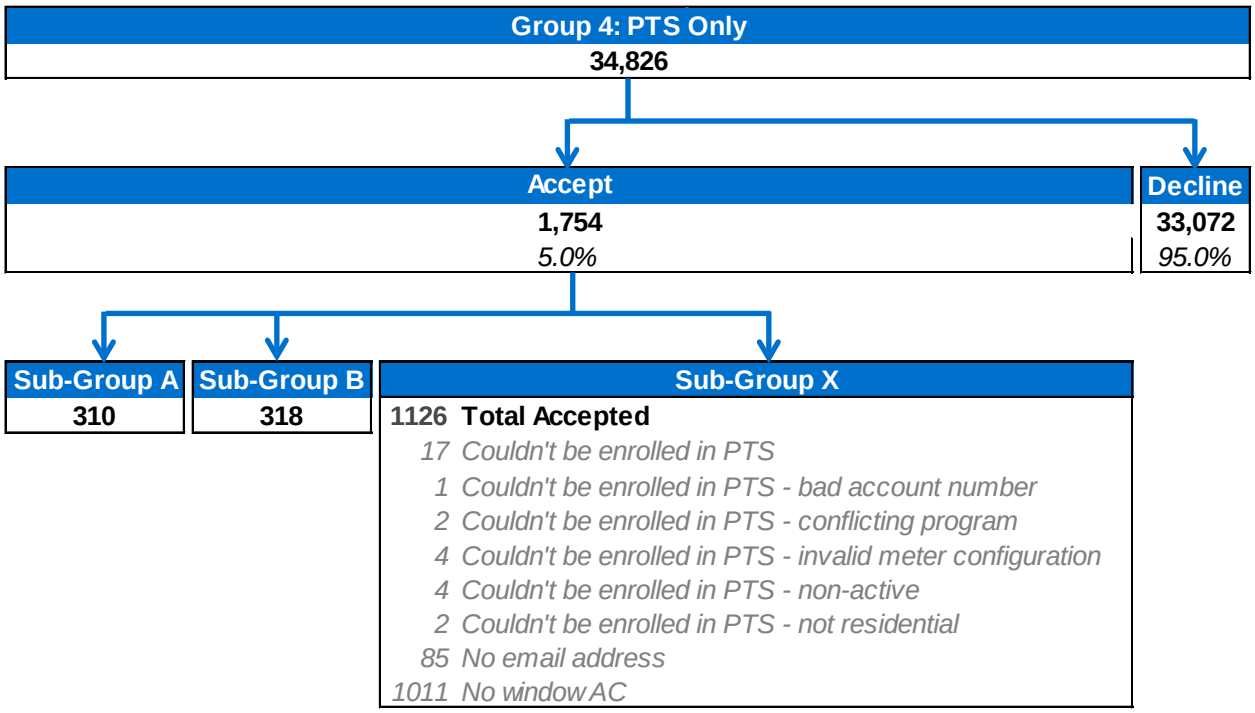
3.4 Treatment Group 4

Figure 3-5 summarizes the customer acceptance and enrollment rates for Group 4, multifamily customers who did not receive an offer of enabling technology. The overall acceptance rate for customers receiving offers was 5%, which was higher than the average acceptance rate across the pilot of 4.1%. This is also in sharp contrast with the Group 5 multifamily customers who were offered technology and exhibited an acceptance rate of only 3.3%. Based on this acceptance data, it appears that not offering technology increases the acceptance rate for multifamily customers by 50% relative to similar multifamily customers who were offered technology. 34,826 customers were recruited in order to yield an initial acceptance group of 1,754. Customers accepting the offer were then assigned to Sub-Group A or B if they met the pilot participation criteria of having window AC and weren't planning to move. Those not assigned to Sub-Group A or B due to eligibility reasons were assigned to Sub-Group X. Of the customers not eligible for the pilot, 90% were due to not having window AC. The reasons for the remaining customers not being eligible for the pilot were generally due to customers not completing the PTS program enrollment process for a variety of issues as noted under Sub-Group X in Figure 3-5.

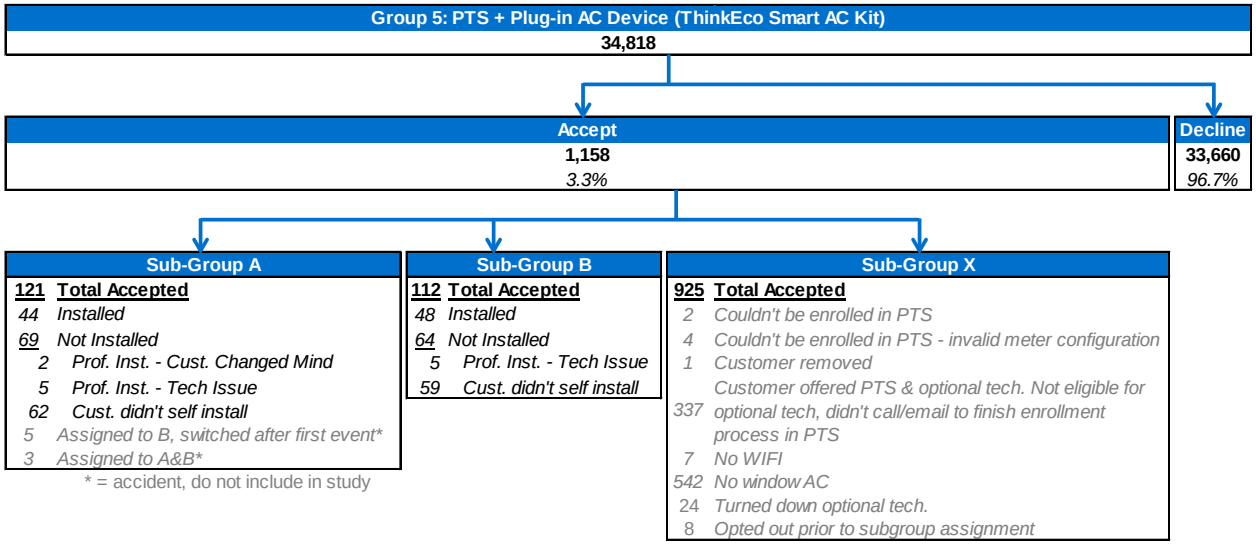
Figure 3-5: Customer Acceptance Rates for Treatment Group 4



3.5 Treatment Group 5

Figure 3-6 summarizes the customer acceptance and enrollment rates for Group 5, multifamily customers who were offered a ThinkEco smartAC plug-in window AC device. The overall acceptance rate for customers receiving offers was 3.3%, which was lower than the general acceptance rate and significantly lower than the acceptance rate of 5% for multifamily customers who were not offered technology. Ultimately, 34,818 customers were recruited in order to obtain an initial acceptance group of 1,158. Customers accepting the offer were randomly assigned to Sub-Group A or B if they met the pilot participation criteria of having window AC, had Wi-Fi, and weren't planning to move during the operational window of the pilot. Customers assigned to Sub-Group A or B were either mailed self-installation kits or contacted to schedule professional installation of the device. Those not assigned to Sub-Group A or B due to eligibility reasons were assigned to Sub-Group X. Of the customers not assigned to a treatment group, 59% were due to not having window AC; an additional 36% of customers never completed the enrollment process. 26% who were mailed devices for self-installation actually installed the device, and 79% of professional installations were completed. The key takeaway from this group is that 64% of eligible customers accepting the initial offer never installed a device. This resulted in less than 0.3% of all recruited customers actually installing a device. Additional details regarding device installation success rates are discussed in Section 2.2.3.

Figure 3-6: Customer Acceptance Rates for Treatment Group 5



3.6 Summary of Participant Survey

ComEd contracted with MarketStrategies, Inc. (MSI) to conduct a survey among pilot participants to obtain quantitative information on a variety of questions of interest, including:[3]

- Participant satisfaction with ComEd overall and with the PTS program between those with and without technology;
- Overall incentives received from the program, including satisfaction with the magnitude of the PTS incentives received for each event;
- Satisfaction with the enrollment process and, for those with technology, satisfaction with scheduling and installation of the equipment;
- The role of technology in deciding to participate in PTS;
- Ease of use of the technology;
- The PTS event process (pre- and post-event communications);
- Understanding customers' knowledge about participating in events;
- Understanding customers' typical energy using behavior and energy-efficiency behavior;
- Determining if customers took actions to save energy during PTS hours and understanding the motivations for taking action;
- Assessing the impact of household characteristics; and
- Assessing the likelihood to participate in PTS events again in 2016.

The telephone survey was conducted from October 23 to November 16, 2015. MSI successfully completed 339 surveys. This response rate of roughly 14% was obtained after making up to six attempts to reach each participant (including calling at different times of day and evening), sending pre-notification letters about the research and paying $25 for each completed survey. Response rates varied from a low of roughly 11% for the central AC control group to a high of approximately 18% for the central AC PCT treatment group and the window AC control group.

3.6.1 Customer Satisfaction, Awareness, and Perceptions

ComEd's Peak Time Savings DLC pilot program was well received by participating customers, showing generally high overall satisfaction as well as likelihood to participate in PTS events in 2016 and to recommend the program to family and friends. Overall, roughly nine in ten (DLC technology, 93%; Control, 88%) participants report being satisfied with the PTS program, i.e., participants rated 6-7 or 8-10 in a 0 to 10 scale (6-10). However, customers with DLC technology were significantly more likely than the Control group, i.e., customers without DLC technology, to rate their satisfaction at the top end of the scale (82% vs. 71% customers rated 8-10 in a 0 - 10 scale (8-10)). Participants in both control and technology groups show the highest satisfaction with ComEd (DLC technology, 81%; Control, 81%, (8-10)).

Considering specific aspects of the PTS program, customers in both groups show the highest satisfaction (8-10) with ease of the enrollment process (DLC technology, 87%; Control, 88%), with notifications sent the day after PTS events to communicate energy saved /credit on the

[3] This section is based on MarketStrategies, Inc. *ComEd Peak Time Savings - DLC Topline Report,* November 24, 2015.

customer's electric bill (DLC technology, 84%; Control, 80%), event notification (DLC technology, 82%; Control, 73%), and mailed reminders and information from ComEd (DLC technology, 70%; Control, 72%). Roughly 70% of participants said they were satisfied (6-10) with the amount they saved on their bill during PTS events and 49% said they were very satisfied (8-10).

Program aspects specific to those with DLC technology were also rated highly by a majority of customers. PCT participants were significantly more satisfied than AC switch participants with the professionalism of the installing technician (98% vs. 84%, (6-10)) and the timeliness of the technician (97% vs. 86%, (6-10)).

Nearly three in four (73%) customers said they would be likely (6-10) to recommend the program to family and friends. However, those with DLC technology show a significantly higher likelihood than the Control group (86% vs. 75%, ((8-10)). Nearly all participants (DLC technology, 95%; Control, 94%) said they are likely (6-10) to participate in future events.

3.6.2 PTS Event Notification

Overall opinions of the PTS events were positive as indicated by overall program satisfaction, awareness, and participation in the events. Roughly four in ten (DLC technology, 39%; Control, 45%) correctly recalled three PTS events occurring over the course of the summer.

Nearly four in ten in the central AC switch group (38%) and roughly half of those in the central AC PCT (53%) and the window AC plug-in (48%) groups believe ComEd wirelessly adjusted their AC during the events. A majority said they did not override ComEd's control during these events.

Customers without DLC technology were significantly more likely to take action to save energy during the event than those with technology (82% vs. 61%), indicating a reliance on the technology to "save" among DLC participants. However, those with technology showed slightly higher recall for receiving a credit (DLC technology, 88%; Control, 82%) and on average believed that they saved more during the events ($4.38 vs. $3.69). Further, recall for average savings was greater among all central AC groups when compared to window AC groups. This aligns with actual event savings where central AC groups earned larger credits, on average, than window AC groups.

The biggest motivator to take action during PTS hours is financial. When asked to state in their own words the most important reason for taking actions, roughly two in three said "saving money." "Saving energy" was a distant second.

Additionally, nine in ten respondents indicated that reducing energy usage to save money (87%) and receiving a credit on their electric bill (85%) were very large factors (8-10) for participating in PTS hours. Conserving as much energy as possible and helping protect the environment followed, with 79% rating this as a very large factor (8-10) for taking action during PTS hours. The least influential factor was the GE smart appliance contest with 29% rating this as a very large factor (8-10). The largest barrier to taking action centered on being unable to take action due to being away from home (DLC technology, 54%; Control, 59%).

Notifications sent after the events were recalled by most and found to be clear and easy to understand. Recall of the post-event notification was high for both groups, though slightly higher among the Control group (86%) compared to those with DLC technology (79%).

Overall, more than eight in ten (DLC technology, 89%; Control, 82%) strongly agree that the amount of the bill credit on the post-event notification was clearly communicated and easy to understand. However, those with DLC technology were much more likely than the Control group to feel the amount of information was “just right” (70% vs. 57%).

3.6.3 Impact on Smart Meter Awareness and Value Perceptions

A strong majority of participants were aware that they have a smart meter at their household. However, customers with DLC technology showed significantly higher awareness than those in the Control group (88% vs. 77%). Customers in the window AC groups were less likely to be aware of their smart meter than all central AC groups.

The PTS program had a positive impact on the value customers place on their smart meter. Of those aware of their smart meter, roughly six in ten feel having a smart meter is valuable to them (6-10), with those with DLC technology showing a slightly higher value (DLC technology, 65%; Control, 58%, non-significant). Further, customers in the Control group (19%) were significantly more likely than those with DLC technology (9%) to find little or no value of smart meter (0 to 4 in a 10 point scale).

While the PTS DLC program had a positive impact on the value of smart meters for both groups, those with DLC technology were significantly more likely than those in the Control group to say the program has made their smart meter more valuable (60% vs. 48%).

4 Load Impacts

One of the primary objectives of the PTS/DLC pilot was to estimate the load reduction during event hours for each treatment group and to estimate the incremental load impact of enabling technology over and above what consumers would do in the absence of load control. This section summarizes the estimate load impacts for each treatment group.

4.1 Load Impact Estimation Methodology

As discussed previously, the pilot was designed and implemented as a RCT, which makes the impact estimation straightforward. For each event, either Sub-Group A or Sub-Group B was notified and had a signal sent to the installed technology, while the other group is neither notified or signaled. A simple difference in loads between the two groups provides an estimate of the load impact of the treatment being tested for that event. Below is a list of the load impact estimates that can be produced from the experiment:

- Group 1, difference in load between Sub-Groups A and B for each event: Estimates the total load impact of PTS without technology for single family participants with central AC.
- Group 2, difference in load between Sub-Groups A and B: Estimates the total load impact of PTS plus AC switches for single family participants with central AC.
- Group 2, difference in load between Sub-Groups A and C or between Sub-Groups B and C: Estimates the incremental load impact of AC switches over and above the behavioral changes made by single family participants who accepted AC switches. As mentioned previously, due to a technical malfunction, it was not possible to directly estimate this impact.
- Group 3, difference in load between Sub-Groups A and B: Estimates the total load impact of PTS plus a PCT for single family participants with central AC.
- Group 4, difference in load between Sub-Groups A and B: Estimates the total load impact of PTS without technology for multifamily customers with window AC.
- Group 5, difference in load between Sub-Groups A and B: Estimates the total load impact of PTS plus the ThinkEco Smart AC Kit for multifamily participants with window AC.

All of the above comparisons except one (discussed below) are devoid of selection effects, since the differencing analysis is done for subsets of each group that are randomly assigned to treatment and control conditions after enrollment. Given the relatively small sample sizes in each cell, there could be differences in load between Sub-Groups A and B on non-event days that would bias the impact estimates due to random sampling variation. These differences will cancel out for the average event as long as an even number of events is called across the summer. For any individual event, the estimated impact might be inaccurate using a simple difference calculation due to random differences in the Sub-Groups A and B. As such, we used a difference-in-differences calculation for event-specific estimates. This approach subtracts any difference in load during the peak period on non-event days that have similar weather conditions to event days from the difference on the event day. To further improve statistical precision, this calculation was done using a fixed-effects regression methodology, which reduces the standard errors of the estimates.

Load impacts for single and multifamily customers are quite different due primarily to differences in the level and pattern of electricity use between the two customer segments as seen in Figure 4-1and Figure 4-2, which show average loads for each group on non-event days with weather conditions similar to event days. Single family customers have much higher loads than multifamily customers at all times of the day and have loads that peak in late afternoon. Multifamily customers have a relatively flat load shape, peak during evening hours, and are quite small compared to single family customers.

There appears to be a small selection bias in Group 3 relative to Groups 1 and 2. Group 2 customers exhibit higher load in the late afternoon and evening. As discussed later, it is important to note that the majority of the difference between Group 3 and the other two single family groups occurs after the average event window from 12 to 4 PM. During those hours, the loads across all single family customer treatment groups are very similar.

There also appears to be some selection bias between customers who accepted and ultimately installed a plug-in window AC device relative to those who were not offered a load control device. Group 5 customers with the load control device only accepted the PTS only offer, with those customers accepting the device exhibiting higher load during all hours.

Figure 4-1: Hourly Average Demand for Single Family Customers with Central AC on Event-Like Days

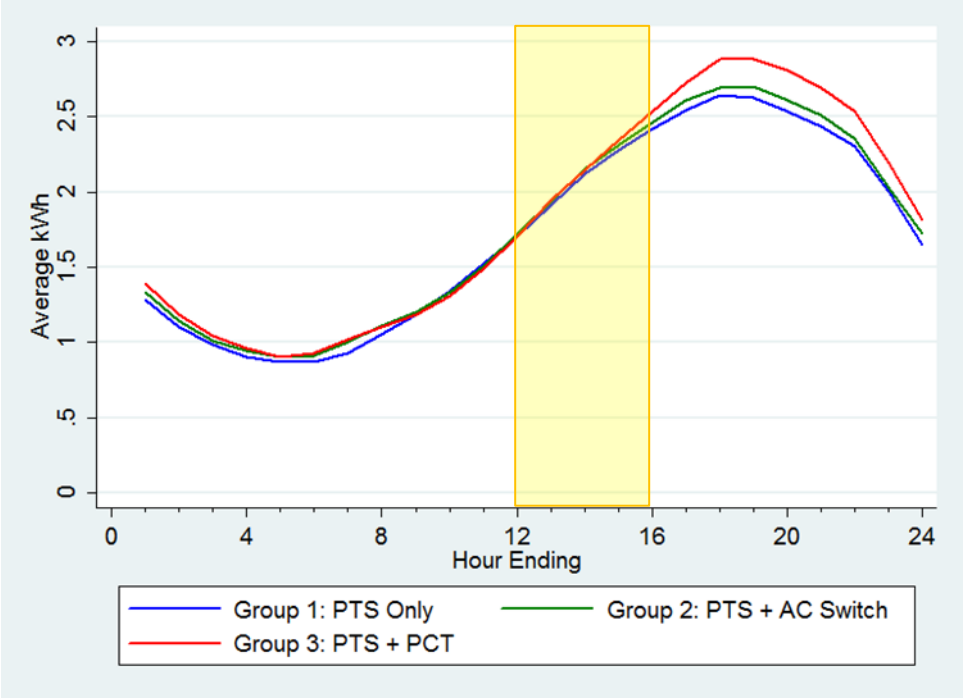
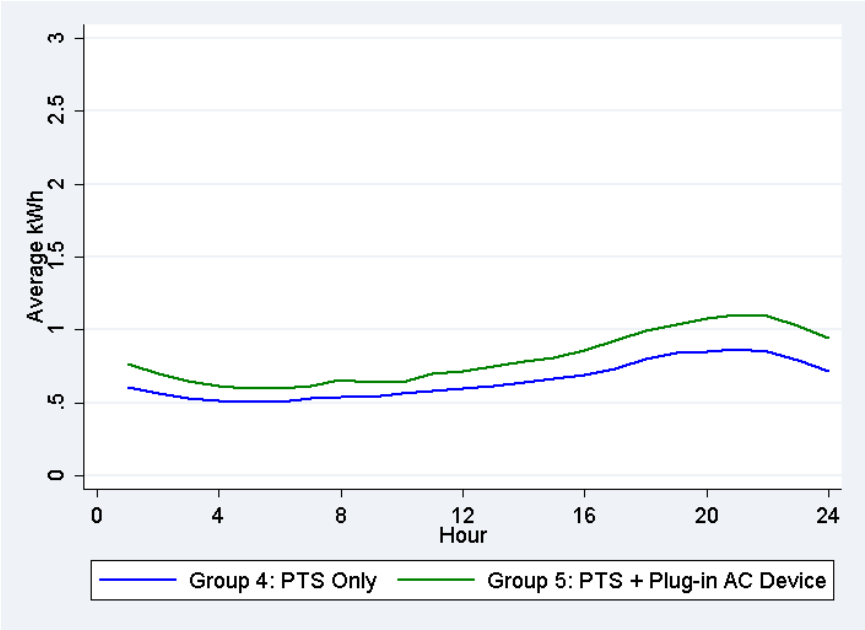


Figure 4-2: Hourly Average Demand for Multifamily Customers with Window AC on Event-Like Days



4.2 Summary of Estimated Load Impacts

Table 4-1 summarizes the estimated load impacts for each treatment group. Customers with DLC devices had much higher impacts than those without devices – but average impacts without technology were also significant. Single family customers exhibited the largest impacts in absolute terms; however the impacts are comparable to the multifamily customers when compared in percentage terms. When comparing PTS only impacts between single family and multifamily customers, single family customers provided average hourly load impacts of 0.18 kW (8.9%) whereas multifamily customers provided impacts about one third the size in absolute terms, at 0.05 kW (8.6%).

Table 4-1: Average Load Reduction per Customer Across All Event Hours

Customer Segment	Treatment Group	Load w/o DR (kW)	Load w/ DR (kW)	Impact (kW)	Impact (%)
Single Family Customers w/ Central AC	1: PTS Only	2.060	1.877	0.183	8.9%
	2: PTS + AC Switch	2.155	2.004	0.151	7.0%
	3: PTS + PCT	2.135	1.625	0.511	23.9%
Multifamily Customers w/ Window AC	4: PTS Only	0.604	0.552	0.052	8.6%
	5: PTS + Plug-in AC Device	0.752	0.602	0.150	20.0%

Impacts for single family customers with PCTs were about three times larger than impacts from multifamily customers with plug-in devices at 0.51 kW and 0.15 kW, respectively. In percentage terms, the impacts are much closer at 24% for PCTs and 20% for plug-in devices. It should be noted these load impacts are for all customers with installed devices, regardless of device

activation for a specific event—which did vary. Based on the average device activation rates in Table 2-5 and Table 2-6 of 91% and 74% for PCTs and plug-in devices, average load impacts for activated devices can be calculated at 26% for PCTs and 27% for plug-in devices.

Impacts from Group 2 only reflect the behavioral component of the program, as the AC switches didn't function properly. More specifically, Group 2 impacts represent load reductions from customers who were expecting their AC to be cycled, when it actually wasn't. The slightly lower impacts from Treatment Group 2 relative to Treatment Group 1 are consistent with a hypothesis that customers might have responded less because they were expecting their AC to be managed for them. The PCTs from Treatment Group 3 were programmed to operate similarly to the AC switches in Treatment Group 2 (e.g., they were cycled in the same way, not subjected to temperature adjustments), so it is reasonable to infer the load impacts for Treatment Group 2 would have been similar to Treatment Group 3 had the switches worked.

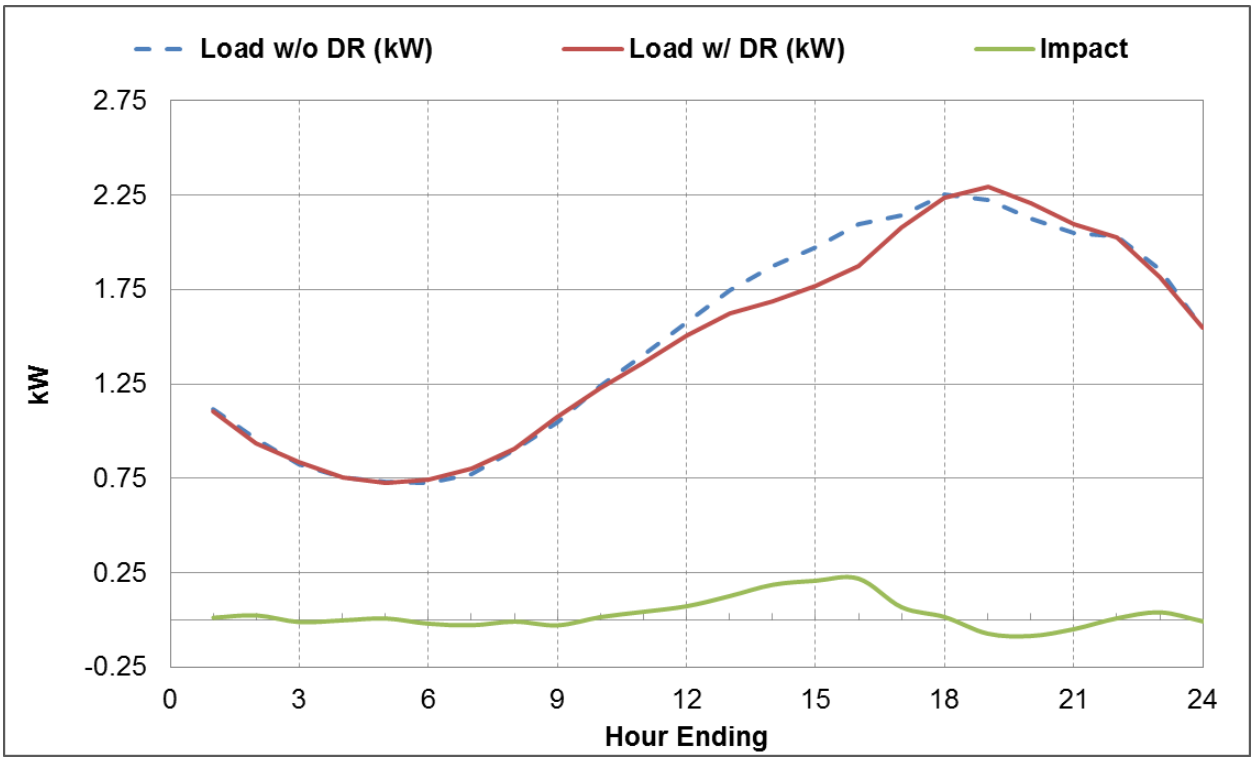
One of the objectives of the pilot was to estimate the incremental impact attributable to the enabling technology, when controlling for potential selection bias from customers willing to install the technology. The switch failures prevented this from being calculated directly. However, it is possible to infer the incremental impact of enabling technology based on the observed load impacts from the other treatment groups when considering the similarities in customer load shapes during event hours on event like days as observed in Figure 4-1. Assuming the AC switches would have resulted in similar load impacts to the PCTs at 0.51 kW (24%), and PTS impacts without technology are within the range of 0.15 kW (7%) to 0.18 kW (9%), the incremental impact of technology can be estimated at between 0.33 kW (15%) and 0.36 kW (17%). This indicates the incremental impact from enabling technology is roughly 2.5 to 3 times the size of the impact from PTS only. While a direct calculation as initially intended would have been ideal, this estimation provides a reasonable basis to support the hypothesis that enabling technology does in fact provide a significant incremental load impact well above what could be attributable to selection bias. This topic will be addressed at a greater level of detail in Section 4.4.

4.3 Treatment Group 1

Figure 4-3 shows the average load with DR, load without DR (reference load), and load impact for Group 1 customers that reduce load through behavior changes in response to the PTS incentive. During typical event hours (12 PM to 4 PM), the average reference load was around 2.06 kW. The average load with DR during event hours was around 1.87 kW. This resulted in an average load reduction of 0.183 kW per customer, representing an 8.9% reduction relative to the reference load. On an hourly basis, impacts were relatively low in the first event hour (0.126 kW) and peak at 0.218 kW from 3 PM to 4 PM. Load reductions continued for at least one hour following the completion of the official event window; at two hours following the event the observed load with DR was similar to the reference load. In the third, fourth, and fifth hours following the event the load with DR was slightly higher than the reference load, indicating that there was some minor snapback[4] after the event.

[4] Snapback is defined as when customer energy use increases relative to the reference load after an event ends. This is typically driven by increased cooling load to restore preferred temperatures after an event, or deferred use of appliances.

Figure 4-3: Average Hourly Load Impact per Customer- Treatment Group 1

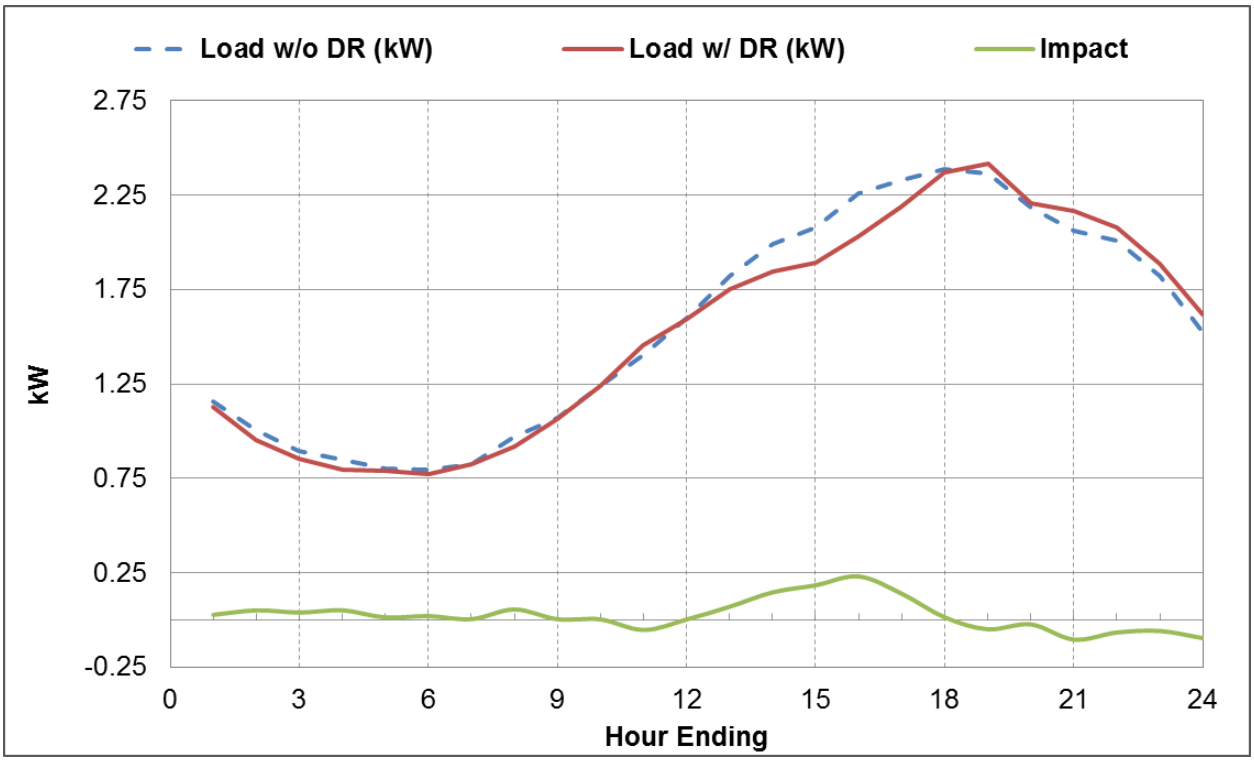


4.4 Treatment Group 2

Figure 4-4 shows the average load with DR, load without DR (reference load), and load impact for Group 2 customers who accepted load control switches on their AC. As previously discussed, the switches were not operational during the events due to installation errors. During typical event hours (12 PM to 4 PM), the average reference load was around 2.15 kW. The average load with DR during event hours was around 2.00 kW. This resulted in an average load reduction of 0.151 kW per customer, representing a 7.0% reduction relative to the reference load. On an hourly basis, impacts were relatively low in the first event hour (0.070 kW) and peak at 0.231 kW from 3 PM to 4 PM. Load reductions continued for one hour following the completion of the official event window; at two hours following the event the observed load with DR was similar to the reference load; exhibiting little to no snapback.

The impacts from Treatment Group 2 are interesting because customers thought their AC was being cycled when it wasn't. This provides a unique look at the behavioral portion of a load impact from a customer who chose the technology and expected it to reduce AC use during event hours. When comparing impacts with Group 1 who were PTS only, without enabling technology—or the expectation of enabling technology— the impacts were actually slightly smaller from Treatment Group 2. While the differences in impacts between the two groups aren't statistically significant given the small sample sizes, it does provide supporting evidence to reject the hypothesis that customers who accepted the technology offer would provide larger impacts on their own, and that technology didn't provide any incremental load impact once selection bias was eliminated.

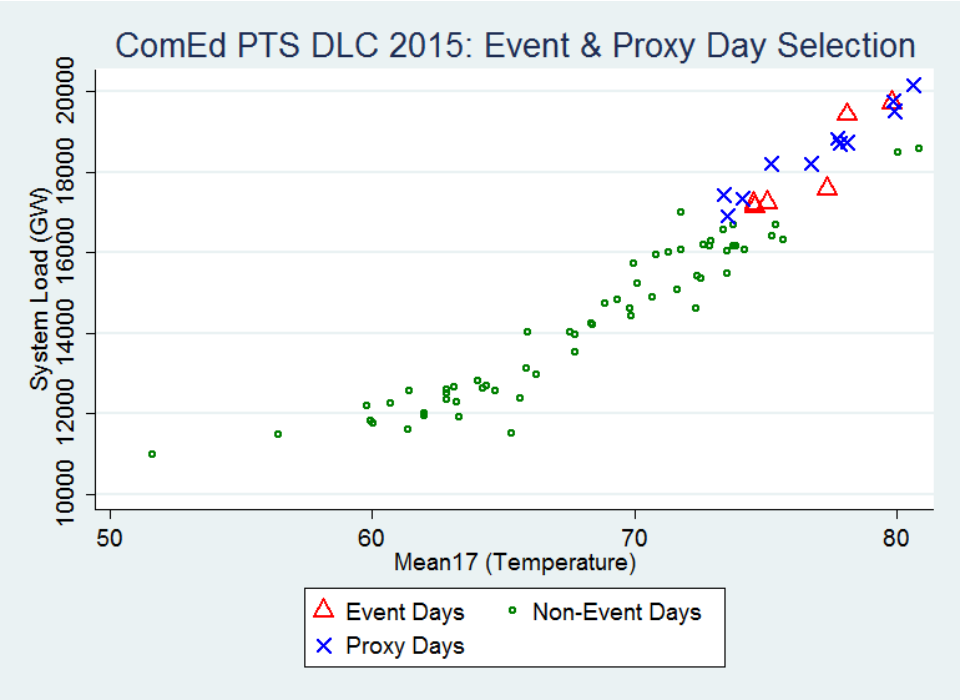
Figure 4-4: Average Hourly Load Impact per Customer- Treatment Group 2



As noted earlier in Section 4, one of the objectives of the pilot was to estimate the incremental impact attributable to the enabling technology, when controlling for potential selection bias from customers willing to install the technology. The switch issues prevented this from being calculated directly. However, it is possible to infer the incremental impact of enabling technology based on the observed load impacts from the other treatment groups when considering the similarities in customer load shapes during event hours on event like days as was seen previously in Figure 4-1, which shows the average hourly load on days with similar temperature and system load conditions as event days.

Figure 4-5 shows how the event-like days used in the load calculation in Figure 4-1 were determined. A propensity score matching algorithm was used to identify proxy days based on finding the closest match to an event day based on system load, temperature, and other factors such as the month and day of the week. In the figure, event days are identified as red triangles, and the event like or proxy event days selected by the model are identified as blue X's. Other non-event days are identified are identified as green circles.

Figure 4-5: Proxy Event Day Selection



When evaluating the load profiles for each of the single family customer treatment groups in Figure 4-1, there are clearly selection effects evident in the load profile of the customers who ultimately installed a PCT. However, most of the variation from the other two treatment groups occurs after the typical event window, highlighted in yellow. In fact, three of the six events actually ended at 3 PM, when there is virtually no difference in load between the three treatment groups. This similarity in load during typical event hours on event like days is the first step towards inferring the incremental load reduction provided by technology based on the available data from the pilot.

The next step requires an assumption regarding the similarity of load impacts between what should have happened with the AC switches and what was observed with the PCTs. The AC switches for Treatment Group 2 were designed to provide a 50% cycling response when they received the event signal. In order to allow for a comparison between the AC switches for the pilot, the PCTs were essentially programmed like a switch and also set to provide 50% cycling to the AC rather than use a simple temperature setback of a few degrees as is sometimes done with PCT. Given that both the AC switch and PCT were programmed to provide 50% cycling, and the customer load during event hours on event like days are similar across the treatment groups; it is reasonable to assume the load reductions from Group 2 would have been similar to the load reductions from Group 3 had the AC switches operated correctly.

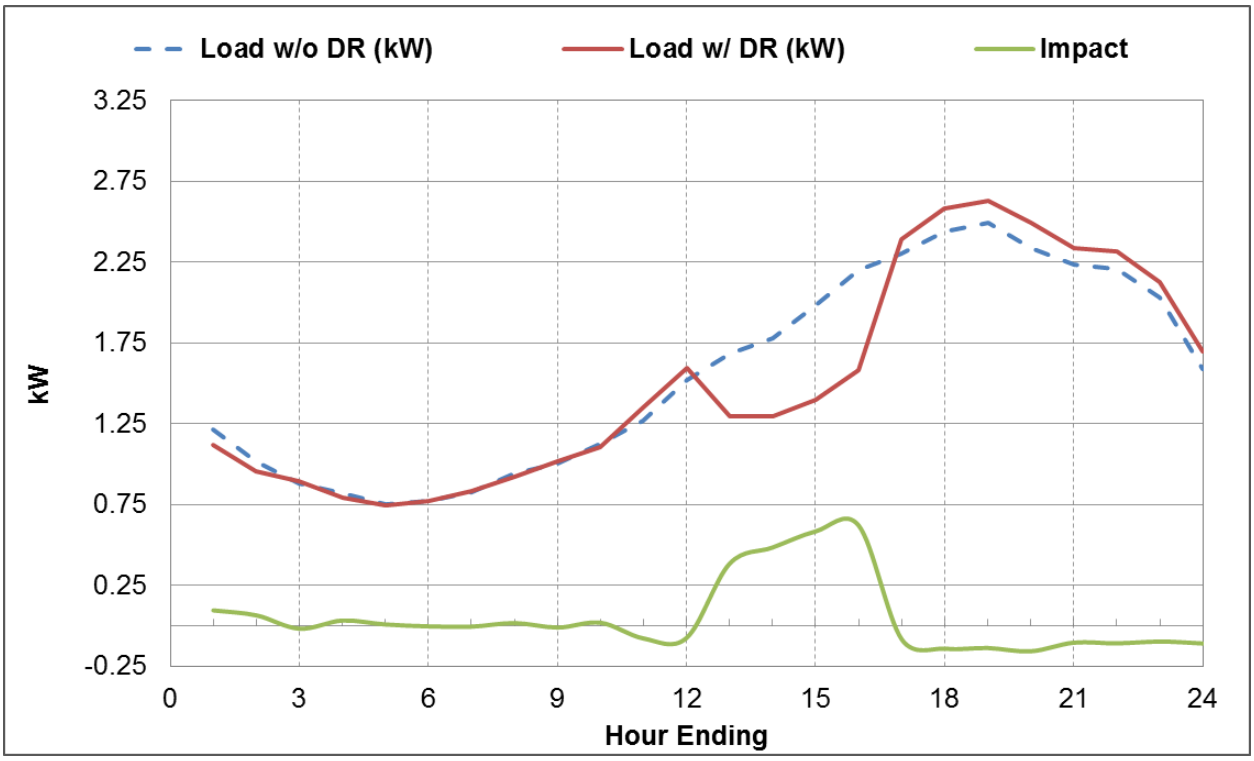
Assuming the AC switches would have resulted in similar load impacts to the PCTs at 0.51 kW (24%), and PTS only impacts without technology are within the range of 0.15 kW (7%) from customers who weren't offered enabling technology to 0.18 kW (9%) from customers who accepted and installed enabling technology; the incremental impact of technology can be estimated at between 0.33 kW (15%) and 0.36 kW (17%). This indicates the incremental impact

from enabling technology is roughly twice the size of the impact from PTS only. While a direct calculation as initially intended would have been ideal, this estimation provides a reasonable basis to support the hypothesis that enabling technology does in fact provide a significant incremental load impact well above what could be attributable to self-selection bias.

4.5 Treatment Group 3

Figure 4-6 shows the average load with DR, load without DR (reference load), and load impact for single family customers with PCTs. During typical event hours (12 PM to 4 PM), the average reference load was around 2.135 kW. The average load with DR during event hours was around 1.625 kW. This resulted in an average load reduction of 0.511 kW per customer, representing a 23.9% reduction relative to the reference load. On an hourly basis, impacts were slightly lower in the first event hour (0.385 kW) and peak at 0.621 kW from 3 PM to 4 PM. Load increased relative to the reference load in the hours following the event for the rest of evening. The average load increase in the 4 hours following the event was 0.129 kW; a 6% increase compared to the reference load. The observed post-event snapback is typical for a DLC program of this nature.

Figure 4-6: Average Hourly Load Impact per Customer- Treatment Group 3

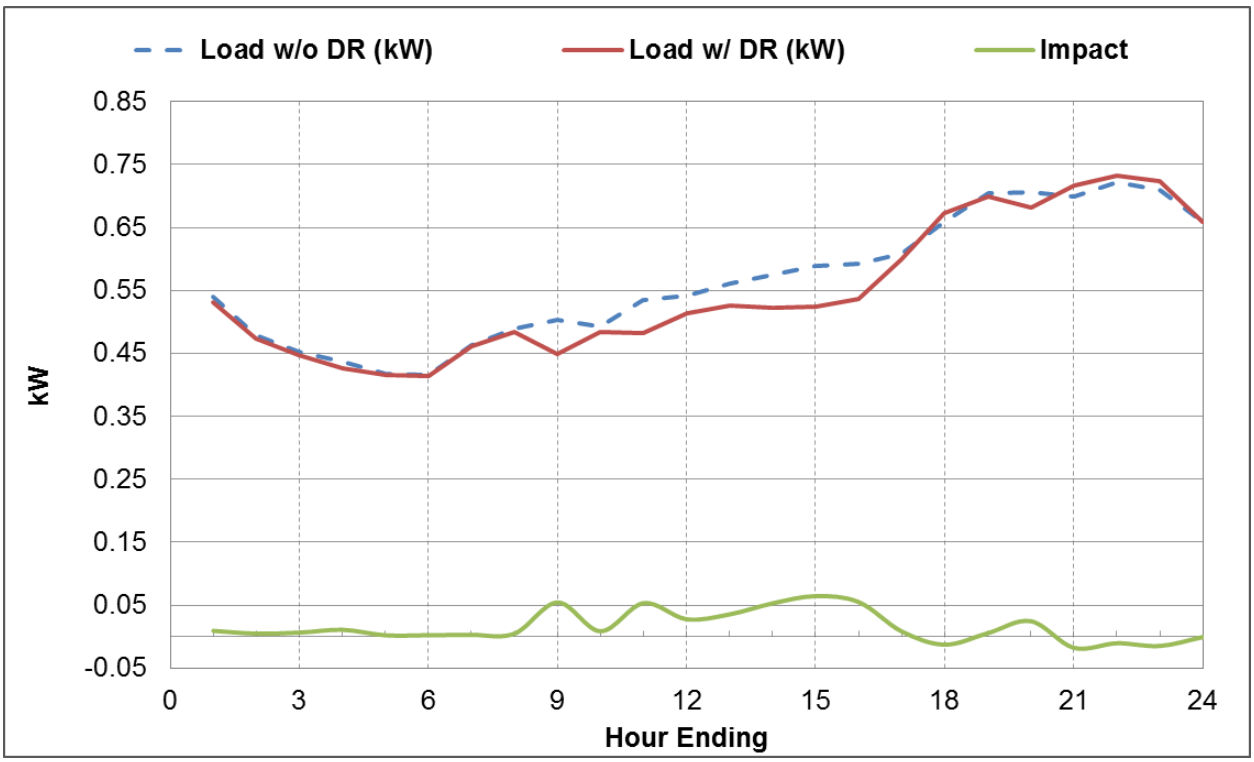


4.6 Treatment Group 4

Figure 4-7 shows the average load with DR, load without DR (reference load), and load impact for multifamily customers with window AC but who were not offered a control device. During typical event hours (12 PM to 4 PM), the average reference load was around 0.604 kW. The average load with DR during event hours was around 0.552 kW. This resulted in an average load reduction of 0.052 kW per customer, representing an 8.6% reduction relative to the

reference load. On an hourly basis, impacts were relatively low in the first event hour (0.036 kW) and peak at 0.064 kW from 2 PM to 3 PM. Load with DR returned to a similar level as the reference load in the hour following the event, and remained similar to the reference load for the rest of the day, exhibiting no snapback after the event. The apparent load reduction prior to the event window is likely due to random customer energy usage variation, as the multifamily customers exhibited significant variation in hourly energy usage, particularly in percentage terms. This is largely attributable to the lower overall energy usage levels of multifamily customers relative to single family customers. At this scale, a single appliance turning on or off significantly affects the customer's load shape.

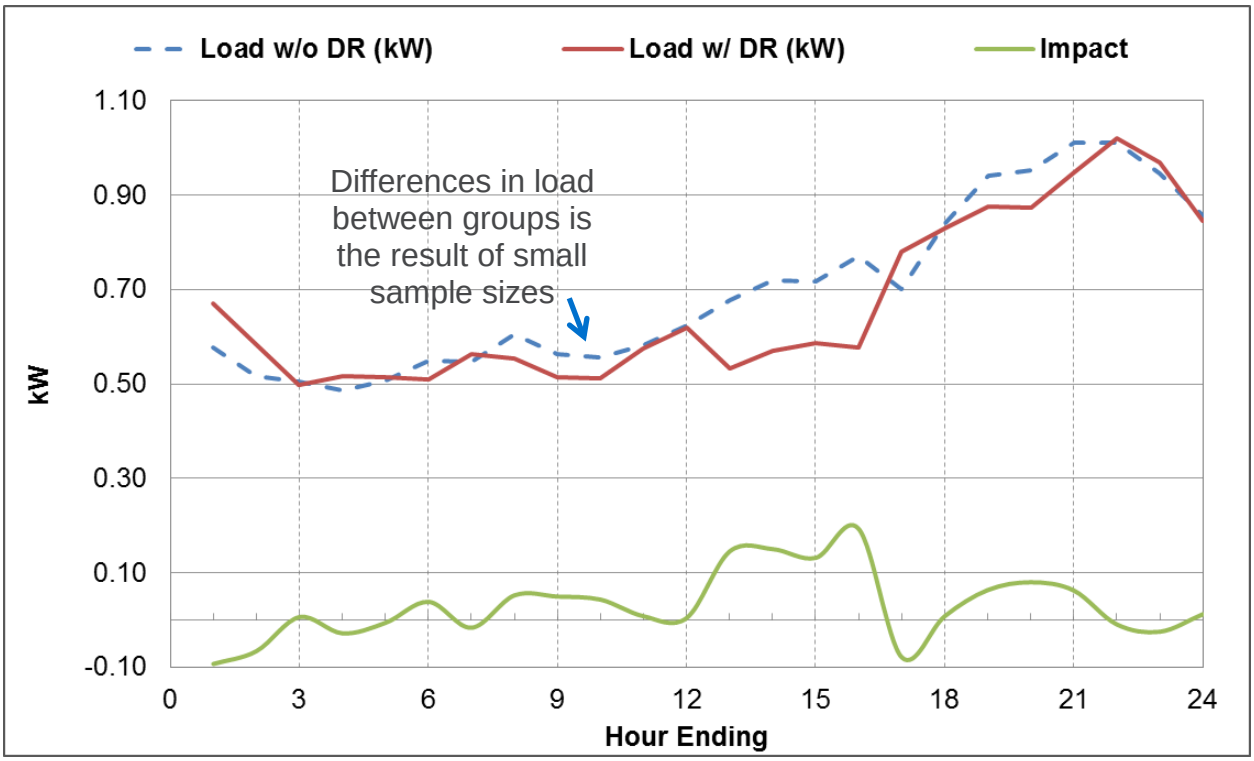
Figure 4-7: Average Hourly Load Impact per Customer- Treatment Group 4



4.7 Treatment Group 5

Figure 4-8 shows the average load with DR, load without DR (reference load), and load impact for multifamily customers with an installed plug-in device in each hour of the average event day. During typical event hours (12 PM to 4 PM), the average reference load was around 0.752 kW. The average load with DR during event hours was around 0.602 kW. This resulted in an average load reduction of 0.150 kW per customer, representing a 20.0% reduction relative to the reference load. On an hourly basis, impacts were generally consistent from hour to hour and peaked at 0.193 kW from 3 PM to 4 PM. Load increased relative to the reference load by 0.078 kW, 11.8% of the reference load, in the hour following the event, but there was no indication of snapback beyond that first post-event hour.

Figure 4-8: Average Hourly Load Impact per Customer- Treatment Group 5



4.8 Load Impacts for Average Event by Hour

Table 4-2 provides load impacts for the average event by hour for each of the treatment groups. Uncertainty adjusted impacts are provided in addition to the point estimates for the load impacts noted in the earlier sections. The uncertainty adjusted impacts help provide context to the effect of relatively small sample sizes on the load impact calculations. Based on overlap between the uncertainty adjusted impacts of Groups 1 and 2, there is not a statistically significant difference in load impacts between customers on PTS only and customers who were effectively on PTS only due to the AC switch failures but opted in to the enabling technology treatment. The lower bound at the 10th percentile for the PTS with PCT treatment group impact was 0.457, and the upper bound at the 90th percentile of the PTS only treatment group impact was 0.206 kW. This indicates there is a difference in load impacts of at least 0.25 kW that can be associated with enabling technology based on the assumptions developed in Section 4.4. Given this evidence, there is very little room to question the existence of incremental impact associated with DLC technologies when accounting for customer selection bias.

Table 4-2: Load Impacts for the Average Event by Hour

Customer Segment	Treatment Group	Hour Ending	Load w/o DR (kW)	Load w/ DR (kW)	Impact (kW)	Impact (%)	Avg. Temp. (°F)	Uncertainty-adjusted Impact - Percentiles				
								10th	30th	50th	70th	90th
Single Family Customer w/ Central AC	1: PTS Only	13	1.833	1.707	0.126	6.9%	85.0	0.099	0.115	0.126	0.137	0.153
		14	2.029	1.843	0.186	9.2%	85.2	0.160	0.175	0.186	0.197	0.213
		15	2.184	1.977	0.208	9.5%	84.7	0.179	0.196	0.208	0.220	0.237
		16	2.244	2.026	0.218	9.7%	83.4	0.183	0.204	0.218	0.233	0.254
		Avg. Hourly	***2.060***	***1.877***	***0.183***	***8.9%***	***84.7***	***0.159***	***0.173***	***0.183***	***0.192***	***0.206***
	2: PTS + AC Switch	13	1.899	1.829	0.070	3.7%	85.0	0.028	0.053	0.070	0.087	0.111
		14	2.131	1.985	0.146	6.9%	85.1	0.103	0.128	0.146	0.164	0.190
		15	2.300	2.117	0.184	8.0%	84.6	0.140	0.166	0.184	0.202	0.227
		16	2.345	2.114	0.231	9.8%	83.3	0.176	0.208	0.231	0.253	0.285
		Avg. Hourly	***2.155***	***2.004***	***0.151***	***7.0%***	***84.7***	***0.115***	***0.136***	***0.151***	***0.166***	***0.187***
	3: PTS + PCT	13	1.886	1.501	0.385	20.4%	85.0	0.331	0.363	0.385	0.407	0.438
		14	2.078	1.593	0.485	23.3%	85.1	0.427	0.461	0.485	0.509	0.543
		15	2.286	1.701	0.585	25.6%	84.6	0.524	0.560	0.585	0.609	0.645
		16	2.362	1.741	0.621	26.3%	83.3	0.552	0.593	0.621	0.649	0.690
		Avg. Hourly	***2.135***	***1.625***	***0.511***	***23.9%***	***84.7***	***0.457***	***0.489***	***0.511***	***0.533***	***0.564***
Multifamily Customer w/ Window AC	4: PTS Only	13	0.571	0.536	0.036	6.2%	85.0	0.018	0.028	0.036	0.043	0.053
		14	0.605	0.552	0.053	8.8%	85.2	0.036	0.046	0.053	0.060	0.070
		15	0.625	0.561	0.064	10.3%	84.7	0.047	0.057	0.064	0.072	0.082
		16	0.617	0.562	0.055	8.9%	83.4	0.031	0.045	0.055	0.065	0.079
		Avg. Hourly	***0.604***	***0.552***	***0.052***	***8.6%***	***84.7***	***0.038***	***0.046***	***0.052***	***0.058***	***0.067***
	5: PTS + Plug-in AC Device	13	0.702	0.557	0.145	20.7%	85.0	0.091	0.123	0.145	0.167	0.199
		14	0.746	0.596	0.150	20.1%	85.2	0.107	0.132	0.150	0.168	0.194
		15	0.774	0.642	0.132	17.0%	84.7	0.080	0.111	0.132	0.152	0.183
		16	0.799	0.606	0.193	24.2%	83.4	0.138	0.170	0.193	0.216	0.248
		Avg. Hourly	***0.752***	***0.602***	***0.150***	***20.0%***	***84.7***	***0.108***	***0.133***	***0.150***	***0.168***	***0.193***

5 Cost Effectiveness Analysis

Cost-effectiveness analysis is critical for comparing different resource options and for optimizing investment decisions. It allows for comparisons across resource options and provides a basis for prioritizing investments. A key goal of cost-effectiveness analysis is to provide factual insights, make tradeoffs transparent, improve the planning process, and help maximize value.

This section assesses the cost-effectiveness of including DLC in the PTS program based on the pilot findings. Inherently, this type of analysis is not a full assessment of the cost-effectiveness of the PTS program or of potential improvements to that program if improvements were identified and implemented.

The analysis here focuses on two main research questions:

- Are the various customer-technology options cost-effective? In other words, do the benefits of additional demand reduction outweigh the costs of recruiting customers, offering them utility provided technology (if applicable), and continuing operations? The analysis focuses on whether the marginal unit pays for itself and does not factor in overhead fixed costs, which are not linked to the number of participants. The results inform whether it is cost-effective to offer customers DLC technology, assuming no changes in the program or targeting practices.
- What are the key drivers of cost-effectiveness? Can cost-effectiveness of DLC options be improved by modifying how the program is designed, implemented, and targeted?

Cost-effectiveness analysis is generally applied on a forward looking basis to investments that typically have large upfront costs but have benefits that accrue over multiple years. While policies and programs can lead to winners and losers, cost-effectiveness focuses on the broader question of whether the overall policy is beneficial. The two most common perspectives applied are known as the total resource cost test (TRC) and the program administrator cost test (PAC), also known as the utility cost test (UCT).

The TRC test answers the question of whether the average utility customer is better off overall. This perspective essentially measures whether customers as a whole group benefit from the program (both participants and non-participants), and therefore considers incentive payments as a transfer from one group (non-participants) to another (participants). As such, incentive payments are not considered costs that burden the cost-effectiveness of the program under the TRC test. The TRC test is generally the primary basis for policy decisions.

The PAC test answers the question of whether the overall program is self-funded, or whether funds are needed to implement the program (i.e., whether the costs of the program, including incentive payments, are paid for by the benefits of the program). The main difference between the two perspectives is how customer incentives are accounted for. Under the TRC test, incentive payments are considered a transfer between customers, and thus are not included as costs in the assessment. Under the PAC perspective, incentive payments need to be accounted for as part of the operating expenses and thus are considered a cost.

5.1 Customer-Technology Combinations Analyzed

The cost-effectiveness analysis was implemented for six distinct customer-technology combinations that correspond to the DLC pilot results:

1. **Single family customers with central AC but no enabling technology (SF PTS only).** Demand reductions for this group were directly measured and purely behavioral.
2. **Single family customers with central AC and AC switches (SF PTS + AC Switch).** For reasons described in Section 2.2.4, demand reductions observed from customers with PCTs were used. Because both technologies work on the same principle (AC cycling, rather than adjusting thermostat set points), it was assumed that the load impacts would be comparable for these technologies.
3. **Single family customers with central AC and PCT (SF PTS + PCT).** Demand reductions for this group were directly measured.
4. **Multifamily residences with window AC but no enabling technology (MF PTS only).** Demand reductions for this group were directly measured and purely behavioral.
5. **Multifamily residences that self-install window AC control devices.** The difference between customers who install devices on their own and those who do so with professional assistance is that installation costs are avoided.
6. **Multifamily residences with professional installation window air conditioner control devices.** These customers have installation costs associated with them.

By design, PTS customers and the respective control groups included in the analysis either had central AC or window AC.

5.2 Cost and Benefit Inputs

Table 5-1 summarizes the main inputs into the cost-effectiveness analysis for each of the six customer-technology combinations. Table 5-2 summarizes the avoided generation capacity costs, the most tangible benefit of demand response programs. This analysis did not include energy or T&D-related benefits, since there are so few event hours in a given year that these benefits are negligible. The avoided generation capacity costs provide the bulk of the benefits, and are the focus of this assessment.

This analysis used a 15 year analysis period, with the program starting in 2017. The results are expressed in terms of 2015 dollars.

Table 5-1: Cost Effectiveness Inputs

Category	Metric	Single Family PTS only	Single Family PTS + AC switch	Single Family PTS + Thermostat	MF PTS only	MF PTS + Window AC modlet - self-install	MF PTS + Window AC modlet - professional install
General inputs	Discount rate	7.05%					
	Inflation rate	1.90%					
	Analysis period	15					
Installed devices per enrollee		0	1.2	1.2	0	1.86	1.86
Annual attrition (includes turnover and opt-outs)		7.50%	7.50%	7.50%	7.50%	7.50%	7.50%
One-time costs per enrollee	Acquisition recruitment	$11.55	$11.55	$11.55	$11.55	$11.55	$11.55
	Utility equipment[1]	$0.00	$88.56	$155.23	$0.00	$384.02	$384.02
	Installation	$0.00	$106.30	$152.50	$0.00	$0.00	$125.00
	Total	$11.55	$206.41	$319.28	$11.55	$395.57	$520.57
Annual recurring costs per enrollee	Reminder mailings	$0.83	$0.83	$0.83	$0.83	$0.83	$0.83
	Notification, analytics, and settlement calculations	$3.25	$3.25	$3.25	$3.25	$3.25	$3.25
	Customer device support	$0.00	$4.00	$4.00	$0.00	$4.00	$4.00
	Device software licensing	$0.00	$0.00	$20.00	$0.00	$20.00	$20.00
	Total	$4.08	$8.08	$28.08	$4.08	$28.08	$28.08
Load Impacts per enrollee	Demand reduction (kW)	0.18	0.52	0.52	0.05	0.16	0.16
	Annual event hours	12	12	12	12	12	12
	Incentive payments ($/kWh)	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00

[1] Equipment costs reflect the average number of devices per enrollee

Table 5-2: Avoided Generation Capacity Costs

Year	$/MW-day
2015	$136.00
2016	$59.37
2017	$120.00
2018	$200.21
2019	$192.48
2020	$201.47
2021	$208.92
2022	$217.21
2023	$225.69
2024	$227.89
2025	$238.07
2026*	$242.59
2027*	$247.20
2028*	$251.90
2029*	$256.69
2030*	$261.56
2031*	$266.53
2032*	$271.60

*Beyond 2025, values are extrapolated using a 1.9% annual inflation rate

5.3 Results

Table 5-3 summarizes the cost-effectiveness for various DLC technology options, assuming a 15 year device life, with the results expressed in terms of 2015 dollars. Based on the DLC pilot program parameters studied, none of the DLC technology options are cost-effective to offer to PTS customers.

Table 5-3: Cost-effectiveness of Customer-technology Combinations

Cost-effectiveness Perspective	Metric	Per Household 15 Year NPV			
		Marginal Benefits	Marginal Cost	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test	Single Family PTS only w/ AC	$78.09	$37.17	$40.92	2.10
	Single Family PTS w/ AC + AC switch	$219.65	$239.21	($19.56)	0.92
	Single Family PTS w/ AC + Thermostat	$219.65	$470.65	($251.00)	0.47
	MF PTS only w/ Room AC	$22.01	$37.17	($15.16)	0.59
	MF PTS + Room AC modlet - self-install	$65.60	$539.77	($474.17)	0.12
	MF PTS + Room AC modlet - professional install	$65.60	$653.04	($587.44)	0.10
Utility Cost Test	Single Family PTS only w/ AC	$78.09	$52.88	$25.20	1.48
	Single Family PTS w/ AC + AC switch	$219.65	$283.42	($63.77)	0.78
	Single Family PTS w/ AC + Thermostat	$219.65	$514.86	($295.21)	0.43
	MF PTS only w/ Room AC	$22.01	$41.60	($19.59)	0.53
	MF PTS + Room AC modlet - self-install	$65.60	$552.98	($487.38)	0.12
	MF PTS + Room AC modlet - professional install	$65.60	$666.24	($600.64)	0.10

5.4 Sensitivity Analysis

Nexant analyzed the key drivers of cost-effectiveness through sensitivity analysis. Sensitivity analysis is a systematic process for identifying the inputs that contribute most to key results such as the benefit cost ratio. This is typically accomplished by varying each component by a specific percentage, typically 20%, while holding all other inputs constant. Sensitivity analysis serves several functions:

- It helps identify the assumptions, inputs and program design characteristics which contribute most to net benefits;
- It helps test the robustness of the results. If a program is cost-ineffective due to small changes in the inputs, it is not very robust, particularly if those values are uncertain;
- It can help focus additional research on inputs and assumptions that drive cost-effectiveness. When inputs are highly influential, it is critical to assess the degree of uncertainty for them and determine if and how the uncertainty can be reduced; and
- It can help focus discussion and efforts on the program components that are most influential.

Figure 5-1, Figure 5-2, and Figure 5-3 summarize how the main inputs influence cost-effectiveness without any technology, with AC switches, and with PCT, respectively. The different inputs are ranked based on their degree of influence on cost-effectiveness and color coded to reflect if the input is directly or inversely related to the cost-effectiveness. Across all three single family technology options, the magnitude of demand reductions and the avoided capacity costs are the biggest drivers of cost-effectiveness. Beyond that, the key drivers of cost-effectiveness vary by technology option. For the PTS only option, recurring customer specific costs such as notifications and settlements are highly influential. This is not surprising since one-time costs related to equipment and installation is avoided. For both AC switch and PCT options, the one-time equipment and installation costs have a more substantial influence on cost-effectiveness. There are, however, important distinctions between the two. PCTs are more expensive in comparison to AC switches and have substantially higher recurring costs, mainly because PCT vendors have adopted a licensing model rather than selling the load control capability outright.

Figure 5-1: Sensitivity Analysis—Single Family—PTS Only

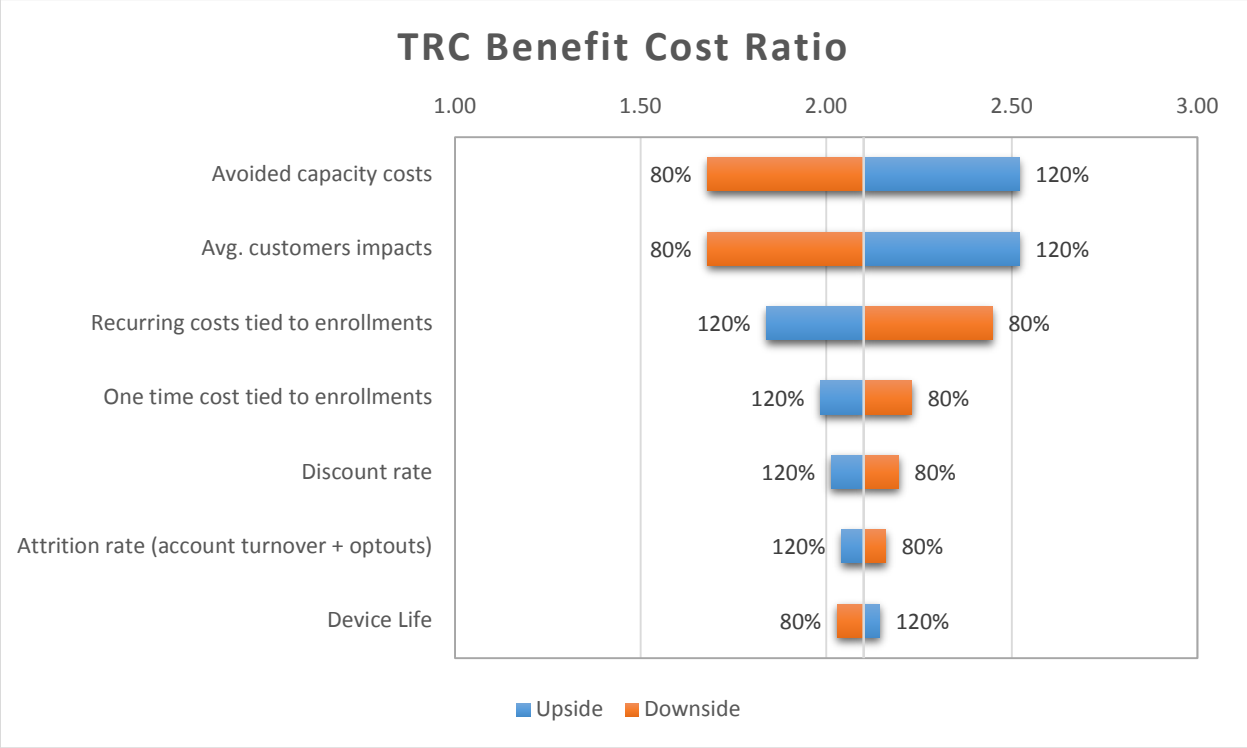


Figure 5-2: Sensitivity Analysis—Single Family—PTS with AC Switch

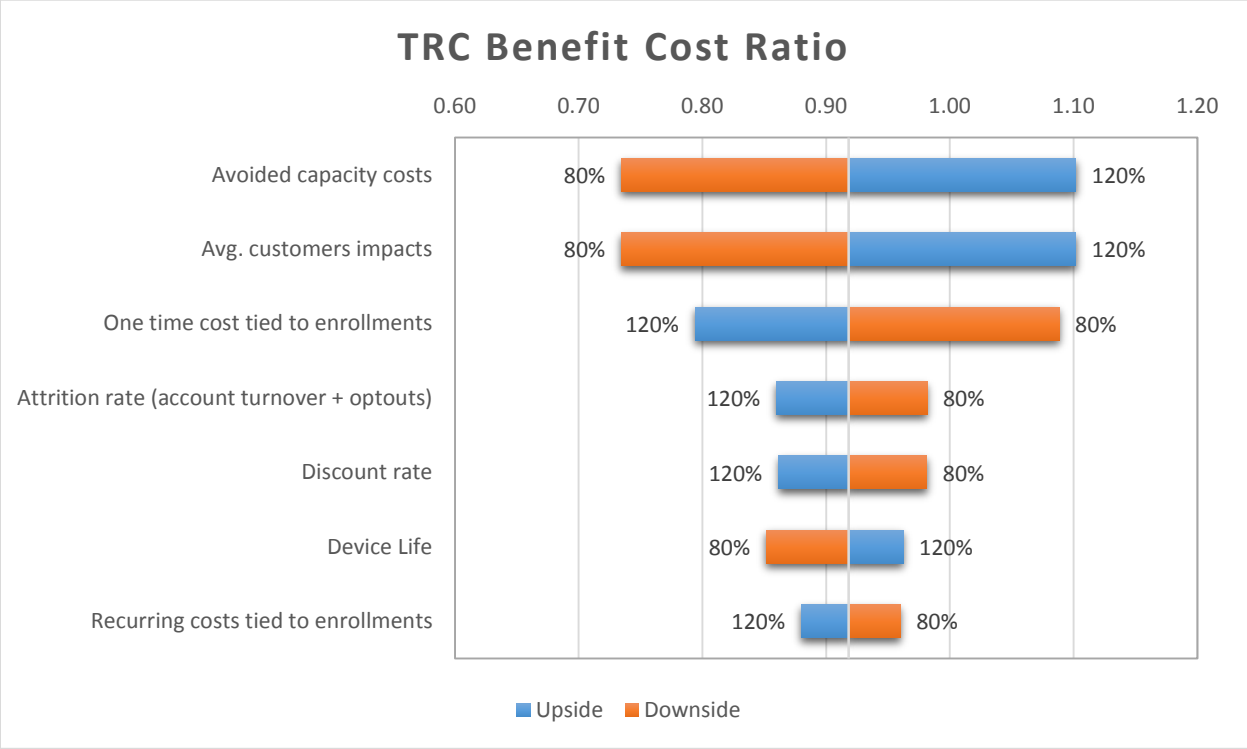


Figure 5-3: Sensitivity Analysis—Single Family—PTS with Thermostat

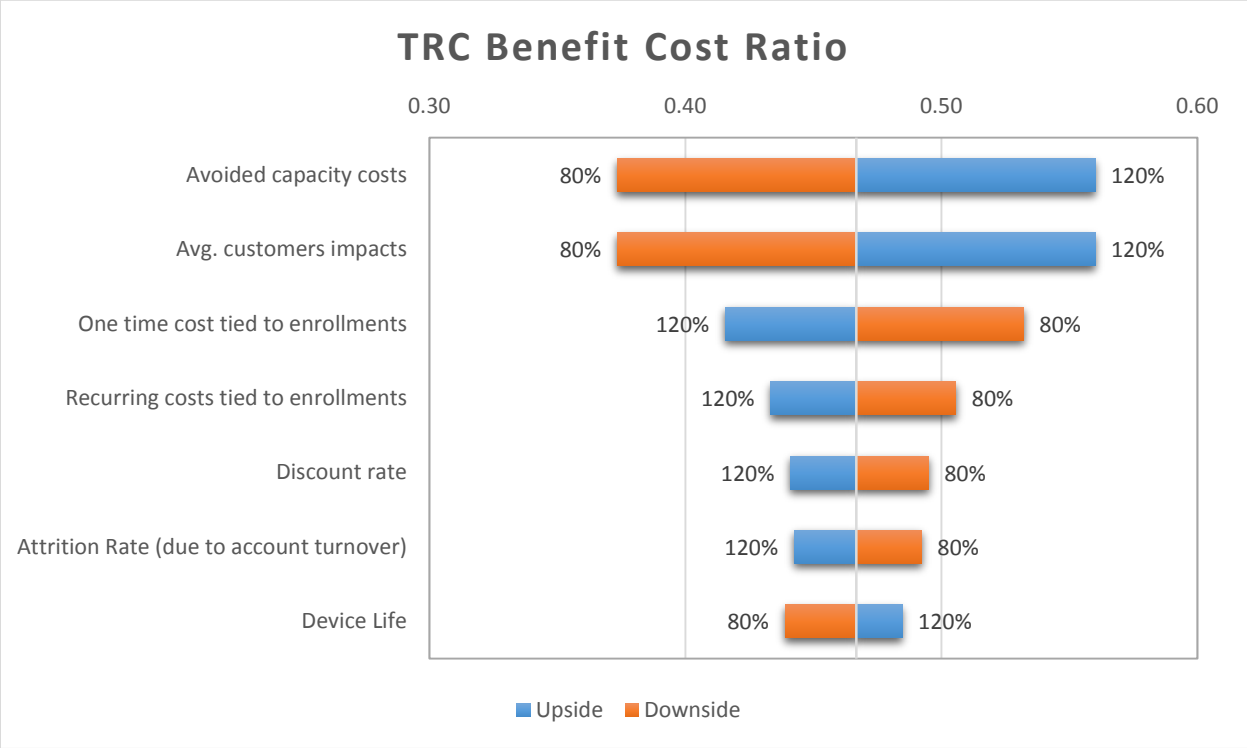
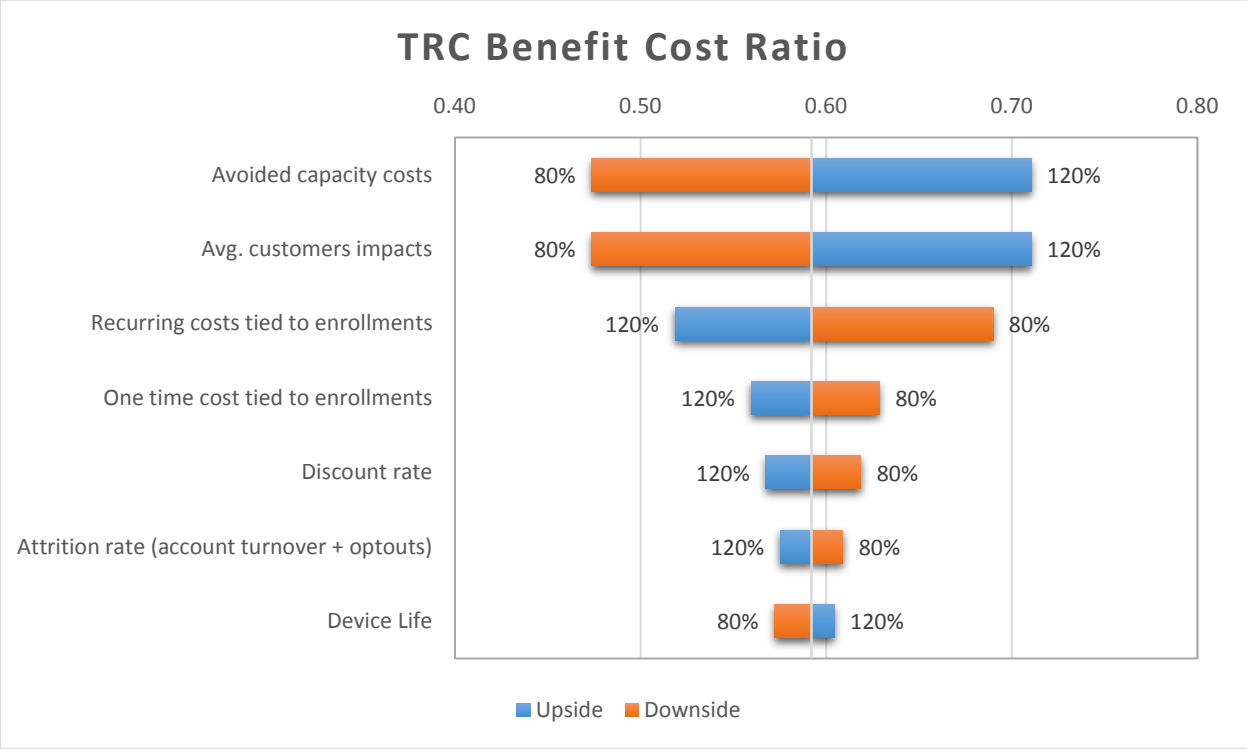


Figure 5-4: Sensitivity Analysis—MultiFamily—PTS Only



In addition to studying the relative importance of inputs for single family options, a sensitivity analysis was performed for multifamily customers without technology. Similar to the other sensitivity analyses, this group's results were most influenced by avoided capacity costs and customer impacts. Similar to the single family option with no technology, recurring costs are more important than one-time costs, and for the same reasons.

Sensitivity analyses for multifamily options with technology were not conducted because those customer-technology options were exceedingly cost ineffective. Adjusting the inputs for those options would not yield attractive results without making unreasonably large adjustments.

5.5 Conclusions

The cost-effectiveness analysis indicates that DLC technology options are not currently cost-effective to offer to PTS customers based on current costs, benefits, demand reductions, and recruitment practices.

6 Conclusions

The ComEd DLC pilot provided significant insight into the value of providing enabling technology in conjunction with the PTS program for single family and multifamily customers. Findings from this evaluation address three primary topics: 1) the influence of offering enabling technology on PTS enrollment rates; 2) whether the presence of enabling technology increased the magnitude of load reductions for PTS participants; and 3) whether the incremental benefits of the technology offset its costs.

Customer acceptance rates from the five treatment groups were analyzed to evaluate the influence of offering enabling technology on PTS enrollment rates. Across the five groups, the average acceptance rate was 4.1%. Ultimately, the offer of an enabling technology did not increase acceptance rates for any of the treatment groups. There was no difference in overall acceptance rates with or without technology for single family customers, regardless of whether the offer was an AC switch or a PCT. For multifamily customers, the offer of technology actually resulted in a lower overall acceptance rate of 3.3% compared to an acceptance rate of 5% from the customers offered PTS without any enabling technology.

Results from the surveys conducted among pilot participants indicate customers with and without technology are very satisfied with the PTS program. While satisfaction in the program is high across all test and control groups, customers with DLC technology are more likely to very satisfied with the PTS program compared to those without technology. While a majority of customers took action to save energy during PTS hours, those with DLC technology were less likely than those without to take action, suggesting some degree of reliance on the technology to save during the events. Consistent with high levels of satisfaction, a majority of participants indicate a high likelihood of recommending the program to family or friends and a high proportion indicate a willingness to participate in the future.

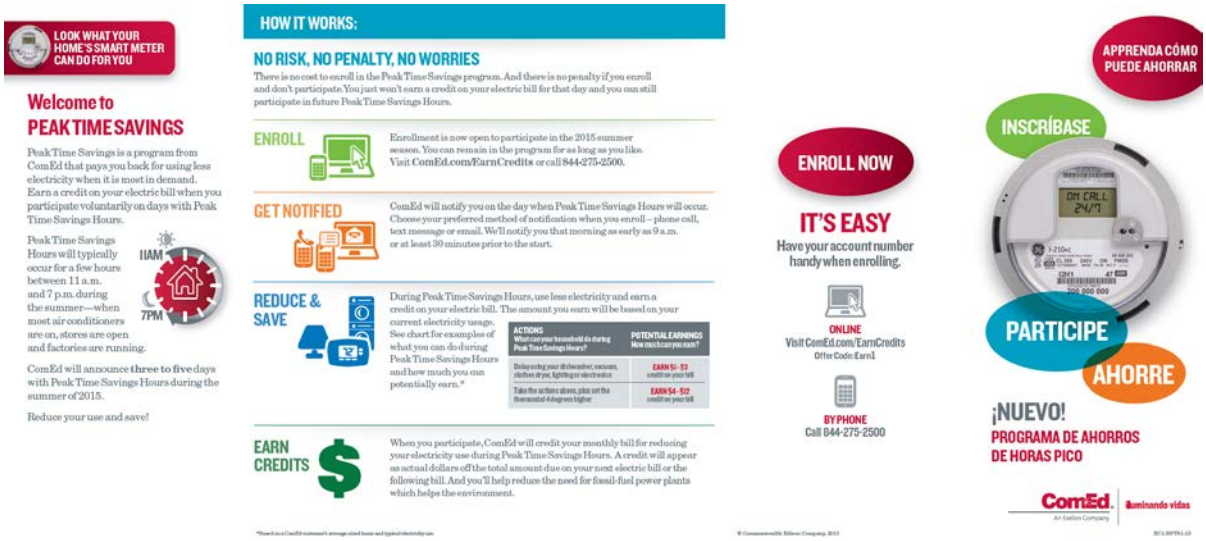
Both single and multifamily customers with no enabling technology reduced loads on average by roughly 9%. The load reduction for Group 3, which had a PCT that cycled the central AC, had an average load reduction of almost 24% and an absolute load reduction of 0.51 kW, which is more than 3 times larger than Group 2 and about 2.8 times larger than Group 1. Given the similarity in loads across the three groups during the hours when events are typically called, it is almost certainly safe to assume that the majority of the difference in load reductions between Groups 1 and 2 and Group 3 is due to the enabling technology. Put another way, it is probably reasonable to assume that the enabling technology, whether a switch or a PCT, increases load reductions by 2.5 to 3 times compared with single family customers with central AC that did not accept the enabling technology.

The average load reduction for multifamily customers with window AC is similar to single family customers in percentage terms but is quite small, 0.05 kW per participant. Adding plug-in load control devices nearly triples the absolute load reduction and more than doubles it in percentage terms.

Appendix A Samples of Direct Mail Marketing Materials

A.1 Treatment Group 1

Recruitment Brochure



Recruitment Letter

Account Number: 285 632 115

ComEd. An Exelon Company

Sample A. Sample
1234 Main Street
Apt. 123
Your Town, IL 12345-6789

LOOK WHAT YOUR HOME'S SMART METER CAN DO FOR YOU

INTRODUCING THE PEAK TIME SAVINGS PROGRAM

Earn during the hottest days of summer.

Dear Sample A. Sample:

Because a smart meter has been installed at your home, you are eligible to enroll in ComEd's new Peak Time Savings program that pays you back for using less electricity. ComEd will credit your electric bill when you reduce your electricity use during Peak Time Savings Hours.

- ComEd will announce Peak Time Savings Hours on days when electricity is most in demand – as early as 9 a.m. or at least 30 minutes prior to the start. Peak Time Savings Hours will typically occur for a few hours between 11 a.m. and 7 p.m. on three to five days during the summer.
- Reduce your electricity use during Peak Time Savings Hours and you'll earn a credit which will appear on your electric bill as actual dollars off the total amount due.
- Enrollment is now open for the 2015 summer season. There's no cost to enroll and no penalty if you enroll and don't participate.

To enroll simply visit ComEd.com/EarnCredits and enter offer code Earn1 or call 844-275-2500. You'll earn a credit on your bill plus save on energy costs.

Sincerely,

Val Jensen, senior vice president, Customer Operations

ENROLL TODAY. There's no cost to enroll and no penalty if you enroll and don't participate.

REDUCE your electricity use during Peak Time Savings Hours.

EARN a credit which will appear on your electric bill as actual dollars off the total amount.

ENROLL NOW in Peak Time Savings for the 2015 season.

ONLINE Visit ComEd.com/EarnCredits Offer code: Earn1

PHONE Call 844-275-2500

HAVE YOUR ACCOUNT NUMBER HANDY. 285 632 115

ComEd. An Exelon Company powering lives

© Commonwealth Edison Company, 2014

LNI-Elevate

FAQ

PEAK TIME SAVINGS PROGRAM

Frequently Asked Questions

Q. WHEN DOES THE PEAK TIME SAVINGS PROGRAM BEGIN?

A. The program begins in the summer of 2015 and enrollment is now open. There is no cost to enroll and you can remain in the program for as long as you like.

Q. WHAT IS A BILL CREDIT?

A. If you are enrolled in the program and reduce your electricity use during Peak Time Savings Hours, you will earn a credit on your next electric bill or the following bill. It will appear as dollars off your total amount due. See the example below.

Q. WHAT CAN I DO TO REDUCE MY USE AND HOW MUCH WILL I EARN?

A. The amount you earn will be based on your current electricity usage. See chart for examples of what you can do during Peak Time Savings Hours and how much you can potentially earn.*

ACTIONS What can your household do during Peak Time Savings Hours?	POTENTIAL EARNINGS How much can you earn?
Delay using your dishwasher, vacuum, clothes dryer, lighting or electronics	EARN $1 - $3 credit on your bill
Take the actions above, plus set the thermostat 4 degrees higher	EARN $4 - $12 credit on your bill

Q. HOW OFTEN WILL PEAK TIME SAVINGS HOURS BE ANNOUNCED?

A. In the summer of 2015, ComEd will announce three to five days with Peak Time Savings Hours, typically occurring for a few hours between 11 a.m. and 7 p.m. – when most air conditioners are on, stores are open, and factories are running.

Q. WHAT IF I DON'T REDUCE MY ELECTRICITY USE DURING PEAK TIME SAVINGS HOURS?

A. There is no penalty for not participating. You just won't earn a credit on your electric bill for that day. And, you can still participate in future Peak Time Savings Hours.

Q. HOW WILL I KNOW WHEN PEAK TIME SAVINGS HOURS WILL OCCUR?

A. When you enroll, you can choose to be notified by phone call, text message or email. You will be notified on the day Peak Time Savings Hours occur – as early as 9 a.m. or at least 30 minutes prior to the start.

Q. WHO CAN PARTICIPATE?

A. Only customers in homes with smart meters are eligible to participate. Since you received this letter, you are eligible to participate.

Q. WHY IS THIS PROGRAM BEING OFFERED?

A. ComEd is offering this program to encourage customers to use less electricity during times when it is most in demand. This can help reduce the need for fossil-fuel power plants, lowering the emissions that would otherwise be released into the atmosphere.

Smart meters are a key part of ComEd's effort to modernize the electric system and provide you with better service and a stronger, more reliable smart grid.

ENROLL TODAY ▶
ComEd.com/EarnCredits
Offer Code: Earn1
844-275-2500

MUST ENROLL BY APRIL 10, 2015, TO PARTICIPATE THIS SUMMER.

*Based on a ComEd customer's average-sized home and typical electricity use.
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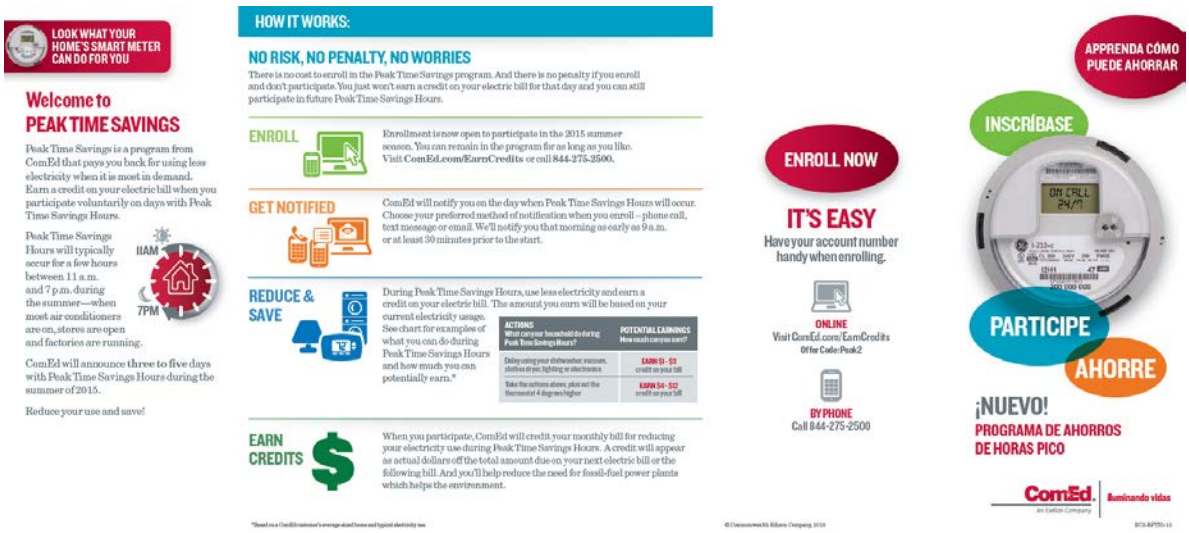
ECI-FPTS-2-15

A.2 Treatment Group 2

Recruitment Brochure



Recruitment Letter

Account Number: 285 632 115

ComEd
An Exelon Company

Sample A. Sample
1234 Main Street
Apt. 123
Your Town, IL 12345-6789

LOOK WHAT YOUR HOME'S SMART METER CAN DO FOR YOU

INTRODUCING THE PEAK TIME SAVINGS PROGRAM

Earn during the hottest days of summer.

Dear Sample A. Sample:

Because a smart meter has been installed at your home, you are eligible to enroll in ComEd's new Peak Time Savings program that pays you back for using less electricity. ComEd will credit your electric bill when you reduce your electricity use during Peak Time Savings Hours.

- ComEd will announce Peak Time Savings Hours on days when electricity is most in demand – as early as 9 a.m. or at least 30 minutes prior to the start. Peak Time Savings Hours will typically occur for a few hours between 11 a.m. and 7 p.m. on three to five days during the summer.
- Reduce your electricity use during Peak Time Savings Hours and you'll earn a credit which will appear on your electric bill as actual dollars off the total amount due.
- Enrollment is now open for the 2015 summer season. There's no cost to enroll and no penalty if you enroll and don't participate.

To enroll simply visit ComEd.com/EarnCredits and enter offer code Peak2 or call 844-275-2500. You'll earn a credit on your bill plus save on energy costs.

Sincerely,

Val Jensen, senior vice president, Customer Operations

P.S. See the enclosed Optional Technology insert for a more convenient way to automatically save during Peak Time Savings Hours.

ENROLL TODAY. There's no cost to enroll and no penalty if you enroll and don't participate.

REDUCE your electricity use during Peak Time Savings Hours.

EARN a credit which will appear on your electric bill as actual dollars off the total amount.

ENROLL NOW in Peak Time Savings for the 2015 season.

ONLINE
Visit ComEd.com/EarnCredits
Offer code: Peak2

PHONE
Call 844-275-2500

HAVE YOUR ACCOUNT NUMBER HANDY.
285 632 115

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© Commonwealth Edison Company, 2014

LCAC

Optional Technology Insert – Central AC Cycling Switch

PEAK TIME SAVINGS OPTIONAL TECHNOLOGY

NEVER MISS A SAVINGS OPPORTUNITY

Save conveniently and automatically with optional technology.

ComEd An Exelon Company | powering lives

PEAK TIME SAVINGS + TECHNOLOGY

A more convenient way to save energy.

If you live in a single-family home with a working central air conditioner, you can take advantage of an additional Peak Time Savings opportunity.

- **During Peak Time Savings Hours**, ComEd will wirelessly adjust your air conditioner through a device installed on your air conditioner.
- The device will be provided and installed by an authorized ComEd contractor **at no cost to you**.
- **ComEd will send a signal to your air conditioner** through the device during Peak Time Savings Hours.
- **The device will raise the temperature by a few degrees when Peak Time Savings Hours occur** so you never miss a savings opportunity. The fan will remain running to circulate cool air.
- **If you choose not to participate on that day simply call ComEd.** You can always participate next time. **You are always in control.**

Enroll today and arrange for your free installation.

ComEd.com/EarnCredits | 844-275-2500
Offer code: Peak2

YOU MUST ENROLL BY APRIL 10, 2015, TO PARTICIPATE THIS SUMMER.

ICAC-3-15