Business & Technology Report

June 2021

Shifting Space Conditioning Load

A Smart Thermostat Demand Response Pilot Measurement & Verification

NRECA

America's Electric Cooperatives

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A Smart Thermostat Demand Response Pilot Measurement & Verification

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Prepared By:

Katherine Dayem
Catherine Mercier
XERGY CONSULTING

Contact:

<u>NRECA</u>
Brian Sloboda
NRECA Director, Consumer Solutions
Brian.Sloboda@nreca.coop

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America's Electric Cooperatives

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Key Highlights & Article Snapshot

- In 2020, 13% of U.S. broadband-connected households had installed a smart thermostat, and 29% planned to purchase one.
- Results of this pilot resulted in an average per-home demand reduction of 0.94 kW during summer events and 1.9 kW during winter events.
- Pilot participants opted-out at rates of 13% and 6% from summer and winter events.
- Key factors in the success of this pilot included a supportive board and executive management, dedicated and enthusiastic staff who ensured that members were well educated about the thermostats and pilot.

REPORT SNAPSHOT

What has changed in the industry?

Consumer acceptance and adoption of "smart," Internet-connected products is growing, with connected thermostats at the top in terms of popularity (Business Wire 2020). In 2020, 13% of U.S. broadband-connected households had installed a smart thermostat, and 29% planned to purchase one (Parks Associates 2020). The connectivity of smart products presents the opportunity for consumers and utilities to control or modify when and how the product uses energy. Some co-ops and other utilities are leveraging smart thermostats for demand response (DR) and other load shifting programs. At the same time, consumers are becoming more interested in and accepting of such programs; 42% of smart thermostat owners say they would allow their utility to adjust their thermostat to achieve savings (Parks Associates 2020).

What is the impact on electric cooperatives?

Co-ops can leverage smart thermostats to run DR programs that reduce peak demand load and associated demand charges. This offers the opportunity to not only keep their members' electricity costs low, but also strengthen the co-op's role as a trusted energy advisor by providing smart technology to interested members.

What do cooperatives need to know or do about it?

Many smart thermostats with DR capability are available on the market today. Co-ops that wish to offer the smart thermostat programs should investigate thermostat options to find the model(s) that can meet co-op demand reduction or energy savings goals. Before launching a full program, co-ops may consider a pilot to test the utility of various thermostats and demand reduction and/or energy savings potential of a program. A successful pilot or program takes executive and board buy-in and significant co-op staff time, but as we discuss in this report, can significantly reduce space conditioning peak demand.

Acknowledgements

NRECA wishes to thank the staff of Jackson County Rural Electric Membership Cooperative and Hoosier Energy for creating this pilot and demonstrating how Internet investments can be leveraged to save consumer-members energy and money.

Introduction

Jackson County Rural Electric Membership Cooperative (REMC) is a distribution co-op in southern Indiana, and a member of generation and transmission (G&T) co-op Hoosier Energy (Hoosier).

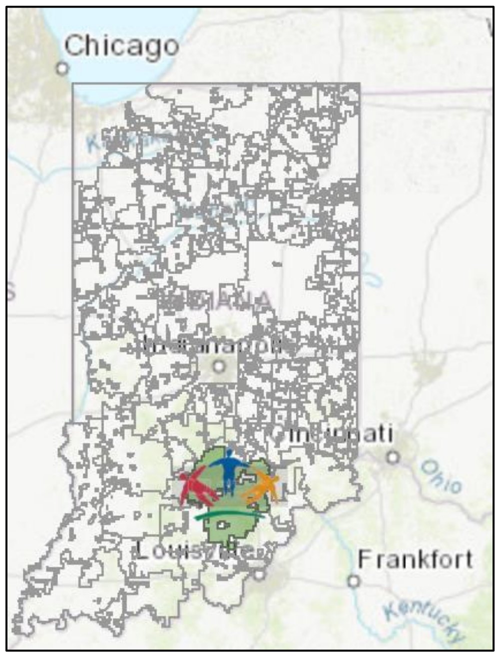

Figure 1: Map of Jackson County REMC Service Area
(Source: Jackson County REMC website)

Jackson County REMC is a summer and winter peaking co-op, with high penetration of air conditioning and electric heating. Mitigating peak demand and associated charges is key to maintaining low electricity rates for their members. In the past, Hoosier and some of its distribution co-ops ran demand response (DR) programs on water heaters and air conditioning, but with little success, as program operation costs tended to exceed demand savings. As an alternative to legacy DR approaches, Jackson County REMC and Hoosier wished to explore using different technology – smart thermostats – to enable DR events that would reduce peak demand in both summer and winter. In addition, since both co-ops focus on providing energy as a service to their members, they wanted to test whether smart thermostat programs could provide technology that members want, while serving as an engagement touch point.

A key element to the success of running DR through smart thermostats is reliable Internet connections to and within members' homes. Jackson County REMC offers fiber optic broadband service to their members. A natural pairing, then, was to target those members with Jackson County REMC's broadband service.

In 2020, the co-ops began a pilot to test the benefits and feasibility of using smart thermostats to enable a DR program. The goal of the pilot was to test the potential to decrease demand during demand peaks by shifting load to non-peak hours using smart thermostats.

NRECA contracted with Xergy Consulting to provide measurement and verification for the pilot, particularly to verify that thermostats responded to DR events and to estimate demand and energy savings. In this report, we address the following research questions:

- Do the smart thermostats reliably control HVAC load through DR events?
- How much peak demand reduction is achieved during load control events?
- How much does demand increase after DR events as HVAC systems recover to their normal set points?
- How often do participants opt-out of events?
- How does precooling and preheating impact load during and after DR events?
- How much energy savings is attributable to smart thermostat usage?

This report outlines findings from the pilot's summer and winter seasons, including pilot methodology, results related to the research questions above, and the co-ops' experience and learnings from the pilot.

Methodology

Thermostat Selection and Installation

Based on responses to a request for proposals issued by Hoosier, the co-ops selected the ecobee3 lite smart thermostat (Figure 2), ecobee's value-level thermostat with a retail price of $170, for the pilot. The ecobee3 lite is a learning thermostat that suggests schedules based on occupant behavior, and tailors DR operation to user preferences through a feature called eco+.

Figure 2: ecobee3 lite smart thermostat.
Source: ecobee

The co-ops started with an initial goal of up to 200 thermostats installed by the end of the pilot, which included the 2020 summer season (June, July, and August) and the 2020-21 winter season (December, January, and February). Jackson County REMC offered the thermostats at no additional cost to members who were signed up for their fiber optic broadband service. This allowed Jackson County REMC to ensure that the thermostats had a reliable broadband connection.

Jackson County REMC originally planned for thermostat installation to be carried out by broadband technicians while they were on site to install broadband service. Technicians would discuss the pilot with the member and, if the member agreed to participate, install a thermostat. Jackson County REMC did not find great success with this approach because many technicians were not comfortable discussing the thermostat pilot with members and felt like they had to "sell" it, according to Brian Reynolds, Energy Advisor at Jackson County REMC. Soon after thermostat installation began, COVID-19-related restrictions hit and technicians were no longer able to enter members' homes. Jackson County REMC adjusted by marketing the pilot to broadband subscribers via email. Members picked up their thermostats at the Jackson County REMC office, and in most cases, installed them at home.

Self-installation success rate was very high. Of the over 200 thermostats installed as of May 2021, Reynolds estimates that he visited about 30 to 35 homes to troubleshoot and complete installation. He credits the high success rate to a responsive and helpful technical support team at ecobee. Members who were having trouble with the self-installation could call ecobee's support team, which would in many cases guide members to a successful installation, eliminating the need for co-op staff to visit the site. Jackson County REMC began installing thermostats in spring of 2020 and started the pilot summer season with about 40 thermostats installed. By the end of the August 2020, 125 thermostats were connected and participating in the pilot. Thermostat installation continued through the fall and winter. By the end of the pilot in February 2021, 171 thermostats were connected.

Participant Characteristics

During thermostat installation, participants were asked to enter HVAC system information by selecting all applicable options from a list that included forced air, heat pump, central air conditioning, boiler, and auxiliary heat. The majority of the participant group have heat pump equipment in their homes; 70% of pilot participants used heat pumps for air conditioning (Table 1). In contrast, heat pump adoption across Jackson County REMC residential members is 19% for air conditioning and 25% for heating (Jackson County REMC 2019). Assuming that reported heat pumps are used as the primary heating source in the winter, 64% of participants heated with heat pumps. We were not able to obtain the heating fuel used by the remaining 36% of participating homes; future participants should be asked to specify heating equipment and fuel type. However, it appears that the participant group uses electric heating at a higher frequency than the Jackson County REMC residential member average; 55% of Jackson County REMC residential members heat their homes with electric technologies, including 25% that use heat pumps (Jackson County REMC 2019).

Table 1: Air conditioning and heating type for pilot participants compared to Jackson County REMC members on average

Equipment type	Participants	Jackson County REMC members
Air conditioning		
Central	30%	69%
Heat pump	70%	19%
Heating		
Heat pump	64%	25%
Other electric heating	36%*	30%
Non-electric heating (propane, natural gas, wood, fuel oil)		45%
* Participant heating fuel information was not collected.		

The ecobee3 lite thermostats were equipped with “eco+,” an ecobee algorithm designed to optimize demand savings based on user comfort preferences. An eco+ setting of 1 is least invasive and prioritizes occupant comfort. A setting of 5 is the most aggressive setting to maximize potential energy and demand savings. The thermostats ship with eco+ set to 4, and Users can change eco+ settings at any time. More than half of the thermostats were set to more aggressive settings of 4 or 5 during the summer and winter (Table 2). In the winter, it appears that some participants disabled eco+.

Table 2: Participant eco+ settings at the end of the summer cooling season (August 2020) and winter heating season (February 2021).

eco+ setting	Share of participants	
	Summer	Winter
1	25%	4%
2	7%	6%
3	11%	9%
4	48%	41%
5	8%	11%
None	0%	30%

Demand Response Events

Hoosier and Jackson County REMC conducted 10 DR events over the summer months (June through August 2020) (Table 3) and 8 events over the winter months (December 2020 through February 2021) (Table 4). Summer events occurred in the evening from 5:00 to 8:00 pm local time, while winter events took place in the morning from 7:00 to 9:00 am. These control periods coincided with Hoosier's demand peak.

The co-ops scheduled DR events via ecobee's utility-facing web portal. The ecobee headend notified participant thermostats up to a day in advance of an event. The co-ops did not specify thermostat set point changes for precooling/preheating or during DR events. Rather, temperature set points were determined by eco+ settings, with higher eco+ settings placing higher priority on demand reduction than lower settings. In our analysis below, we examine the impact of eco+ setting on demand reduction.

Measurement and Verification

Pilot measurement and verification relied on two main data sets. First, to verify that thermostats received DR requests, estimate participation rates, and confirm set point changes, we analyzed thermostat "runtime" data downloaded from an ecobee API. Each thermostat records status data every 5 minutes including current set point, indoor temperature, and schedule setting (e.g., home, away, sleep). The runtime data also records the current state of the thermostat: whether it is responding to the user's schedule, holding a set point, preparing for a DR event by precooling or preheating, or responding to a DR event. For each DR event, we confirmed that the thermostats participating in the event carried out set point changes to reduce the home's cooling or heating demand during the event. We verified that most thermostats precooled or preheated the home before the event, usually in the 30 minutes before the event began.

We used hourly whole-home AMI data to estimate the load reduction during DR events and energy savings related to the thermostats. For each estimate, we compared the participant group to a baseline group as described previously.

We find that the thermostats responded reliably to DR events, which resulted in considerable load reduction. Smart thermostats might have the potential to yield energy savings as well, however savings estimates are highly uncertain due to likely behavior changes during the COVID-19 pandemic that occurred during the pilot.

Results

This section presents results of the evaluation, including participant opt-out rate, demand reduction, and energy savings.

Thermostat Response and Participant Opt-Outs

To verify that the thermostats received and executed DR commands, we acquired and analyzed runtime data from each thermostat. For each DR event day, we determined the number of thermostats that were connected to the ecobee headend and reporting data (Table 3) prior to the DR event. These thermostats received DR event signals and carried out setpoint modifications during preconditioning and DR event intervals.

We estimated DR event opt-out rates from the runtime data. Interestingly, while some participants opted out of the event before it started, many opted out after the event had started, often within the first hour. Summer opt-out rates ranged from 6% to 23% and averaged 13%. Opt-out rate appeared to be slightly correlated to high temperature. The highest opt-rate of 23% occurred on August 26, which was the second of two consecutive DR event days. We expect that opt-out rates during the pilot may be higher than usual due to the COVID-19 pandemic, which likely led participants to spend more time than usual at home. On summer DR event days, about 90% of thermostats were in “home” mode at 3 pm, the earliest time precooling began (Table 3).

Table 3: Summary of DR events for cooling season: June-August 2020.

DR event date	Average temperature (°F)	High temperature (°F)	Thermostats transmitting data	Opt-out before event	Opt-out during event	Opt-out total	Thermostats in home mode at 3:00 pm
6/3/20	73.9	89.6	41	0	4	10%	90%
6/8/20	73.4	86.0	64	0	5	8%	89%
6/26/20	76.2	87.2	87	4	6	11%	90%
6/29/20	75.7	86.0	88	0	10	11%	90%
7/6/20	76.7	89.6	93	5	14	20%	89%
7/8/20	78.6	90.8	95	2	4	6%	86%
7/27/20	76.5	87.7	103	1	10	11%	89%
8/10/20	72.6	82.4	109	2	12	13%	90%
8/25/20	77.0	89.0	119	1	18	16%	88%
8/26/20	76.8	87.2	122	21	7	23%	88%

Note: Temperature data from Madison Municipal Airport weather station, accessed via Iowa State University https://mesonet.agron.iastate.edu/request/download.phtml

Opt-out rates during DR events in the winter were lower than in the summer; rates ranged from 2% to 13%, and averaged 6% (Table 4). A majority of participant homes appeared to be occupied during the winter events, with about 80% of thermostats in “home” setting at the beginning of DR events.

Table 4: Summary of DR events for heating season: December 2020 – February 2021

DR event date	Average Temperature (°F)	Low Temperature (°F)	Thermostats transmitting data	Opt-out before event	Opt-out during event	Opt-out total	Thermostats in home mode at 9:00 am
12/2/20	30.6	21.1	147	4	6	6.8%	81%
12/15/20	29.0	21.2	150	3	0	2.0%	79%
12/18/20	31.0	23.0	150	1	3	2.7%	84%
1/12/21	28.9	24.8	153	2	3	3.3%	81%
1/28/21	23.0	14.0	159	5	8	8.2%	80%
1/29/21	24.0	14.0	159	11	9	13%	82%
2/8/21	25.7	15.8	167	3	7	6.0%	80%
2/17/21	16.3	3.8	169	14	1	8.9%	85%

Note: Temperature data from Madison Municipal Airport weather station, accessed via Iowa State University https://mesonet.agron.iastate.edu/request/download.phtml

We confirmed that set point changes before and during DR events depended on eco+ settings. Table 5 shows the median set point change for preconditioning and DR events by eco+ setting. With the exception thermostats set to an eco+ of 1, median precooling and preheating set point changes were -4 °F and 4 °F, respectively. DR event set point changes were more aggressive for eco+ settings of 4 and 5, and less aggressive for lower eco+ settings (Table 5).

Table 5: Median set point change for preconditioning and DR events.

eco+ setting	Set point change (°F)			
	Summer		Winter	
	Pre-cool	DR event	Pre-heat	DR event
1	0	3	2	-1
2	-4	2	4	-2
3	-4	3	4	-3
4	-4	4	4	-4
5	-4	4	4	-4
None	n/a	n/a	4	-3

Demand Savings

Creating the Baseline Group

To estimate demand savings of DR events, we compared whole-home AMI data from members participating in the DR pilot to a baseline group that represents the energy use of the participants in the absence of a DR event. We first considered developing the baseline group from Jackson County REMC residential meters that were not participating in the pilot (non-participants).[1] If the participant and non-participant groups exhibited similar load shapes and magnitude, then the non-participant group might be used as the baseline group. However, we found this not to be the case; pilot participants used substantially more energy than non-participants throughout the day (Figure 3).[2] On non-DR days from June to August, participants consumed an average of 55 kWh total, and 10 kWh during the peak hours of 5 to 8 pm. In contrast, non-participants consumed an average of 46 kWh per day and 7.3 kWh during peak hours, 18% and 35% less than participants, respectively. In addition, participants exhibited small morning peak from 6 to 8 am, which the non-participant group did not. This discrepancy between participant and non-participant demand and energy use occurred in the winter season as well; participants used an average of 31% more energy over the day than non-participants, and 33% more energy during the winter peak hours of 7 to 9 am (Figure 3).

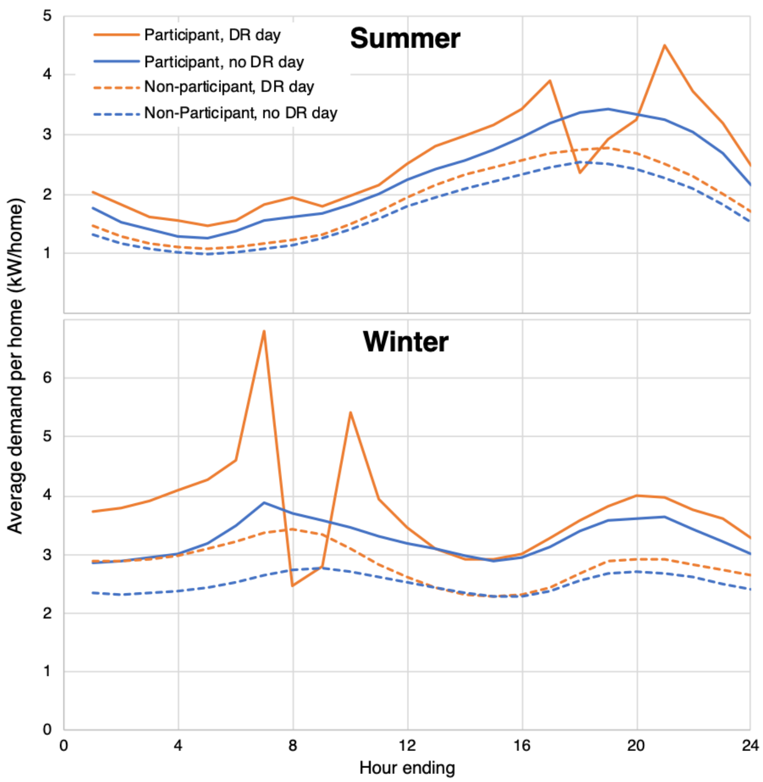

Figure 3: Participant (solid line) and non-participant (dashed line) average per-home demand on DR days (orange) and all other days (blue) during pilot summer (top) and winter (bottom) seasons.

[1] As of August 31, 2020, about 23,700 meters were in the non-participant group.
[2] To evaluate demand and demand reduction we use metrics that average demand across time and a set of homes. For example, average per-home demand on a single DR day for the participant group is calculated as the total hourly demand of the participant group divided by the number of participants. The data presented below is further aggregated by season by averaging the per-home hourly demand for all summer or winter DR days.

Because the hourly demand and load shape of the participant group differed significantly from the non-participant group, we developed the baseline by estimating the average participant demand on DR event days had the DR event not occurred. To do so, first we calculated the difference in the non-participant group's hourly demand on DR and non-DR days as a percentage (dashed orange line minus dashed blue line in Figure 3). We increased the participant hourly energy use (solid blue line in Figure 3) by that percentage. The resulting baseline closely matched actual energy use of the participant group on DR days before and after the DR event, and peaked proportionally to the participant group on non-DR days (Figure 4). We used this baseline to estimate demand savings below.

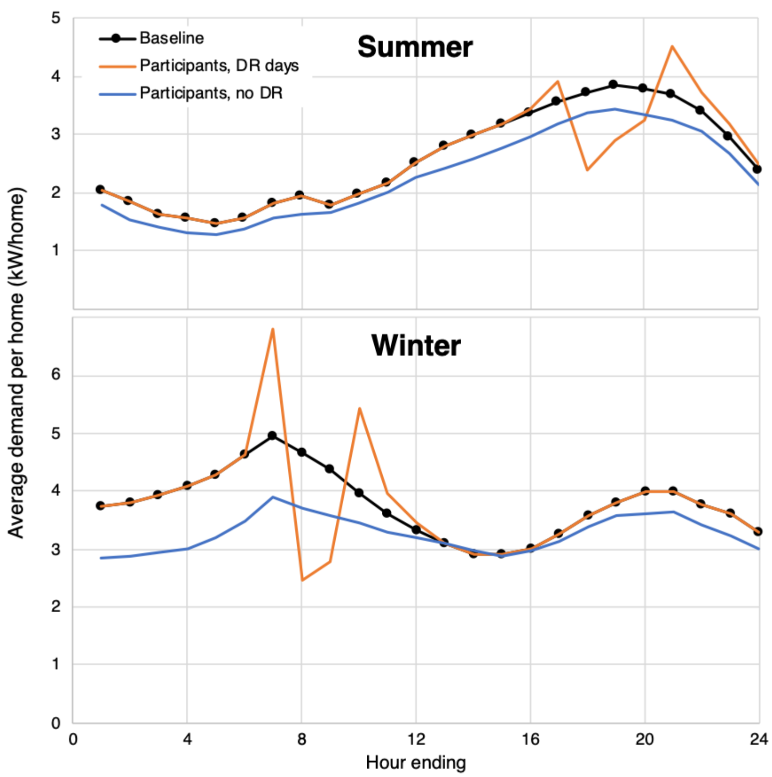

Figure 4: Average per-home baseline and actual demand of pilot participants during DR days (black and orange lines, respectively) and average per-home demand of pilot participants on non-DR days (blue line) during pilot summer (top) and winter (bottom) seasons.

Estimated Demand Savings

As shown in Figure 4, participant energy use increases before the DR event, which is related to precooling during the summer or preheating in the winter. Early in the pilot summer season, some homes began precooling up to 2 hours before the DR event. By the end of the summer, however, the eco+ algorithm had been updated and all precooling took place in the half-hour before the DR event. Analysis of the hourly AMI data indicates that summer precooling demand averaged about 0.34 kW per home from 4:00 to 5:00 pm (Table 6). Since most precooling occurred between 4:30 and 5:00 pm, we estimate that summer precooling demand is about 0.68 kW per home in the half hour before a DR event. All winter preheating occurred in the half-hour prior to a DR event. Hourly AMI data analysis yields an average demand increase of 1.85 kW per home in the hour before a DR event, which equates to a demand increase of 3.7 kW per home in the half hour before the event (Table 7).

The ecobee thermostats responded to a DR event by altering the thermostat setpoint based on the user's eco+ settings. Setpoints were increased during summer events and decreased during winter events to decrease the operation time of HVAC equipment during the event (Table 5). If indoor temperature exceeded (or fell below) the setpoint during a summer (or winter) DR event, the HVAC system operated and returned the home to the DR setpoint. This resulted in maximum demand reduction during the first hour of a DR event, and decreased but still substantial reductions in subsequent hours of the event (Table 6, Table 7). During the summer, first hour demand reduction averaged 1.4 kW per home. Second and third hour reductions averaged 0.93 kW and 0.53 kW per home, respectively (Table 6). Winter demand reductions were greater, averaging 2.2 kW and 1.6 kW per home during the first and second hours of the event, respectively.

Table 6: Average per-home demand savings, summer cooling season.

Hour	Phase	Estimated demand savings (kW per home)**
15:00 - 16:00	Pre-cooling*	0.06
16:00 - 17:00		0.34
17:00 - 18:00	DR event	-1.36
18:00 - 19:00		-0.93
19:00 - 20:00		-0.53
20:00 - 21:00	Recovery	0.82
21:00 - 22:00		0.33
22:00 - 23:00		0.21
23:00 - 0:00		0.10

* For early summer events, precooling occurred up to two hours before a DR event and varied by thermostat. By the end of the summer, all precooling took place from 16:30 to 17:00.
** Negative values indicate demand savings; positive values indicate demand increase.

Table 7: Average per-home demand savings, winter heating season.

Hour	Phase	Estimated demand savings (kW/home)**
06:00 - 07:00	Pre-heating*	1.85
07:00 - 08:00	DR event	-2.19
08:00 - 09:00		-1.57
09:00 - 10:00	Recovery	1.47
10:00 - 11:00		0.35
11:00 - 12:00		0.13

* Pre-heating took place in the half hour before each DR event (06:30 to 07:00).

** Demand increase is positive, demand savings is negative.

Once the DR event ended, the thermostats resumed their normal setpoint schedules. A significant rebound peak occurred after the DR event when HVAC equipment worked to return homes to their normal setpoints (Figure 4). We estimate a 0.82 kW per-home recovery peak in the first hour after a summer DR event, decreasing throughout the remainder of the day (Table 6). After winter DR events, demand increase averaged 1.5 kW per home the hour after an event, and decreased over the next two hours (Table 7).

Participant Group Segmentation

To begin to understand factors that may impact participant load shape and demand savings, we segmented the participant group by HVAC equipment type and eco+ setting. The top panel in Figure 5 shows load shapes on summer DR event days for participants with heat pumps (central or ductless) compared to participants with central air conditioning. The two equipment types show differences in precooling, DR event, and rebound intervals. The heat pump systems on average draw less load during precooling, DR event, and recovery periods than central system, with the exception of the first hour of the recovery period after the DR event.

More drastic differences between heat pump systems and other heating systems are evident in the winter load curves (Figure 5, bottom panel). Because we do not have heating fuel information for the participants, heating systems other than heat pumps, including boilers and forced air furnaces, may be electric or fueled with natural gas or propane. The average load curve for non-heat pump systems is much lower than the average heat pump load curve, likely because the non-heat pump systems contain a significant number of fossil fuel-fired systems. Collecting information on heating fuel information when members enter the program would be useful to better understand demand impacts of electricity-intense systems like electric resistance furnaces or boilers.

As discussed previously, pilot participants are far more likely to have heat pump systems than the Jackson County REMC membership as a whole. If Jackson County REMC develops an expanded program, the proportion of participants with heat pump equipment will likely decrease, leading to changes in load curves and demand reduction. We expect the main change would be decreased winter demand savings due to a lower percentage of participants that have electric, especially heat pump, heating systems.

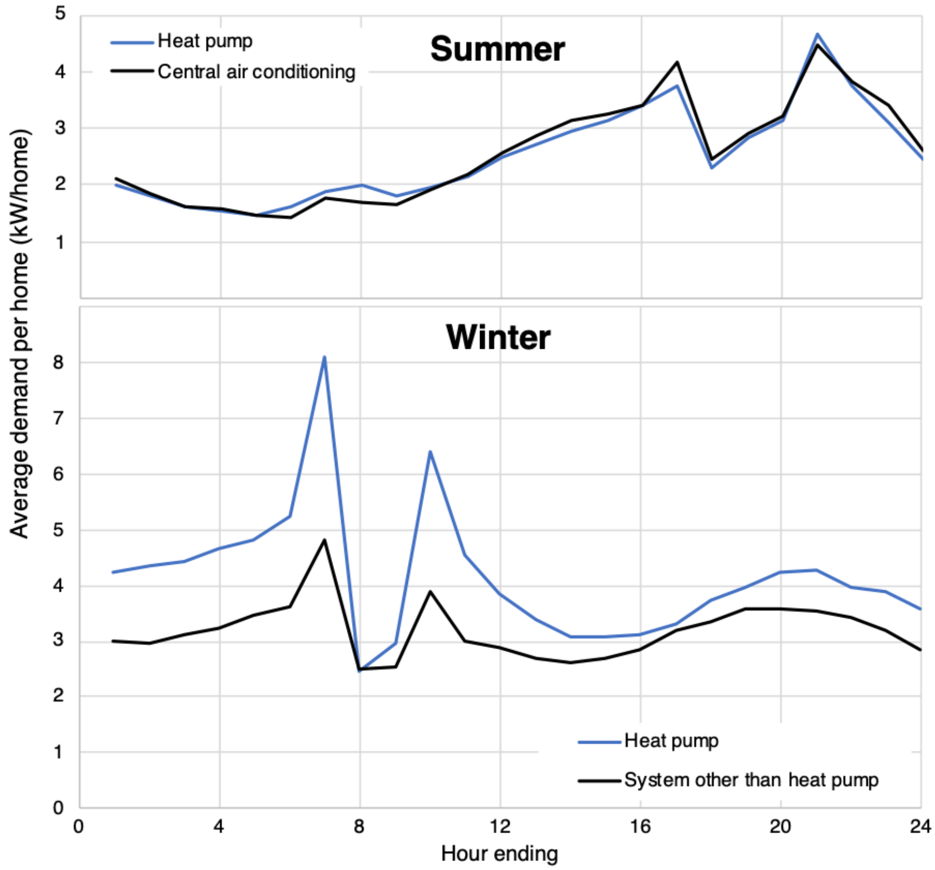

Figure 5: Average hourly per-home demand on DR days segmented by equipment type during pilot summer (top) and winter (bottom) seasons.

While setting up their thermostat, most participants selected an eco+ setting based on their preferred balance between comfort and energy savings; lower eco+ settings prioritize comfort and higher settings prioritize energy savings. Our analysis shows that eco+ settings have a noticeable impact on average demand during DR events (Figure 6). Homes that chose the more aggressive eco+ settings of 4 or 5 achieved greater demand reduction than homes that chose less aggressive settings. In the summer, greater demand reduction during the DR event led to an only slightly higher recovery peak. In the winter, however, the recovery peak for eco+ 4 or 5 homes was about 0.7 kW per home greater than homes with eco+ 1 or 2. Note that in order to see demand differences related to eco+ settings, we removed a small number of homes that had consistently lower demand than the rest of the participants group (Figure 6, black lines) from this analysis. Overall, however, it appears that encouraging participants to use eco+ settings or 4 or 5 can increase demand savings.

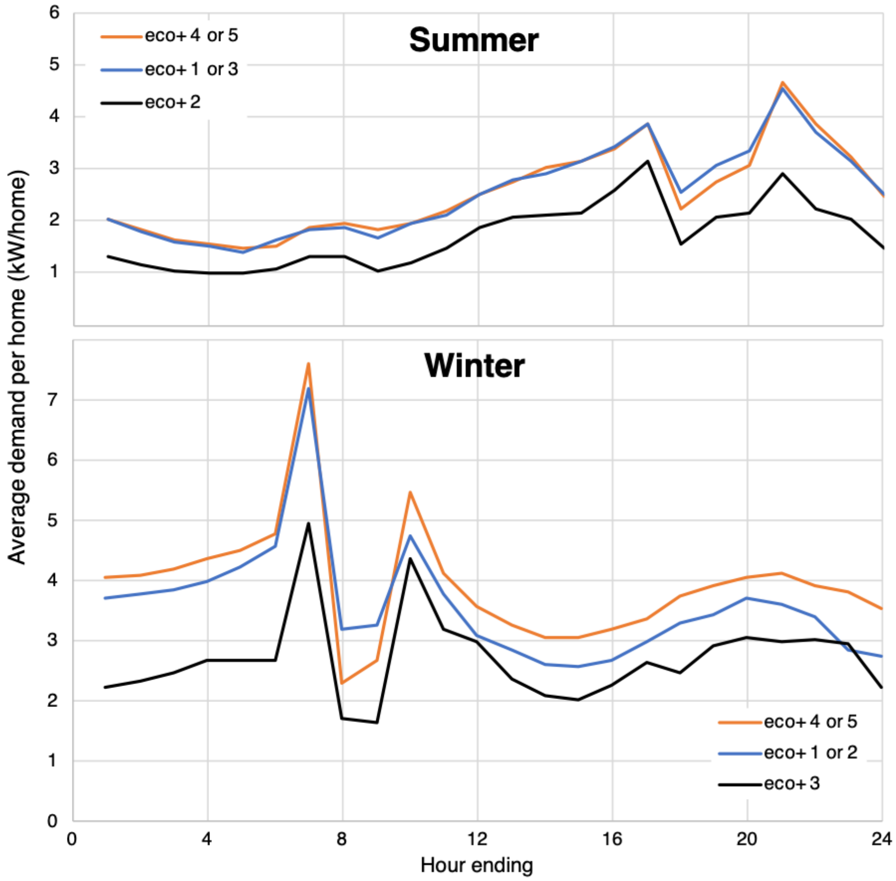

Figure 6: Average hourly per-home demand on DR days segmented by eco+ setting during pilot summer (top) and winter (bottom) seasons.

Energy Savings

Smart thermostats claim to reduce energy use of heating and cooling loads compared to programmable and non-programmable thermostats. To estimate the energy savings due to the smart thermostats, we compared weather-normalized electricity use during the pilot summer and winter seasons to the year prior.[3] Our analysis showed that participants used more electricity during the pilot than they had in the prior year: 0.4% more electricity in the summer of 2020 compared to 2019, and 6.5% more in winter 2020-21 compared to 2019-20 (Table 8). Although these figures are adjusted for weather differences between years, we cannot adjust for behavioral changes, in particular more people staying home because of the COVID-19 pandemic. We, therefore, examine electricity use changes in the non-participant group between the years prior to and of the pilot. We find that non-participant electricity use decreased in the summer of 2020 compared with the year before, and increased in the winter of 2020-21 compared with the year before (Table 8).

Table 8: Change in weather normalized whole-home electricity use between year prior to pilot (summer 2019, winter 2019-20) and year of pilot (summer 2020, winter 2020-21) for participant and non-participant groups.

Positive values indicate more electricity used in the pilot year than the year prior; negative value indicates reduced use during the pilot year compared to the year prior.

	Estimated change in electricity use	
Season	Participant	Non-participant
Summer	0.4%	-2.6%
Winter	6.5%	9.7%

Although the energy savings results are highly uncertain, they are similar to other pilot studies, which find single-digit electricity savings or increases (e.g., Applied Energy Group 2018, Cadmus 2015, Nexant 2017). Studies suggest that user behavior is a major factor in whether smart thermostats yield energy savings (e.g., NCLC 2020). Additional data collected in typical years may better show the degree to which smart thermostats yield energy savings. Overall, however, it appears that the primary value of smart thermostats to Jackson County REMC and its members is the ability to reduce peak load rather than overall energy savings.

[3] We used daily average temperature data from Madison Municipal Airport weather station to weather-normalize whole-home electricity use. Weather data accessed from Iowa State University: https://mesonet.agron.iastate.edu/request/download.phtml

The Co-ops' Perspective

Both Jackson County REMC and Hoosier had a positive experience with the pilot and view the thermostats as an effective tool to achieve demand savings. Success was not necessarily automatic, however; both co-ops noted the success of the pilot hinged on the following conditions:

1. **A supportive board and management and dedicated, knowledgeable staff that is excited to engage members about the program.**

   Brian Reynolds of Jackson County REMC estimates that he spent about half his time on the pilot, mainly performing member education and recruitment, installation troubleshooting, and site visits.

2. **Member education.**

   For many members, understanding the co-op's goals and approach was key in their decision to participate. When answering questions about the pilot, Reynolds would explain that the pilot is part of an effort to keep electricity rates as low as possible, but that having a smart thermostat does not necessarily mean the member will see immediate electricity bill savings, which is highly dependent on how the thermostat is used. He also found that members had concerns with the co-op controlling equipment in their home. He explained to members, "you have the final say" as to whether they participate in DR events or not. Careful messaging paid off; after discussing the co-op goals, benefits, and how control is in the member's hands, only two members decided not to participate in the pilot.

3. **A good relationship with and support from the vendor.**

   Choosing a vendor with good customer support for both the co-ops and members streamlined pilot operations. Blake Kleaving, Manager of Energy Management Solutions at Hoosier and Jeff Myers, Consultant to Hoosier, noted that ecobee staff was very responsive to questions and issues that came up during the pilot. On the member-facing side, the ecobee support hotline was key in the success of member self-installations. As noted above, about 85% of installations were successfully carried out by members and did not require a co-op staff visit. For members that were having trouble with installation, Reynolds would refer them to the ecobee support hotline, which in most cases guided the member through installation and prevented the need for a site visit.

Although we were unable to survey participants to quantitatively assess their experience during the pilot, Reynolds did not receive any complaints regarding comfort or other issues during the pilot. Kleaving and Myers noted that the smart thermostats are performing better than legacy control programs. Smart thermostats provide several benefits over legacy load control switches, including 2-way communication that gives co-ops insight into which members are not participating in events, so they can reach out and understand why. The thermostats are less costly than load control switches and allow the co-ops to run DR for both cooling and heating loads. In addition, members engage with the thermostat and have insight into their HVAC operation during DR events. Kleaving and Myers noted that thermostats and other connected products in the home change the equation: control is now in the hands of the members, rather than the co-op. They say their challenge in this new paradigm is to develop programs that incorporate technology that members want to adopt. These programs should leverage technologies that can scale the level of demand reduction or energy savings to member preferences when possible, as eco+ settings allowed in this pilot.

Hoosier and Jackson County REMC have plans to expand the smart thermostat offering. Jackson County REMC recently secured board approval to offer 200 more thermostats to members who subscribe to their broadband Internet service and hopes to continue to offer the thermostat at no charge. In addition, Hoosier is examining how they can expand the pilot into a bring-your-own-thermostat (BYOT) program to allow members who already have or want thermostats from other vendors to participate.

Both co-ops note that the smart thermostats are a valuable offering for co-ops whose focus is on being their members' energy service provider. Speaking about the pilot, Reynolds said that "everyone has been thrilled with it." Members tell him, "oh hey, we love that thermostat."

Conclusions

Smart thermostats are a promising way for co-ops to implement DR programs. Results of the Jackson County REMC and Hoosier pilot indicate that ecobee3 lite thermostats carried out DR events reliably and resulted in an average per-home demand reduction of 0.94 kW during summer events and 1.9 kW during winter events. Pilot participants opted-out at rates of 13% and 6% from summer and winter events, respectively, despite the fact that the majority of thermostats were in home mode during DR events. Key factors in the success of the pilot included a supportive board and executive management, dedicated and enthusiastic staff who ensured that members were well educated about the thermostats and pilot, and a good relationship with the thermostat vendor.

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Related Resources

- Do Smart Thermostats Make for Smart Demand Response Programs?
- Smart Thermostats: An Alternative to Load Control Switches