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Do Smart Thermostats Make for Smart Demand Response Programs?

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SUBJECT MATTER EXPERT FOR QUESTIONS ON THIS TOPIC

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ARTICLE SNAPSHOT:

What is the issue in the industry?

Electric demand is swiftly becoming a significant variable in the U.S. due to changes on the supply side, like intermittent renewables and increasing electrification. Electric utilities and independent system operators (ISOs) must decide whether to invest in transmission and distribution infrastructure. Investment options are costly, ranging from generating facilities to power purchases to transmission and distribution capacity additions. All the while, demand continues to increase on the consumer side; the average annual energy bill for U.S. homes is $2,200, with 46 percent of residential energy usage from heating and cooling.

These changes in the market environment have led to more time-of-use and peak pricing programs across the country, and utilities are looking at new strategies and technologies for demand response (DR) over previous SCADA/load control switches — one solution is smart thermostats. Advancements in thermostat technology have introduced connected and smart thermostats into the broader consumer electronics market and has led more utilities to consider using these technologies for DR programs.

These advances have also led to a growth in interest by third-party demand response aggregators. These entities earn revenue by aggregating the demand response available from operating behind-the-meter technology, including thermostats, and bidding that demand response directly into the wholesale market. Some aggregators are also interested in inherent economic value of the consumer data they can gather from behind-the-meter technology. Such programs, where permitted, would bypass the cooperative, potentially undermining its relationship with its members, and undermining its ability to manage load on behalf of all of its members.

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America's Electric Cooperatives

What is the impact on the electric cooperatives?

Electric cooperatives aim to provide cost-management options to individual members to increase their satisfaction and engagement. Load management also helps reduce all members' costs by giving the cooperative tools to manage the operation of the distribution grid, defer distribution investment, avoid purchasing energy during high-cost periods, and reduce wholesale demand charges.

Smart thermostats provide new opportunities for co-ops to achieve demand reduction through these devices. Smart cycling capabilities found in newer thermostat models can be used to achieve greater demand reduction while maintaining end user comfort.

What do co-ops need to know and do?

The acceleration of thermostat technology has inspired electricity providers across the country to pilot smart thermostat DR programs. Some of these studies have shown that demand reduction and savings associated with these devices are achievable, but results vary based on end-user behavior, the technology, and platform. Co-ops considering smart thermostat DR programs can proactively address these variables by conducting initial planning and research to inform goal-setting and program design strategies; carefully evaluating vendor options to assess factors, such as technology features, data availability and data security; outlining customer engagement and marketing strategies; and formulating a plan to track and analyze data. The key to success, however, truly lies in addressing these factors as part of program design — overlooking them on the front-end may lead to missed opportunities and costly course-corrections.

Smart thermostats provide opportunities for utilities to regulate demand and engage customers.

NEW HORIZONS FOR DEMAND RESPONSE

Electric demand is swiftly becoming a significant variable in the U.S. due to changes on the supply side like intermittent renewables and increasing electrification. This presents a common challenge for investor-owned utilities and co-ops as they strive to meet customer needs while maintaining grid stability and managing costs. Generation and transmission of electricity during peak periods — the time of day or season during which electric demand is highest — is very expensive, as are infrastructure investments such as power plants, storage, or sub-stations. Luckily, technological advancements offer a potential solution. When combined with demand response (DR) strategies, such as peak pricing and time-of-use (TOU) rates, smart thermostats, in particular, provide opportunities for utilities to regulate demand and engage customers.

Thermostats have evolved steadily over the last 40 years. The first generation of *digital* (aka "programmable") thermostats emerged on the market in the 1980s. They eventually evolved in the 1990s to enable customized automatic temperature adjustments by time of day or week (DOE, 2016). *Connected* thermostats then emerged in the 2000s (DOE, 2016), joining the growing network of Wi-Fi enabled consumer electronics entering the marketplace, also known as the Internet-of-Things (IoT). These devices allow customers to adjust schedules and track energy usage through a mobile app from home or away.

Smart thermostats represent the most recent evolution in thermostat technologies. They not only have Wi-Fi functionality like their digital predecessor, but also include occupancy-sensing and learning capabilities. Sensing features give households the ability to set back temperatures automatically, without any manual adjustments. Learning features utilize algorithms to auto-adjust thermostat settings based on the users' behavior, proximity to their home, local weather patterns, and other building and systems considerations. These new features have, in turn, introduced advancements in DR program design and customer engagement strategies.

The Evolution of DR and Smart Thermostat Programs

Before connected thermostats entered the scene, electric utilities relied on load control switches for DR. Utilities installed these radio switches — also known as supervisory control and data acquisition systems, or SCADA — throughout their service territories to help automate electric power systems operations. They then delivered radio signals to these one-way communication devices during peak periods or outages to shut off or transfer current.

Utilities installed these devices directly on energy-intensive equipment, such as air conditioners. These switches enabled electricity providers to turn off the AC in a customer's home or business, typically in 15-minute increments, to regulate peak demand. This approach, while effective and popular with utilities and dispatchers, did have a few drawbacks. Switches were unpopular with some customers, who were reluctant to hand over control of their heating and cooling systems to their utility; some service territories had dead zones where the radio control could not penetrate, limiting ability to include all customers; and due to lack of two-way communication, the utility could not determine when switches needed replacement or repair.

Unlike load control switches, smart thermostats enable two-way communication.

A New Window of Opportunity

Smart thermostats may offer an opportunity to overcome these barriers. Their advanced features help utilities to better manage, automate, and augment electric supply during peak demand. Unlike load control switches, smart thermostats enable two-way communication. A utility can communicate a need for DR, deliver a price signal reflecting DR opportunity costs, or it can directly control equipment in a customer's home. Access to the whole service territory is only limited by whether customers have internet and wireless in their homes, and the potential for more locations means less load reduction per customer may be required, as well as potential for even more aggregate load reduction.

The smart features on newer thermostats also offer unprecedented access to data related to energy use and occupant behavior. Unlike load control switches, which simply turn equipment on or off, smart thermostats have the capacity to anticipate events and gather intelligence and to automatically pre-cool or pre-heat. They have the potential to, among other things, forecast weather patterns, determine how high the peak is, and estimate associated cost savings. Utilities can also better understand how much pre-cooling or pre-heating is necessary to operate systems during peak temperature conditions, when the demand is considerably higher.

Smart Thermostat Program Breakdown

The undeniable potential of smart thermostats for DR has inspired utilities across the country to design and pilot innovative programs to get these devices in the hands of consumers.

- **Bring Your Own Thermostat (BYOT)** is a self-install program that provides incentives to customers who enroll their existing qualified thermostat(s) in a DR program to receive a rebate or bill credit for the demand reduction. Typically, these programs include several options to ensure consumers can purchase the device that best meets their needs, and often provide an incentive for the thermostat.
- Conversely, **direct-install (DI) programs** provide customers with a specific thermostat model and installation at no cost.
- In **buy-down programs**, utilities partner with one thermostat manufacturer to buy down the cost of the thermostat to consumers. Buy-down programs can include either self-install and/or direct-install elements.

STATE OF THE MARKET

Smart and connected thermostats continue to gain popularity in tandem with the rapid evolution of these technologies. The U.S. Department of Energy (DOE) reported that, of the 40 million thermostats sold in 2015, 40 percent were smart thermostats (DOE, 2016). Forecasting suggests that by 2020, the smart thermostat market will be worth $5.9 billion (Markets and Markets, 2015).

This growth has spurred thermostat manufacturers to develop web-enabled software platforms that work with new and existing connected and smart thermostat models, solidifying their place in the IoT. These platforms enable end-users to track energy usage and manage thermostat settings. Some platforms also help utilities streamline customer enrollment, aggregate connected devices, collect and analyze of data, and deliver more reliable DR and demand side management (DSM) strategies.

Rapid evolution of the thermostat market has spurred the development of web-enabled software platforms for smart and connected models.

Open Automated DR (OpenADR), for example, is an open, standardized, and interoperable DR interface model. The interface is non-proprietary, allowing energy providers across the country to communicate directly with customer-installed equipment and building controls (OpenADR Alliance, 2017). This interface sends DR price and reliability signals to end-user devices, including smart thermostats, air conditioners, electric vehicles, vehicle charging stations, water heaters, and other devices (OpenADR Alliance, 2017). It has helped reduce operation costs and enabled more technologies for DR. The OpenADR Alliance reports that over 60 utilities and controls vendors are currently working with OpenADR.

Barriers and Challenges

Smart thermostats are not, however, a silver bullet. There are trade-offs and compromises utilities must make when entering this arena.

- **Data availability** represents one of the foremost challenges. Thermostat manufacturers and vendors allow access to varying levels of data to protect intellectual property, proprietary ownership, market share, and customer privacy (DOE, 2016) — and each vendor has a different policy. Some allow utilities to securely access customer data, while others restrict access. Many manufacturers offer closed application programming interfaces (API), in which vendors serve as the gatekeepers and decide who can access these devices and when (DOE, 2016). Recently, more vendors have transitioned towards open API, which helps connect more thermostats with utility systems and existing home energy management platforms (DOE, 2016). In addition to issues on the vendor side, encouraging homeowners to connect the thermostat to the internet (and stay connected) can be a challenge.
- **Data standardization** is another potential barrier for utilities interested in DR thermostat programs. There are currently no data standards in the market for these devices. This has made it challenging for utilities to test different use cases (DOE, 2016).
- **Interoperability** represents another hurdle. Developing standards for exchanging information across a mix of different devices in a secure and consistent manner remains a challenge (DOE, 2016). Many energy industry actors are developing interoperability standards, such as OpenADR to address these communication barriers (DOE, 2016).
- **Data security and privacy** presents major barriers in the connected-homes and smart-building markets. As in other sectors, such as retail or finance, it is imperative that utilities and their vendors develop data encryption and implement other cyber security strategies and protocols to secure customer information during data collection and data transfers. On the other hand, strict data and privacy rules may also prevent many utilities and third-party vendors from utilizing the data.

Technological Solutions

The emphasis on IoT and data-driven technology today has created new opportunities for software vendors in the energy market. These entities have developed software platforms that help building owners and energy providers communicate, track, and manage energy consumption of individual building systems. Utilities are now adopting similar software platforms to better implement and manage DR thermostat programs. Many thermostat manufacturers have also integrated these platforms directly into their products. Some of the most prominent vendors in this arena include EnergyHub, Whisker Labs, and OATI, though there are also lesser known vendors in the market.

EnergyHub

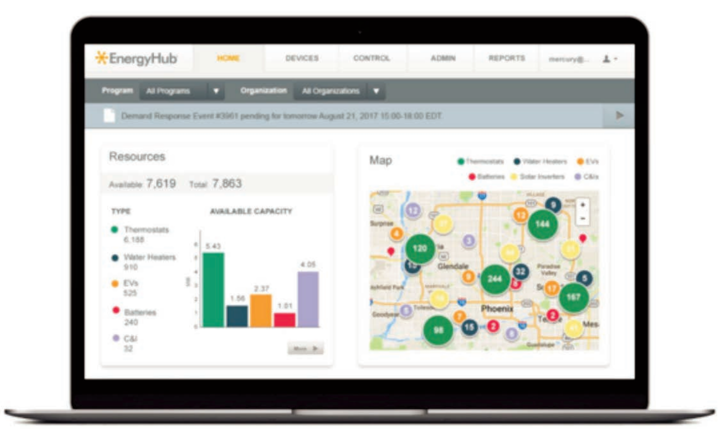
EnergyHub offers software and program management solutions and currently supports 30 utilities across the country. Their software monitors individual devices over time to learn and better understand usage patterns. It then delivers a customized load control strategy for the utility based on these data, and manages load via "real-time corrective controls" (EnergyHub, 2016). The software integrates with existing utility data platforms and works with multiple devices to streamline customer enrollment. It uses end-to-end platform security to protect customer information and ensures authentication protocols are in place when interacting with customer devices and utility systems. Utility customers then have access to real-time energy usage tracking on web and mobile devices through an online dashboard. See Figure 1.

Whisker Labs

Whisker Labs offers a software platform that integrates connected thermostats and other end-user devices, utility meter data, and weather data (Smart Energy Consumer Collaborative, 2017). This software leverages proprietary weather data and uses predictive algorithms for real-time automatic temperature adjustments in a home or business (Business Wire, 2017). Whisker Labs' DR management system (DRMS) uses a single interface across all connected and intelligent devices. It then aggregates data from these devices and utilizes proprietary weather data to create several customized DR strategies for utilities. It uses predicative algorithms to forecast capacity and load forecasts. The platform is scalable and flexible, working with BYOT, DI, and other self-install programs. The software also grants end-users access to a dashboard where they can compare their energy usage to their neighbor's and receive tips on how to lower their energy usage. See Figure 2.

Open Access Technology International

Open Access Technology International (OATI) offers software solutions to help utilities manage, monitor, control, and schedule DR programs. Energy providers can integrate OATI with different DR programs and resources. The software works with notification-based, price-responsive, and



Source: http://www/energyhub.com

FIGURE 1: EnergyHub Platform

Source: https://www.whiskerlabs.com/services

FIGURE 2: Whisker Labs Platform

dynamic tariff-based DR programs. OATI also integrates easily with advanced meter infrastructure (AMI), Meter Data Management, and older systems, such as supervisory control and data acquisition (SCADA), Customer Information Systems, and Geographic Information Systems (GIS). OATI supports utility customers and technology end-users through a web-based and mobile app that enables users to view energy usage, manage consumption, and participate in DR programs. Users can view billing information, receive DR and energy usage alerts, and can opt-out of demand events directly through the portal.

Thermostat Vendors

While there are many vendors who offer connected thermostats, some of the most notable smart thermostat vendors include Nest, Honeywell, and Ecobee. These manufacturers offer multiple models of connected and smart thermostats, along with software platforms to help end-users track and manage HVAC energy usage. They may also implement or manage utility DR thermostat programs.

Nest

Nest is at the forefront of thermostat technology and launched their first consumer thermostat, the Nest Learning Thermostat, in 2011. Nest thermostats contain a motion sensor and use algorithms to change setpoints based on occupant behavior and weather. These algorithms can determine how long it will take to warm up a home, gauge how drafty it is, detect outdoor weather patterns, and capture other inputs which customize when and how long to run a HVAC system in an individual home (Nest Labs). See Figure 3.

The Nest mobile app allows customers to remotely adjust temperatures, program unique schedules, set home and away features, and access advanced fan settings. It also sends emergency alerts to notify users when there is an issue or maintenance is required.

Honeywell

Honeywell offers 10 DR-enabled thermostats. It also offers an integrated DR software platform, which allow end-users to remotely access their thermostats. Like the Nest app, this platform sends alerts and reminders when there is an issue. It also communicates via OpenADR 2.0 and provides load projections and forecasting, participant and event management capabilities, reporting and analytics, and system integration, and it can assist with customer recruitment and enrollment processes. See Figure 4.

Source: Nest Website

FIGURE 3: Example of a Nest Smart Thermostat

Source: Honewell Website

FIGURE 4: Example of Honewell Smart Thermostat

Ecobee

Ecobee offers three smart thermostat models, which have programming and scheduling features and include motion and occupancy sensors to facilitate learning capabilities (see Figure 5 for example). They use local weather data to optimize the runtime of the HVAC system and improve efficiency. The newer models also utilize stand-alone remote sensors to record and analyze various temperatures in different parts of a home. This allows the technology to detect occupants and adjust thermostat settings across different rooms. Like its competitors, Ecobee offers a mobile app that enables users to control their HVAC systems remotely and receive alerts when issues arise. Users also have access to free online energy reports where they can track monthly savings and compare energy usages with others in their community.

In designing a smart thermostat program, co-ops should first develop and align on research objectives and program goals.

DESIGNING SMART THERMOSTAT PROGRAMS

Designing a cost-effective smart thermostat program requires a systematic process that involves formal planning activities and decision-making premised upon primary and secondary research.

STEP 1: Conduct Initial Planning and Research

Electric cooperatives should first develop and align on research objectives and program goals. Internal and external data collection and analyses are also strongly recommended before implementing the program. Internal data collection should incorporate and utilize research on advanced metering infrastructure (AMI) systems, customer surveys, and analysis of usage and load shape data (Franklin Energy, 2015).

Source: EcobeeWebsite

FIGURE 5: Example of an Ecobee Smart Thermostat

Electricity providers should also review external sources, including historical weather patterns and trends, Residential Energy Consumption Survey data, and Census data to design the best DR program (Franklin Energy, 2015).

Key Considerations

There are four factors that a utility should consider when designing a smart thermostat program: housing characteristics, climate, geography, and internet connectivity.

- **Housing characteristics.** Household energy usage will vary by building type, age, and level of income. DOE reports that today new homes consume 21 percent less energy on heating compared to older homes. Homes in rural communities are older, tend to be leakier, and are generally less energy efficient due less efficient heating and cooling equipment and weaker building shells (DOE, 2016). This can lessen the value of DR until homes are fully weatherized and equipment upgraded.

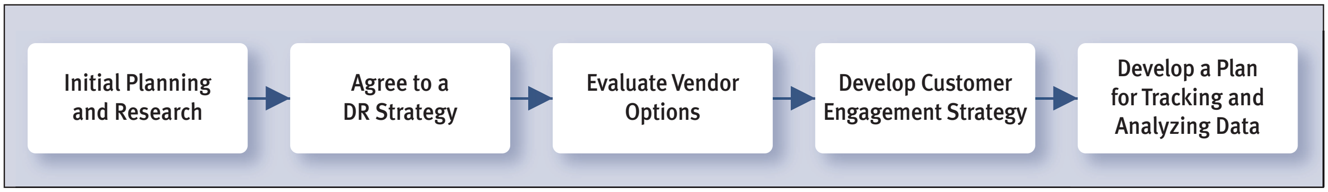


FIGURE 6: Systematic Process for Designing a Smart Thermostat Program

Expenditures on home energy will also vary significantly by household income level. According to the U.S. Bureau of Labor, lower income households spend a greater proportion of their annual income on energy-related expenditures than higher-income households (DOE, 2016) — and, the U.S. Energy Information Administration (EIA) estimates that a third of U.S. households struggle to pay their energy bills or sustaining heating and cooling in their homes (EIA, 2013).

New thermostat models are generally expensive, costing around \$150 – \$300. Because of this, direct-install and buy-down programs are a potentially more effective strategy for low-income customers, giving them an opportunity to interact with this new technology that they likely would not have been able to purchase on their own.

One feature found especially valuable to electric cooperative members was the home energy management portal.

- **Climate and geography.** Electric cooperatives should also consider the impact of geography and climate on energy usage. Thanks to longer heating seasons, utility customers in the Northeast and Midwest have the highest annual energy consumption in the U.S. on average, at about 108 to 112 million Btus per household per year (EIA, 2013).

  A Michigan Electric Cooperative Association (MECA) sponsored thermostat pilot study of a collaboration among 12 rural cooperatives and municipalities in Michigan found that rural customers with electric heating systems saved 1,249 kWh on average during the winter months (WECC, 2015). The research also found that thermostat usage was largely weather-dependent. Participants in the study spent more time manually controlling their thermostats when weather patterns were more variable. Cooperative members also programmed schedules more frequently in the heating season compared to the summer months. One feature that was especially valuable to electric cooperative members in this study was the home energy management portal. Participants who lived in colder climate zones and were away for prolonged periods, frequently used the remote monitoring features to control and manage HVAC systems to ensure that pipes did not burst in their homes (WECC, 2015).

- **Internet connectivity.** Thermostat DR programs require customers to connect their devices to the internet. This can present a major obstacle in rural areas, where internet connectivity is not always reliable. Thirty-five percent of people living in rural areas of the country do not have access to broadband (CBS, 2017). The slower, dial-up service common in rural areas may affect a co-op's ability to successfully manage end-user devices and implement DR programs.

STEP 2: Agree to a DR Strategy

After conducting initial research, co-ops need to consider whether BYOT, direct-install, buy-down, or another DR program design strategy is the right fit for their objectives — and their member-consumers.

- **BYOT** programs are attractive to many electric utilities because they are generally cheap and flexible. As thermostat technology improves, energy providers can continue to update their list of qualifying thermostats, and studies have found providing more device options may lead to higher enrollment (Gulf Power, 2015).

  BYOT programs do, however, require careful attention to detail. While these programs are generally inexpensive, it can be difficult to verify thermostat installations or to determine which model the new device replaced, which can affect how a utility claims savings. Utilities cannot place too much burden on the customer in resolving this issue, as it may affect their willingness to participate. Some utility pilot programs overcome this hurdle by asking customers to submit photos of their old thermostats and the newly installed devices, as means of verification. Many vendors in the market today also offer software solutions for utilities to easily implement and scale-up BYOT programs.

- **Direct-install** programs have straightforward equipment verification, unlike other self-install programs. Technicians working for or on behalf of the electric utility can confirm the thermostat installation and document which model the new device replaced. Direct install programs also enable behavioral components. Technicians can show homeowners how to use the thermostat, explain advanced features, such as sensing and learning capabilities, and recommend additional energy-saving strategies. Some programs have found that including a free-energy audit during installation of a thermostat is good strategy to engage and inform consumers about other home energy improvements.

  Direct-install programs do, however, present some barriers. They are less flexible than BYOT and normally only offer one type of thermostat model. They are also more expensive. Utilities cover the full cost of the thermostat and employ trained staff or a third-party to install the devices.

Including a free energy audit during installation of a thermostat is a good strategy to engage and inform consumers.

- **Buy-down** programs give customers the option of selecting thermostats from one vendor, which helps mitigate issues around installation verification and claiming savings. Working with a single vendor also makes it easier to calculate and verify savings; however, it does require tracking multiple models. Electric utilities that have strong relationships with trusted thermostat vendors may benefit from designing a buy-down programs in their territory.
- **Other strategies:** Some utilities across the country have also taken a hybrid approach, which give customers the option of direct-install, self-install, or BYOT thermostat. However, this approach is likely better suited to larger investor-owned utilities than to municipalities and cooperatives with less available capital and a focus on keeping rates low.

A study has shown that although consumers prefer higher incentives, they will not lose interest if offered substantially lower incentives.

Key Considerations

There are four additional factors co-ops should consider in discussion and decisions around program design: incentive structures, event-specific details, end-user capabilities, and opt-out penalties.

- **Incentive structures.** Consider how to motivate customers to participate. Behavioral DR programs inform customers of upcoming demand events, but they do not provide any additional financial incentives or credits. Other DR thermostat programs provide a fixed bill credit by event, month, or year; or will send customers a check-in the mail for their participation in demand events.
- **Incentives to purchase the thermostat.** Many programs include an incentive to purchase the thermostat. In the Smart Energy Consumer Collaborative's study, *The Empowered Consumer*, a conjoint simulation of smart thermostat programs found that, although consumers prefer higher incentives, relatively few end-users will lose interest in participating in a smart thermostat program if offered substantially lower incentives. Most respondents (68 percent) believed a $250 incentive was the most appealing, as it covers the total cost of purchasing the smart thermostat; however, an incentive of $125 had virtually identical consumer appeal (only .03 percent lose interest). Even limiting the incentive level to $50, the interest dropped by only 4 percent.
- **Event-specific details.** Decide how much advanced notice to give a customer before an event, how many degrees to adjust a thermostat setpoint during the event, and for how long to cycle the compressor for cooling; how many events customers need to commit to; and when the events are likely to occur.

- **End-user capabilities.** Determine whether to give end-users the ability to override their devices and opt out of demand events throughout the year. Some utilities offering DR thermostat programs will allow end-users a fixed number of opt-outs per month or year.
- **Opt-out penalties.** Decide whether there will be penalties associated with opting-out of the program. Utilities may decide to both remove customers from the program for lack of participation, and ask the customer to return his or her thermostat.

STEP 3: Evaluate Vendor Options

Partnering with the right vendors is the next crucial step in designing a DR thermostat program. Co-ops should consider customer options, cost, data availability, and thermostat features when making this decision.

- **Customer options.** Decide whether to offer multiple thermostats or just one model to members, based on the overarching program design. In the case of direct-install programs, one model is typical.
- **Cost.** Compare the financial costs for each thermostat vendor. This is especially important for electric cooperatives with less available capital. Some of the larger thermostat vendors in the market charge additional licensing fees, which may present a challenge for smaller utilities.

Some of the larger thermostat vendors in the market charge additional licensing fees, which may present a challenge for smaller utilities.

- **Data availability.** Consider how much data will be available. Some thermostat vendors only provide data at the macro level. Other thermostat vendors provide a utility or cooperative micro-level data, giving them access to individual customer energy-usage data and other unique variables. Examine the quality of the data from each vendor to ensure that it can be used effectively. If the quality of the data is below standard, the amount of available data provided by vendors has little consequence.
- **Thermostat features.** Determine which device features are necessary or important from both the program and customer perspective. For example, selecting thermostats with smart cycling capabilities may result in more savings, if the program includes pre-cooling or pre-heating. Since many thermostat vendors do not offer built-in demand side management (DSM) and DR capabilities, software vendors may be necessary to help with enrollment and implementation, as well as to provide additional DSM and DR strategies.

STEP 4: Develop Customer Engagement and Marketing Strategies

It is important to discuss aspects of customer engagement and marketing early in the design process to troubleshoot potential challenges and anticipate consumer wants and needs. This may include reviewing secondary resources or conducting primary research on customer or member demographics, awareness, attitudes, and behaviors with respect to energy, emerging technologies, and communications. This research will inform program messaging, promotions, outreach, and customer service strategies.

Key Considerations

There are five key factors that come into play when setting goals and setting final marketing and communications strategies.

- **Targeting.** Segment target audiences based on customer insights and market characteristics. A recent study conducted by Nexant on behalf of Sacramento Municipal Utility District found that targeting different market segments is a more cost-effective strategy than mass market strategies focused on expediting enrollment (Lamarchand and Sherman, 2017). Factors such as housing characteristics, climate zone, income level, media preferences, awareness, and other variables will help co-ops identify target markets and characterize primary and secondary audiences in those markets.

Targeting different market segments is more cost-effective than mass market strategies focused on expediting enrollment.

— Nexant study

- **Messaging.** It is important to consider consumer needs, preferences, and concerns when developing messaging. For example, low-income and fixed-income populations may have a greater focus on cost than other populations, while members in more extreme climates may be more focused on comfort and control. Also, consider if members have any concerns, such as data security, which may impede promotional efforts and require a specific response strategy.
- **Awareness.** Consider the specific media or communication preferences of customers or members in a target market when identifying specific marketing tactics. For example, traditional media, such as local newspapers, radio, or television may be more effective among rural populations, while digital media may be more effective among younger, urban audiences.
- **Information and education.** Clearly articulate program benefits, enrollment processes, and requirements. Target audiences must easily understand why and how to participate, what models qualify, what sort of incentives or bill credits they will receive (if applicable), any penalties they may incur for opting out, how the co-op will use their data, and how they can access information on their usage. It may also be beneficial to provide additional education on energy-saving strategies or how to maximize the benefits of their smart thermostats.
- **Ongoing communication.** Integrate ongoing communication and feedback mechanisms into the program to gauge customer satisfaction, address concerns, or answer questions. This will help the co-op adapt to the evolving needs of its members.
- **Installation Issues and Troubleshooting.** Issues can arise for end-users when thermostats malfunction or when installers make mistakes. In these situations, it is important for utilities and cooperatives to have a plan in place to effectively resolve the problems, even if the solution is to have the consumer call the thermostat provider or manufacturer. Cooperatives should provide their member-consumers and call center staff with information on who to contact to quickly resolve the problem.

One of the most critical aspects of effectively running smart thermostat DR programs involves effectively managing and leveraging the flood of data that suddenly becomes available.

STEP 5: Develop a Plan for Tracking and Analyzing Data

One of the most critical aspects of effectively running smart thermostat DR programs involves effectively managing and leveraging the flood of data that suddenly becomes available. If there is not enough planning conducted on the front-end during program design consideration, utilities may struggle in how to understand and effectively use all the data at their disposal. This requires formulating a plan in advance that takes into consideration both the volume and nature of the data, as well as the tools necessary to analyze them.

Key Considerations

There are four fundamental factors to consider when developing a data tracking and analysis approach:

- **Program objectives and key performance indicators.** Once the co-op finalizes the program design, goal, and objectives, it is important to determine how to track progress toward those goals and measure success. Success metrics may be directly tied to customer usage and sales data, which help measure load reduction and market penetration. Many thermostat vendors offer zip code level data that can support targeted marketing efforts and track participation across different areas (e.g., Nest).
- **The data itself.** Many utilities won’t know how actionable their data and analyses are until long after program initiation. As a consumer electronic device, smart thermostats collect an enormous amount of information and a large volume of various data points.

On the front end, utilities should understand their thermostat data and how to integrate this information with other available data sources to test different use cases and to better explain how customers are using the devices. In addition, digital marketing tactics provide access to large amounts of quantitative data on online behaviors, user demographics, and media consumption habits that can inform customer engagement approaches.

- **Necessary tools and resources.** The size and scale of these data also prevents many utilities from managing and analyzing smart thermostat information through conventional analysis software and tools, such as Microsoft Excel. They may instead call for more sophisticated statistical analysis tools and platforms, customized to data tracking and analysis needs. Digital tracking mechanisms can also help assess the effectiveness of marketing investments. Examples include Google Analytics or social media trackers (e.g., Hootsuite), which allow co-ops to monitor online response and behaviors.
- **Additional research.** Consumer feedback mechanisms may also help measure program success. These might include general awareness or participant satisfaction surveys to assess the effectiveness of marketing tactics in reaching target audiences and determining how consumers are responding to the program. Also, it may be useful to track contractor satisfaction, some contractors are unfamiliar with smart thermostats and blame mechanical issues on the thermostats, keeping track of contractor perceptions can help identify training and education opportunities to help contractors get on board with the technology.

Smart thermostats programs are still in their infancy, and further research is needed to fully determine the effectiveness and impacts of utility programs.

WHAT TO EXPECT

Research Into Action compared 15 thermostat studies across the country to assess the potential heating and cooling savings and demand reduction associated with these programs. This research revealed that thermostats attached to gas furnaces or ductless heat pumps (DHP) reduce energy usage by 7.7 percent on average during winter months. The study's authors expect that thermostats attached to electric heating can obtain consistent energy savings of 12 percent during the winter season. For summer months, the average potential cooling savings equaled 14.3 percent, totaling 3.1 percent savings over the annual electric load (Research Into Action, 2017). Research into Action expects cooling savings to be closer to 10 percent in the summer. Research Into Action compared four additional studies to determine DR potential associated with these thermostat DR programs. Utilities should anticipate an average demand reduction of 0.6 kW to 2.37 kW for each thermostat, based on this comparison (Research Into Action, 2017).

It is important to remember smart thermostat programs are still in their infancy. Utilities and co-ops across the country have run several smart thermostat DR trials and pilots, which have demonstrated DR potential. Findings from these pilot studies suggest these programs have the potential to reduce load and save energy, but results vary based on the devices, occupant behavior, weather, and program software — and, no program to date has successfully leveraged the sensing and learning features found in newer thermostat models to achieve savings. Thus, fully determining the effectiveness and impacts of these programs will require further research and pilot studies.

Case Studies

MIDSTATE ELECTRIC COOPERATIVE PEAK HOUR REWARDS PILOT

Midstate Electric (MEC) is a non-profit rural cooperative with approximately 19,000 members across Central Oregon. MEC is a full requirement customer of Bonneville Power Administration (BPA) and is subject to BPA's new tiered rates, which penalize poor load factors. MEC's territory includes areas with particularly high elevations, which can experience large temperature swings of up to 50°F and lead to dramatic demand surges. (Hull, 2017).

MEC designed and piloted the *Peak Hour Rewards Program* to reduce peak demand in their territory. This smart thermostat DR pilot program kicked off in March 2017 and will run through June 2018. MEC seeks to enroll 300 thermostats across their service area within the 18-month period (Hull, 2017).

Program Design and Implementation

The Peak Hour Rewards Program is a direct-install program in which MEC members receive a free Lux/Geo-Wifi programmable thermostat, worth approximately $150. Homeowners who enroll also receive free installation and a complimentary home energy audit, as well as a $10 bill credit for each month they participate in the program without opting out.

Participants receive an email, text, or thermostat message alert prior to a peak demand event (Hull, 2017). MEC then adjusts thermostat setpoints by two to three degrees during the subsequent event. MEC's system peaks between 7:00 a.m. and 9:00 a.m., and each demand event lasts around two hours. The co-op experiences three to five peak events on average per month.

Consumers can opt out of demand events directly through their thermostat, though MEC removes members who opt out of more than 25 percent of peak demand events from the program. The co-op also requires these members to return or pay for their new thermostat.

Vendor Relationship

MEC partnered with EnergyHub for this pilot. The co-op is the first energy provider to introduce winter peaking to the EnergyHub platform, and the two organizations have collaborated to test and determine the length of pre-heating needed for heat pumps and electric furnaces.

Customer Engagement and Marketing

MEC launched a marketing campaign to support the launch of the Peak Hour Rewards Program and encourage enrollment. The co-op ran advertisements in rural community publications, developed banners, and distributed multiple rounds of bill-inserts and postcards to raise awareness of the pilot. As an added impetus, the first 100 customers to enroll qualified to enter a sweepstakes to win $500.

Case Studies (cont.)

The Peak Hour Rewards direct-installation approach has also presented an opportunity for MEC to engage its members and enable further discussions around energy efficiency. Installers can educate participants about their thermostats and other energy savings opportunities during the audits. This strategy has helped to increase program participation among older populations in MEC's service area who are typically harder to reach.

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Results

The pilot has installed 191 thermostats since it launched on March 1, 2017. MEC has reported a member opt-out rate of only two percent so far in the pilot, and to-date, it has not removed any members from the pilot. Retirees and older populations within MEC's territory have shown a high-level of participation in the pilot. Overall, MEC members are very satisfied with the pilot program offered.

MEC has reported shedding 300 to 400 kilowatts of load per event on average. The co-op is in the process of determining the level of savings for the pilot.

FARMERS ELECTRIC COOPERATIVE RUSH HOUR REWARDS PROGRAM

Farmers Electric Cooperative

Farmers Electric Cooperative (Farmers EC) serves almost 50,000 homes in Northeast Texas. The co-op partnered with Nest Thermostats in summer 2017 to offer its members *Rush Hour Rewards*, a BYOT program that provides financial incentives to residential members who enroll their own Nest thermostats and participate in demand reduction events during the summer months of the year.

Program Design and Implementation

Each household can enroll a maximum of two Nest thermostats in Rush Hour Rewards. Members who participate in the program receive a $100 bill credit for the first year, and an annual bill credit of $50 thereafter.

Customers who purchase Nest thermostats must create an account online before they can use their devices. During the account set up, members supply their account number on the form. Using the Nest portal, Farmers EC member services staff can then verify the applicant is a cooperative member and quickly apply a credit on a member's electricity bill. Farmers EC estimates that it takes around three to five days for a member to enroll in the program after applying online.

Farmers EC peak periods occur in the summer months, running from May through October. The system normally peaks a few days each month between 4:00 p.m. and 7:00 p.m. The Nest Rush Hour Rewards program schedules events using precise 15-minute intervals, enabling the co-op to reduce demand when the Electric Reliability Council of Texas (ERCOT) system peaks.

Case Studies (cont.)

Farmers EC notifies Nest when they want to schedule an upcoming demand event. Nest then alerts and sends an advanced notice to members two hours ahead of each event. Before the actual event, Nest conducts pre-cooling unique to each home based on specific usage patterns, insulation and building shells, and other end-user behavior and building characteristics.

The Rush Hour Rewards program places a cap on the number of demand events that occur each day, week, and year. Farmers EC allows a maximum of one demand event per day and three demand events per week.

Vendor Relationship

Farmers EC selected Nest as a partner due to the manufacturer's industry leadership and the success of other Nest thermostat programs within proximity of their service area. Nest provides Farmers EC a simple but sophisticated system for enrollment and implementation, and demand side management support. Nest's portal also provides Farmers EC with macro-level data, including average demand reduction, various event characteristics, and 15-minute interval load data.

Customer Engagement and Marketing

Opportunities for customer engagement represented one of the major motivating factors behind the program. Both Nest and Farmers EC conducted marketing and outreach to support Rush Hour Rewards. Nest used zip code-level data to track program participation and delivered direct-email advertisements to Farmers EC members who had yet to participate in the program.

Farmers EC employed other marketing tactics to raise awareness of the program, including advertising in newspapers and online, inserts in new member account packets, and banner ads on their online member portal. Farmers EC also conducts frequent surveys to assess member satisfaction with both the program and the cooperative.

Results

Farmers EC is an example of a successful BYOT program for a rural electric cooperative. Since the initiation of the program, Farmers EC has enrolled 650 thermostats into the Rush Hour Rewards and plans to continue the program.

Through Rush Hour Rewards, Farmers EC has been able to offer generous incentives and maintain high levels of member satisfaction. Nest's simple and straightforward enrollment and implementation approach shows how smaller electric providers can offer strong BYOT DR programs to their members.

Case Studies (cont.)

MIDWEST ENERGY

Midwest Energy Cooperative (Midwest Energy) is a member-owned electric utility that serves 35,000 customers in 12 counties located in rural areas of Michigan, Indiana, and Ohio.

The success and high level of participation in their water heater and irrigation programs motivated Midwest Energy to develop a new offering to their members. The co-op was particularly attracted to smart thermostat programs because of their relatively simple design and low implementation costs. They also wanted to offer a product to their members that would use both the internet and electric services, which are both services of Midwest Energy. This led to the eventual launch of the Rush Hour Rewards program in November 2017, which sought to enroll 100 thermostats over the first quarter.

Program Design and Implementation

Rush Hour Rewards is a BYOT and buy-down program, which provided incentives to end-users for purchasing and installing a qualifying thermostat. Midwest Energy members can enroll up to three thermostats on the application, and they can choose between two qualifying Nest models.

Members who take part in demand events throughout the summer and winter peak periods also receive $50 for participating in each season (up to $100 annually). The Rush Hour Rewards program permits members to opt out of demand events; however, Midwest Energy has observed only a few instances where this has occurred.

Midwest Energy's summer peak runs from 12:00 p.m. to 9:00 p.m., and winter peak runs from 6:00 a.m. to 9:00 p.m. Each event can last up to four hours. The program allows a maximum of one event per day, three events per week, and fifteen events for the heating and cooling seasons respectively. The Rush Hour Rewards program also utilizes pre-cooling and pre-heating features, which has helped to keep members' homes more comfortable throughout the entire event period.

Vendors

Midwest Energy partnered with NRTC to implement Rush Hour Rewards. NRTC provides technology solutions for rural populations across the country, and it has supported the program in many ways. NRTC researched and compared various thermostat vendors on behalf of Midwest Energy, and they were responsible for negotiating an agreement directly with Nest.

NRTC was able to negotiate for their entire conglomerate, which helped to keep Midwest Energy's program costs lower than if the cooperative had negotiated with Nest independently. NRTC also assists Midwest Energy by easing the enrollment process. Midwest Energy customer representatives work closely with NRTC's portal to approve member applications, which

Case Studies (cont.)

automatically triggers orders directly with Nest. Midwest Energy's partnership with NRTC has helped to ease the burden on the coop through the design and implementation of the program, while keeping costs low.

Customer Engagement and Marketing

Midwest Energy has used various marketing tactics to promote the program and increase member awareness. This includes print advertising, bill inserts, social media, and direct mail campaigns. The co-op also held a promotion, which provided an extra $50 incentive to the first 100 cooperative members who purchased a Nest thermostat. In 2018, Midwest Energy plans to target older homes in low-income and elderly communities, which make up a large percentage of their member base.

Results

Midwest Energy achieved its initial enrollment goal in December 2017, as planned. Enrollments continue on a rolling basis, and the co-op plans to generate new program goals every quarter. Since November 2017, 50 members have participated in the Rush Hour Rewards program, purchasing a total of 175 Nest thermostats. Midwest is highly motivated to find ways to increase Rush Hour Rewards incentive levels for members in 2018. Since the program is in its infancy, the level of program savings and demand reduction is still unclear. However, the program has not experienced any pitfalls to date, and continues to encourage members to purchase and install an affordable smart thermostat in their home.

KANSAS CITY POWER & LIGHT

Kansas City Power & Light (KCP&L) is an investor owned utility that provides electricity to 800,000 customers across eastern Kansas and western Missouri. KCP&L started their first thermostat program in 2005, originally offering residential and small commercial customers a one-way programmable Honeywell thermostat. Today, KCP&L has partnered with Nest and their implementation contractor CLEAResult to deliver the Rush Hour Rewards program.

KCP&L sought to install 23,000 Nest Learning Thermostats and to achieve 29 megawatt deemed demand savings and 9.7 GWh of deemed energy savings over a three-year period through Rush Hour Rewards (CLEAResult, 2016). KCP&L first prioritized replacing existing legacy one-way programmable Honeywell thermostats, which were installed several years before in the service area.

Program Design and Implementation

Rush Hour Rewards provides an annual incentive of $25 to customers who participate in demand events throughout the year. Customers have a few options on how to install a

Case Studies (cont.)

Nest thermostat in their home or business. KCP&L offers customers self-install, direct-install, or BYOT options. For self-installations, customers are shipped a Nest learning thermostat in the mail and receive $50 rebate when they successfully install the device. The direct-install option supplies KCP&L customers with a free Nest thermostat, installed by CLEAResult at no charge. The BYOT option gives KCP&L customers up to $100 in incentives after they enroll their existing Nest Thermostat(s).

Demand events occur between 1:00 p.m. and 7:00 p.m. and can last up to four hours. The Rush Hour Rewards program has up to 15 events occurring throughout the summer season. The program also allows a maximum of one event per day and three events per week.

Vendor Relationship
KCP&L has partnered with CLEAResult for Rush Hour Rewards, which uses Nest thermostats and Nest Rush Hour Rewards management. CLEAResult supports KCP&L through program implementation. CLEAResult technicians are responsible for installing Nest thermostats in residences. In addition to the installations, CLEAResult also operates a call center, manages the inventory of KCP&L's thermostats, processes applications and incentives, and tracks and reports on marketing initiatives (CLEAResult, 2016).

Customer Engagement and Marketing
KCP&L's Rush Hour Rewards used a customer-centric approach to their program. Marketing tactics were conducted to engage and inform customers about Rush Rewards program, as well as drive traffic online. KCP&L utilized social media channels on Facebook, Instagram, Twitter, Reddit, and Nextdoor to reach customers. CLEAResult reported a customer satisfaction level of 97 percent for direct-installations which were completed (CLEAResult, 2016).

Results
KCP&L's sought to achieve 1,200 direct installations and 2,800 do-it-yourself installations across their service territory in the first year. They exceeded this goal, achieving close to 2,000 direct installations and 4,000 do-it-yourself installations (CLEAResult, 2016). Through April 2016, KCP&L reported that 85 percent of the program participants had participated in the demand events without choosing to opt out or adjust their thermostat. They also reported achieving a 55 percent cooling load reduction, and an annual reduction of 462 kWh. KCP&L estimates that customers participating in the Rush Hour Rewards program have attained 1.2 kW reduction on average per thermostat. This equates to 15 percent savings on cooling bills, 10 to 12 percent savings on heating bills, and an average annual savings of $131 to $145 on their utility bill (Brown, 2016).

KCP&L's Rush Hour Rewards program received a Thought Leaders award at the 14th annual Peak Load Management Alliance Awards and continues to be recognized as a leading DR thermostat program. By January 2018, KCP&L had enrolled 32,542 Nest thermostats in the program and raised their initial three-year enrollment goal from 23,000 thermostats to 35,000 units installed by the end of March 2019.

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