDH x Sat	0.0000	0.0043	-0.01	0.992	-0.0084	0.0083
CDH x Sat - squared	0.0000	0.0003	0.04	0.968	-0.0006	0.0006
CDH x Sat - cubed	0.0000	0.0000	0.04	0.972	0.0000	0.0000
Constant	-0.0002	0.0518	0.00	0.998	-0.1018	0.1015
ARMA						
ar						
L1.	0.4765	0.0047	102.27	0.000	0.4673737	0.4856
/sigma	0.1124	0.0004	312.71	0.000	0.1116809	0.1131

APPENDIX F: PROPENSITY SCORE MATCHING PROBIT MODEL

Probit regression — **Number of obs** 16438

Log pseudolikelihood = -2471.32 — **Pseudo R2** 0.2587

Dependent Variables - ASP feeder	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Energy efficiency rebate in past 5 years	-0.063	0.130	-0.49	0.627	-0.318	0.191
Thermostat device	-0.017	0.047	-0.35	0.723	-0.109	0.075
CARE status	0.070	0.066	1.07	0.286	-0.059	0.199
Correlation of monthly kWh to monthly CDH	0.050	0.049	1.02	0.305	-0.045	0.145
summer to nonsummer month bill ratio	-1.206	0.454	-2.66	0.008	-2.096	-0.317
Number of AC units at home	-0.070	0.058	-1.2	0.229	-0.184	0.044
Tons per AC unit	-0.008	0.011	-0.74	0.459	-0.029	0.013
1st CBG median income decile	(Base omitted)					
2nd CBG median income decile	-0.353	0.125	-2.82	0.005	-0.598	-0.107
3rd CBG median income decile	-0.262	0.123	-2.14	0.033	-0.503	-0.022
4th CBG median income decile	-0.245	0.146	-1.68	0.093	-0.530	0.040
5th CBG median income decile	0.284	0.125	2.27	0.023	0.039	0.529
6th CBG median income decile	0.273	0.136	2.02	0.044	0.008	0.539
7th CBG median income decile	-0.400	0.164	-2.44	0.015	-0.720	-0.079
8th CBG median income decile	-4.848	.	.	.	.	.
9th CBG median income decile	1.462	0.160	9.15	0.000	1.149	1.775
10th CBG median income decile	-0.927	0.269	-3.45	0.001	-1.454	-0.401
1st CBG median income decile X Fresno	(Base omitted)					
2nd CBG median income decile X Fresno	5.267	0.281	18.71	0.000	4.715	5.818
3rd CBG median income decile X Fresno	5.225	0.265	19.71	0.000	4.705	5.745
4th CBG median income decile X Fresno	4.730	.	.	.	.	.
5th CBG median income decile X Fresno	4.874	0.258	18.87	0.000	4.368	5.380
6th CBG median income decile X Fresno	5.861	0.251	23.32	0.000	5.369	6.354
7th CBG median income decile X Fresno	6.439	0.260	24.76	0.000	5.929	6.948
8th CBG median income decile X Fresno	10.580	0.267	39.68	0.000	10.057	11.102
9th CBG median income decile X Fresno	5.133	0.259	19.82	0.000	4.625	5.640
10th CBG median income decile X Fresno	6.282	0.360	17.44	0.000	5.576	6.988
4th CBG median home age decile	(Base omitted)					
5th CBG median home age decile	6.191	0.361	17.14	0.000	5.483	6.899
6th CBG median home age decile	6.621	0.369	17.94	0.000	5.898	7.345
7th CBG median home age decile	7.425	0.353	21.05	0.000	6.734	8.117
8th CBG median home age decile	6.541	0.353	18.5	0.000	5.848	7.233
9th CBG median home age decile	5.895	0.343	17.19	0.000	5.223	6.566
10th CBG median home age decile	5.456	.	.	.	.	.
4th CBG median home age decile X Fresno	(Base omitted)					
5th CBG median home age decile X Fresno	-1.028	0.226	-4.55	0.000	-1.471	-0.585
6th CBG median home age decile X Fresno	-2.707	0.209	-12.97	0.000	-3.116	-2.298
7th CBG median home age decile X Fresno	-1.859	0.212	-8.78	0.000	-2.275	-1.444
8th CBG median home age decile X Fresno	-1.348	0.217	-6.22	0.000	-1.773	-0.923
9th CBG median home age decile X Fresno	-2.915	0.302	-9.65	0.000	-3.507	-2.322
CBG median head of household age	0.052	0.013	3.91	0.000	0.026	0.079
CBG median head of household age X Fresno	-0.288	0.019	-14.93	0.000	-0.325	-0.250
Annual kWh decile	-0.015	0.028	-0.52	0.605	-0.070	0.041
Average monthly electric bill decile	0.050	0.027	1.83	0.067	-0.003	0.104
Marketing persona 1	(Base omitted)					

Marketing persona 2	0.113	0.084	1.34	0.180	-0.052	0.278
Marketing persona 3	-0.306	0.114	-2.68	0.007	-0.530	-0.082
Marketing persona 4	-0.193	0.390	-0.49	0.621	-0.958	0.572
Marketing persona 5	-0.129	0.149	-0.87	0.386	-0.422	0.163
Marketing persona 6	-0.108	0.064	-1.68	0.092	-0.233	0.018
Marketing persona 7	0.026	0.065	0.4	0.688	-0.102	0.154
Marketing persona 8	0.020	0.069	0.28	0.776	-0.116	0.156
Marketing persona 9	0.327	0.214	1.52	0.128	-0.093	0.747
Marketing persona 10	-0.046	0.077	-0.6	0.550	-0.196	0.104
Constant	-8.212	0.365	-22.49	0.000	-8.928	-7.496
CBG = Census block group (approximately 600 households)						

APPENDIX G: PROJECT COSTS

Summary of Project Costs

Cost Component	Cost	Cost Category	Cost Type	Fixed/Variable
Project Planning and Design Services	$ 43,244	One time	Services	Fixed
Recruiting To Supplement AC Loads on Feeders	$ 120,966	One time	Services	Variable
Recruiting for Telemeter and Logger Installations	$ 32,366	One time	Services	Variable
Telemeters	$ 162,000	One time	Hardware	Variable
Hobo Loggers	$ 90,662	One time	Hardware	Variable
Telemeter and Logger Installation and Retrieval	$ 231,600	One time	Installation/ Retrieval	Variable
Engineering Services to Telemetry Data Management and Display	$ 99,280	One time	Services	Fixed
Cellular Communications	$ 17,280	Repeating	Services	Variable
Unit Commissioning Cost	$ 62,000	Repeating	Services	Variable
Manage Test Operations	$ 40,772	One-time	Services	Fixed
Customer Surveying	$ 73,520	One-time	Services	Fixed
Analysis and Report Preparation	$ 141,866	One-time	Services	Fixed
PG&E Project Management Cost	$ 280,193	Repeating	Administration	Fixed
TOTAL	**$ 1,395,749**			