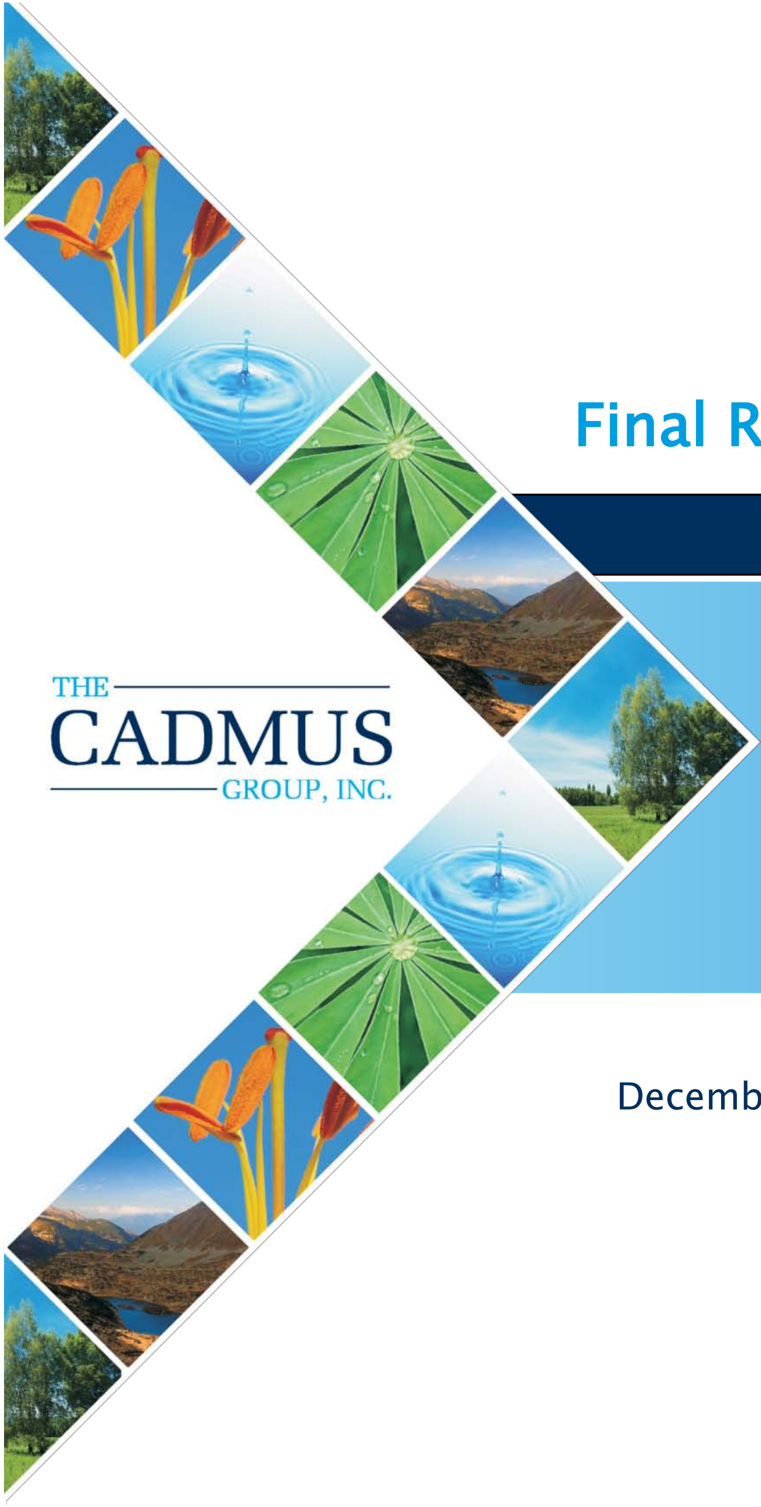

Final Report

Kootenai DR Pilot Evaluation: Full Pilot Report

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Executive Summary

The Bonneville Power Administration (BPA) sponsored a residential direct load control (DLC) pilot program, the Peak Project, at Kootenai Electric Cooperative (KEC) in Hayden, Idaho. KEC installed DLC equipment at participants' homes, including programmable thermostats for their heating systems and controls on their water heaters. Participants had to be using electric space heating and water heating to qualify for the program. Pilot installations began in February 2010, with DLC equipment installed in 92 homes by January 2011. Seventy-eight of these homes received a programmable thermostat to receive heating event signals. Twenty-four homes had heat pumps, which allowed KEC to call cooling events during the summer. KEC called events in winter 2011 and summer 2011. Winter events occurred from 7:00 a.m. to 10:00 a.m., with the water heater cycled off the entire time and thermostat temperatures reduced by 3 degrees Fahrenheit. Summer events occurred between 2:00 p.m. and 5:00 p.m., with the water heater cycled off the entire time and thermostat temperatures increased by 3 degrees Fahrenheit.

Cadmus evaluated the Peak Project's implementation and administration process and its demand impacts. The evaluation sought to:

- Assess and provide recommendations for program implementation; and
- Estimate demand impacts per home, per event hour.

Methodology

Cadmus conducted interviews with program staff to assess program implementation and administration processes. Program participant surveys sought feedback on program satisfaction and comfort during events. Cadmus assessed program demand impacts by analyzing participant interval billing data. A regression model, based on hourly demand and controlling for variables such as weather, was used to estimate demand impacts by comparing customer demand in non-event hours to customer demand during event hours.

Process Evaluation Conclusions

The process evaluation revealed challenges regarding implementation and customer recruitment, but found that program staff were versatile and dedicated to utility member satisfaction, a finding confirmed by the program participants' overall satisfaction with the program. Key conclusions from the process evaluation are as follows:

- **Participant Recruitment.** Recruiting participants for the program proved difficult. Incompatibility between heat pumps and furnaces and the DLC thermostat limited eligibility. Furthermore, most members did not understand the DLC program, and educating them about it became a major part of the marketing campaign.
- **Participant Satisfaction.** The events did not affect participant comfort, particularly during the summer events. Participants expressed satisfaction with the overall program, but expressed numerous complaints about the thermostats and the difficulty of programming them.

- **DLC Thermostats.** The DLC thermostats proved to be complicated to install and program, requiring KEC to hire HVAC contractors. The HVAC contractors programmed the thermostats during installation, and participants reported difficulty changing the programming.
- **Program Data.** Retrieving interval data from an advanced metering infrastructure (AMI) system proved time-consuming and difficult, and required working closely with the AMI system manufacturer.
- **Program Administration.** KEC staff successfully managed numerous responsibilities, including:
    - Coordination among BPA, KEC, and Aclara;
    - Program marketing;
    - Installation and operation of DLC equipment; and
    - Managing program complaints and member concerns.
- **Communication.** Communication among all involved parties can be challenging but is important for maintaining member satisfaction and managing member complaints.

Impact Evaluation Conclusions

Impacts were estimated separately for winter and summer events. The winter event conclusions are:

- **Demand Reduction.** The program exceeded its expected demand savings during winter. The average demand per home was reduced by 1.65 kW over all event hours, exceeding the expected demand reduction of 1.3 kW. Demand reductions in all but two event hours were statistically different from zero. The largest demand reductions occurred during the first event hour when demand per home was between 2 and 3 kW below baseline.
- **Rebound.** There was significant rebound in demand after the events. Rebound increased with colder event hour temperatures.

The analysis of summer events resulted in similar conclusions:

- **Demand Reduction.** The program achieved its expected savings of 0.7 kW for homes with both air conditioning and water heating DLC (AC-WH homes), where the program reduced average demand per home by 0.65 kW over all event hours. Demand reductions in all but one event hour (event 1, hour 2) were statistically different from zero. In homes with only water heating DLC (WH homes), the program reduced average demand per home by 0.26 kW over all event hours. In AC-WH homes, the largest average demand reductions (approximately 1 kW) occurred during event 3 when temperatures were warmest. During the first and second hours of event 3, the estimated load reductions were more than twice as large as those during the same hours in events 1 and 2.
- **Rebound.** Significant rebound in demand occurred after summer events ended. In both AC-WH and WH homes, rebound in the first post-event hour was equal to or greater than

the maximum demand reduction during the event. However, rebound was limited to the first post-event hour.

Program Implementation Recommendations

BPA intends to work with other utilities to implement DLC pilot programs. Cadmus' suggestions regarding future programs include the following:

- Future programs should consider hiring a third-party program implementer, provided this does not adversely impact program participation rates (e.g., due to member perceptions following utility rate-increases).
- Educating customers comprises a major part of program marketing and participant recruitment. Customers must be educated about the capabilities (and limitations) of AMI meters and about DR and its benefits. New DR programs should not underestimate resources required for educating customers about the program and technology.
- As space heating or cooling events have larger impacts in each season than water heating, BPA should assess tradeoffs between larger demand impacts and higher program costs for installing DLC thermostats. Other thermostat options should be explored, as they become available, for compatibility with more types of systems or ease of use.
- To improve program planning and budgeting, future programs should implement a strategy for transferring equipment ownership to participants when equipment is installed at the beginning of the program.
- The utility should coordinate with the AMI system provider to establish reliable methods for retrieving data as needed. Data retrieval should not rely on the AMI system provider. The utility should be able to retrieve data independently without having to make requests.

Recommendations to Improve Demand Impact Estimates

BPA asked Cadmus to provide recommendations on data requirements or other needs that could improve demand impact estimates for residential DR programs. Cadmus' recommendations are:

- If future program budgets allow, more data should be collected about participants, especially information about building envelopes such as wall, attic, and basement insulation and windows.
- The utility should call more than five events each season and for a wider range of temperatures. Comparing data for non-event days to data from event days with similar temperatures would improve the precision of predicted event impacts. Therefore, we recommend the utility allow a non-event day, with extreme hot or cold temperatures, so the evaluation can control for demand impacts coinciding with summer or winter events that may be unrelated to the program.
- Future program evaluations should include a control group of participant homes, where DR events are not called, to compare to homes where events are called. A control group would allow the regression model to account for unrelated impacts coinciding with events.

- If BPA wishes to estimate end-use impacts separately, more data loggers should be installed during future programs to further test relationships between end-use and whole-house impacts. Sample sizes should be based on:
    - Number of participants in the different strata (e.g., heat pumps or furnaces);
    - Expected demand reduction;
    - Variance of hourly loads; and
    - Desired statistical confidence and precision.[1]
- BPA should carefully consider the sample size. For this evaluation of combined space heating and water heating, the relatively small sample size (n = 73 for winter heating events and n = 19 for summer cooling events) proved sufficient due to large demand impacts. [2] A larger sample size, however, may be necessary for a DR program with smaller anticipated impacts, especially if metering is conducted at the whole-house level.

[1] Cadmus typically recommends treatment and control groups include approximately 120 homes. With a 0.4 coefficient of variation of demand and a 50% expected demand reduction, this sample size would result in a demand reduction estimate within +/- 10% of the true reduction, with 90% confidence.

[2] Only 73 of 78 had valid data during the winter events, and only 19 of the 24 homes with heat pumps had valid data during the summer event analysis.

1. Introduction

The Northwest's hydropower system will likely face increased capacity and flexibility constraints within the next three to five years. The Bonneville Power Administration (BPA) seeks to address these constraints in part through demand response (DR). The Sixth Regional Power Plan (Plan) assumes DR's regional technical potential at about 5% of peak load over the 20-year-plan horizon; this assumption is based on experience in the region and elsewhere in the country. As BPA has a peak load which is 90% coincident with individual public utilities' system peaks, BPA's overall peak will likely reduce as utilities address their own peaks through DR (assuming BPA remains the supplier for the utilities' peak load).

The Plan, however, recognizing a lack of DR experience in the region, recommended conducting pilot DR programs to establish research, development, and demonstration. Additionally, while the Pacific Northwest has seen past direct load control (DLC) programs, these programs did not leverage advanced metering infrastructure (AMI) systems. Thus, BPA sponsored the residential DLC pilot program (the Peak Project), operated by Kootenai Electric Cooperative (KEC), in Hayden, Idaho.

BPA sponsored this pilot program to achieve with the following goals:

- Gain valuable data and programmatic experience.
- Estimate per-unit impacts of DR technologies in the residential sector using collected data.
- Understand impacts of DR events on consumer's behavior and comfort levels.

Program Overview

BPA selected KEC to participate in this project due to the company's investment in a two-way Aclara ™ AMI system, which measured and collected 15-minute energy data allowing DLC program impacts to be determined for each event. For the Peak Project, KEC installed and operated control modules on residential hot water heaters and thermostats. The DLC equipment consisted of:

- An Aclara Powerline Carrier hot-water heater switch; and
- An Energate programmable thermostat, communicating via Zigbee wireless with the AMI meter.

Pilot installations began in February 2010 and, by January 2011, DLC equipment was installed in 92 homes. All 92 homes received the hot-water heater switch. Seventy-eight homes received a programmable thermostat to receive heating event signals and 24 of these homes had heat pumps, which allowed cooling events to be called. KEC called events in winter 2011 and summer 2011. Winter events occurred from 7:00 a.m. to 10:00 a.m., with water heaters cycled off for the entire period, and thermostat settings reduced by 3 degrees Fahrenheit. Summer events occurred from 2:00 p.m. to 5:00 p.m., with water heaters cycled off the entire time and thermostat temperature increased by 3 degrees Fahrenheit.

BPA and KEC also installed data loggers at five homes to monitor energy use of heating systems and water heaters. Logger data allowed impacts to be estimated at the end-use level, rather than the whole-house level.

Evaluation Goals

BPA retained Cadmus to perform an impact and process evaluation of the Peak Project with the following objectives:

- Develop estimates of impacts for individual homes, and for the overall program, using whole-house AMI data and portable loggers installed in a subset of homes.
- Examine the accuracy of impacts reflected in AMI data, compared to logger data, to recommend whether future program evaluations could rely solely on AMI data.
- Determine the relative kW impacts of space and water heat.
- Develop recommendations on data collection and other processes that BPA could use to maximize evaluation efficiency for subsequent pilot programs.
- Evaluate the strengths and weaknesses of the implementation process and participant awareness, behavioral response, and satisfaction.

The impact evaluation used AMI data to quantify event demand reductions at the whole-house level. The second and third goals, regarding accuracy of impacts reflected in AMI data and end-use impacts, could not be addressed due to insufficient logger data collection. The process evaluation relied primarily on data obtained through staff interviews and participant surveys.

2. Methodology

This section explains methodologies for the process and impact evaluations.

Process Evaluation Methodology

The process evaluation involved two main tasks:

- Interviews with BPA and KEC staff to assess program implementation; and
- Surveys of program participants to assess satisfaction.

BPA and KEC Staff Interviews

Cadmus conducted two rounds of interviews with program staff. During the first round—conducted between March and May 2011, after the winter events—one BPA staff member and two KEC staff members were asked questions about the following topics:

- Program design
    - Program goals and objectives
    - History of program development
    - Midstream changes to program design
- Program implementation and delivery
    - Marketing and participant recruitment
    - Equipment installations
    - Winter load control events
    - Participant feedback
- Program administration
    - Communication
    - Data management and reporting
- Recommendations for the summer events
- Recommendations for implementation of similar programs at other utilities
- Future of the Peak Project

Interviews with staff followed a structured guide, but allowed flexibility for conversations to focus on areas particularly relevant to each interviewee. Interviews also sought to collect feedback from program staff regarding potential evaluation topics to be pursued during the remainder of the evaluation.

In November 2011, after the summer events, one BPA staff member and one KEC staff member participated in a second round of interviews. Cadmus asked similar questions, following up on concerns and recommendations drawn from the winter events. The second round primarily sought to find out whether program implementation changed since the winter events and how successful the summer events had been. Appendix A contains interview guides for the spring and fall interviews.

Program Participant Surveys

In September 2011, participant surveys sought to collect information about participant experiences during summer and winter events. Cadmus and KEC coordinated efforts, offering survey respondents a $100 credit on their utility bill. A few weeks in advance, KEC notified program participants about the survey, informing them of the $100 bill credit, and requesting their permission to be called for the surveys. Appendix B provides the participant survey guide.

The survey covered the following topics:

- Awareness of DR before program participation;
- Satisfaction with participation;
- Value of participation;
- Comfort associated with participation;
- Behavior changes in response to events;
- Likelihood of participation in future programs; and
- Recommendations for the pilot program.

Though the survey sought to interview 70 participants, only 63 of 92 program participants agreed to be contacted. Cadmus attempted to interview all 63 participants and completed 40 surveys. Of the 40 respondents, six did not have thermostats installed by the program and only had DLC equipment installed on their water heaters.

Impact Evaluation Methodology

Cadmus estimated load impacts as the differences between the observed load and the reference load, which equaled what demand would have been had the event not been called. A multivariate regression model was used to estimate the reference load.

Data Collection

BPA provided Cadmus with 15-minute interval AMI data for all 78 pilot homes with thermostats installed through the pilot program. For the winter events, the first meter read took place on November 4, 2010, and the last took place on March 28, 2011. Some homes had meter read dates beginning after November 4, but all read dates began before the first event was called. For the summer events, BPA provided Cadmus with data for 79 pilot homes. The first meter read occurred on August 1, 2011, and the last took place on September 30, 2011. Aclara was unable to provide AMI data prior to this for reasons discussed in the Process Evaluation Results.

Cadmus first prepared the interval data for analysis. There were missing values for some 15-minute intervals and over some longer periods (including a few stretches of several days) for some pilot homes. In winter, missing data represented 4.5% of all reads. We discarded five homes with a large percentage of missing reads, as establishing a reliable reference load proved impossible. In summer, missing data represented 5.6% of all reads. We excluded two sites with a large percentage of missing data.

Using regression analysis, Cadmus analyzed the frequency and correlates of missing values and found them uncorrelated with the time of day, day of week, day of month, or weather, thus suggesting the missing data was effectively random.

Cadmus averaged 15-minute interval data to estimate average hourly demand for each hour. When one or more missing reads occurred in an hour, Cadmus estimated that hour's demand by averaging available reads. When missing all reads in an hour, Cadmus could not estimate demand in that hour and omitted it from the impact analysis.

After estimating average hourly demand, the analysis merged in hourly Coeur d'Alene weather station data, including variables for temperature, wind speed, and barometric pressure.

Cadmus plotted hourly loads for each home and visually inspected them for abnormalities, including implausibly low or high demand values. This identified five homes in the winter data with load shapes suggesting metering problems (and consequently removed from the estimation sample), leaving 73 homes for estimating load impacts. In the summer data, we identified 10 homes with load shapes suggesting metering problems. Excluding these and the two with missing data, 67 homes remained. In 19 of these homes, the program directly controlled air conditioners and water heaters. In the remaining 48 homes, the program only controlled water heaters.

Define Baseline

Cadmus used an hourly regression model to estimate load impacts in:

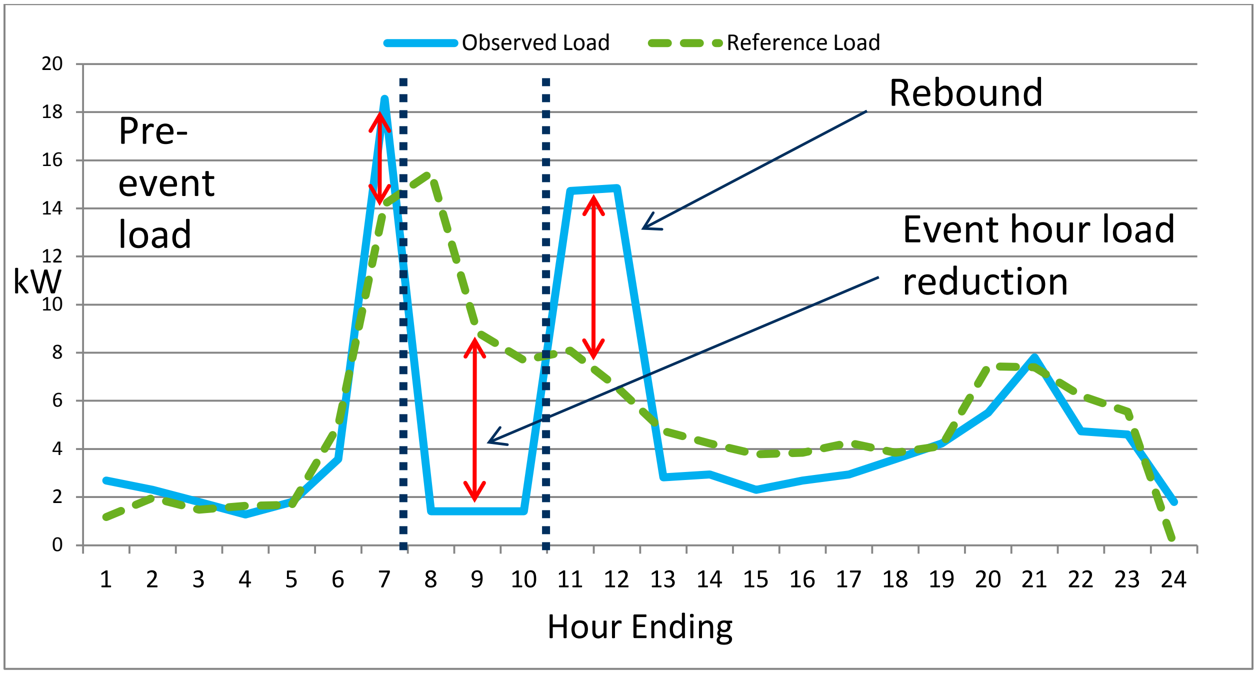
- The 12 hours before (-1, -2, etc. to -12) each event;
- The three hours during each event; and
- The four hours after (+1, +2, +3, and +4) each event.

The difference between the observed load and the reference load provided an estimate of the load impact in an event hour. The reference load is what demand would have been in that hour had the event not been called.

Upon specifying a demand regression model, we estimated it for each pilot home, which supported estimation of the whole distribution of electricity usage patterns and demand impacts in the pilot population and not just an estimation of the population average. Estimating individual participant models also allowed impacts of explanatory variables in the model (such as hourly indicators of the DR event, weather, and time-of-day controls) to vary between participants and improved the model's fit.

Figure 1 illustrates this approach, showing hourly loads for a pilot home on a winter event day. The solid blue line represents the observed load, and the dashed green line represents the reference load generated with a regression model. The event's demand impact in each hour equals the difference between the observed load and the reference load.

Figure 1. Example Winter Load Shape with Demand Impacts



The figure shows three types of demand impacts, corresponding to hours before, during, and after the event.

In the hours before an event, households received an event notification, and some participants may have adjusted their thermostats or taken other actions to use or reduce energy in anticipation of the event.

When the event began, KEC set the thermostat back 3 degrees Fahrenheit and cycled the water heater off.[3] Home electricity demand was expected to decrease during these hours, compared to typical demand. Such demand reduction was expected to be highest in the first event hour (from 7:00 to 8:00 a.m.) then to decrease in the next two hours due to electricity demand from space heating, which would cycle on in the second or third event hour, when home temperatures hit the lower set points. The probability of the unit turning back on increased with time and decreased with higher home insulation levels and warmer outside temperatures.

After an event, KEC returned the thermostat set point to the programmed temperature and, if that temperature was greater than the interior temperature, the heater turned back on. As heaters returned houses to programmed temperatures, it likely ran longer than normal. Figure 1 also shows this additional demand, labeled as rebound.

[3] Homes in Hayden, Idaho receive water from the Rathdrum Prairie Aquifer; its cold water likely results in colder-than-normal intake temperatures, and high electricity demand for water heat.

Estimate Impacts

Using the hourly demand data, Cadmus established a baseline for each participant by estimating a regression model. For the winter analysis, we used the following model to estimate the reference load in each event hour:[4]

$$kW_t = \alpha + \Sigma_{w=1}^{W}\pi_w week_{wt} + \Sigma_{d=1}^{6}\delta_d dayofweek_{dt} + \Sigma_{k=1}^{23}\gamma_k hour_{kt} +$$

$$\Sigma_{k=1}^{24}\lambda_k hour_{kt} * weekday_t + \Sigma^{24}_{k=1}\phi_k hour_{kt} * HDH_t + \Sigma^{24}_{k=1}\tau_k hour_{kt} * HDH_t^{\ 2}$$
$$+ \Sigma_{k=1}^{24}\mu_k hour_{kt} * weekday_t * HDH_t + f(\text{other weather}_t * HDH_t) +$$
$$\Sigma_{j=1}^{5}\Sigma_{h=1}^{3}\rho_{jh}\text{event hour}_{jht} + \Sigma_{j=1}^{5}\Sigma_{h=1}^{12}\theta_{jh}\text{ pre-event hour}_{jht} +$$

$$\Sigma_{j=1}^{5}\Sigma_{h=1}^{4}\omega_{jh}\text{ post-event hour}_{jht} + \varepsilon_t$$

where:

kW_t	=	average demand in hour t, t=1, 2, …, T, where hour 1 is the first hour of meter data and hour T is the last hour on March 28.
$week_{wt}$	=	an indicator variable for the week in the estimation period, w=1 to W. The number of week indicator variable depends on the date of the first meter read: it equals 1 if hour t is in week w and it equals 0 otherwise. The coefficient π_w captures variation in demand between weeks of the year. For example, it would capture a reduction in demand due to a week of vacation.
$dayofweek_{dt}$	=	an indicator variable for the day of the week, d=1 to 6 (day 7 would be a reference day, to which the rest of the days are compared). It equals 1 if hour t is in day d, and it equals 0 otherwise. The coefficient δ_d captures any non-weather sensitive, time-invariant differences in demand between days of the week.
$hour_{kt}$,	=	an indicator variable for the hour of the day, k=1 to 23 (hour 24 would be a reference hour, to which the rest of the hours would be compared). It equals 1 if hour t is hour k of the day, and it equals 0 otherwise. The coefficient γ_k captures time-varying, non-weather sensitive demand.
$weekday_t$	=	an indicator variable for whether the day is a weekday. It equals 1 if hour t is during the week, and it equals 0 otherwise. $\Sigma_{k=1}^{24}\lambda_k hour_{kt} * weekday_t$ captures differences between weekdays and weekends in time-varying, non-weather-sensitive demand.
HDH_t	=	heating degree hours in hour t, using 65 degrees Fahrenheit as a base temperature. $\Sigma^{24}_{k=1}\phi_k hour_{kt} * HDH_t$ and $\Sigma^{24}_{k=1}\tau_k hour_{kt} * HDH_t^{\ 2}$ capture time-varying, weather-sensitive demand. $\Sigma_{k=1}^{24}\mu_k hour_{kt} * weekday_t * HDH_t$ captures differences between weekdays and weekends in time-varying, weather-sensitive demand.

[4] The summer model used the same specification, except CDHs were used in place of HDHs.

event $hour_{jht}$	=	an indicator variable for event hour h, h=1 to 3, of event j, j=1 to 5. It equals 1 if hour t is in hour h of event j and it equals 0 otherwise. There is a separate indicator variable for each event hour. The coefficient ρ_{jh} is the demand reduction in hour h of event j.
pre-event $hour_{jht}$	=	an indicator variable for hour h, h=-12, -11, …, -1, preceding event j, j=1 to 5. It equals 1 if hour t is in hour h preceding event j, and it equals 0 otherwise. There is a separate indicator variable for each pre-event hour. The coefficient ω_{jh} is the demand impact of the event in hour h preceding event j.
post-event $hour_{jht}$	=	an indicator variable for hour h, h=1 to 4, following event j, j=-1 to 5. It equals 1 if hour t is in hour h following event j, and 0 otherwise. There is a separate indicator variable for each post-event hour. The coefficient θ_{jh} is the demand impact of the event in hour h following event j.
ε_t	=	the random error term of the model, reflecting unobservable influences on demand in hour t. We assume ε_t follows an autoregressive process with one lag.

Model Estimation and Diagnostics

Cadmus estimated the models by Generalized Least Squares, assuming auto-correlated errors; that is, we assumed, after controlling for observable characteristics, demand in each hour correlated with demand in the preceding hour. We modeled the error term as an autoregressive process, with lag one.

We performed a number of tests to evaluate the pilot home demand models' predictive ability. These tests included: inspecting signs and statistical significance of model coefficients; estimating the overall explanatory power of each model—represented by the R^2 statistic; and testing the predictive ability of the models in hours when events could have been called on non-event days. We used these test results to select the final model specifications.

In general, model coefficients had the expected signs and were statistically significant. The models also accurately predicted what loads would have been in hours when events were not called but could have been.

Logger Data Analysis

The pilot program collected 15-minute interval logger data for heating systems and water heaters in five pilot homes during the winter. The pilot also collected 15-minute interval logger data for cooling systems and/or water heaters in the same five homes during the summer. Cadmus analyzed the winter logger data, with results summarized in the section titled Comparison of Demand Reductions Using Logger and AMI Data. We conducted a preliminary analysis of the summer logger data, but results of that analysis are not included for two reasons:

- Concerns arose about the accuracy of day times recorded in the data. The logger data may have had timestamp errors related to time zone and daylight savings time; therefore, hours may not have been accurately captured in the analysis.
- Concerns arose about the number of loggers used in the analysis. Even if the data were perfect, an insufficient number of homes had loggers to precisely estimate end-use impacts or to compare AMI-estimated impacts.

3. Process Evaluation Results

The process evaluation consisted of interviews with BPA and KEC staff and surveys with program participants. This section presents findings from those interviews and surveys. For more detail on the methodology and results, staff interview guides can be found in Appendix A, the participant survey in Appendix B, and the participant survey frequency tables in Appendix C.

BPA and KEC Staff Interview Findings

Cadmus conducted three interviews with implementation staff in spring 2011, and two interviews in fall 2011. From these interviews we identified pilot program implementation strengths and weaknesses. After the first round of interviews about winter DR events, we summarized our findings and provided recommendations to improve summer event implementation. The second round of interviews followed the summer events and were useful for reassessing program progress, evaluating changes, and developing further recommendations to improve implementation in future program years. This evaluation's recommendatioFns may also inform future DLC programs or other DR applications.

Program Design and Implementation

KEC and BPA staff members reported that the program was largely designed from the BPA's 2008 Request for Proposals (RFP), which invited utilities to conduct residential DR pilot programs. BPA selected KEC as the first utility to implement the program because it already used an AMI system. BPA funded additional incremental elements so KEC could implement DLC and pay a cost-share portion of the project. KEC's board of directors had to approve the project before implementation could begin.

Though BPA's RFP influenced program design, KEC contributed significantly to implementation strategies. For example, BPA suggested hiring an external program manager to guide implementation. KEC rejected this idea, favoring internal management. KEC determined that implementing the project with its own staff would minimize any possible negative perceptions by its members regarding a third-party, non-local implementer.

During 2011, KEC called five winter events and three summer events. Events were called in the same manner for winter and summer events: BPA chose which days to call events and notified KEC at least two business days in advance. KEC then notified participants of events using e-mail alerts, automated phone messages, and alerts on the thermostat. One staff member raised concerns about summer events being called for all participants, rather than only for participants with heat pumps. The concern was that raising temperatures on thermostats for participants without heat pumps (those that only used DLC heating) could result in heat switching on in some homes and therefore increase demand from those homes during the event. The impact evaluation investigated this issue and did not find any evidence to support this concern.

Program Goals

BPA staff reported that the DLC pilot program intended to determine load reduction impacts from both end uses (space heating/cooling and water heating) together and separately. BPA also wanted to assess costs for running DLC programs. KEC staff agreed that determining the load reduction impacts presented an important goal for the program; they also, however, highlighted the importance of learning more about DR and how to effectively implement a residential DR program. KEC staff also noted the pilot program allowed them to test member responses to such programs in their service areas.

Marketing and Participant Recruitment

KEC reported using the following channels to market the program and recruit participants:

- Information on KEC's Website;
- Postcards and letters sent to members in eligible areas;
- Information in its member newsletter; and
- Information booths at its annual meeting and at the Kootenai County Fair.

BPA provided marketing support including contracting with ID Branding, an external marketing consultant, to develop the Peak Project brand and to create the letter and postcard KEC mailed to members. BPA also gave a welcome kit to those signing up to participate. KEC-branded materials (a hat and sticker) and a low-flow showerhead were delivered to participants during DLC equipment installation.

KEC initially sought to enroll 400 residential members in the program during its first year of implementation. The recruitment strategy began by targeting 2,500 member homes in an area served by one substation, where no gas service was available. KEC sent postcards to one-half of the members in that area and a letter to the other half, explaining the program and inviting them to participate. KEC staff reported that postcards elicited a better response rate than letters, but neither effort resulted in the desired 400 participating homes. Therefore, KEC extended eligibility to three additional substations,[5] accounting for approximately 5,000 additional members. Ultimately, the program fell short of its recruitment target, achieving a final enrollment of 92 homes, 78 of which had DLC-capable thermostats installed.

KEC reported that the challenges with recruitment were in finding homes with electric central heat. KEC staff estimated approximately 40% of its members had all-electric homes, but some homes had baseboard or other electric resistance heating, which made them ineligible for the program (as the DLC thermostat would not be compatible). To participate, members also had to have electric water heating, which further reduced the pool of eligible members. Equipment compatibility also limited participation, as discussed in the following section, Equipment Selection, Installation, and Operation.

KEC reported that an additional recruitment challenge was members' perceptions of the program. As members in KEC's service territory had never experienced high electricity rates resulting from peak demand, they had low awareness of the benefits of load curtailment.

Some members expressed skepticism about participating in a program they perceived as a means for the government to control or monitor their electric usage. A few of these members expressed concerns about the AMI system itself, believing KEC could control members' electric usage solely through the AMI. Additionally, some members expressed uncertainty about impacts on their comfort levels if KEC was allowed control of their thermostats.

[5] Gas service was available at the three additional substations.

Unlike eligibility limitations, such perceptions could be partially remedied. KEC staff reported they discussed concerns with members by explaining:

- The AMI system had been in place for a number of years, and the AMI system in itself did not allow KEC to control member equipment;
- DLC components were additional equipment KEC would have to install, should the member choose to participate in the program; and
- Participants could override thermostat settings or opt out of events.

KEC staff encouraged members to contact them with questions or concerns about program participation and reported that once questions were answered members generally could be convinced to participate.

Although these limitations contributed to the program's low participation, KEC staff reported that meeting a target number of participants was not crucial for the program's success. KEC's original 400-participant goal was lowered to 200, and it gave half of the DLC equipment, provided by BPA, to another utility. KEC staff also reported that despite the low number of participants, the pilot program still served to test whether a full-scale program would be viable in its service territory.

Equipment Selection, Installation, and Operation

KEC installed the two-way Aclara AMI system in 2006, and selected equipment compatible with this system for implementing the DLC program. Aclara provided the hot water heater switch used to control participants' water heating equipment. Only Energate thermostats, used to control space heating and cooling equipment, were capable of DLC at the program's inception. (Honeywell now offers a DLC-capable thermostat.) However, as reported by KEC and BPA staff, Energate thermostats were not compatible with all heating systems or models, which further limited program participation.

Some participants already had programmable thermostats, and in some cases the Energate thermostat did not have as many features and did not prove as user-friendly as their replaced thermostats; this led to complaints from participants. Twelve participants who had an Energate thermostat installed later complained about system compatibility issues or other difficulties and KEC had to return to their homes to remove thermostats. Both KEC and BPA commented that DLC thermostat technology needed to advance to achieve a more successful DR program.

When the installation process began, KEC staff reported contracting with three electricians to install equipment in participant homes. KEC and the electricians agreed to a fixed cost per installation, which helped KEC plan for and control project expenses. BPA, Aclara, and Energate representatives trained the electricians and participated in the first few installations. KEC said this strategy worked well to ensure quality. Installations went very smoothly, and all parties collaborated and learned from each other. After a few more installations, however, KEC began to receive complaints about thermostats. KEC decided the electricians did not have sufficient expertise with wiring and programming thermostats and hired HVAC technicians to repair thermostats installed by the electricians and to install or be present for the installation of all future participant thermostats.

KEC will continue to enroll members in the program and install the hot water controls through December 2011 but will no longer install thermostats. KEC emphasized the importance of retaining a reliable HVAC contractor and electrician, even after all thermostats had been installed so repairs could be made when needed.

KEC also noted the importance of implementing a strategy to turn ownership of equipment over to homeowners. Currently, when participants call KEC to report problems with equipment. KEC must then arrange for a contractor to visit the home and make any necessary repairs. After the pilot program ends, KEC would like to turn the equipment over to the homeowners and no longer be responsible for its maintenance.

Member Feedback

KEC staff reported some members were skeptical about the program, expressing concerns about privacy and government control over their electricity use. The program was initiated shortly after a rate increase and some members were concerned the program would cause additional rate increases.

After installation, a few participants had difficulty understanding the technology. For example, one participant reportedly called KEC nearly every time he wanted to change his thermostat setting, and another member tracked her energy usage closely, concerned the thermostat would increase her total usage. KEC reassured these members by providing direct technical support. KEC reported receiving many calls during the winter events from participants curious about the blinking light on their water heater or the event notification on their thermostat. During summer events, KEC received very few calls and attributed this to participants becoming comfortable with the process and to fewer participants noticing temperature changes in their homes.

KEC staff emphasized member education was crucial to program implementation. One staff member reported developing an effective strategy to explain the program that emphasized program participation in each event was optional. When members were uncertain about participating, such phone conversations often became the deciding factor.

Program Administration

Cadmus asked program staff about staffing, communication among parties, and data management.

Staffing

KEC’s staff comprised a program manager, an engineering manager, and the customer care staff. The program manager’s role entailed marketing, recruiting participants, representing KEC during equipment installations, coordinating with contractors, and scheduling equipment installation with home owners. The engineering manager’s role involved overseeing the technical staff, coordinating with the AMI vendor, executing event commands through the AMI software, selecting the installation contractors, and coordinating data logger data extracts. KEC's customer care staff included the phone banks and administrative staff and played a key role in answering initial questions from members about the program.

BPA reported that KEC’s project staffing level may not have been adequate initially and perhaps a third-party project manager could have taken on some of the burden of managing the program’s many technical aspects, such as installing DLC equipment and coordinating with

Aclara. KEC staff agreed more technical expertise would have been helpful, but reported that staffing had been adequate. KEC also stated a third-party project manager might have further limited program participation by exacerbating members' perceptions about privacy and additional rate increases, as noted in the Member Feedback section.

KEC and BPA staff noted the wide range of the KEC program manager's responsibilities: directing member service, managing contracts, overseeing installations, and performing home energy audits. Both BPA and KEC staff emphasized that the KEC project manager did an excellent job. One KEC staff stated someone with greater technical expertise might have been better suited to perform home energy audits and manage installations, and BPA staff noted greater technical expertise across the board would have been helpful. BPA staff said KEC needed more than one engineer on the project, as the responsible engineer had to carry out Peak Project tasks in addition to the usual daily responsibilities. For the summer events, the engineer delegated tasks to other staff, such as collecting logger data.

Communication

Effective communication proved to be a critical factor in the pilot program's successful implementation and administration. The implementation of a DLC program requires coordination within the utility between IT, engineering, marketing, and billing departments. KEC staff also reported the importance of effective communication with the AMI system manufacturer and BPA. During the program's initial implementation months, BPA, KEC, and Aclara participated in weekly conference calls. Once the program had been established, meetings slowed to biweekly. In addition to regular meetings, parties communicated on an *ad hoc* basis via e-mail and telephone. During the summer events, communication was mainly via e-mail. Because Aclara had less extensive involvement with the summer events, communication with focused mainly on data extraction.

Cadmus asked interviewees whether they were satisfied with the communication levels between BPA and KEC, and all three responded affirmatively. Communication with Aclara reportedly posed challenges, with one interviewee indicating Aclara was not very responsive at first, but that communication improved over time.

In one case, KEC staff cited the consequences of insufficient communication from Aclara. Aclara tested system functionality by running a test load control event, with a setback of zero degrees Fahrenheit, but neglected to notify KEC. This problematic action meant participants' thermostat displays indicated a load control event was occurring, but they received no notification about the event and were unable to override the thermostat. This resulted in some members calling KEC to complain. Because Aclara had not notified KEC, KEC could not offer an explanation to participating members. KEC managed these member complaints by offering bill credits.

Data Management and Reporting

Interviews revealed concerns about data quality, as detailed in the Impact Evaluation Methodology section. All staff members interviewed by Cadmus expected, at the program's inception, KEC would be able to extract interval data on participating homes using its AMI system. However, the AMI system software did not have this capability. Aclara had to perform every data download, and BPA had to request reports directly from Aclara. According to KEC staff, a regular data extract schedule was never established, and BPA requested data as needed.

BPA staff reported, after the winter events, Aclara initially was unresponsive to data requests, but over time a system became established. However, issues with missing observations persisted, apparently due to the data transmission process, and BPA and KEC repeatedly had to follow up with Aclara to obtain good quality data. Aclara reportedly planned to transfer the data extraction responsibility to KEC, but this transfer has yet to take place. After the winter events, KEC reported it has hired a new staff person to work with Aclara to transfer this responsibility to KEC. However, follow-up interviews after the summer events revealed Aclara continues to be responsible for data extraction.

BPA noted additional data issues with Aclara during the summer events. Despite e-mail reminders BPA staff sent to Aclara about the summer events, Aclara failed to download the 15-minute billing data. When BPA requested these data at the end of September, they were told that May through July readings missing, as only the last two months (August and September) had been stored. Aclara recovered data for August (when all three events occurred) and September. The evaluation discussed the implications of this issue under the Impact Evaluation Methodology section.

Difficulties also emerged with end-use data collection for evaluation purposes. Implementers intended to install 30 data loggers for the project but, due to logistical barriers, could only install five. In many cases, the data loggers did not fit the panels and, in other cases, DLC equipment installation had already been completed and KEC was reluctant to return and install additional equipment.

Planning for the Future of this Program or Other Similar Programs

KEC intends to continue to recruit members for water heating controls. It has not, however, decided whether to continue thermostat and data logger installations. Given equipment installation difficulties and low program participation rates, both related to thermostats, KEC likely will not continue the program’s space heating and cooling load control portions for new participants but will continue the space heating and cooling DLC for pilot participants who already have thermostats. This would simplify the installation process for new participants, allowing members ineligible for the pilot program to participate in the future. Per-member-demand impacts, however, will not be as large. KEC may again consider including thermostats if the technology improves.

One staff member familiar with different AMI systems said that the availability of interval data depends on the AMI manufacturer, and investments in AMI systems does not mean interval data will be available. If a utility with AMI expresses interest in a DR program (and in evaluating its impacts), it should first determine whether interval data can be obtained. Some AMI companies do not store interval data, or store it only for a limited period due to file sizes. Even stored interval data can be difficult and time-consuming to upload into a useful format, such as Excel, and is a process that requires working closely with the AMI manufacturer. Any utility considering a DR program should be aware of and willing to accommodate data collection challenges.

Program Participant Survey Findings

Forty program participants responded to the phone survey conducted in September 2011. Questions addressed household demographics, awareness of DR, satisfaction with the pilot program, and comfort levels during events.

Participant Household Demographics

The respondent demographics proved balanced across gender lines, with 22 males and 18 females answering the survey. Respondents lived mostly in small households; one- and two-person households accounted for 33 of the 40 participants. Most participants owned their homes (39 of 40 surveyed, one participant replied “don’t know”).

Prior Demand Response Awareness

Twenty-one respondents reported not being aware of DR efforts prior to participating in the program. When asked their primary reasons for participating, 25 respondents cited energy conservation. The next most frequent reason was to save money by lowering energy bills (10 respondents). Other common responses included helping the utility manage demand for electricity and receiving KEC incentives (each cited by four respondents as primary reasons for participating).

Table 1. Reasons Participants Signed Up for the Peak Project

Response	Frequency* (n=40)
To conserve energy	25
Save money by lowering my energy bill	10
Help the utility manage demand for electricity	4
KEC incentives (energy audit, energy credit contests, etc.)	4
To help the environment.	1
Keep utility rates lower in the future	1
"It was a good idea."	1
Don't know	2

*Question was open-ended and participants were allowed more than one response.

Behavior Changes

Questions asked for survey respondents’ comfort levels during events and how they changed their behaviors during events. Overall, participants reported minimal behavioral changes. Only 12 respondents replied being aware of their hot water heater cycling off. No participants recalled running out of hot water during an event (38 replied “no” and two said “don’t know”). This was particularly noteworthy, as only seven participants recalled modifying their schedules to avoid using hot water during events.

Eight of 40 respondents (20%) recalled their homes felt colder than usual during winter events, and, among these, only two reported overriding thermostats to raise temperatures. Others said they put on warmer clothes, used a blanket, turned on a space heater, or covered doors and windows with plastic. Only one respondent recalled the home feeling warmer during a summer event. She reported turning on a ceiling fan to manage the home’s comfort level.

Participation Experience and Satisfaction

Surveys addressed participants' experience and satisfaction with different program aspects, including:

- The equipment and installation process;
- The event notifications
- The events themselves; and
- The program as a whole.

Difficulty with the pilot program's programmable thermostat emerged as a theme of the participant survey responses. Initially, only 14 of 34 respondents said the installed thermostat was not easy to use but comments about programming difficulties repeatedly came up during follow-up questions. Two respondents gave the equipment installation process dissatisfactory ratings because of problems with thermostats, and nine participants later suggested improving the program with a more user-friendly thermostat or better-written unit instructions.

Cadmus asked participants about event notifications. Thirty-five reported receiving word prior to events; only one respondent recalled receiving notifications for all eight events during the pilot study. All 35 participants who recalled receiving notification expressed satisfaction with the notifications, with 86% rating it 10 (representing extremely satisfied) on a 10-point scale.

When asked to respond yes or no to whether different notification methods would be a good way to communicate upcoming events, 33 participants said that e-mail and phone calls were good methods. Most respondents said text messages, alerts on a Peak Project Web page, and messages on Facebook or Twitter were not effective methods. As shown in Table 2, for each unpopular method over 80% of participants reported these as poor methods for reaching them.

Table 2. Participants' Notification Methods Preferences

Notification Method	Frequency (n=40)	
	Yes	No
E-mail	33	7
Text message	7	33
Phone call	33	7
Message on the thermostat	20	20
Peak Project Web page with alerts	6	34
Facebook or Twitter message	4	36

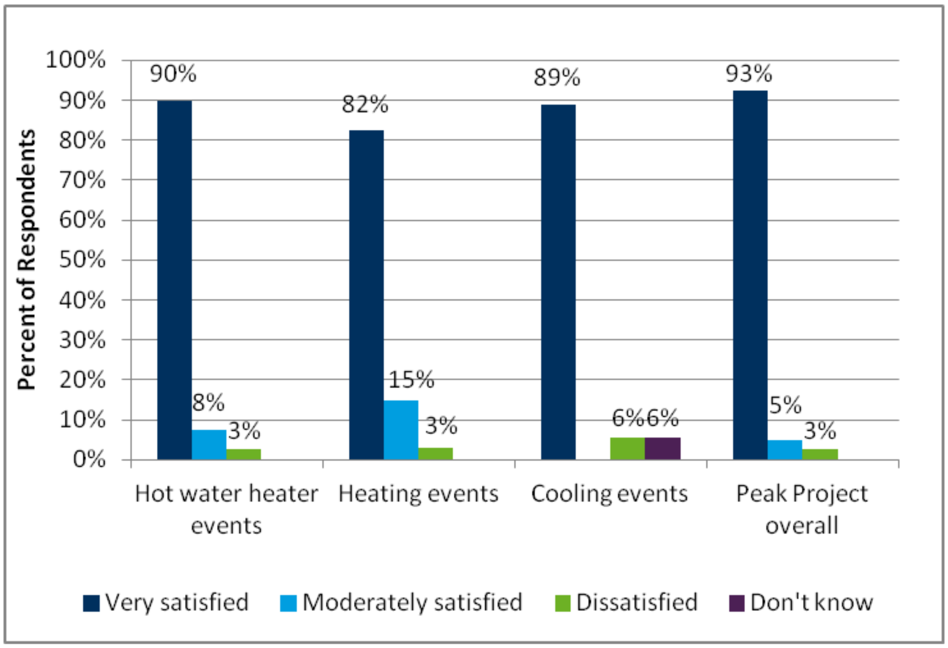
When asked if they opted out of events, only two respondents replied they had (and one of these may have misunderstood the question). One respondent reported opting out of the event on Friday, February 25, 2011, due to illness and an increased need for heat that day. The other, who reported opting out twice, could not recall the event dates, and, based on follow-up responses, clearly misunderstood the term "event" as a meeting to attend (rather than a temporary reduction in electricity).

As shown in Figure 2, participants expressed overall satisfaction with events and the Peak Project:

- 90% of respondents (36 of 40) were very satisfied with the program's water heating portion of the program;
- 82% of respondents (28 of 36) with space heating DLC were very satisfied with heating events; and
- 89% of respondents (16 out of 18) with space cooling DLC were very satisfied with cooling events.

Additionally, nearly all participants (38 of 40) said they would be very likely to participate in another DR program. Only two of the 40 respondents rated their likelihood to participate as less than 8 on a 10-point scale (where 10 indicated "very likely"), and those two indicated it would depend on the program offered. Only one participant reported a less-than-positive opinion of the utility due to the pilot program experience.

Figure 2: Participant Satisfaction with Events and Peak Project Overall



*Very satisfied indicates a rating between 8 and 10, moderately satisfied indicates a rating between 4 and 7, and dissatisfied indicates a rating between 1 and 3.

When survey respondents were asked to provide recommendations for the Peak Project, eight suggested future DR programs may benefit from more widespread publicity. Two others suggested KEC might expand eligibility (e.g., including households with multiple thermostats or not requiring that both the heating system and water heater be electric).

Other suggestions for improving program participation (each put forth by two respondents) included:

- Emphasize participation can lower electricity bills;
- Mention participation can save energy or help the environment; and
- Offer more financial incentives.

4. Impact Evaluation Results

Program impacts were estimated for winter and summer events and are discussed below. Detailed results by event hour are presented in Appendix D.

Winter Events

For the winter events, Cadmus estimated the demand impact in each event hour and impacts during the 12 hours before each event and the three hours after each event. The sample included 78 homes. All 78 homes had a water heater control and a DLC thermostat. The heating system was either an electric furnace or heat pump.

Winter Average kW Impacts in Event Hours

Table 3 presents estimated average demand impacts and temperatures in each event hour and the associated 95% confidence intervals. We estimated demand impacts for each pilot home as a regression of hourly demand on calendar and time variables, interaction variables between weather and calendar and time effects, and indicator variables for hours before, during, and after each event.[6] Confidence intervals show average demand reductions statistically different from zero, with 95% confidence in all hours except hour 3 of events 1 and 2.

Average home demand impacts ranged from -0.2 to -3.1 kW and varied according to event day and hour. The first event hours consistently exhibited the highest demand reductions, typically between 1.8 and 3.1 kW per home. Impacts in the first hour represented a 53% reduction in home demand, on average. Second and third event hours had lower impacts, especially for events 1 and 2. Impacts for hours 2 and 3 ranged between -0.2 and -2.3 kW. Demand impacts over all event hours averaged -1.65 kW or 40%, with a 95% confidence interval lower bound of -1.76 kW and upper bound of -1.54 kW. Estimated demand impact exceeded BPA's -1.3 kW expectation.

Events 1 and 2 experienced relatively low demand reductions due to the extremely cold temperatures on those days. On cold days, interior temperatures of pilot homes would have decreased, reaching their thermostat set points more rapidly than on the milder days. Heating units resumed operation earlier on those days, decreasing the overall demand impact.

6 To check results, we estimated a regression model pooling all pilot home hours, and including home-fixed effects. This model constrained impacts of explanatory variables to be the same across customers. We obtained the same results as when estimating a model for each pilot home separately.

Table 3. Mean Estimated Load Impacts (kW) for all Winter Events and Hours with 95% Confidence Intervals

Event	Hour	Temperature (ºF)	Estimated Impacts (kW)	LB 95% CI (kW)	UB 95% CI (kW)
1	1	16	-2.26	-2.68	-1.83
1	2	14	-0.83	-1.25	-0.40
1	3	18	-0.16	-0.58	0.26
2	1	16	-2.21	-2.64	-1.79
2	2	14	-0.61	-1.04	-0.19
2	3	18	-0.23	-0.66	0.19
3	1	42	-2.65	-3.11	-2.19
3	2	36	-2.31	-2.77	-1.85
3	3	45	-1.51	-1.97	-1.04
4	1	31	-3.07	-3.49	-2.64
4	2	27	-2.16	-2.58	-1.73
4	3	41	-1.57	-1.99	-1.15
5	1	41	-2.44	-2.86	-2.02
5	2	37	-1.71	-2.14	-1.29
5	3	45	-1.00	-1.42	-0.58

Notes: LB = lower bound, UB = upper bound

Winter Event Impacts Before and After Each Event

Figure 3 through Figure 7 show demand impacts in the 12 hours before, three hours during, and three hours after each event.[7] Participants received 12 hours advanced notification of events and may have increased their heating demands in anticipation, especially on cold days. After events ended, pilot home heaters returned home interiors to programmed temperatures. If temperature set points were higher than event hour set points, the heater would turn on, and demand would be higher in post-event hours than if the event had not been called. (This is the rebound effect.)

Figure 3 shows demand impacts for event 1, which was a cold weather event with an average daytime temperature of 16 degrees Fahrenheit. Events 1 and 2 show significant demand impacts in the pre- and post-periods. Demand averaged between 0.4 and 1.7 kW higher in pre-event hours than it would have been without the event, although not all impacts were significant at the 95% confidence level. Event 1 also exhibited significantly higher demand in the hours after the event, as home interiors returned to their programmed temperatures.

[7] All hourly average demand impacts are reported in the Appendix with 95% confidence intervals.

Figure 3. Winter Event 1 Hourly Impacts

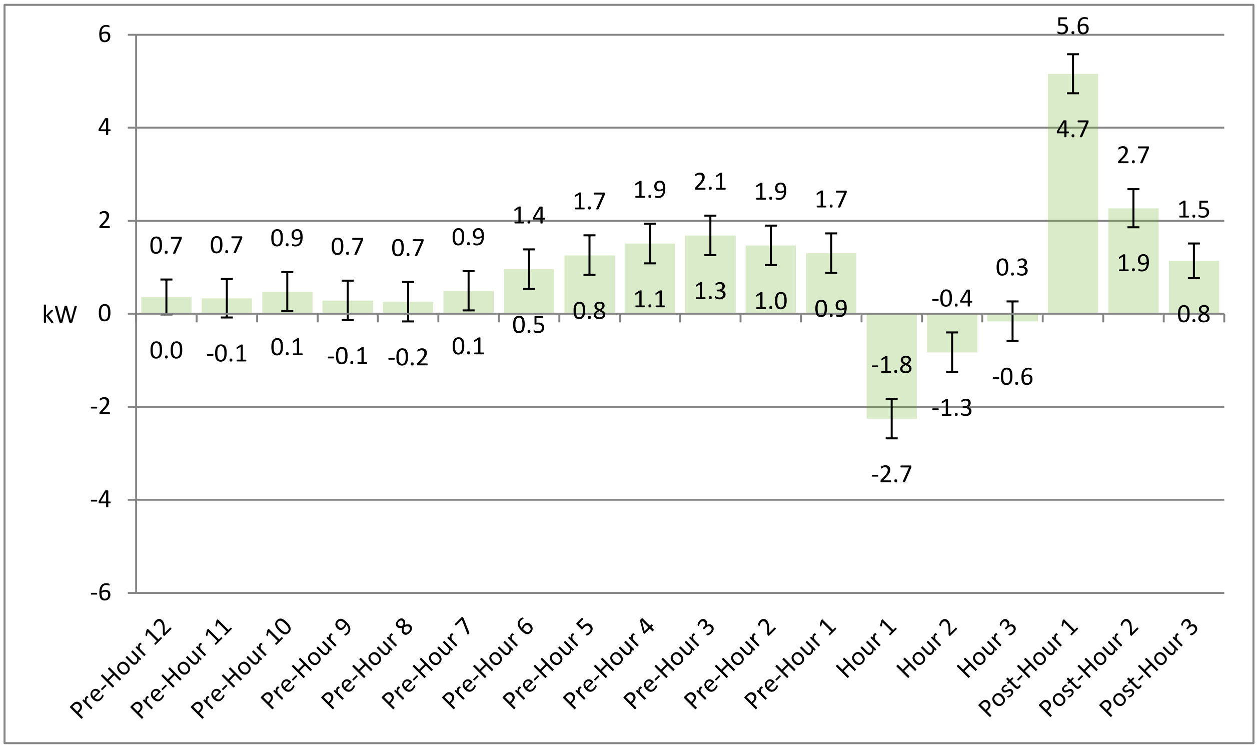


Figure 4 shows larger demand impacts in the hours before event 2 than before event 1. Rebound was approximately the same.

Demand impacts in the hours before events 1 and 2 were consistent with participants turning up or programming their thermostats in anticipation of events. However, it is difficult to attribute pre-event impacts to such behaviors due to the coincidence of extreme cold on event days. Table 3 shows events 1 and 2 were called during the coldest temperatures of the season, making it difficult to disentangle the impacts of severe cold (which had no precedent) from participants' behaviors in the hours leading up to the events. Separately identifying impacts could only be achieved by observing the behavior of a control group of members during the same hours. If the demand of control members did not increase in the pre-event hours, pilot program demand impacts in the pre-event hours could be attributed to the events.

Figure 4. Winter Event 2 Hourly Impacts

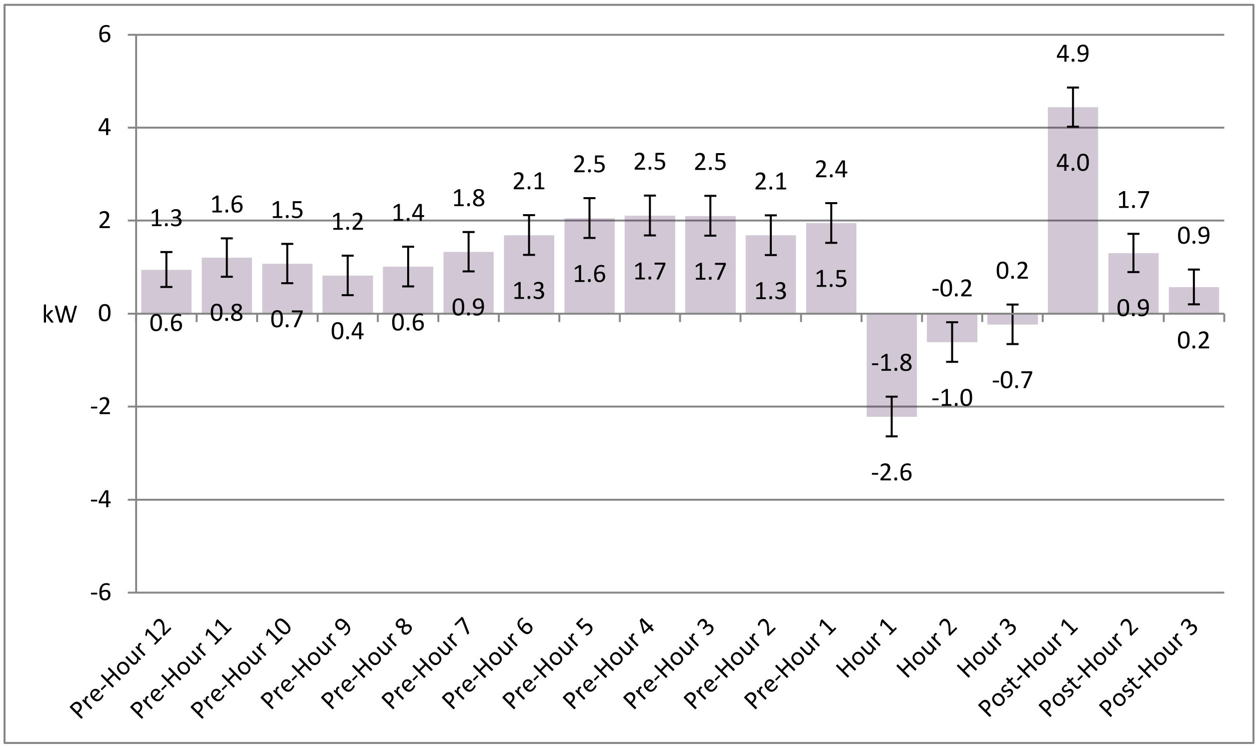


Figure 5 through Figure 7 show demand impacts for Events 3 to 5. Impacts in hours before the events generally proved negligible, possibly due to milder temperatures, or participants becoming more comfortable with events being called.

Participant homes exhibited significant rebound in demand after the events; however, rebound was limited to the first and second hours after events, and was significantly less than the rebound after events 1 and 2.

Figure 5. Winter Event 3 Hourly Impacts

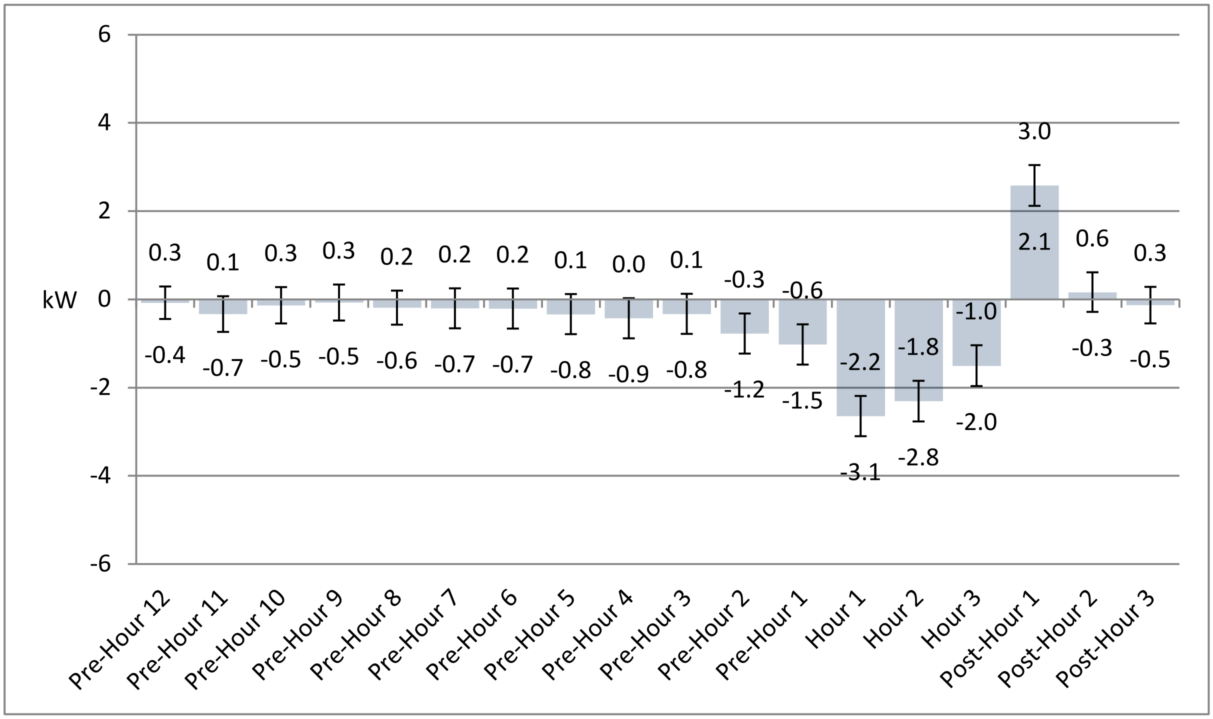


Figure 6. Winter Event 4 Hourly Impacts

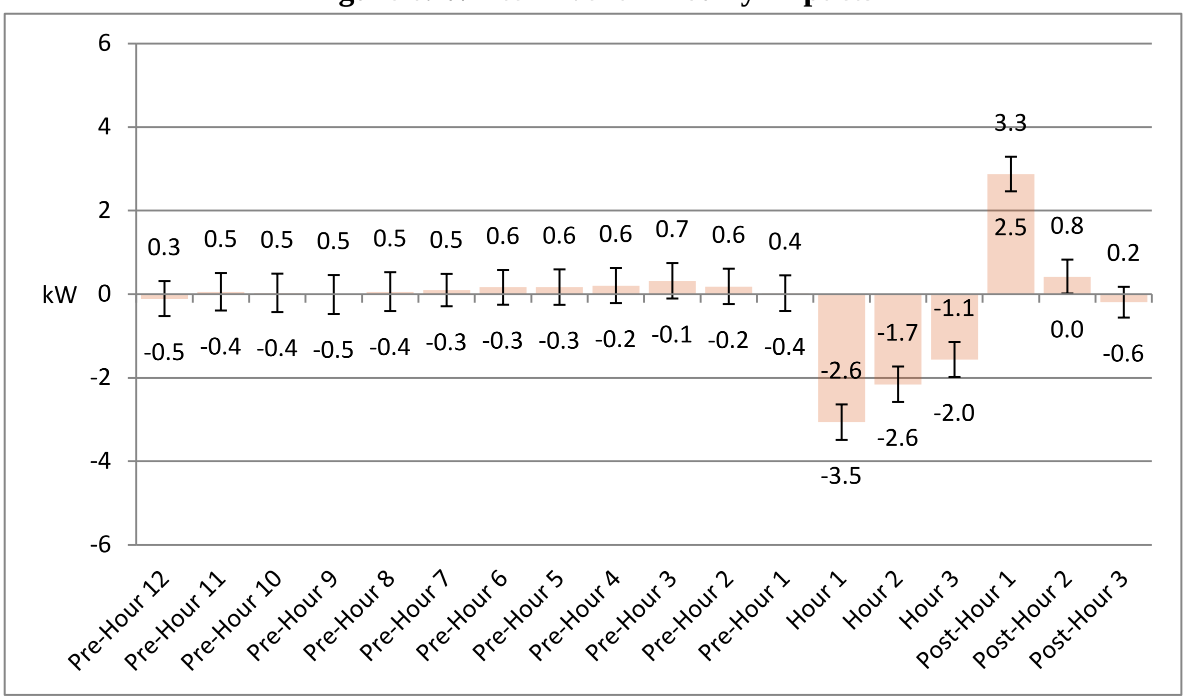
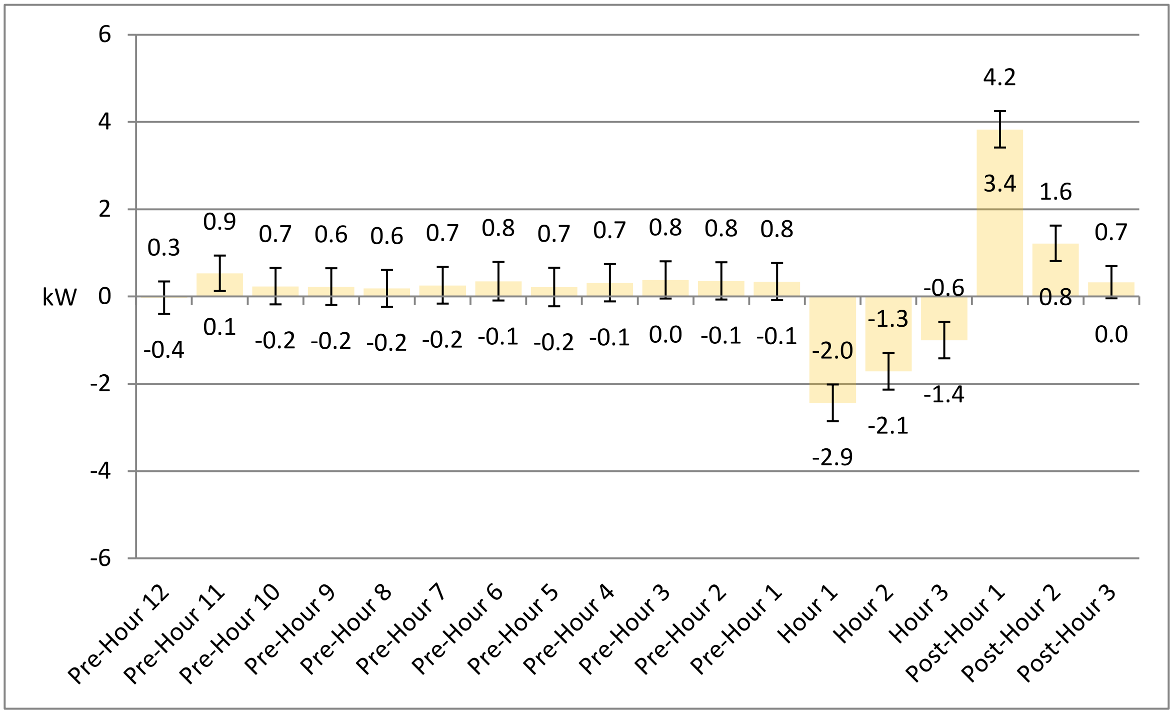


Figure 7. Winter Event 5 Hourly Impacts



Total Winter Pilot Program kW Impact per Event

Table 4 shows estimates of the pilot program's total kW demand impacts during the three hours of each event. We calculated impacts by multiplying the total number of pilot homes by the average home demand reduction. In the first hour, program impacts ranged from -124 to -240 kW. The impacts were less in hours 2 and 3. The program achieved a maximum load reduction of 239 kW in hour 1 of event 4.

Table 4. Total Estimated Demand Impacts by Winter Event and Hour (kW)

Winter Event	Participants (n)	Hour 1 Impact (kW)	Hour 2 Impact (kW)	Hour 3 Impact (kW)
1	78	-176.0	-64.6	-12.6
2	78	-172.8	-47.8	-18.1
3	47	-124.5	-108.6	-70.8
4	78	-239.2	-168.3	-122.2
5	78	-190.3	-133.6	-78.0

Demand Impacts by Participant Characteristics

We also studied whether the demand impacts were related to home characteristics. We compared the demand impacts in homes with heat pumps to homes with electric furnace heating, homes of different vintages, and manufactured and non-manufactured homes. The demand impacts for event 3 are not reported, as the substation failure resulted in a sample size that was too small for meaningful comparisons.

Table 5 shows the demand impact comparison by heating system type. Homes with a heat pump exhibited much higher impacts than those with furnaces in all of the event hours. The differences were particularly large during the first two events when temperatures were extremely cold. In 11 of the 12 event hours, we can reject the hypothesis that the demand impacts of heat pumps and electric furnace heating systems were equal. We cannot reject the hypothesis of equality in hour 3 of event 4.

Table 5. Comparison of Heat Pump and Furnace kW Impacts

Event and Hour	Heat Pump kW Impact (n = 24)	Electric Furnace kW Impact (n = 38)	t-stat for Difference	p-value
Event 1: Hour 1	-4.04	-0.90	-11.8	0.00
Event 1: Hour 2	-1.96	-0.05	-7.2	0.00
Event 1: Hour 3	-1.31	0.38	-6.4	0.00
Event 2: Hour 1	-3.35	-1.18	-8.2	0.00
Event 2: Hour 2	-1.60	0.18	-6.7	0.00
Event 2: Hour 3	-0.99	0.29	-4.9	0.00
Event 4: Hour 1	-4.40	-2.23	-8.0	0.00
Event 4: Hour 2	-3.06	-1.46	-6.0	0.00
Event 4: Hour 3	-1.72	-1.40	-1.2	0.22
Event 5: Hour 1	-3.08	-2.03	-3.9	0.00
Event 5: Hour 2	-2.21	-1.31	-3.4	0.00
Event 5: Hour 3	-1.35	-0.76	-2.2	0.03

Table 6 compares the demand impacts for each event hour in homes with different vintages. The small sample sizes should be kept in mind but, in general, recently-built homes (in the last decade) experienced larger event hour demand reductions. Newer homes would have been subject to more stringent building codes and are therefore more efficient. Higher insulation levels would have helped newer homes maintain interior temperatures and delay the resumption of heating. Homes built before the 1980s generally had the smallest demand impacts. Interestingly, homes built in the 1980s had larger demand impacts than those built in the 1990s. One reason may be that energy prices were high during the 1980s and homes may have been built to be more efficient during this decade than those built during the 1990s.

Table 6. Demand Impacts (kW) by Home Vintage

Event and Hour	Pre-1980s (n=16)	1980s (n=10)	1990s (n=29)	2000s (n=17)
Event 1: Hour 1	-2.00	-2.90	-1.90	-2.82
Event 1: Hour 2	-0.61	-0.86	-1.16	-0.54
Event 1: Hour 3	0.66	0.03	-0.93	0.25
Event 2: Hour 1	-2.48	-3.20	-1.30	-3.00
Event 2: Hour 2	-1.13	-1.15	-0.04	-0.83
Event 2: Hour 3	-0.25	-1.26	-0.10	0.14
Event 4: Hour 1	-2.88	-2.53	-2.56	-4.42
Event 4: Hour 2	-2.19	-1.77	-1.73	-3.12
Event 4: Hour 3	-1.74	-2.21	-1.39	-1.30
Event 5: Hour 1	-1.69	-2.95	-2.25	-3.14
Event 5: Hour 2	-1.85	-1.60	-1.33	-2.36
Event 5: Hour 3	-1.09	-1.84	-0.97	-0.50

Table 7 compares manufactured homes with standard single-family homes. For the majority of the event hours, statistically significant differences were found in the mean kW impacts between the two groups. In nearly all cases, non-manufactured homes had higher levels of savings. This is most likely due to the higher construction quality of non-manufactured homes.

Table 7. Comparison of Manufactured and Non-Manufactured Home kW Impacts

Hour	Manufactured Homes (N=23)	Non-Manufactured Homes (N=20)	t-stat for difference	p-value
Event 1: Hour 1	-1.84	-2.03	0.61	0.55
Event 1: Hour 2	-0.75	-0.12	-2.01	0.05
Event 1: Hour 3	-0.19	0.26	-1.43	0.16
Event 2: Hour 1	-1.88	-2.72	2.67	0.01
Event 2: Hour 2	-0.1	-0.83	2.30	0.03
Event 2: Hour 3	0.39	-0.92	4.17	0.00
Event 4: Hour 1	-2.17	-3.99	5.63	0.00
Event 4: Hour 2	-1.79	-2.4	1.89	0.07
Event 4: Hour 3	-1.43	-1.92	1.56	0.13
Event 5: Hour 1	-2.11	-2.49	1.19	0.24
Event 5: Hour 2	-1.49	-1.91	1.33	0.19
Event 5: Hour 3	-0.73	-1.56	2.66	0.01

Table 8 shows the relationship between estimated demand reductions and home size. We categorized homes as small (<2,500 sq. ft.) or large (≥2,500 sq. ft.). On average, large homes experienced greater demand reductions. This is to be expected, as large homes typically have greater consumption and therefore have more potential for savings.

Table 8. Comparison of Small and Large Home kW Impacts

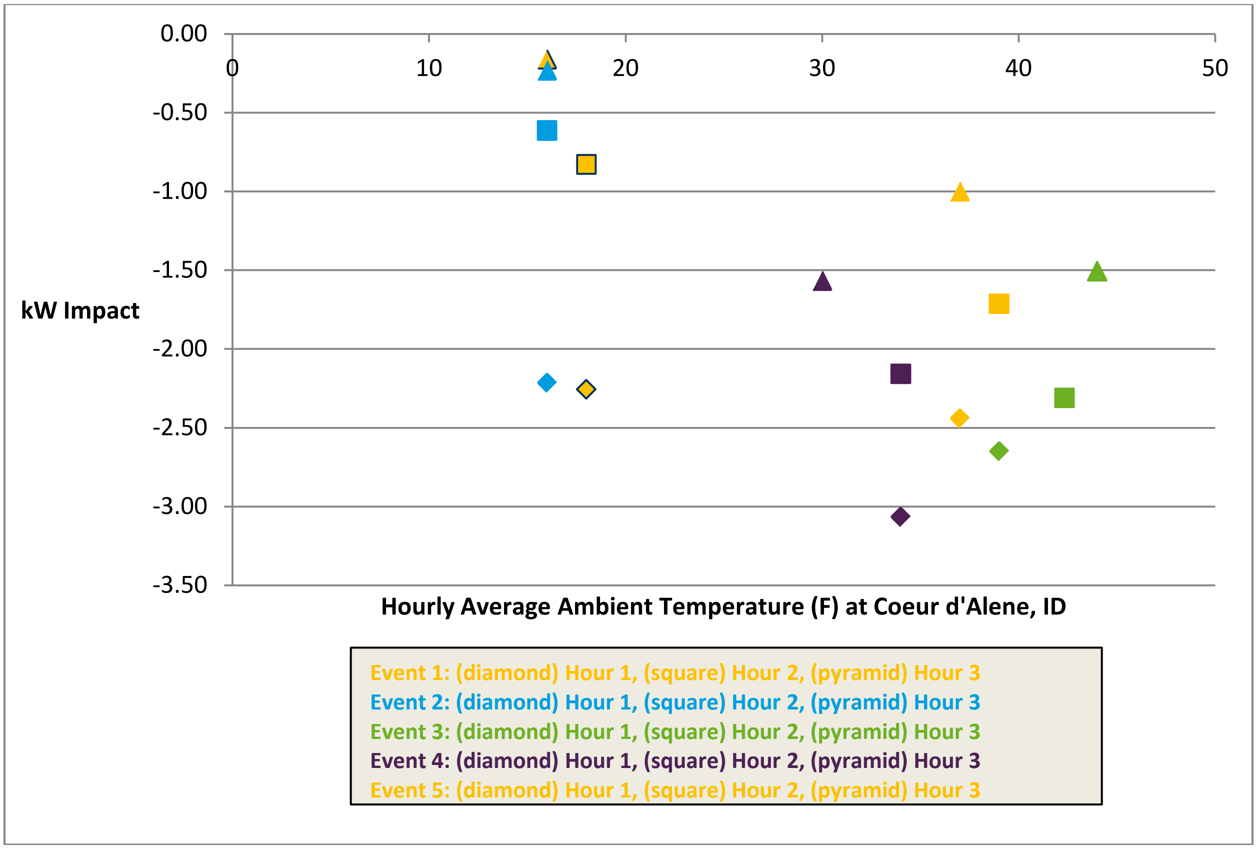
Hour	Large Homes (≥ 2,500 Sq. ft., N=17)	Small homes (< 2,500 sq. ft., N=43)	t-stat for difference	p-value
Event 1: Hour 1	-3.07	-1.70	-4.22	0.00
Event 1: Hour 2	-1.86	-0.29	-4.84	0.00
Event 1: Hour 3	-1.47	0.13	-4.93	0.00
Event 2: Hour 1	-2.88	-1.68	-3.68	0.00
Event 2: Hour 2	-1.59	-0.03	-4.81	0.00
Event 2: Hour 3	-0.99	0.06	-3.26	0.00
Event 4: Hour 1	-4.41	-2.62	-5.54	0.00
Event 4: Hour 2	-2.72	-1.82	-2.79	0.01
Event 4: Hour 3	-1.64	-1.47	-0.55	0.59
Event 5: Hour 1	-3.12	-2.22	-2.76	0.01
Event 5: Hour 2	-1.79	-1.60	-0.60	0.55
Event 5: Hour 3	-0.92	-1.02	0.30	0.76

Demand Impacts as a Function of Outside Temperature

Cadmus also examined the relationship between outside temperature and the estimated demand reductions. We plotted the average demand reduction in each event hour against the temperature in that hour. Our expectation was that the relationship would be quadratic, that is, at extreme (very cold or very mild) temperatures the demand reductions would be smaller than those at normal winter temperatures. However, we realize that this relationship may not be evident in a scatter plot because only five events and eight different event hour temperatures occurred.

Figure 8 shows the scatter plot in which event hours are indicated by shapes (diamonds for hour 1, square for hour 2, and pyramids for hour 3) and the events by colors (gold for event 1, red for event 2, green for event 3, purple for event 4, and blue for event 5). As expected, within each event, the estimated demand reductions are largest in the first hour and smallest in the third hour. This reflects decreasing energy use in pilot homes between 7 and 9 a.m., and greater heating demand in event hours 2 and 3 than in event hour 1. Also, a comparison of demand reductions across events shows the reductions in hours 2 and 3 are generally decreasing with temperature. Hour 1 exhibits a much weaker relationship between estimated demand reductions and temperature. As expected, it is difficult to detect a decrease in demand impacts as temperature decreases at milder temperatures. This is likely because of the limited range of event hour temperatures that were observed.

Figure 8. Demand Impacts as a Function of Temperature



Cross Sectional Model of Demand Impacts

To control for the simultaneous influence of different home characteristics on demand savings, we also estimated regression models of customer demand impacts in the three event hours. The models estimate the kW impact in a home in an hour (1, 2, or 3) as a function of heating degrees Fahrenheit, the presence of a heat pump (=1 if heat pump; =0, otherwise), home size (=1 if ≥2,500; =0, otherwise), and home vintage.[8] The kW impacts were obtained from the estimation of the customer demand models described above.

[8] We also estimated the model with a variable indicating the home was manufactured; however, because information about whether the home was manufactured was missing for a large number of homes in the sample, the estimation sample was significantly reduced. Including manufactured homes did not significantly affect the results.

Table 9. Cross-Sectional Model Results by Hour Type[9]

Parameter	Hour 1	Hour 2	Hour 3
Intercept	-0.86 (0.73)	-1.18* (0.61)	-0.64 (0.45)
HD	0.02 (0.01)	0.04* (0.01)	0.03* (0.01)
Dummy: Heat Pump	-1.49* (0.62)	-1.08* (0.33)	-1.12* (0.27)
Dummy: Homes Manufactured in the 2000s	-1.98* (0.89)	-0.97 (0.65)	-0.12 (0.45)
Dummy: Homes Manufactured in the 1990s	-1.53* (0.55)	-1.15* (0.48)	-1.07* (0.3)
Dummy: Homes Manufactured in the 1980s	-2.04* (0.70)	-1.78* (0.52)	-1.49* (0.36)
Dummy: Home Size Greater than 2,500 Sq ft	0.42 (0.66)	0.02 (0.4)	0.01 (0.26)
R^2	0.18	0.18	0.19
N	254	254	254
Notes: The dependent variable is the demand impact in hour k. Standard errors in parentheses are adjusted for clustering on customers. * denotes statistically significant at the 5 percent level. The omitted category is electric furnaces, homes built in the 1970s, and homes less than 2,500 feet.			

Table 10 reports the results of the demand impact regressions. In general, the regression results are consistent with the results from the unconditional comparisons above. The demand impacts were decreasing in heating degrees Fahrenheit, increasing with a heating pump (compared to a furnace), smallest in homes built before the 1980s, and largest in homes built in the 1980s and the 2000s. For example, the model predicts that in hour 2 the demand reduction in a home with a heat pump is 1.08 kW greater than the reduction in a home with an electric furnace. After controlling for the other characteristics, the demand impacts were uncorrelated with home size. Comparison of the intercepts and variable coefficients across models shows the demand reductions were largest in the first event hour and diminished over time. Homes built in the 1980s and 1990s and those with heat pumps experienced the largest demand reductions in the first event hour.

Comparison of Demand Reductions Using Logger and AMI Data

Cadmus analyzed 15-minute interval logger data for heating systems and water heaters in five pilot homes.[10] We estimated demand impacts in each event hour using demand models for water heating and space heating with specifications similar to those used for the whole house. We compared the whole-house demand impacts to the sum of the space heating and water heating end-use impacts, then formally tested the hypothesis that the end-use impacts equaled the AMI impacts.

Table 9 shows the average whole-house and end-use results. The estimates of the demand impacts at the whole-house level and the sum of the end-use impacts are quite different in most hours. However, in only one of 15 event hours (Event 4, Hour 1) could we reject the hypothesis that the demand impacts were equal. In general, the demand reductions are not estimated precisely, which is responsible for our failure to reject the hypothesis in more hours. Given the

[9] Standard errors included in parentheses were estimated by clustering the sample by Aclara number to mitigate correlation within a given home across events.

[10] The logger data may have had timestamp errors in regard to daylight savings time; therefore it is possible that the event hours were not accurately captured in the analysis.

small sample size (n = 5), it is difficult to generalize these results to the whole pilot population. More research comparing the whole-house and end-use impacts is needed.

Table 9. Comparison of Logger and AMI Data (N=5)

Hour	Water heat (kW)	Space heat (kW)	Total end use (kW)	Total End Use SE	AMI (kW)	AMI SE	Test statistic for H0: AMI=ΣEnd Use	p-value
Event1 Hr1	-0.46	-0.63	-1.09	0.71	-2.31	1.27	0.84	0.40
Event1 Hr2	-1.41	-1.38	-2.79	0.71	-1.35	1.26	-0.99	0.32
Event1 Hr3	-1.38	-1.42	-2.8	0.71	-0.60	1.26	-1.52	0.13
Event2 Hr1	0.24	0.05	0.29	0.72	-1.18	1.27	1.01	0.31
Event2 Hr2	-1.07	-1.04	-2.11	0.71	0.13	1.26	-1.55	0.12
Event2 Hr3	-0.82	-0.85	-1.67	0.71	0.19	1.26	-1.29	0.20
Event3 Hr1	-0.38	-0.04	-0.42	0.71	-2.37	1.26	1.35	0.18
Event3 Hr2	-0.86	-0.83	-1.69	0.72	-2.40	1.27	0.49	0.63
Event3 Hr3	-1.05	-1.06	-2.11	0.72	-1.22	1.27	-0.61	0.54
Event4 Hr1	0.36	0.76	1.12	0.71	-1.98	1.25	2.16	0.03
Event4 Hr2	-0.89	-0.81	-1.7	0.71	-1.60	1.25	-0.07	0.94
Event4 Hr3	-1.26	-1.28	-2.54	0.71	-1.39	1.24	-0.81	0.42
Event5 Hr1	-1.67	-1.87	-3.54	0.71	-2.00	1.26	-1.07	0.29
Event5 Hr2	-1.39	-1.26	-2.65	0.71	-1.14	1.26	-1.05	0.30
Event5 Hr3	-0.47	-0.42	-0.89	0.71	-0.85	1.25	-0.03	0.98

Summer Events

The sample size for the summer events was 67 homes. Nineteen homes had both air conditioning and water heater load control (AC-WH), and the remaining 48 had only water heat load control (WH). We used AMI data from August 1 through September 30 to estimate the load impacts.

Table 11 shows estimates of the average demand impacts in each summer event hour and the associated 95% confidence intervals for AC-WH homes and WH homes. As with winter event impacts, we estimated summer demand impacts for each pilot home as a regression of hourly demand on weather, calendar, and time variables with:

- Interaction variables between weather and calendar and time effects; and
- Indicator variables for hours before, during, and after each event.

Average demand reductions in AC-WH homes were statistically different from zero, with 95% confidence in all hours except hour 2 of event 1. Average demand reductions in WH homes were statistically different from zero with 95% confidence in hours 2 and 3 of event 1 and for all hours of event 2.

In AC-WH homes, average hourly demand impacts ranged between 0.4 and just over 1 kW. The first two events had temperatures in the mid- to low-80s and exhibited impacts of around 0.5 kW. These impacts represented a 28% reduction in home demand on average. In the third event, where temperatures were near 90 degrees, the impacts were closer to 1 kW, representing an average reduction in home demand of 45%. The average demand impact over all event hours was -0.67 kW, or 34%, with a 95% confidence interval lower bound of -0.81 kW and upper bound of

-0.53 kW. The estimated demand reduction met the lower end of BPA's expectation of 0.7 to 1.2 kW for combined space cooling and water heat.

Table 10. Mean Estimated Load Impacts (kW) for all Summer Event Hours with 95% Confidence Intervals by Controlled End Uses

Event	Hour	Temperature (ºF)	AC-WH Estimated Impacts (kW)	LB 95% CI (kW)	UB 95% CI (kW)	WH Estimated Impacts (kW)	LB 95% CI (kW)	UB 95% CI (kW)
1	1	82	-0.46	-0.88	-0.05	-0.25	-0.52	0.01
1	2	84	-0.41	-0.83	0.01	-0.44	-0.70	-0.17
1	3	83	-0.58	-1.00	-0.17	-0.37	-0.64	-0.10
2	1	82	-0.46	-0.88	-0.04	-0.37	-0.64	-0.10
2	2	84	-0.45	-0.87	-0.03	-0.37	-0.64	-0.10
2	3	84	-0.68	-1.10	-0.26	-0.30	-0.57	-0.03
3	1	88	-1.08	-1.51	-0.66	-0.05	-0.33	0.22
3	2	89	-0.99	-1.41	-0.57	-0.05	-0.33	0.23
3	3	89	-0.87	-1.30	-0.44	-0.13	-0.41	0.15

In WH homes, average hourly demand impacts ranged between -0.05 and -0.4 kW. The first two events exhibited impacts of around -0.3 kW. These impacts represented a 30% reduction in demand per home on average. In the third event, impacts did not differ significantly from zero with 95% confidence. Average demand impact over all event hours was -0.26 kW, or 22%, with a 95% confidence interval lower bound of -0.35 kW and upper bound of -0.17 kW.

Summer Event Impacts Before and After Each Event

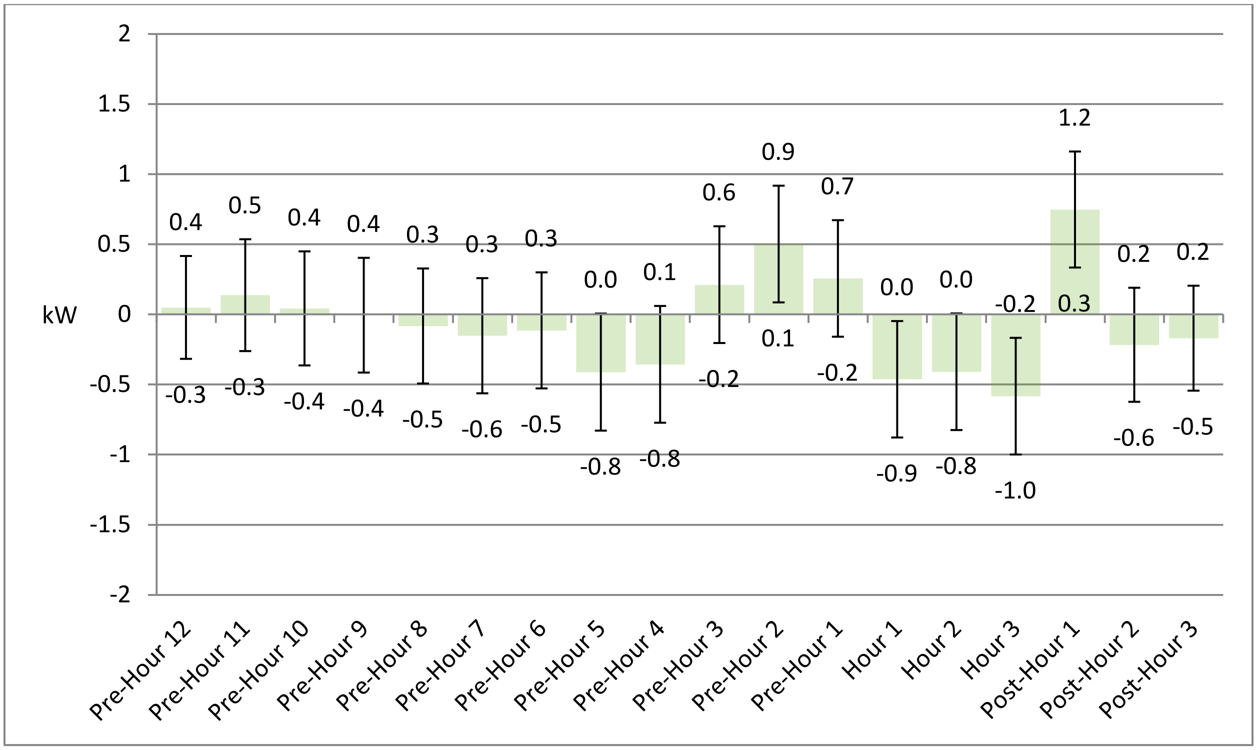
Figure 3 through Figure 7 show the demand impacts in the 12 hours before, three hours during, and three hours after each summer event for AC-WH homes.[11] Participants received 18 to 24 hours advance notification of the events. After an event ended, the cooling system returned home interiors to their programmed temperature, and the water heater turned back on to reheat the water. Thus, rebound effects should occur, with higher than normal demand in post-event hours.

In most hours preceding the events, the 95 % confidence interval includes zero, and demand was not statistically different from the expected level. In hours following the events, there was always evidence of strong rebound in the first event hour. There was not significant rebound in post-event hours 2 or 3.

In pre-hour 2 of event 1 (Figure 9), there was a slight but statistically significant increase in consumption in AC-WH homes. Because of the small sample and absence of a control group, it is unclear whether this is a program effect or some other unobservable factor unrelated to the program.

[11] All hourly average demand impacts are reported in Appendix D with 95% confidence intervals.

Figure 9. Summer AC-WH Event 1 Hourly Impacts (N=19)



Rebound effects were substantial on average in AC-WH homes. In post-hour 1 of event 1, demand was 1.2 kW higher on average than normal.

Events 2 (Figure 9) and 3 (Figure 10) exhibited very large rebound in post-hour 1. These effects were larger than the maximum of the hourly demand reduction during the events.

Figure 10. Summer AC-WH Event 2 Hourly Impacts (N=19)

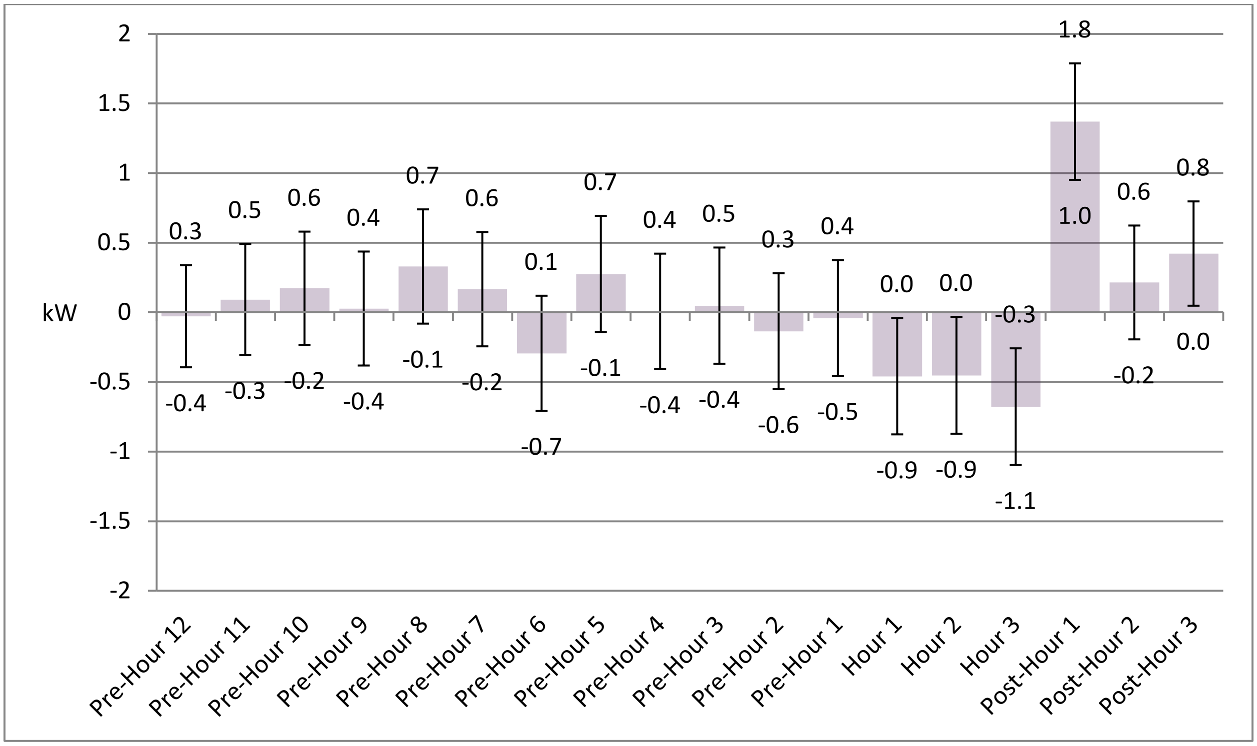


Figure 11 shows event 3 had the largest event-hour demand impacts. The demand reductions in hours 1 and 2 were more than twice as large as those in the same hours in events 1 and 2. This was due to the high temperatures and large air conditioning loads on the third event day.

Figure 11. Summer AC-WH Event 3 Hourly Impacts (N=19)

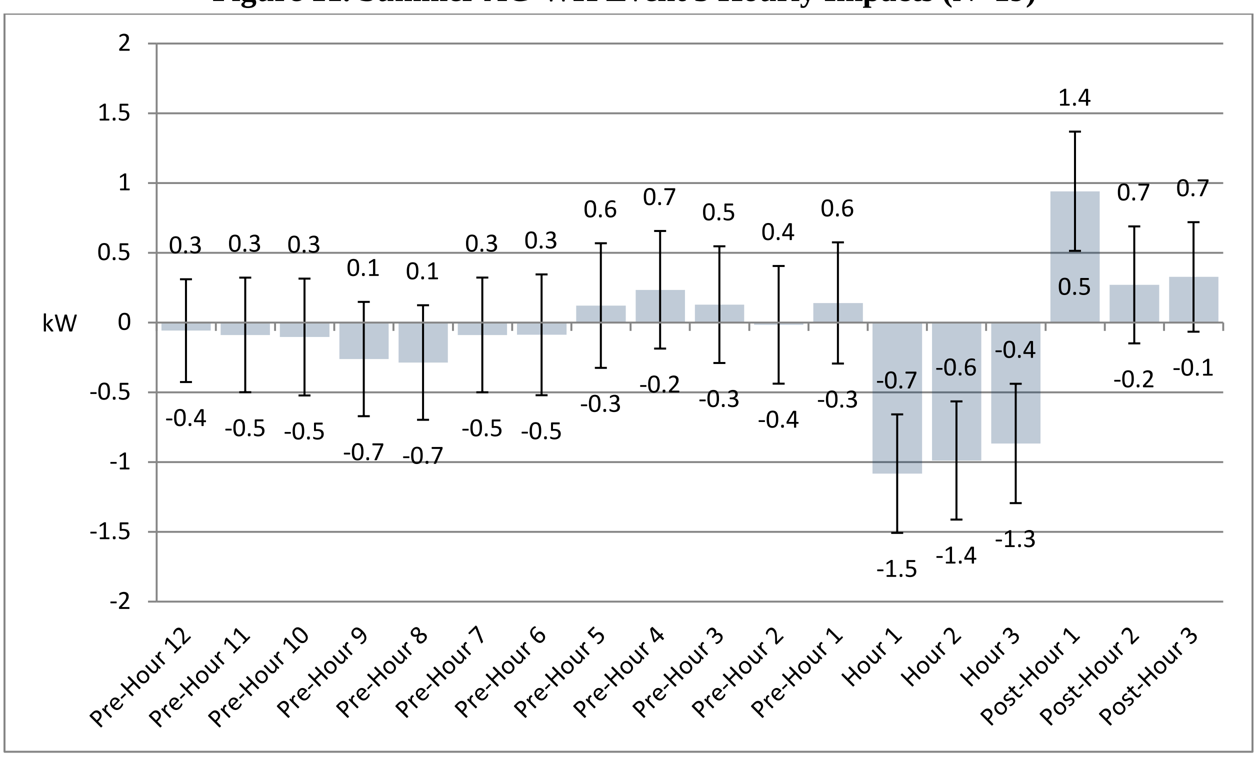
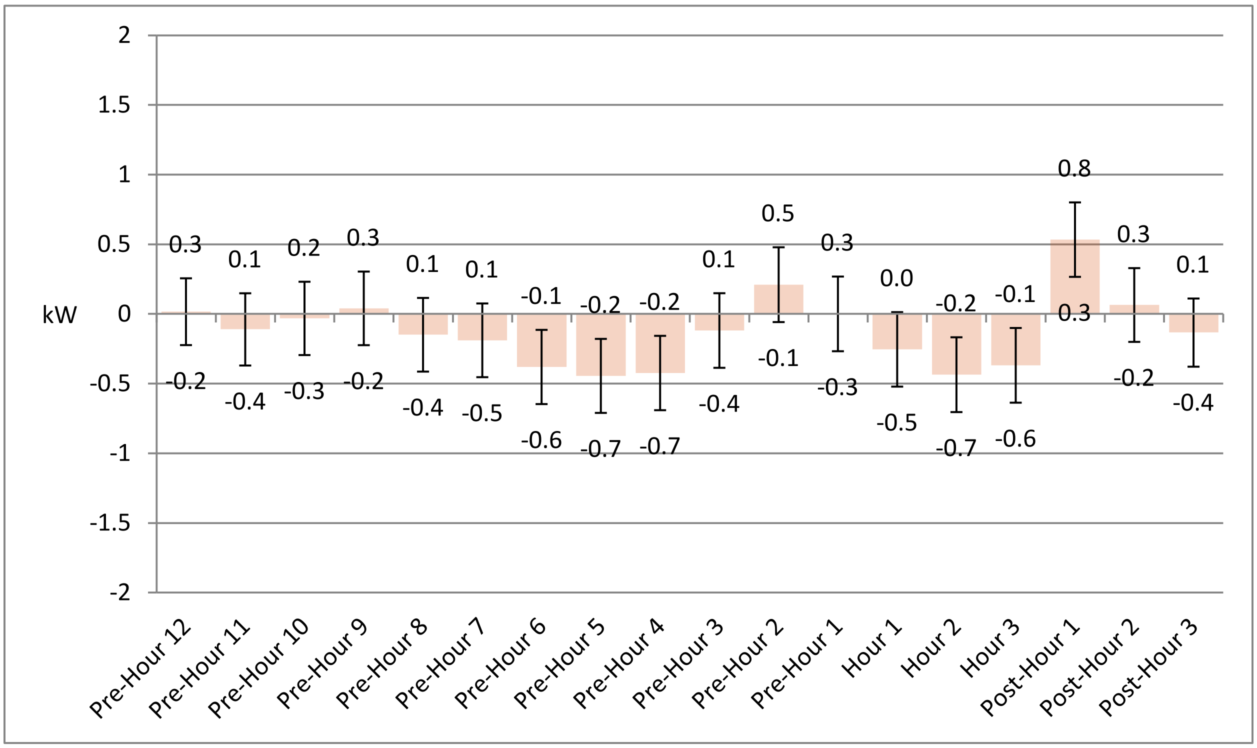


Figure 12 through Figure 14 show the demand impacts in the hours before, during, and after each event for WH homes. In most hours preceding the event, demand is not statistically different from the expected level. In hours following the events, there is evidence of rebound in the first event hour. Rebound did not occur in post-event hours 2 or 3.

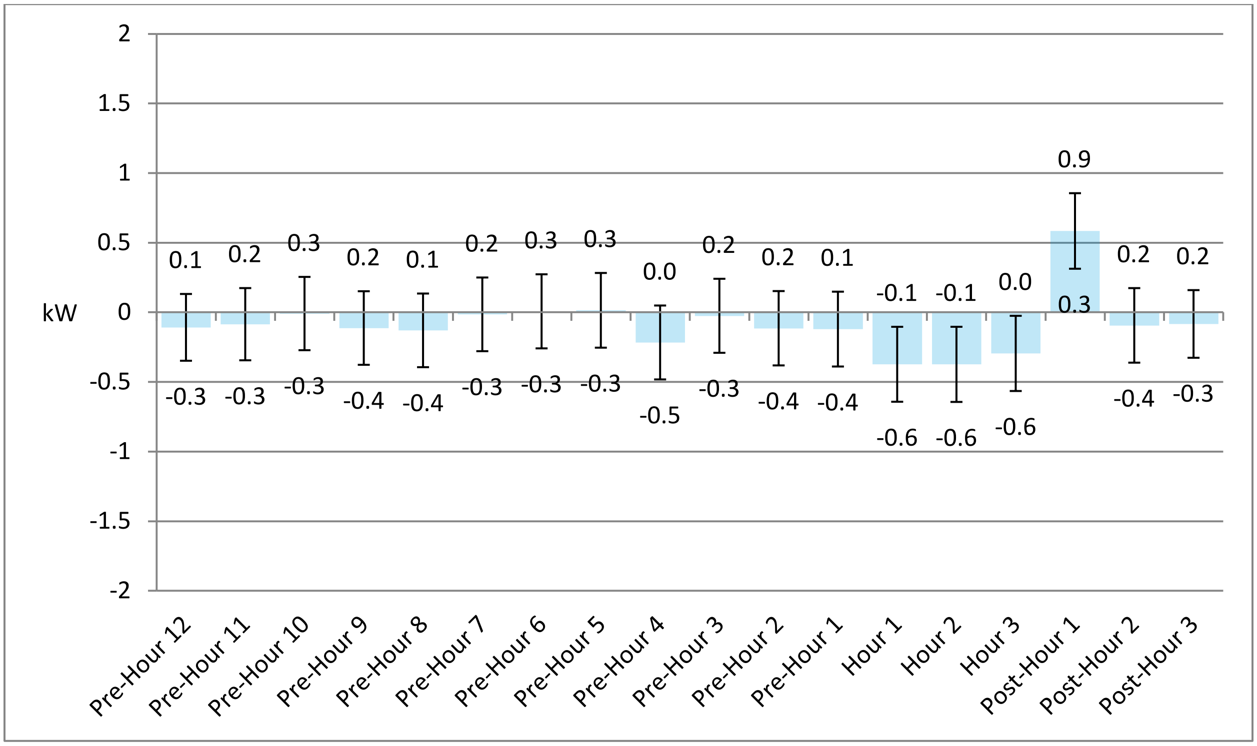
Figure 11 show that in pre-hours 4 through 6 of event 1, demand was significantly lower than the baseline. This was due to a small number of homes (accounting for less than 10% of the sample) with significantly smaller than expected demand. We do not think this low demand was related to the event, but as there was no indication of compromised data or other explanation for the demand reduction, we did not exclude these observations from the sample. In a small sample, chance demand in a small number of homes can skew the results.

Figure 12. Summer WH Event 1 Hourly Impacts (N=48)



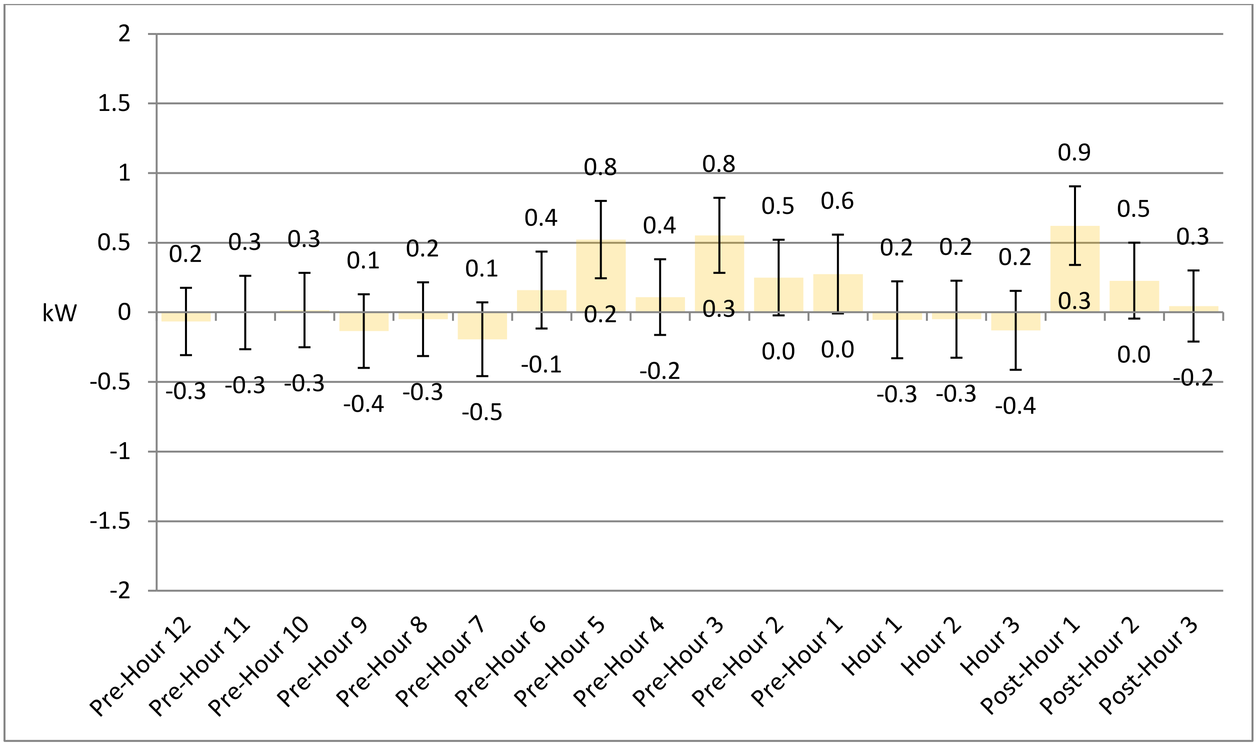
In Figure 12, demand during the pre-period closely matched the baseline. There was a modest decrease in demand during the event hours.

Figure 13. Summer WH Event 2 Hourly Impacts



In the pre-period in event 3, there were also deviations from the baseline. These deviations occurred in pre-hours 3 and 5 and were due to a small number of homes that showed an unexpected increase in demand. Again, we do not think the increase in demand was due to the program.

Figure 14. Summer WH Event 3 Hourly Impacts



Total Summer Pilot Program kW Impact per Event

Table 12 shows estimates of the total kW demand impacts for the pilot during the three hours of each event. We calculated impacts by multiplying the total number of AC-WH and WH pilot homes by the average home demand reduction and added the AC-WH home and WH home results. Program impacts ranged from -22 to -30 kW. The program achieved a maximum load reduction of 29.9 kW in hour 3 of event 1.

Table 11. Total Estimated Demand Impacts by Summer Event and Hour (kW)

Summer Event	Participants (n)	Hour 1 (kW)	Hour 2 (kW)	Hour 3 (kW)
1	67	-22.03	-28.55	-29.85
2	67	-27.10	-26.97	-29.00
3	67	-28.35	-25.91	-26.42

Demand Impacts by Participant Characteristics

Cadmus did not analyze the demand impacts of summer events by participant characteristics or weather. The estimation samples of AC-WH homes (N=19) and WH homes (N=48) were too small and the number of events (N=3) was too small for statistical analysis of demand reductions by home size, home vintage, or outside temperature.

5. Conclusions and Recommendations

The BPA set forth the following Peak Project evaluation goals:

- Evaluate program implementation strengths and weaknesses, and participant awareness, behavior changes, and satisfaction.
- Develop impact assessments for individual homes and for the program overall, using both whole-house AMI data and portable loggers installed in a subset of homes.
- Check the accuracy of impacts reflected in the AMI data, compared to the logger data, to recommend whether future program evaluations could rely solely on AMI data.
- Determine the relative kW impacts of space and water heat.
- Develop recommendations on data collection and other processes that BPA can use to maximize evaluation efficiency use on subsequent programs.

In addition to BPA’s goals, process and impact evaluations uncovered other key conclusions and recommendations for future residential DR programs.

Process Evaluation Conclusions

The process evaluation revealed challenges to program implementation and member recruitment but also highlighted that program staff were versatile and dedicated to member satisfaction, as demonstrated by program participants largely expressing satisfaction with the program.

Program Implementation and Administration

- KEC staff successfully managed numerous responsibilities involving coordination between BPA, KEC, and Aclara; program marketing; installation and operation of DLC equipment; and managing program complaints and member concerns.
- Communication proved very important among all involved parties and across departments within the utility in maintaining member satisfaction and managing member complaints.
- A third-party implementer would have been useful in coordinating and communicating among BPA, KEC, the electricians, HVAC technicians, and Aclara. KEC reported, however, this could have caused another barrier to program participation due to member concerns about rate increases and government control of their electric use.

Equipment and Data Collection

- Due to the complexity of installing and programming DLC thermostats, KEC hired HVAC contractors.
- During the program, electricians and HVAC contractors who conducted the DLC equipment installations should remain on-call to investigate customer complaints or repair equipment, as needed. The utility should also maintain a strategy for transferring equipment ownership and responsibility to participants once the program has ended.

- Due to the time required and difficulty, retrieving interval data from an AMI systems requires working closely with the AMI system manufacturer.

Participant Recruitment, Awareness, and Satisfaction

- Recruiting program participants proved difficult for the following reasons:
  - Eligibility was limited to members with electric heat, representing approximately 40% of KEC members. Of these, only members with heat pumps and electric furnaces were eligible, and not all heat pumps or furnaces were compatible with the DLC thermostat.
  - Some eligible members were not interested in giving the utility control of their thermostats, despite options for the participant to override the settings.
  - Some eligible members expressed concern about the government controlling or monitoring their electricity use, and they refused to participate in the program.
  - Members did not understand the program, and educating them became a major component of the marketing campaign.
- Participant comfort was largely unaffected during events, particularly for summer events. Few surveyed participants reported adjusting their thermostats during events (2 of 40) or opting out of events (2 of 40).
- Participants expressed satisfaction with the overall program, but had numerous complaints about the thermostats.

Impact Evaluation Conclusions

Impact evaluation conclusions for winter are:

- The program exceeded its demand savings goals during winter, reducing average demand per home by 1.65 kW over all event hours, with a 95% confidence interval lower bound of 1.54 kW and an upper bound of 1.76 kW. Demand reductions in all but two event hours were statistically different from zero. Combined space heating and water heating expected demand reduction was 1.3 kW, which lies below the estimated confidence interval.
- The largest demand reductions occurred during the first event hour. The program reduced average winter demand per home between 2 and 3 kW in the first event hour, and between 0 and 2 kW in the second and third event hours.
- Significant rebound in demand occurred after events ended. In winter, rebound impacts increased with colder event hour temperatures.
- During events 1 and 2, demand in hours before the event was greater than it would have been if the event had not been called. Such behavior is consistent with participants turning up thermostats in anticipation of events. However, without a control group, this claim cannot be verified; the impacts may have been due to extreme cold temperatures not fully captured by the model.

Impact evaluation conclusions for summer are:

- In homes with direct load control of central air conditioning and water heat, the program reduced average demand per home by 0.65 kW over all event hours, with a 95% confidence interval lower bound of 0.53 kW and an upper bound of 0.81 kW. Demand reductions in all but one event hour (event 1, hour 2) were statistically different from zero. In homes with direct load control of water heat only, the program reduced average demand per home by 0.26 kW over all event hours, with a 95% confidence interval lower bound of 0.17 kW and an upper bound of 0.35 kW.
- Estimated demand reductions did not vary significantly between the first, second, and third event hours in AC-WH and WH homes.
- In AC-WH homes, the largest demand reductions occurred during event 3 when event hour temperatures reached 89 degrees Fahrenheit. During the first and second hours of event 3, the estimated load reductions were more than twice as large as those during the same hours in events 1 and 2.
- Significant rebound in demand occurred after events ended. In AC-WH and WH homes, rebound in the first post-event hour was equal to or greater than the maximum demand reduction during the event. Rebound was limited to the first post-event hour.
- In AC-WH and WH homes, there is not conclusive evidence of changes in demand before the events. In most pre-event hours, demand is close to the baseline.

For both summer and winter:

- End-use logger data need to be collected at more homes to draw conclusions about how whole-home meter impacts compare to end-use impacts.

Recommendations for Future Programs

BPA intends to work with other utilities to implement DLC programs. Drawing from this study, we offer the following suggestions for conducting future programs:

- As space heating or cooling DLC events have larger impacts in each season than water heating, BPA should assess tradeoffs between larger demand impacts and higher program costs for installing DLC thermostats. Other thermostat options should be explored. For example, BPA could consider purchasing more than one type of thermostat, maximizing the number of heating systems compatible with DLC. Only one manufacturer was available when the KEC Peak Project was implemented. Currently, two thermostat manufacturers are available, and there may be more options in the future.
- Future programs should consider hiring a third-party program implementer, provided this will not negatively impact program participation rates. One option would be to hire a third-party employee on a temporary basis to help the utility with the initial implementation and administration of the program.
- Educating customers comprises a major component in marketing the program and recruiting participants. Customers must be taught about AMI meters’ capabilities and

limitations and DR concepts and benefits. Administrators of new DR programs should not underestimate the resources required for educating customers about these programs.

- Implement a strategy for transferring equipment ownership to participants at the beginning of the program, during equipment installation. Establishing a date or timeframe where responsibility for maintaining the equipment transfers to participants will be an important consideration in program planning and budgeting.

- The utility should work with the AMI system provider to establish a reliable method for retrieving data, as needed. If possible, data retrieval should not rely on the AMI system provider and should be done independently by the utility.

Recommendations to Improve Demand Impact Estimates

- If program budgets allow, future programs should collect more data about participants. The most important would be information about building envelopes, including wall, attic, and basement insulation and windows.

- The utility should call more than five events each season and should call them during a wider range of temperatures. Procuring data for non-event days, which could be compared to data from event days with similar temperatures, would improve the model's prediction of event impacts. We also recommend the utility allow a non-event day, with extreme hot or cold temperatures, to occur; this will allow the program evaluator to control for demand impacts coinciding with summer or winter events, but unrelated to the program.

- Future program evaluations should establish a control group of participant homes where DR events are not called, allowing comparison to homes where events are called. A control group would allow the regression model to account for impacts coinciding with but unrelated to events.

- BPA should install more data loggers in future programs to conduct further testing of the relationships between end-use and whole-house impacts. The sample size should be determined based on the number of program participants in different strata (e.g., heat pumps or furnaces), the expected demand reduction, the variance of hourly loads, and the desired statistical confidence and precision.[12]

- BPA should carefully consider the sample size. For this evaluation of combined space heating and water heating, the relatively small sample size (n = 73 for winter heating events and n = 19 for summer cooling events) proved to be sufficient due to large demand impacts. However, a larger sample size may be necessary for a DR program that has smaller anticipated impacts, especially when conducting metering at the whole-house level.

[12] Cadmus typically recommends that treatment and control groups include approximately 120 homes. With a coefficient of variation of demand of 0.4 and an expected demand reduction of 50%, this sample size would result in a demand reduction estimate within +/- 10% of the true reduction with 90% confidence.

Appendix A: Program Staff Interview Guide

BPA/Kootenai Electric Cooperative

Peak Project

Staff Interview Guide – Spring 2011

The purpose of the interview is to explore your experience with the Peak Project. Please feel free to let me know when there are areas that you do not have experience with so that we can move on to those areas in which you've worked most closely. In our report, we will not identify you by name, but we may associate your comments with your organization.

Introduction

1. Can you please begin by telling me your title, and briefly describing your role in the Peak Project?
2. Do you have any additional responsibilities on the Peak Project?
3. What other responsibilities do you have aside from the Peak Project?
4. How long have you held this position?
5. What is your technical background, and do you have any prior experience with similar programs?

Program Implementation and Delivery

6. Can you describe in general terms how the program is being delivered to the customers? In other words, give an overview of program implementation – possible topics:
    a. Program design
    b. Contracting with technical partners
    c. Customer recruitment
    d. Equipment installation
    e. Data management
    f. Calling events
    g. Evaluation
7. Who are the various parties involved in program delivery and what are their roles?
8. What training, if any, was provided to staff (BPA, KEC)? To technical partners (e.g. Aclara)? What additional training, if any, would be helpful?
9. Has staffing for the program been adequate?
10. What is working particularly well about program delivery? Is there anything specific you would change?
11. How is quality control/compliance with program requirements assessed?
12. How is communication between stakeholders (BPA, KEC, Aclara, any others) conducted? (Probe: both formal and informal) How are stakeholders informed of program changes?

Program Design

13. What do you believe are the primary goals/objectives of the Peak Project?
14. (BPA) Are you aware of a logic model and process flow chart for the program? If so, can you please describe these? (Note: Also see if we can get a copy of each if they have these)

15. What was the history and context of the pilot's development? (*Probe: whose idea? why needed? factors at work?*)
16. During implementation, were any changes made to the pilot in response to issues/concerns from its original design? If so how?
17. What additional changes (from the original design) do you think would help future implementation? Which of these do you think could be implemented for the summer events?

Program Administration, Data and Reporting

18. How were the technical partners chosen?
    a. Was it a bid process?
    b. Did BPA/KEC have experience with these firms from past programs?
    c. Are they contracted with BPA or KEC?
    d. What is the length of the contract?
19. What is your method for data collection and tracking? Can you describe the system you use?
20. Have there been any difficulties with the data tracking systems?
21. How effective and accurate is the data-tracking and data collection system?
22. How are the data used to manage the program?
23. What are the reporting processes? (From Aclara, from KEC, etc.) Are they providing the information needed to monitor program implementation/identify issues?
24. Do you have any recommendations for improving the data-tracking and collection systems?

Marketing

25. How is/was the pilot marketed:
    a. To program participants?
    b. Other parties?
26. What are/were the most effective promotional activities?
    a. To program participants?
    b. Other parties?
27. Were any marketing activities ineffective?
28. What was the marketing budget?
29. If budget were not an issue, what do you think would be the most effective way to promote the program and/or increase awareness?
30. Do participants share any characteristics or life events that might prompt them to sign up (such as purchase of a new home/change of address)?
31. Do any other factors come to mind that may have affected participation (positively or negatively – e.g., economic climate, weather, other DSM programs)

Customer Feedback

32. What has been the response of customers to the program?
33. Has program participation (new sign-ups) varied by geographic area? If so, why do you think this has been the case?
34. What have customers liked best/least about the program? Have there been any major problems or complaints?

35. How aware of the program are eligible customers? What participation barriers exist?
36. We will be interviewing program participants in the fall. Are there any questions you would like us to ask them?

Future of the Program

37. Do you think this pilot has demonstrated potential for successful DR programs in BPA/KEC's territory?
38. What technology changes/advances will affect the program? How will they affect the program?
39. What else, if anything, might affect future scenarios?

Any other comments or areas we did not cover on which you like to add your views?

BPA/Kootenai Electric Cooperative
Peak Project
Staff Interview Guide – Fall 2011

The purpose of the interview is to explore your experience with the Peak Project. Please feel free to let me know when there are areas that you do not have experience with so that we can move on to those areas in which you've worked most closely. In our report, we will not identify you by name, but we may associate your comments with your organization.

Introduction

1. Has your role with the Peak Project changed since we last spoke?

Program Implementation and Delivery

2. Have there been any staffing changes? What, if any, changes could be made to improve staffing or use it more effectively?
3. What is working particularly well about program delivery? Is there anything specific you would change?
4. How was communication between BPA, KEC, Aclara, during the summer events? (Probe: both formal and informal)

Program Design

5. During the summer events, were any changes made to the pilot in response to issues/concerns from the winter events? If so how?
6. What additional changes (from the original design) do you think would help future implementation at KEC, or at other utilities?

Data and Reporting

7. Is Aclara still assisting with data downloads? Or has KEC been able to take over this process?
8. Do you have any recommendations for improving the data tracking and collection systems?

Customer Feedback

9. What has been the response of customers to the summer events?
10. What have customers liked best/least about the program? Have there been any major problems or complaints?
11. Has customer perception changed since the winter events?

Future of the Program

12. Do you think this pilot has demonstrated potential for successful DR programs in BPA/KEC's territory?
13. What technology changes/advances will affect the program? How will they affect the program?
14. [KEC only] What is KEC's plan for continuing the program? (ask about customer eligibility changes, marketing strategy changes)
15. What else, if anything, might affect future scenarios?

Any other comments or areas we did not cover on which you like to add your views?

Appendix B: Program Participant Survey Guide

KEC's Peak Project
Residential Participant Survey

INTRODUCTION:

Hello, my name is *[FIRST NAME]* and I am calling from Discovery Research Group on behalf of Kootenai Electric.

SCREENING QUESTIONS

S1. **May I please speak with the person that has been involved with the Kootenai Electric Peak Project at *[address]*?**
   1. Yes ***[CONTINUE WITH SCRIPT]***
   2. No [*Ask:* "*Who would be the person we should talk to* ***UNAVAILABLE, SCHEDULE CALLBACK FOR DECISION MAKER]***
   3. Respondent shares responsibility [*Continue with script*]
   99. Refused ***[THANK AND END SURVEY***]

[*Reintroduce if necessary*]

S2. **Our records indicate that your household is currently enrolled in the Kootenai Electric Peak Project pilot program, is this correct? [IF CUSTOMER IS UNSURE, SAY: "The Peak Project is a program that reduces power consumption at times of peak demand by changing the temperature settings on participants' heating or cooling equipment, and cycling off water heaters for a few hours at a time."]**
   1. Yes *[CONTINUE]*
   2. No *[**THANK AND TERMINATE**.]*
   98. Don't know ***[THANK AND TERMINATE***]

We are conducting a study for Kootenai Electric's Peak Project program and we'd like to ask you some questions about your home energy use. Your responses will remain confidential, and will help improve the program. You will receive a $100 energy credit towards your Kootenai Electric bill for completing the survey, and the survey should take about ten minutes.

[IF RESPONDENT WANTS TO VERIFY THE VALIDITY OF THE SURVEY, HE/SHE CAN CALL: MELISSA NEWCOMER, KOOTENAI ELECTRIC COOPERATIVE, 208-292-3289]

PROGRAM AWARENESS:

1. **How did you first hear about the Peak Project Pilot program? (**Do not prompt. *ONE ANSWER ONLY***)**
   1. KEC post card
   2. KEC letter
   3. KEC Web site
   4. KEC newsletter (sometimes referred to as a bill insert)
   5. Brochure
   6. Friend, Family member, co-worker (word of mouth)
   7. KEC booth at an event (e.g. home and garden show, KEC annual meeting, fair)
   8. Other (please specify):__________________________
   98. Don't know

2. **What information sources were most influential in your decision to participate in the program?** [*Do not read list, MULTIPLE RESPONSES POSSIBLE; Please remove the response given in Q1 to avoid duplicating the first response.*]
   1. KEC post card
   2. KEC letter
   3. KEC Web site
   4. KEC newsletter (sometimes referred to as a bill insert)
   5. Brochure
   6. Friend, Family member, co-worker (word of mouth)
   7. KEC employee
   8. None
   9. Other [SPECIFY]

   98. Don't know

3. **Before you learned about the Peak Project, did you already know about demand response, where the utility reduces your power consumption at times of peak demand?**
   1. Yes
   2. No

   98. Don't know

PARTICIPATION AND APPLICATION PROCESS

4. **What was the primary reason that you signed up for the Peak Project?** [*do not read, mark all that apply*]
   1. Save money by lowering my energy bill
   2. To conserve energy
   3. To help the environment [*use this code only if they say the word 'environment.' All other similar responses (such as references to 'global warming') should be coded as 8. 'Other.'*]
   4. Help the utility manage demand for electricity
   5. Friend/family suggested it
   6. Keep utility rates lower in the future
   7. KEC Incentives (energy audit, energy credit contests, etc.)
   8. Other [SPECIFY]

   98. Don't know

5. **How did you sign-up for the program?** [*do not read, choose only one*]
   1. Called the KEC office
   2. Signed up online/ KEC website

   98. Don't know

COMFORT LEVEL AND CYCLING PERCEPTIONS

6. **Did you have a thermostat installed because of your enrollment in the Peak Project?**
   1. Yes
   2. Yes, but it was later removed
   3. No
   98. Don't know

[if Q6 = 1]

7. **Did you find the thermostat easy to use?**
   1. Yes
   2. No
   98. Don't know

7a.[if Q7 = 2] **What did you find difficult about the new thermostat?**
[RECORD VERBATIM]

[if Q6 = 2]

8. **Why was the thermostat removed?**
[RECORD VERBATIM]

9. **Did you receive notifications prior to events?**
   1. Yes
   2. No
   98. Don't know

9a. [if Q9 = 1] **How many events did you receive notifications for? [Require the respondent to provide a numeric response, as opposed to saying "All of them" or "All but one"]**

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
8. 8 (All of them)
9. More than 8
98. Don't know

10. **On a scale of 1 to 10, where 1 is very dissatisfied and 10 is very satisfied, how satisfied are you with the notifications you received prior to events?**
[*RECORD RATING]* 98. Don't know

11. **I'm going to read a list of ways that Kootenai Electric may notify you about events. For each one, please tell me yes or no, whether it is a good way to reach you.**
   A. E-mail
   B. Text message notification
   C. A phone call
   D. A message on your thermostat
   E. A Peak Project web page with alerts
   F. Facebook or Twitter message

Now I'm going to ask some questions about your comfort during the events.

12. **Were you at home during the winter events, which occurred from 7 to 10 in the morning on weekdays?**
   1. No, was not home during any event
   2. Was at home for part of each event
   3. Was at home during some events but not others
   4. Yes, was home during all events for the entire duration
   98. Don't know

13. **Were you typically at home during the summer events, which occurred from 2 to 5 in the afternoon on weekdays?**
    1. No, was not home during any event
    2. Was at home for part of each event
    3. Was at home during some events but not others
    4. Yes, was home during all events for the entire duration
    98. Don't know

14. **Do you recall being aware of times when your hot water heater was cycled off?**
    1. Yes
    2. No
    98. Don't know

15. **Did you ever notice running out of hot water during events?**
    1. Yes
    2. No
    98. Don't know

    15a. [if Q15 = 1] **How many events did you run out of hot water during? [Require the respondent to provide a numeric response, as opposed to saying "All of them" or "All but one"]**
    1. 1
    2. 2
    3. 3
    4. 4
    5. 5
    6. 6
    7. 7
    8. 8 (All of them)
    9. More than 8
    98. Don't know

16. **On event days, did you modify your schedule of hot water use, to avoid using hot water during the event?**
    1. Yes
    2. No
    98. Don't know

17. **On a scale of 1 to 10, with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with demand response events for your hot water heater?**
    [*RECORD RATING]* 98. Don't know

[if Q6 = 1, ask Q18 – Q21, else skip to Q22]

18. **During this past winter did your home feel cooler than usual during the events?**
    1. Yes
    2. No
    3. Didn't notice a difference
    98. Don't know

15a. *[If Q18=1*] **If your home felt cooler, did you do anything different to manage the comfort level in your home? For example…** [*Read list, mark all that apply*]
1. Turn on space heaters
2. Raise the temperature on the thermostat
3. Leave the house
4. Other [SPECIFY]

98. Don't know

19. **On a scale of 1 to 10, with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with demand response events for heating your home?**
[*RECORD RATING]* 98. Don't know

[FOR THERMOSTAT CUSTOMERS WITH AC ASK Q20-Q21 ELSE SKIP TO Q22]

20. **During this summer did your home feel warmer than usual during the events?**
1. Yes
2. No
3. Didn't notice a difference
98. Don't know

20a. *[If Q20=1*] **Did you do anything different to manage the comfort level in your home? For example…** [*Read list, mark all that apply*]
1. Turn on ceiling fan(s)
2. Turn on a window-unit AC or other AC
3. Shut blinds
4. Lower the temperature on the thermostat
5. Leave the house
6. Other [SPECIFY]
7. Nothing

98. Don't know

21. **On a scale of 1 to 10, with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with demand response events for cooling your home?**
[*RECORD RATING]* 98. Don't know

22. **During the time that you have been enrolled in the Peak Project, have you opted out of any events? [If respondent is unsure, say: "By that I mean did you override your heat or air conditioning settings rather than allowing the utility to control it."]**
1. Yes
2. No
98. Don't know

22a. [If Q22=1] **How many events did you opt out of?**
[RECORD VERBATIM]

22b. [If Q22=1] **Do you remember which date(s) the event(s) occurred that you opted out of**? [Read options]

1. Thursday February 24, 2011
2. Friday February 25, 2011
3. Thursday March 10, 2011
4. Friday March 11, 2011
5. Friday March 25, 2011

6. Friday August 12, 2011
7. Wednesday August 17, 2011
8. Monday August 22, 2011
98. Don't know

22c. [If Q22=1] **What was your reasoning for opting out of the event?**
[RECORD VERBATIM]

<u>TEMPERATURE SETTINGS</u>

[IF Q6 = 1, ASK Q23 - 25]
Now I have a few questions about your programmable thermostat settings.

23. **Before participating in the Peak Project, did you have a programmable thermostat for your heating system?**
    1. Yes
    2. No

98. Don't know

23a. [If Q23=1] **Are the temperature settings the same on the new thermostat as they were on the old programmable thermostat**?
1. Yes
2. No
98. Don't know

24. **In winter, what temperature do you usually keep your thermostat between 7 and 10 in the morning**? [*prompt if needed*]
    1. Higher than 80 F
    2. 78 – 80 F
    3. 75 – 77 F
    4. 72 – 74 F
    5. 69 – 71 F
    6. 65 – 68 F
    7. Lower than 65 F

98. Don't know

[IF CUSTOMER HAS AC ASK Q25 ELSE SKIP TO Q26]
25. **In summer, what temperature do you usually keep your thermostat between 2 and 5 in the afternoon**? [*prompt if needed*]

1. Higher than 80 F
2. 78 – 80 F
3. 75 – 77 F
4. 72 – 74 F
5. 69 – 71 F
6. 65 – 68 F
7. Lower than 65 F
8. Do not cool—whatever air temperature is

98. Don't know

SATISFACTION

Now I am going to ask you about your satisfaction with the Peak Project.

26. **On a scale of 1 to 10, where 1 is very unsatisfied and 10 is very satisfied, how satisfied are you with the equipment installation process?**

    [*RECORD RATING]*

    98. Don't know

    26a. [*Only ask if Q26=less than 6*] **What is the reason for your rating?**
    [RECORD VERBATIM]

    26b. [*Only ask if Q26=less than 6*] **How could the installation process be improved?**
    [RECORD VERBATIM]

27. **Overall, on a scale of 1 to 10 with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with the Peak Project?**

    [*RECORD RATING*]

    98. Don't know

    27a. [*If Q27=less than 6*] **What is the reason for your rating?**
    [RECORD VERBATIM]

28. **[Ask all] Based on your experience, can you recommend any ways to improve the program?**
    [RECORD VERBATIM]

29. **Would you recommend this pilot to your neighbors and friends served by KEC?**
    1. Yes
    2. No
    98. Don't know

    29a. [if Q29 =2] **Why not?**
    [RECORD VERBATIM]

30. **In your opinion, is there anything about the program that could be changed that may encourage more people to sign up?**
    [RECORD VERBATIM]

31. **On a scale of 1 to 10, where 1 is very unlikely and 10 is very likely, what is the likelihood that you would participate in another Demand Response project?**
[*RECORD RATING]*

98. Don't know

31a. [*Only ask if Q31=less than 6*] **What is the reason for your rating?**
[RECORD VERBATIM]

32. **Do you feel more positive about your utility due to this pilot project experience or is there no change in that opinion?**
    1. More positive
    2. No change
    3. Less positive
    98. Don't know

HOME DEMOGRAPHICS

Lastly, I'd like to ask you a few questions about your home characteristics.

[*Note to surveyor: If respondent asks questions about what this information will be used for, remind them that their answers are completely anonymous/confidential and the information is only used to help Kootenai Electric gather information about their service territory and member energy use.*]

33. **Do you own or rent your home?**
    1. Own
    2. Rent
    98. Don't know

34. **How many people live in your home year round?**
    1. 1
    2. 2
    3. 3
    4. 4
    5. 5
    6. 6
    7. More than 6
    98. Don't Know
    99. Refused

35. **Record sex of respondent [***DO NOT ASK]*
    1. Male
    2. Female
    98. Don't know

THAT COMPLETES THE SURVEY, THANK YOU FOR YOUR TIME. WE WILL NOTIFY KOOTENAI ELECTRIC THAT YOU HAVE COMPLETED THE SURVEY, AND YOU WILL SEE A $100 CREDIT ON YOUR OCTOBER OR NOVEMBER BILLING STATEMENTS.

Appendix C: Program Participant Response Frequency Tables

Q1. How did you first hear about the Peak Project Pilot program?

Response	Frequency (n=40)
KEC letter	15
KEC Web site	2
KEC newsletter (sometimes referred to as a bill insert)	17
KEC mentioned it during an unrelated call to the utility	1
KEC door-to-door advertising	1
Brochure	1
Friend, Family member, co-worker (word of mouth)	1
Don't know	2

Q2. What information sources were most influential in your decision to participate in the program? (multiple responses allowed)

Response	Frequency (n=28)
KEC post card	2
KEC letter	6
KEC Web site	4
KEC newsletter (sometimes referred to as a bill insert)	3
Brochure	7
Friend, Family member, co-worker (word of mouth)	1
KEC employee	5
None	2
Don't know	2
Other Responses (Question was Misunderstood)	Frequency (n=12)
To save electricity	5
To save money	2
The $100 incentive	1
The programmable thermostat	1
Sounded like an interesting program/good idea	2
Satisfied with KEC and wanted to help out	1

Q3. Before you learned about the Peak Project, did you already know about demand response, where the utility reduces your power consumption at times of peak demand?

Response	Frequency (n=40)
Yes	17
No	21
Don't know	2

Q4. What was the primary reason that you signed up for the Peak Project? (multiple responses allowed)

Response	Frequency (n=40)
To conserve energy	25
Save money by lowering my energy bill	10
Help the utility manage demand for electricity	4
KEC Incentives (energy audit, energy credit contests, etc.)	4
To help the environment.	1
Keep utility rates lower in the future	1
"It was a good idea."	1
Don't know	2

Q5. How did you sign-up for the program?

Response	Frequency (n=40)
Called the KEC office	29
Signed up online/ KEC website	6
Don't know	5

Q6. Did you have a thermostat installed because of your enrollment in the Peak Project?

Response	Frequency (n=40)
Yes	34
No	6

Q7. Did you find the thermostat easy to use?

Response	Frequency (n=34)
Yes	20
No	14

Q7a. If you responded that the thermostat was not easy to use, what did you find difficult about the new thermostat?

Response	Frequency (n=14)
Programming or navigating settings (particular to this thermostat)	6
Turning heat up/down or maintaining a constant temperature was hard to do	3
Display was hard to read	1
Manual was not clear	1
Programmable thermostats are complicated in general	3

Q9. Did you receive notifications prior to events?

Response	Frequency (n=40)
Yes	35
No	2
Don't know	3

Q9a. If you received notifications prior to events, how many events did you receive notifications for?

Response	Frequency (n=35)
1	1
2	4
3	6
4	7
5	5
6	6
7	1
8 (All of them)	1
More than 8	1
Don't know	3

Q10. On a scale of 1 to 10, where 1 is very dissatisfied and 10 is very satisfied, how satisfied are you with the notifications you received prior to events?

Response	Frequency (n=35)
6	1
7	1
8	2
9	1
10 - Very satisfied	30

Q11. I'm going to read a list of ways that Kootenai Electric may notify you about events. For each one, please tell me yes or no, whether it is a good way to reach you.

Notification Method	Frequency (n=40)	
	Yes	No
E-mail	33	7
Text message	7	33
Phone Call	33	7
Message on the thermostat	20	20
Peak Project Web Page with Alerts	6	34
Facebook or Twitter Message	4	36

Q12. Were you at home during the winter events, which occurred from 7 to 10 in the morning on weekdays?

Response	Frequency (n=40)
No, was not home during any event	9
Was at home for part of each event	5
Was at home during some events but not others	10
Yes, was home during all events for the entire duration	13
Don't know	3

Q13. Were you typically at home during the summer events, which occurred from 2 to 5 in the afternoon on weekdays?

Response	Frequency (n=40)
No, was not home during any event	5
Was at home for part of each event	7
Was at home during some events but not others	10
Yes, was home during all events for the entire duration	16
Don't know	2

Q14. Do you recall being aware of times when your hot water heater was cycled off?

Response	Frequency (n=40)
Yes	12
No	22
Don't know	6

Q15. Did you ever notice running out of hot water during events?

Response	Frequency (n=40)
No	38
Don't know	2

Q16. On event days, did you modify your schedule of hot water use, to avoid using hot water during the event?

Response	Frequency (n=40)
Yes	7
No	32
Don't know	1

Q17. On a scale of 1 to 10, with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with demand response events for your hot water heater?

Response	Frequency (n=40)	Reason for Response
5	1	"Because it does not concern me. It does not affect me."
7	3	--
8	4	--
9	3	--
10 - Very satisfied	29	--

Q18. During this past winter did your home feel cooler than usual during the events?

Response	Frequency (n=34)
Yes	8
No	14
Didn't notice a difference	6
Don't know	6

Q18a. If your home felt cooler than usual during the events, did you do anything different to manage the comfort level in your home? (multiple responses allowed)

Response	Frequency (n=8)
Raised the temperature on the thermostat	2
Put on warmer clothes or used a blanket	2
Covered the door and windows with plastic	1
Opened the windows	1
Turned on space heaters	1
Nothing	1
Don't know	1

Q19. On a scale of 1 to 10, with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with demand response events for heating your home?

Response	Frequency (n=34)	Reason for Response
5	1	"Well I was not dissatisfied or satisfied. I just wish it was a little warmer."
7	5	--
8	3	--
9	22	--
10 - Very satisfied	3	--

Q20. During this summer did your home feel warmer than usual during the events?

Response	Frequency (n=18)	Did you do anything different to manage the comfort level in your home?
Yes	1	Turned on ceiling fan(s)
No	12	--
Didn't notice a difference	3	--
Don't know	2	--

Q21. On a scale of 1 to 10, with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with demand response events for cooling your home?

Response	Frequency (n=18)	Reason for Rating
5	1	"It doesn't affect me at all."
10 - Very satisfied	16	--
Don't know	1	--

Q22. During the time that you have been enrolled in the Peak Project, have you opted out of any events?

Response	Frequency (n=40)
Yes	2
No	37
Don't know	1

Q22a-c. If you responded that you opted out of events, how many events did you opt out of? Do you remember which date(s) the event(s) occurred that you opted out of? What was your reason for opting out of the event(s)?

Number of events	Frequency (n=2)	Date of event(s)	Reason for opting out
1	1	Friday Feb. 25, 2011	“I was very sick and it was too cold for me.”
2	1	Don’t know	“I have no time to come to the event.”

Q23. Before participating in the Peak Project, did you have a programmable thermostat for your heating system?

Response	Frequency (n=34)
Yes	14
No	20

Q23a. If you already had a programmable thermostat, are the temperature settings the same on the new thermostat as they were on the old programmable thermostat?

Response	Frequency (n=14)
Yes	11
No	3

Q24. In winter, what temperature do you usually keep your thermostat between 7 and 10 in the morning?

Response	Frequency (n=34)
78 - 80 F	2
72 - 74 F	3
69 - 71 F	11
65 - 68 F	8
Lower than 65 F	10

Q25. In summer, what temperature do you usually keep your thermostat between 2 and 5 in the afternoon?

Response	Frequency (n=18)
Higher than 80 F	2
78 - 80 F	4
75 - 77 F	2
72 - 74 F	4
69 - 71 F	3
Lower than 65 F	2
Do not cool - whatever air temperature is	1

Q26. On a scale of 1 to 10, where 1 is very unsatisfied and 10 is very satisfied, how satisfied are you with the equipment installation process?

Response	Frequency (n=40)
5	2
8	6
9	3
10 - Very satisfied	29

Q26a-b. If you gave a rating less than 6 for your satisfaction with the equipment installation process, what is the reason for your rating? How could the installation process be improved?

Reason for rating	Frequency (n=2)	Suggestions for improvement
Trouble setting up the thermostat. (This was one of the first installations done for the program and it was a learning process.)	1	No comment.
Extreme dissatisfaction with the thermostat.	1	Use a simpler thermostat.

Q27. Overall, on a scale of 1 to 10 with 1 being very dissatisfied and 10 being very satisfied, how satisfied are you with the Peak Project?

Response	Frequency (n=40)	Reason for Rating
2	1	"Because I can't run the thermostat and they were supposed to take it out and they didn't."
7	2	
8	6	
9	3	
10 - Very satisfied	28	

Q28. Based on your experience, can you recommend any ways to improve the program?

Response	Frequency (n=39)
Install a thermostat that is easier to use or give better directions (either during installation or in the manual)	9
Focus on AC instead of heating	1
Allow homes with more than one thermostat to participate	1
Follow up with an internet survey rather than on the phone	1
Offer more incentives to boost participation	1
Use a thermostat that is compatible with older heating systems	1
Provide feedback on participants' reduction in energy use and perform home audits to identify other ways energy use could be reduced	1
No, I can't think of anything.	23
"Someone from Kootenai Electric had to come out and download the data and our bill was higher than last spring with the programmable thermostat. I think they realized there's still some bugs to work out."	1

Q29. Would you recommend this pilot to your neighbors and friends served by KEC?

Response	Frequency (n=40)
Yes	38
No	2

Q29a. If you answered that you would not recommend this pilot, why not?

Response	Frequency (n=2)
The thermostat used by the program.	1
Neighbors and friends are not close enough.	1

Q30. In your opinion, is there anything about the program that could be changed that may encourage more people to sign up?

Response	Frequency (n=40)
Increase publicity	8
Offer financial incentives	2
Emphasize that it can lower your electricity bill	2
Emphasize that it can save energy or help the environment	2
Emphasize that the installation of the thermostat and the evaluation are free	1
Offer a less complicated thermostat or better instructions	4
Expand eligibility	2
No	17
Don't know	2

Q31. On a scale of 1 to 10, where 1 is very unlikely and 10 is very likely, what is the likelihood that you would participate in another Demand Response project?

Response	Frequency (n=40)
5	2
8	3
9	2
10 - Very likely	33

Q31a. If you gave a rating of less than 6 for your likelihood of participating in another Demand Response project, what is the reason for your rating?

Response	Frequency (n=2)
"Because I have not seen any notice of any event like phone calls or thermostat."	1
Depending on the project	1

Q32. Do you feel more positive about your utility due to this pilot project experience or is there no change in that opinion?

Response	Frequency (n=40)
More positive	21
No change	16
Less positive	1
Don't know	2

Q33. Do you own or rent your home?

Response	Frequency (n=40)
Own	39
Don't know	1

Q34. How many people live in your home year round?

Response	Frequency (n=40)
1	6
2	27
3	2
4	2
5	2
Refused	1

Q35 (Recorded by interviewer). Sex of Respondent

Response	Frequency (n=40)
Male	22
Female	18

Appendix D: Detailed Impact Evaluation Results

Table D.1. Winter Average Pilot Home Hourly Demand Impacts

Date	Event	Hour	Block	Mean Observed Load (kW)	Estimated Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
2/23/2011	1	7:00 p.m.	Pre-Event	4.82	4.46	0.36	-0.02	0.73
2/23/2011	1	8:00 p.m.	Pre-Event	4.60	4.27	0.33	-0.08	0.74
2/23/2011	1	9:00 p.m.	Pre-Event	4.29	3.82	0.47	0.05	0.89
2/23/2011	1	10:00 p.m.	Pre-Event	3.23	2.95	0.28	-0.14	0.71
2/23/2011	1	11:00 p.m.	Pre-Event	2.78	2.53	0.26	-0.17	0.68
2/24/2011	1	12:00 a.m.	Pre-Event	2.92	2.43	0.49	0.07	0.91
2/24/2011	1	1:00 a.m.	Pre-Event	3.52	2.56	0.96	0.53	1.38
2/24/2011	1	2:00 a.m.	Pre-Event	3.94	2.69	1.26	0.83	1.68
2/24/2011	1	3:00 a.m.	Pre-Event	4.53	3.02	1.51	1.08	1.93
2/24/2011	1	4:00 a.m.	Pre-Event	5.77	4.09	1.68	1.26	2.11
2/24/2011	1	5:00 a.m.	Pre-Event	7.64	6.18	1.47	1.04	1.89
2/24/2011	1	6:00 a.m.	Pre-Event	8.03	6.74	1.30	0.87	1.72
2/24/2011	1	7:00 a.m.	Event	3.46	5.72	-2.26	-2.68	-1.83
2/24/2011	1	8:00 a.m.	Event	3.99	4.82	-0.83	-1.25	-0.40
2/24/2011	1	9:00 a.m.	Event	4.32	4.48	-0.16	-0.58	0.26
2/24/2011	1	10:00 a.m.	Post-Event	9.34	4.18	5.16	4.74	5.58
2/24/2011	1	11:00 a.m.	Post-Event	6.32	4.05	2.27	1.86	2.67
2/24/2011	1	12:00 p.m.	Post-Event	5.37	4.24	1.13	0.76	1.51
2/24/2011	2	7:00 p.m.	Pre-Event	6.36	5.41	0.95	0.57	1.32
2/24/2011	2	8:00 p.m.	Pre-Event	5.90	4.70	1.20	0.79	1.62
2/24/2011	2	9:00 p.m.	Pre-Event	5.12	4.05	1.07	0.65	1.50
2/24/2011	2	10:00 p.m.	Pre-Event	3.83	3.01	0.82	0.39	1.24
2/24/2011	2	11:00 p.m.	Pre-Event	3.55	2.54	1.01	0.58	1.44
2/25/2011	2	12:00 a.m.	Pre-Event	3.79	2.46	1.33	0.91	1.75
2/25/2011	2	1:00 a.m.	Pre-Event	4.26	2.57	1.69	1.26	2.11
2/25/2011	2	2:00 a.m.	Pre-Event	4.74	2.69	2.05	1.62	2.48
2/25/2011	2	3:00 a.m.	Pre-Event	5.12	3.01	2.11	1.68	2.54
2/25/2011	2	4:00 a.m.	Pre-Event	6.17	4.07	2.10	1.67	2.53
2/25/2011	2	5:00 a.m.	Pre-Event	7.77	6.09	1.68	1.26	2.11
2/25/2011	2	6:00 a.m.	Pre-Event	8.59	6.64	1.95	1.52	2.37
2/25/2011	2	7:00 a.m.	Event	3.42	5.63	-2.21	-2.64	-1.79
2/25/2011	2	8:00 a.m.	Event	4.08	4.70	-0.61	-1.04	-0.19
2/25/2011	2	9:00 a.m.	Event	4.10	4.33	-0.23	-0.66	0.19
2/25/2011	2	10:00 a.m.	Post-Event	8.47	4.04	4.44	4.02	4.86
2/25/2011	2	11:00 a.m.	Post-Event	5.06	3.76	1.30	0.89	1.71
2/25/2011	2	12:00 p.m.	Post-Event	4.27	3.70	0.57	0.20	0.95
3/9/2011	3	7:00 p.m.	Pre-Event	3.30	3.38	-0.08	-0.45	0.29
3/9/2011	3	8:00 p.m.	Pre-Event	2.93	3.27	-0.34	-0.74	0.07

Date	Event	Hour	Block	Mean Observed Load (kW)	Estimated Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
3/9/2011	3	9:00 p.m.	Pre-Event	2.80	2.94	-0.14	-0.55	0.27
3/9/2011	3	10:00 p.m.	Pre-Event	2.11	2.18	-0.08	-0.48	0.33
3/9/2011	3	11:00 p.m.	Pre-Event	1.57	1.77	-0.19	-0.58	0.19
3/10/2011	3	12:00 a.m.	Pre-Event	1.12	1.33	-0.21	-0.66	0.25
3/10/2011	3	1:00 a.m.	Pre-Event	1.23	1.44	-0.21	-0.67	0.24
3/10/2011	3	2:00 a.m.	Pre-Event	1.21	1.55	-0.34	-0.79	0.12
3/10/2011	3	3:00 a.m.	Pre-Event	1.57	2.00	-0.43	-0.89	0.02
3/10/2011	3	4:00 a.m.	Pre-Event	2.91	3.24	-0.33	-0.79	0.12
3/10/2011	3	5:00 a.m.	Pre-Event	4.21	4.99	-0.78	-1.23	-0.32
3/10/2011	3	6:00 a.m.	Pre-Event	3.88	4.90	-1.03	-1.48	-0.57
3/10/2011	3	7:00 a.m.	Event	1.24	3.89	-2.65	-3.11	-2.19
3/10/2011	3	8:00 a.m.	Event	1.27	3.58	-2.31	-2.77	-1.85
3/10/2011	3	9:00 a.m.	Event	1.56	3.07	-1.51	-1.97	-1.04
3/10/2011	3	10:00 a.m.	Post-Event	5.25	2.67	2.58	2.12	3.04
3/10/2011	3	11:00 a.m.	Post-Event	2.58	2.42	0.16	-0.29	0.61
3/10/2011	3	12:00 p.m.	Post-Event	2.15	2.28	-0.13	-0.55	0.28
3/10/2010	4	7:00 p.m.	Pre-Event	2.44	2.56	-0.11	-0.53	0.31
3/10/2010	4	8:00 p.m.	Pre-Event	2.51	2.45	0.06	-0.39	0.50
3/10/2010	4	9:00 p.m.	Pre-Event	2.21	2.18	0.03	-0.44	0.49
3/10/2010	4	10:00 p.m.	Pre-Event	1.49	1.50	-0.01	-0.47	0.46
3/10/2010	4	11:00 p.m.	Pre-Event	1.38	1.32	0.05	-0.41	0.52
3/11/2010	4	12:00 a.m.	Pre-Event	1.76	1.67	0.10	-0.30	0.49
3/11/2010	4	1:00 a.m.	Pre-Event	1.89	1.73	0.16	-0.25	0.58
3/11/2010	4	2:00 a.m.	Pre-Event	2.00	1.84	0.17	-0.26	0.59
3/11/2010	4	3:00 a.m.	Pre-Event	2.39	2.19	0.20	-0.22	0.63
3/11/2010	4	4:00 a.m.	Pre-Event	3.50	3.18	0.32	-0.11	0.74
3/11/2010	4	5:00 a.m.	Pre-Event	5.31	5.12	0.18	-0.24	0.61
3/11/2010	4	6:00 a.m.	Pre-Event	5.99	5.97	0.02	-0.40	0.45
3/11/2010	4	7:00 a.m.	Event	1.81	4.88	-3.07	-3.49	-2.64
3/11/2010	4	8:00 a.m.	Event	1.80	3.95	-2.16	-2.58	-1.73
3/11/2010	4	9:00 a.m.	Event	1.93	3.50	-1.57	-1.99	-1.15
3/11/2010	4	10:00 a.m.	Post-Event	5.91	3.03	2.87	2.46	3.29
3/11/2010	4	11:00 a.m.	Post-Event	3.13	2.71	0.42	0.01	0.82
3/11/2010	4	12:00 p.m.	Post-Event	2.23	2.42	-0.19	-0.56	0.18
3/16/2011	5	7:00 p.m.	Pre-Event	2.76	2.79	-0.03	-0.40	0.34
3/16/2011	5	8:00 p.m.	Pre-Event	3.22	2.69	0.53	0.12	0.94
3/16/2011	5	9:00 p.m.	Pre-Event	2.60	2.37	0.23	-0.18	0.65
3/16/2011	5	10:00 p.m.	Pre-Event	1.96	1.74	0.22	-0.20	0.64
3/16/2011	5	11:00 p.m.	Pre-Event	1.54	1.35	0.18	-0.24	0.61
3/17/2011	5	12:00 a.m.	Pre-Event	1.51	1.26	0.26	-0.16	0.68
3/17/2011	5	1:00 a.m.	Pre-Event	1.71	1.36	0.35	-0.09	0.79

Date	Event	Hour	Block	Mean Observed Load (kW)	Estimated Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
3/17/2011	5	2:00 a.m.	Pre-Event	1.71	1.49	0.22	-0.23	0.66
3/17/2011	5	3:00 a.m.	Pre-Event	2.12	1.81	0.31	-0.11	0.74
3/17/2011	5	4:00 a.m.	Pre-Event	3.14	2.76	0.38	-0.05	0.80
3/17/2011	5	5:00 a.m.	Pre-Event	5.10	4.74	0.35	-0.07	0.78
3/17/2011	5	6:00 a.m.	Pre-Event	5.92	5.58	0.34	-0.09	0.76
3/17/2011	5	7:00 a.m.	Event	2.06	4.50	-2.44	-2.86	-2.02
3/17/2011	5	8:00 a.m.	Event	1.88	3.59	-1.71	-2.14	-1.29
3/17/2011	5	9:00 a.m.	Event	2.08	3.08	-1.00	-1.42	-0.58
3/17/2011	5	10:00 a.m.	Post-Event	6.46	2.63	3.83	3.41	4.24
3/17/2011	5	11:00 a.m.	Post-Event	3.52	2.31	1.22	0.81	1.62
3/17/2011	5	12:00 p.m.	Post-Event	2.44	2.11	0.32	-0.04	0.69

Table D.2. Summer AC-WH Average Pilot Home Hourly Demand Impacts

Date	Event	Hour	Block	Mean Observed Load (kW)	Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
8/12/2011	1	2:00 a.m.	Pre-Event	0.81	0.76	0.05	-0.32	0.42
8/12/2011	1	3:00 a.m.	Pre-Event	0.86	0.73	0.14	-0.26	0.53
8/12/2011	1	4:00 a.m.	Pre-Event	0.82	0.78	0.04	-0.36	0.45
8/12/2011	1	5:00 a.m.	Pre-Event	1.06	1.07	-0.01	-0.42	0.40
8/12/2011	1	6:00 a.m.	Pre-Event	1.51	1.60	-0.08	-0.49	0.33
8/12/2011	1	7:00 a.m.	Pre-Event	1.67	1.82	-0.15	-0.56	0.26
8/12/2011	1	8:00 a.m.	Pre-Event	1.50	1.61	-0.11	-0.53	0.30
8/12/2011	1	9:00 a.m.	Pre-Event	1.20	1.61	-0.41	-0.83	0.00
8/12/2011	1	10:00 a.m.	Pre-Event	1.31	1.67	-0.36	-0.77	0.06
8/12/2011	1	11:00 a.m.	Pre-Event	1.75	1.54	0.21	-0.21	0.63
8/12/2011	1	12:00 p.m.	Pre-Event	2.01	1.51	0.50	0.08	0.92
8/12/2011	1	1:00 p.m.	Pre-Event	1.73	1.47	0.26	-0.16	0.67
8/12/2011	1	2:00 p.m.	Event	1.18	1.64	-0.46	-0.88	-0.05
8/12/2011	1	3:00 p.m.	Event	1.53	1.94	-0.41	-0.83	0.01
8/12/2011	1	4:00 p.m.	Event	1.61	2.19	-0.58	-1.00	-0.17
8/12/2011	1	5:00 p.m.	Post-Event	3.22	2.47	0.75	0.33	1.16
8/12/2011	1	6:00 p.m.	Post-Event	2.38	2.60	-0.22	-0.62	0.19
8/12/2011	1	7:00 p.m.	Post-Event	2.34	2.51	-0.17	-0.54	0.20

Date	Event	Hour	Block	Mean Observed Load (kW)	Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
8/17/2011	2	2:00 a.m.	Pre-Event	0.81	0.84	-0.03	-0.40	0.34
8/17/2011	2	3:00 a.m.	Pre-Event	0.88	0.79	0.09	-0.31	0.49
8/17/2011	2	4:00 a.m.	Pre-Event	1.01	0.84	0.17	-0.23	0.58
8/17/2011	2	5:00 a.m.	Pre-Event	1.15	1.12	0.03	-0.38	0.44
8/17/2011	2	6:00 a.m.	Pre-Event	1.98	1.65	0.33	-0.08	0.74
8/17/2011	2	7:00 a.m.	Pre-Event	2.04	1.87	0.17	-0.25	0.58
8/17/2011	2	8:00 a.m.	Pre-Event	1.37	1.67	-0.29	-0.71	0.12
8/17/2011	2	9:00 a.m.	Pre-Event	1.79	1.51	0.27	-0.14	0.69
8/17/2011	2	10:00 a.m.	Pre-Event	1.67	1.66	0.01	-0.41	0.42
8/17/2011	2	11:00 a.m.	Pre-Event	1.51	1.46	0.05	-0.37	0.46
8/17/2011	2	12:00 p.m.	Pre-Event	1.32	1.46	-0.14	-0.55	0.28
8/17/2011	2	1:00 p.m.	Pre-Event	1.30	1.34	-0.04	-0.46	0.37
8/17/2011	2	2:00 p.m.	Event	1.08	1.54	-0.46	-0.88	-0.04
8/17/2011	2	3:00 p.m.	Event	1.25	1.70	-0.45	-0.87	-0.03
8/17/2011	2	4:00 p.m.	Event	1.33	2.00	-0.68	-1.10	-0.26
8/17/2011	2	5:00 p.m.	Post-Event	3.61	2.24	1.37	0.95	1.79
8/17/2011	2	6:00 p.m.	Post-Event	2.48	2.27	0.21	-0.20	0.62
8/17/2011	2	7:00 p.m.	Post-Event	2.58	2.15	0.42	0.05	0.80
8/22/2011	3	2:00 a.m.	Pre-Event	0.86	0.92	-0.06	-0.43	0.31
8/22/2011	3	3:00 a.m.	Pre-Event	0.74	0.83	-0.09	-0.50	0.32
8/22/2011	3	4:00 a.m.	Pre-Event	0.77	0.88	-0.10	-0.52	0.31
8/22/2011	3	5:00 a.m.	Pre-Event	0.92	1.19	-0.26	-0.67	0.15
8/22/2011	3	6:00 a.m.	Pre-Event	1.43	1.71	-0.29	-0.70	0.12
8/22/2011	3	7:00 a.m.	Pre-Event	1.85	1.93	-0.09	-0.50	0.32
8/22/2011	3	8:00 a.m.	Pre-Event	1.68	1.77	-0.09	-0.52	0.34
8/22/2011	3	9:00 a.m.	Pre-Event	1.57	1.44	0.12	-0.33	0.57
8/22/2011	3	10:00 a.m.	Pre-Event	1.91	1.67	0.23	-0.19	0.66
8/22/2011	3	11:00 a.m.	Pre-Event	1.81	1.69	0.13	-0.29	0.55
8/22/2011	3	12:00 p.m.	Pre-Event	1.79	1.81	-0.02	-0.44	0.40
8/22/2011	3	1:00 p.m.	Pre-Event	2.02	1.88	0.14	-0.29	0.57
8/22/2011	3	2:00 p.m.	Event	0.97	2.06	-1.08	-1.51	-0.66
8/22/2011	3	3:00 p.m.	Event	1.16	2.15	-0.99	-1.41	-0.57
8/22/2011	3	4:00 p.m.	Event	1.47	2.34	-0.87	-1.30	-0.44
8/22/2011	3	5:00 p.m.	Post-Event	3.61	2.67	0.94	0.51	1.37

Date	Event	Hour	Block	Mean Observed Load (kW)	Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
8/22/2011	3	6:00 p.m.	Post-Event	2.78	2.51	0.27	-0.15	0.69
8/22/2011	3	7:00 p.m.	Post-Event	2.60	2.27	0.33	-0.07	0.72

Table D.3. Summer WH Average Pilot Home Hourly Demand Impacts

Date	Event	Hour	Block	Mean Observed Load (kW)	Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
8/11/2011	1	2:00 a.m.	Pre-Event	0.71	0.70	0.02	-0.22	0.26
8/11/2011	1	3:00 a.m.	Pre-Event	0.59	0.70	-0.11	-0.37	0.15
8/11/2011	1	4:00 a.m.	Pre-Event	0.70	0.73	-0.03	-0.29	0.23
8/11/2011	1	5:00 a.m.	Pre-Event	1.01	0.97	0.04	-0.22	0.30
8/11/2011	1	6:00 a.m.	Pre-Event	1.10	1.25	-0.15	-0.41	0.12
8/12/2011	1	7:00 a.m.	Pre-Event	1.05	1.23	-0.19	-0.45	0.08
8/12/2011	1	8:00 a.m.	Pre-Event	0.83	1.21	-0.38	-0.65	-0.11
8/12/2011	1	9:00 a.m.	Pre-Event	0.83	1.27	-0.44	-0.71	-0.18
8/12/2011	1	10:00 a.m.	Pre-Event	0.84	1.26	-0.42	-0.69	-0.16
8/12/2011	1	11:00 a.m.	Pre-Event	1.04	1.16	-0.12	-0.39	0.15
8/12/2011	1	12:00 p.m.	Pre-Event	1.38	1.17	0.21	-0.06	0.48
8/12/2011	1	1:00 p.m.	Pre-Event	1.15	1.15	0.00	-0.27	0.27
8/12/2011	1	2:00 p.m.	Event	0.89	1.14	-0.25	-0.52	0.01
8/12/2011	1	3:00 p.m.	Event	0.82	1.25	-0.44	-0.70	-0.17
8/12/2011	1	4:00 p.m.	Event	0.92	1.29	-0.37	-0.64	-0.10
8/12/2011	1	5:00 p.m.	Post-Event	1.97	1.43	0.53	0.27	0.80
8/12/2011	1	6:00 p.m.	Post-Event	1.61	1.54	0.06	-0.20	0.33
8/12/2011	1	7:00 p.m.	Post-Event	1.40	1.54	-0.13	-0.38	0.11
8/16/2011	2	2:00 a.m.	Pre-Event	0.60	0.71	-0.11	-0.35	0.13
8/16/2011	2	3:00 a.m.	Pre-Event	0.63	0.71	-0.09	-0.35	0.17
8/16/2011	2	4:00 a.m.	Pre-Event	0.73	0.74	-0.01	-0.27	0.25
8/16/2011	2	5:00 a.m.	Pre-Event	0.87	0.98	-0.11	-0.38	0.15
8/16/2011	2	6:00 a.m.	Pre-Event	1.13	1.26	-0.13	-0.39	0.13
8/17/2011	2	7:00 a.m.	Pre-Event	1.24	1.25	-0.02	-0.28	0.25
8/17/2011	2	8:00 a.m.	Pre-Event	1.24	1.23	0.01	-0.26	0.27
8/17/2011	2	9:00 a.m.	Pre-Event	1.28	1.27	0.01	-0.25	0.28

Date	Event	Hour	Block	Mean Observed Load (kW)	Mean Reference Load (kW)	Estimated Mean Load Impact (kW)	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
8/17/2011	2	10:00 a.m.	Pre-Event	1.01	1.23	-0.22	-0.48	0.05
8/17/2011	2	11:00 a.m.	Pre-Event	1.11	1.13	-0.03	-0.29	0.24
8/17/2011	2	12:00 p.m.	Pre-Event	1.03	1.15	-0.12	-0.38	0.15
8/17/2011	2	1:00 p.m.	Pre-Event	0.98	1.10	-0.12	-0.39	0.15
8/17/2011	2	2:00 p.m.	Event	0.71	1.09	-0.37	-0.64	-0.10
8/17/2011	2	3:00 p.m.	Event	0.74	1.11	-0.37	-0.64	-0.10
8/17/2011	2	4:00 p.m.	Event	0.88	1.17	-0.30	-0.57	-0.03
8/17/2011	2	5:00 p.m.	Post-Event	1.87	1.28	0.58	0.31	0.85
8/17/2011	2	6:00 p.m.	Post-Event	1.29	1.38	-0.09	-0.36	0.17
8/17/2011	2	7:00 p.m.	Post-Event	1.36	1.44	-0.08	-0.33	0.16
8/21/2011	3	2:00 a.m.	Pre-Event	0.60	0.66	-0.07	-0.31	0.18
8/21/2011	3	3:00 a.m.	Pre-Event	0.69	0.69	0.00	-0.27	0.26
8/21/2011	3	4:00 a.m.	Pre-Event	0.74	0.72	0.02	-0.25	0.28
8/21/2011	3	5:00 a.m.	Pre-Event	0.80	0.94	-0.14	-0.40	0.13
8/21/2011	3	6:00 a.m.	Pre-Event	1.17	1.22	-0.05	-0.31	0.21
8/22/2011	3	7:00 a.m.	Pre-Event	1.01	1.21	-0.19	-0.46	0.07
8/22/2011	3	8:00 a.m.	Pre-Event	1.37	1.21	0.16	-0.12	0.44
8/22/2011	3	9:00 a.m.	Pre-Event	1.73	1.21	0.52	0.24	0.80
8/22/2011	3	10:00 a.m.	Pre-Event	1.35	1.24	0.11	-0.16	0.38
8/22/2011	3	11:00 a.m.	Pre-Event	1.69	1.13	0.55	0.28	0.82
8/22/2011	3	12:00 p.m.	Pre-Event	1.44	1.19	0.25	-0.02	0.52
8/22/2011	3	1:00 p.m.	Pre-Event	1.36	1.08	0.27	-0.01	0.56
8/22/2011	3	2:00 p.m.	Event	1.08	1.14	-0.05	-0.33	0.22
8/22/2011	3	3:00 p.m.	Event	1.11	1.16	-0.05	-0.33	0.23
8/22/2011	3	4:00 p.m.	Event	1.08	1.21	-0.13	-0.41	0.15
8/22/2011	3	5:00 p.m.	Post-Event	1.94	1.32	0.62	0.34	0.90
8/22/2011	3	6:00 p.m.	Post-Event	1.59	1.37	0.23	-0.05	0.50
8/22/2011	3	7:00 p.m.	Post-Event	1.44	1.40	0.04	-0.21	0.30