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Practitioner Perspectives™

The Future of Utility "Bring Your Own Thermostat" Programs

A Compendium of Industry Viewpoints

Edited by
PLMA Thermostat Interest Group
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PLMA Practitioner Perspectives: The Future of Utility "Bring Your Own Thermostat" Programs, A Compendium of Industry Viewpoints

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PLMA strives to be the source of verifiable, reliable information that the practitioner can use to make informed decisions.

Mission Statement

PLMA was founded in 1999 as the voice of demand response practitioners. It is a community of experts and practitioners dedicated to sharing knowledge and providing resources to promote inclusiveness in the design, delivery, technology, and management of solutions addressing energy and natural resource integration.

PLMA members share expertise to educate each other and explore innovative approaches to demand response programs, price and rate response, regional regulatory issues, and technologies as the energy markets evolve. PLMA will continue to maintain a forum where practical experience, ideas, and knowledge are promoted to those seeking access to a vast network of industry professionals and practitioners. It is also a place where members gather to keep abreast of the latest industry trends in load management and to inform the next generation. We offer timely subject matter and training opportunities to address key facets of our industry charge.

The PLMA Thermostat Interest Group examines the costs and benefits of all types of utility-sponsored programs that leverage thermostat technology to deliver the demand response, energy efficiency, or other system benefits. Their goal is to identify the resources and partners that help articulate a comprehensive value assessment of the Demand Response and energy efficiency benefits associated with smart thermostats.

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THERMOSTAT

The Thermostat Interest Group is co-chaired by Justin Chamberlain from CPS Energy and Olivia Patterson from Opinion Dynamics.

At every PLMA conference, the Thermostat Interest Group meets as part of the Pre Conference Interest Group Activities. We encourage all readers to participate in the PLMA Conference and the Thermostat Interest Group Activities.

Panelist discussion at PLMA Thermostat Interest Group meeting in Cambridge, Mass.

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ACRONYM LIST

AC	Air Conditioning
ACCA	Air Conditioning Contractors of America
BYO	Bring Your Own
BYOB	Bring Your Own Bottle
BYOD	Bring Your Own Device
BYOT	Bring Your Own Thermostat or Bring Your Own Things
C&I	Commercial and Industrial
CO2	Carbon Dioxide
DER	Distributed Energy Resources
DLC	Direct Load Control
DM	Demand Management
DR	Demand Response
DRMS	Distributed Resource Management Systems
DSM	Demand Side Management
EIA	Energy Information Administration
EPRI	Electric Power Research Institute
EV	Electric Vehicles
HVAC	Heating, Ventilation, and Air Conditioning
IFTTT	If-This-Then-That
IoT	Internet of Things
M&V	Measurement and Verification
OEM	Original Equipment Manufacturer
PCT	Programmable, Communicating Thermostats
REV	Revising the Energy Vision
RHR	Rush Hour Rewards
ROI	Return on Investment
RTO	Regional Transmission Operator

For additional terms and definitions, consult the PLMA Demand Response Glossary at www.peakload.org/training.

INTRODUCTION

The rise of smart thermostats for demand response (DR). Utilities have been administering thermostat-based DR programs for many years, originally providing customers with programmable, communicating thermostats that receive radio frequency (paging) signals from the utility to temporarily raise setpoints or cycle air conditioners.

This edition of PLMA's *Practitioner Perspectives* offers a broad view of BYOT's future role in utility-sponsored DR programs.

In recent years, consumers have independently begun purchasing "smart," Wi-Fi enabled thermostats capable of receiving DR control signals. Although the major drivers for this emerging market may be comfort, convenience, usability, ability to remotely control the thermostat setting, or even energy savings; *the increasing adoption of smart thermostats is influencing the business model for thermostat-based DR*. However, it is unclear how large a role Bring Your Own (BYO) Thermostat, or other Things, might play in the future of utility DR programs and questions abound:

- Will Bring Your Own Thermostat (BYOT) fully replace traditional direct install programs, or will it be a feature that increases participation by engaging a subset of customers who prefer smart thermostats?
- Do the costs of integrating multiple vendors outweigh the benefits of streamlined marketing and installation?
- Will there be sufficient customer adoption of smart thermostats to make BYOT models cost-effective
- To what extent will BYOT programs evolve to include more than just DR and energy efficiency (EE)?
- Should we think about BYOT in terms of program model or in terms of devices?
- Is BYO Thing a reality or will it be simply BYO Thermostat for the foreseeable future?

Practitioner Perspectives on the future of BYOT for DR. This edition of PLMA Practitioner Perspectives™ from the PLMA Thermostat Interest Group presents the perspectives of manufacturers, implementers, and utilities on the future of BYOT in utility DR programs. BYOT programs are changing the face of DR and the way customers interact with their utilities, and this compendium offers a suite of perspectives regarding BYOT's future role in utility-sponsored DR programs. The contributing practitioners were selected in an open call for submissions to participate in authoring this compendium. Drafts were reviewed by a team of mentors including the Thermostat Interest Group co-chairs, and PLMA published this compendium.

These snapshots provide a glimpse into the views of the eight practitioners who contributed to this compendium of perspectives on the future of BYOT for DR. The remainder of this publication is devoted to a fuller discussion of each of the eight perspectives as contributed by the authoring organization, with limited editing by PLMA for consistency across articles and to ensure an adequate level of attribution and citation for fact, figures, and quotations.

There is consensus among the contributing practitioners that BYOT will remain a part of DR programs, but varying opinions on whether BYOT will replace or augment traditional direct install DR program models; the relevance of new market segments as they relate to BYOT; and approaches to enhancing the value BYOT brings to DR programs. Regardless of whether any one viewpoint is better than another, market growth for smart thermostats is competing with traditional DR technology adoption and the continued growth is sure to have a significant influence on future DR programs.

Today's trends in smart thermostat adoption and BYOT program deployment are a harbinger of things to come, and the prognostications proffered by our

contributing practitioners provide a window into the future of BYOT for DR. This future may well include:

- **Thermostats as an increasing share of DR enabling technology, and BYOT as an increasing share of how thermostats are acquired for DR programs.** The proliferation of smart thermostat adoption enables many more residential customers to participate in DR programs without the need for utilities or their contractors to install a device in or at the home. This lowers a substantial barrier to program participation and avoids the potential impediment of a customer wishing to keep their existing thermostat—a situation becoming more common as market adoption of smart thermostats increases.
- **Continued reliance on legacy DLC switches as part of the DR portfolio.** Despite the growing adoption of smart thermostats, BYOT as a DR program participation concept is still in a relatively early stage of evolution and is not yet sufficiently advanced to provide for a seamless resource, especially at the resource (megawatt) sizes that are commonly desired by utilities. The existing deployments of switch-based DR for air conditioning and heating curtailment likely will continue as long as maintenance requirements allow them to remain cost-effective. Program expansions and even some new programs may utilize a mix of switches and thermostats to address varying customer interests.
- **Reduced barriers to participation by small-medium commercial customers.** The phenomenon of smart thermostats enabling DR is not limited to residential customers. Connected thermostats are already penetrating small and medium-sized commercial facilities to aid in management of heating, ventilation, and air conditioning (HVAC) systems for efficiency and comfort. The growing prevalence of DR-capable thermostats is lowering the cost of participating in DR programs as well as enabling control strategies that could previously be implemented only by more expensive management systems used in large buildings.
- **Utilities are leveraging previously installed and newly incentivized smart thermostats for customer engagement** in an attempt to become a trusted advisor and full-service energy services coordinator. This trend may be characterized by more sophisticated, yet flexible program designs, incentive schemes and personalized offerings bundled with other products and services. The objectives will extend beyond DR curtailments or even precise load management, but rather to provide energy value for the customer while delivering multiple benefits for the utility.
- **BYOT evolving into a broader concept that includes many types of connected "Things".** Many more appliances and consumer electronics devices will be DR-enabled, but DR will be just one of many ways that a utility or customer interacts with connected devices. Because of this expansion beyond narrowly focused BYOT for DR, utilities will need to future-proof programs to be able to include multiple devices and services. To get the most value for the utility system from these investments, control software and the internal utility integrations will be capable of utilizing the newly connected devices to provide a variety of grid services that are not commonly associated with DR programs of today.

The Future of BYOT articles presented in this compendium of PLMA Practitioner Perspectives™ are grouped according the contributors' industry role as follows:

- Utilities Managing BYOT Programs;
- Device/System Manufacturers; and
- Solution Providers and Program Implementers.

Key "Future of BYOT for DR" conclusions by each contributor by category:

Perspectives from Utilities Managing BYOT Programs within their DR/demand side management (DSM)/distributed energy resource (DER) portfolios including Commonwealth Edison and Xcel Energy, offers considerations as customers continue to adopt thermostats through BYOT program models.

Commonwealth Edison:

The future of BYOT relies on the movement from early to mature customer adoption. Greater adoption will increase with the expansion of smart thermostat integration with connected devices. This interconnection will unlock other value streams beyond DR, serving as another gateway between the customer and grid. As these thermostats become more connected, partnerships between utilities and BYOT providers will evolve to offer more robust and properly valued DR resources on the grid. This partnership will enable BYOT manufacturers and providers to offer more personalized offerings, bundled with other products and services, integrated across both gas and electric utilities.

Xcel Energy:

BYOT models offer utilities a relatively quick and less expensive path to market, but they are not meant to be fully comprehensive. If the goal is to enroll as many customers as possible, utilities must look at combining the BYOT model with other program models. It's completely reasonable for a DR portfolio to include both smart thermostats and the "ol' trusty" direct load control (DLC) switches, as each technology will appeal to different customers.

Perspectives from Device / System Manufacturers who engage with multiple programs, including Encycle and Nest, suggest that the future will bring broader use-cases for BYOT beyond the traditional residential thermostat program.

Encycle:

Connected thermostats are already opening DR opportunities for commercial buildings through control and optimization of heating, ventilation, and air conditioning (HVAC) loads. BYOT will accelerate this trend as owners of small- and medium-sized buildings install their own thermostats and register them with the cloud service of their choice to cost-effectively participate in utility-sponsored DR programs. BYOT is lowering the cost of entry for DR as well as enabling control strategies that could previously be implemented only by more expensive commercial building management systems. In the future, the BYOT concept will become relevant to other devices and loads as well; with the projected growth of the Internet of Things (IoT), smart buildings, and smart cities, it is certain there are future applications that have not yet been conceived.

Nest:

BYOT will change the way residential load is managed with mass adoption of connected thermostats and broad use of sophisticated DR program designs. Key factors driving the future of BYOT include:

- utility priorities around customer engagement,
- potential for low-cost targeted load management using a broad, installed base of devices,
- technology innovation that pushes product cost down and program variety up, and
- success of efficiency-driven BYOT programs will increase because of the value shared by both the utility company and the customers.

Perspectives from Solution Providers and Program Implementers (who are integrating BYOT within a larger DR/DER portfolio, including AutoGrid, CLEAResult, EnergyHub, and Itron), indicate that the BYOT model presents unique opportunities for the utility to redefine their relationship with their customers.

AutoGrid:

While smart thermostats are currently the most widely adopted smart home devices, in the future, the BYOT concept will become relevant to other devices which control a variety of loads for both residential and commercial customers. As such, utilities must design versatile and future-proof programs that can quickly expand to include multiple devices and customer types, creating multi-asset programs that are bound to become an important component of utility-wide flexible management programs. As the meaning of BYOT evolves from Bring-Your-Own-Thermostats to Bring-Your-Own-Things, expanded programs will deliver greater benefits not only to utilities, but also to

their smart device partners, and ultimately to their customers.

CLEAResult:

Going forward, it is likely there will be less of a need for direct installation of DR hardware as retail forces and technology adoption tip the market. There could be a point where the norm would be BYOT program designs; however, that does not mean that utilities should follow that track. As utility business models change, and possibly their role and relationship with the customer changes, utilities may want to take every opportunity to act in the role of the trusted advisor and full-service coordinator. Being flexible with program design and incentives to provide the 10% of the customer base who want DR with installation services will pay off as an opportunity for the utility to be the provider not just of energy, but of energy value.

EnergyHub:

The future of BYOT DR centers on utilities' willingness to work with a constantly growing ecosystem made up of various devices and manufacturers. Hundreds of thousands of customers already have connected thermostats, and utilities are missing an important opportunity by not taking the steps to utilize those devices to provide grid services.

Itron:

For BYOT programs, it is imperative that utilities understand the impact of opt-outs and how to work with a variety of devices that offer different levels of control. It is also important to understand that BYOT devices have yet to achieve widespread adoption, which makes it difficult to rely on these resources to meet any large-scale megawatt requirements. That is changing as more consumers purchase these devices. And as the devices mature, their performance characteristics should also improve. In today's environment however, utilities would benefit from including BYOT as part of a strategy that includes other distributed energy resources (DER) such as direct install DR assets, solar, energy storage and electric vehicles (EVs).

1.0 UTILITIES MANAGING BYOT PROGRAMS

1.1 Commonwealth Edison, An Exelon Company Perspective: Perspectives on The Future of BYOT for DR

The future of BYOT programs for DR initiatives continues to evolve with emerging technologies and customer expectations. This section focuses on key industry trends driving the proliferation of BYOT, as well as the major barriers that must be resolved for scalable adaption[1].

For more than two decades ComEd has operated a DLC program known as the Residential Central Air Conditioning (AC) Cycling Program that currently impacts over 89,000 customers. This program allows ComEd to cycle their customers' central AC compressor off and on during a DR event. ComEd most frequently employs this program during the hottest days of the summer. As an incentive, customers that participate in this program can earn up to $40 in bill credits on their electric bills each summer. The program has evolved to take advantage of emerging technology and the changing needs of customers. Beginning in 2014, ComEd partnered with Nest Labs to pilot a BYOT offering under the AC Cycling program. Currently, over 18,000 customers have chosen the smart Wi-Fi enabled thermostat option using the Nest Rush Hour Rewards (RHR) application compared to more than 71,000 customers that still use the original DLC option. As a BYOT solution, the Nest Rush Hour Rewards application communicates with a customer's Nest smart thermostat to help lower the smart thermostat's energy use when ComEd calls a DR event.

1.1.1 BYOT Industry Drivers

For decades, DR has relied on traditional utility-owned and operated DLC switches as the primary residential curtailment method. With the increasing growth of home automation technologies and IoT devices, the connected home is now on the brink of moving into the mainstream for average consumers and has opened the door to broader utility BYOT programs and partnerships.

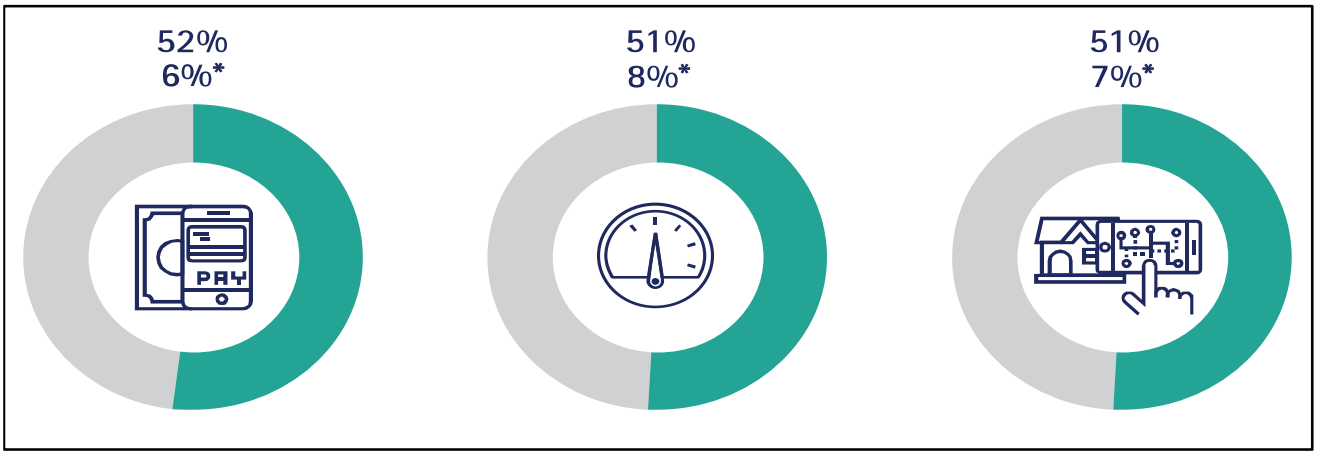
As BYOT becomes a viable alternative to traditional DLC programs, the following key trends are evolving in the market.

- **Increasing Consumer Interest —** While the market continues to mature, the adoption of connected thermostats and connected home technologies continues to grow. According to a recent Accenture research study[2], which surveyed 9,537 end use energy customers in 2016, over half of the respondents were interested in a smart thermostat, a thermostat-based utility program, or a connected home platform in the next five years (See Figure 1)[3].
- **Growing Choices for Utilities and Customers —** The quantity of smart thermostat manufacturers and companies offering BYOT related services has greatly expanded. Consumers have witnessed a burst of smart thermostat options available both in retail outlets and online marketplaces (Figure 2).
- **Improved BYOT Functionality —** In response to the growth in the smart thermostat market, DLC providers are beginning to offer thermostat aggregation services, or other consumer-facing mobile platforms, for the BYOT marketplace. This new concept of BYOT aggregation services allows utilities to better manage multiple thermostat manufacturers and grow BYOT programs while increasing the number of eligible devices available to customers. As seen in recent years, the legacy HVAC Original Equipment Manufacturers (OEMs) are enabling smart features on their equipment, which allows their end users to participate in BYOT programs.

1 The opinions expressed in the article are the authors alone and do not necessarily reflect those of Commonwealth Edison Company or Accenture.

2 Accenture Consulting. (2017). New Energy Consumer: Thriving in the Energy Ecosystem. [online] Available at: https://www.accenture.com/us-en/insight-new-energy-consumer-thriving-new-retail-ecosystem [Accessed 27 Jul. 2017].

3 Accenture Interactive. (2017). The Internet of Things: The Future of Consumer Adoption. [online] Available at: https://www.accenture.com/t20150624T211456__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Technology_9/Accenture-Internet-Things.pdf [Accessed 27 Jul. 2017].



A **program** that credits my bill when my provider makes minor adjustments to my smart thermostat during peak usage hours

A **smart thermostat** that learns what temperatures I like, automatically adjusts the temperature when I'm away, and allows me to make adjustments from anywhere via my smartphone

An **application** that enables me to remotely monitor and control elements of my home

Figure 1 Consumer interest in lifestyle energy products and services in the next five years. * indicates the % of customers that have already signed up or purchased.

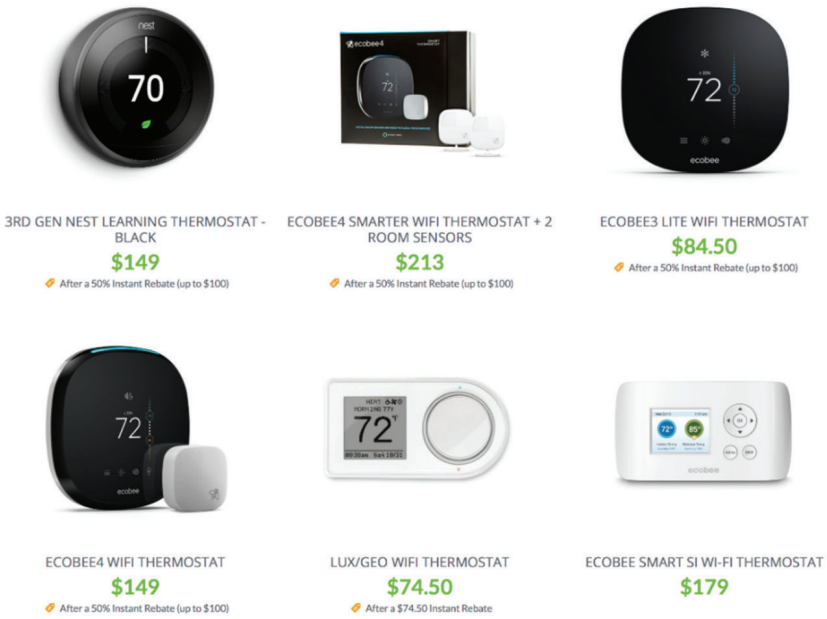


Figure 2 Smart Thermostats Available Through the ComEd Marketplace.

1.1.2 ComEd Case Study

Beginning in 2014, ComEd partnered with Nest Labs to pilot a BYOT offering under the AC Cycling program. In 2015, roughly 3,000 customers enrolled in the pilot via Nest RHR application. In 2016, the BYOT offering transitioned from an annual pilot to a permanent option in the AC Cycling Program.

ComEd currently has over 18,000 customers participating in the AC Cycling Program under the Nest Smart Thermostat Option. The expansion of this program allows ComEd to test the viability of alternative residential DR devices, enhance the customer experience and engagement, and introduce a channel for customers to obtain innovative technology.

The co-branding and partnering of utilities with BYOT providers has proven to be a successful tactic for recruiting customers to join utility DR programs. The marketing for BYOT is primarily through partnership with the solution provider, Nest (Figure 3). The content is co-branded and messaged as Nest's RHR program offered through ComEd. Marketing channels mainly include digital ads and targeted mass media campaigns, including billboards, street ads and in-store retail signage.

Figure 3 ComEd BYOT Marketing Sample.

ComEd initiated five DR events with the BYOT thermostats during the three-year period between 2014-2016. Load profile data has proven that smart thermostats offer a comparable amount of DR reduction to DLC switches that had the AC completely switched off during event hours. In some cases, the smart thermostat load reductions were greater than the DLC switches that had the AC completely switched off when a pre-cooling curtailment method was deployed. The greater load reduction is believed to be due to the smart thermostat participants having on average a larger AC load than the average DLC switch participant. As the BYOT program continues, ComEd will continue analyzing the DR capabilities of smart thermostats under more rigorous conditions.

1.1.3 Asymmetric Cost and DR Value

The economic benefits behind BYOT programs continues to evolve but has not yet reached the tipping point where customer adoption will quickly accelerate. The cost structure and magnitude of operating BYOT programs must align closer to the structure and magnitude of the utilities' DR value. Although this may vary by region and utility, this BYOT cost and DR value alignment must occur to make BYOT scalable to reach maturity. The gap between value and cost widens even further when operating a program through a BYOT aggregator. Although aggregation services expand the list of eligible devices that customers can use to participate, it also significantly drives up the operational costs. Until BYOT providers can offer devices and aggregation services combined into a cost competitive DR solution, marketing such programs beyond small populations will likely be constrained.

1.1.4 Offering Robust DR to the Grid

Larger operational and regulatory considerations have also impacted the proliferation of BYOT programs. Smart thermostat and device manufacturers that enter the DR space will need to provide load curtailment that meets or exceeds the requirements of utilities and their respective Regional Transmission Operator (RTO) in terms of response timeliness, duration, and frequency in order to make BYOT a scalable DR tool for utilities. Currently, there are several BYOT providers that do not meet the operational needs of today's grid. For example, DR events can occur on short notice — some notices may occur less than 30 minutes prior to the start of an event and can last up to 10 hours. Many BYOT providers do not abide by such requirements. Thus, they fall short of offering their

full value potential. Until providers can fully offer a BYOT solution that offers flexibility to dispatch BYOT programs and devices at the latencies and durations required by the grid operators and utilities, they will offer only partial benefits for wholesale market participation and/or grid reliability. It is understood that BYOT providers cannot develop customized solutions catered to each utility's dispatching needs. However, solutions cannot follow a one-size-fits-all methodology. The BYOT industry must reach a balance between flexibility and standardization. With the growing intelligence of smart thermostats and other in-home technology, it is possible for BYOT to meet the needs of the grid while maintaining a seamless and comfortable customer experience.

1.1.5 Connected Everything

The smart thermostat is becoming an increasingly integrated part of the connected home. Manufacturers continue to integrate various platforms, which enables the smart thermostat to act as part of a connected whole home solution. The interoperability between connected home devices offers complementary value. A growing number of interoperable products are arriving in consumers' homes, such as connected appliances, lighting, and plug-loads. These devices are a gateway to addressing a larger portfolio of electric end-uses, allowing consumers to become part of the residential DR ecosystem. This evolution will allow progression from BYOT to BYOD, extending beyond just heating and cooling loads.

The interoperability of the smart thermostat with other smart devices will also become crucial to unlocking the full customer and utility value of the connected home. Since the thermostat is responsible for controlling upwards of half of a home's energy usage, it can become another connection between the home and the grid, which could unlock additional value streams besides DR.

Looking forward, smart thermostats could serve as an enabler of the next generation of the utility business model — such as peer-to-peer energy trading and transactions. As an example, energy savings generated by smart thermostats could be sold to their neighbors for immediate consumption. This example, along with others, show that the smart thermostat will become a key element in merging the connected home with the grid.

1.1.6 BYOT Alternatives

New platforms, such as "If This Then That" (IFTTT), offer utilities and customers an alternative approach to BYOT partnerships. IFTTT is a free IoT service that provides customers the ability to subscribe, share, and create custom applets capable of controlling practically every residential connected home device currently available. This alternative BYOT partnership approach is a lower cost alternative that opens the door for ample customer choice as far as compatibility with connected home devices. However, the approach is currently in its infancy, and at this time is less predictable and limited as far as DR control strategies and DR reliability, along with feedback and reporting to the utility. Regardless, such platforms should continue to proliferate, providing customers more choice and lower cost alternatives for operating BYOT offerings.

1.1.7 Better Understanding Customer Segments

Enhanced data mining — leveraging smart meter as well as internal and external customer data — to inform a more holistic view of customers, will lead to more effective marketing communications and customer engagement. Marketing and recruitment tactics must become more targeted to effectively communicate the value proposition of BYOT and appeal to the unique needs of different segments of the population, such as:

- Customers interested in saving money and energy
- Customers who are environmentally and community conscious — these customers will participate even without financial return to benefit their community and environment
- Customers who want full control over their residential energy consumption
- Customers who want to "set it and forget it" and value convenience

- Customers who enjoy experimenting with new gadgets and the latest technologies

Segmentation and personalization can work hand-in-hand, leading to more meaningful interactions with customers regarding BYOT offerings, with the desired effect of driving increased enrollment responses. This, in turn, results in a higher return on acquisition/recruitment efforts for BYOT campaigns and helps better align BYOT costs with DR value.

1.1.8 Conclusion

Though still in its early stages, BYOT offers a potentially valuable DR tool for utilities and a meaningful customer experience. Utilities and their partners must work together on resolving several market barriers, which includes aligning the cost structure to DR value and developing flexible solutions with smart thermostat manufacturers/aggregators (i.e., offering robust DR to the grid) to successfully scale BYOT to maturity.

As the current market barriers are resolved and new ones arise, the promise of BYOT will grow closer to meeting the growing needs of utilities and consumers alike. The following potential trends are critical to supporting the future of BYOT:

- Movement from early adopter to mature customer adoption will allow for greater scalability of BYOT programs.
- Smart thermostat integration with connected devices can unlock other value streams beyond DR, serving as another gateway between the customer and grid.
- Partnerships between utilities and BYOT providers will continue to evolve to offer more robust and properly valued DR resources on the grid.
- BYOT manufacturers and providers will offer more personalized offerings, bundled with other products and services, integrated across both gas and electric utilities.

IoT devices, including smart thermostats, will extend beyond early adopters. Marketing and recruitment into BYOT programs will become a more cost effective and valuable addition to a utility's DR portfolio as adoption reaches maturity. It is truly an exciting time for utilities as this relatively new endeavor in BYOT continues to grow and develop.

1.2 Xcel Energy Perspective: BYOT — The Future Is Bright

The future looks bright for utility BYOT DR programs, but like most everything in the regulated utility industry, there is no one-size-fits-all approach that satisfies every utility or their customers. BYOT program models won't fully replace their direct install program counterparts, especially those legacy DR programs that have consistently delivered DSM achievement year after year. But perhaps both models can co-exist and operate simultaneously, offering utilities a new capacity resource at a lower cost without jeopardizing existing capacity resources. Nevertheless, even though the right go-to-market strategy will differ for each utility looking to leverage smart thermostats for DR, expect the number of BYOT programs to continue growing as the value of BYOT programs is better understood, utilities grow more confident in smart thermostat technology delivering reliable results, and utilities desire — or need — to keep pace with the growing consumer smart thermostat market.

1.2.1 History of BYOT

The BYOT program model is a game-changer for utility DR programs because — for the first time — a DR enabled technology exists that customers actually want. Formally, a BYOT program model means customers can "bring" or enroll a smart thermostat they already own into a utility DR program. Informally, it's analogous to the roots behind the BYOT acronym itself, "BYOB" or bring your own bottle. BYOB can apply to any social gathering, but it's well known to anyone in college, that it's normal for hosts to provide party staples like music and lava lamps, but not adult beverages because that could be cost-prohibitive. Thus, everyone understood and accepted parties with BYOB terms. The hosts (utility) can't provide booze to attendees (utility can't provide the technology to customers for free), but everyone is welcome to bring the beer/beverage of their choice (eligible smart thermostat)

and can still partake in the party (DR events). Beyond the costs, there's another reason for hosts to choose a BYOB model. With so many options available to their guests, whether it's local craft beer, cinnamon whiskey, or wine in a can, it's hard for the hosts to choose one or two beverages that will make all their guests happy while maintaining their party budget. So rather than restrict their guests' choices, the hosts focus on providing quality staples while allowing the guests to choose their favorite beverage to bring along.

This is essentially the opposite of traditional direct install programs, where utilities provide a technology solution and installation to customers for free. Historically, this has been the best option to utilities as residential DR technologies have never been consumer-facing or something customers would acquire on their own without the existence of a utility DR program. Customers have never gone out and put DLC switches on their AC units because the technology was irresistible, nor have they subsequently complained that their switch brand wasn't included in their local utility's DR program.

In 2011, smart thermostats hit the market with serious momentum and disrupted the status quo. The spark occurred in Q4 2011 when Nest Labs introduced their first-generation model. Nest did something unusual for the thermostat market and utility DR programs alike: they invested heavily in consumer marketing. Consumers seemed instantly drawn to the technology, and with home Wi-Fi networks and smart phone penetration seemingly ubiquitous, the sky was the limit.

The opportunity for utilities was clear, although the market behavior was not business as usual. Smart thermostat technology offered utilities strong DR potential since it controlled customers' HVAC equipment, but the difference was customers were purchasing smart thermostats on their own, without the help of utility programs or incentives. This was a significant shift for utilities that historically needed to pay customers healthy incentives to enroll in DR programs.

The market moved quickly, and utilities were now presented with a growing base of customers that had already installed smart thermostats in their home. By partnering with thermostat manufacturers who can identify customers with a smart thermostat, utilities could target and market directly to this installed base of smart thermostats for a fraction of the acquisition costs typical seen with utility DR programs, particularly direct install models.

1.2.2 BYOT Pros & Cons

The BYOT model offers some clear and some not-so-clear advantages and disadvantages for utilities. It is prudent to discuss all impacts — good and bad — so utilities, manufacturers, implementers, and others understand what to expect from a BYOT program model.

1.2.3 BYOT Advantages

The advantages of the BYOT channel can be summarized in the following ways:

- Less expensive than traditional DR program models
- Customer base is established and easy to reach
- Easy to establish and confirm thermostat-level eligibility requirements
- Provides customers choice

1.2.3.1 Less Expensive Than Traditional DR Program Models

Simply put, it will cost a utility less money to recruit and acquire participants for a BYOT smart thermostat program than it will for a direct install smart thermostat program[4]. For any utility smart thermostat DR program, certain program costs will not be significantly affected by the program model; such as annual program incentives, costs to access thermostat data, or annual program evaluations. That means a key cost differentiator between program designs are the incentives paid to (or otherwise offered to) customers for joining the program. For BYOT models, a simple one-time payment to customers upon enrollment is all that's needed to drive program participation. A quick

4 Xcel Energy personal experience from program operation. Data is not publicly available at the time of publication.

comparison across similar utility BYOT programs shows upfront incentives can range from $25 to over $100. By comparison, direct install models can easily be 2x–3x more expensive per customer. Based on device and installation cost alone, a direct install program is likely spending over $200 per participant.

1.2.3.2 Customer Base is Established and Easy to Reach

The BYOT model also benefits from a customer base that's engaged and easy to market to. Smart thermostat manufacturers collect email addresses from each customer during installation and will market utility programs to these customers on behalf of their utility partner. Xcel Energy's recent experience with this tactic observed customers that were very receptive to emails from their thermostat manufacturer. In fact, BYOT marketing for the Xcel Energy pilots saw email campaigns with open-rates and click-through rates well above company benchmarks.

Traditional DR marketing has been expensive and leveraged strategies like direct mail pieces blanketing entire customer bases. This approach favors wide-spread coverage over precision primarily because no data is available to increase campaign accuracy. Smart thermostat owners live connected lives and actively monitor digital and social channels. Smart thermostat technology allows utility programs to precisely target smart thermostat owners and deliver digital campaigns to channels where customers are paying attention, resulting in significantly cheaper campaigns and conversion rates 5x–10x higher than direct mail campaigns.

Further, the digital nature of marketing a BYOT model makes the world smaller. This is advantageous for utilities who provide service over a large geographic area, or whose customers are spread out into multiple population centers, or any other scenario where it's hard for the utility to connect with their remote customers. For a direct install program, it's much cheaper to provide a device and installation for 10 customers clustered in the same suburb than it is to provide the same device and installation for 10 customers widely dispersed on the outskirts of the utility's territory. The BYOT model keeps acquisition costs the same per customer, whether it's a city-dweller or the most remote customer in the territory.

1.2.3.3 Easy to Establish and Confirm Thermostat-Level Eligibility Requirements

A key aspect to any DR program is that load-control devices are installed properly and are controllable by the utility. BYOT models accomplish this by building the verification step seamlessly into the enrollment process. The details of how this can be accomplished vary by design and selected partners, but conceptually the process works by having customers enroll online. At some point during the online enrollment, customers will be directed to authorize their smart thermostat for the program using their thermostat account credentials. This step happens fast for customers, but what's happening in the background is important for utilities: it ensures that every enrollee has an eligible, registered, and installed smart thermostat. Manufacturers are working to incorporate more verification requirements into this process, such as ensuring the thermostat is controlling a central AC unit or that the registering device has been online recently. These additional requirements may take time to deploy, but the technology creates the potential for BYOT models to create tighter program requirements while ensuring the seamless online enrollment experience customers are accustomed to.

1.2.3.4 Provides Customers' Choice

Historically, utilities have a bad habit of selecting technologies or vendors that meet their own needs, then asking customers to comply. This hasn't bothered many DR participants in the past since customers don't care what brand of DLC switch is controlling their AC unit. Because smart thermostats are a consumer electronics product, utilities risk eliminating significant chunks of market potential by selecting only one device or vendor to participate. This is typical behavior for direct install models; limiting technology and partners lends itself to better pricing and cost-efficiencies. But the winds of change blow hard in consumer markets — consumers' preferences change quickly, new market entrants, mergers and acquisitions redefine market winners and losers instantly, price points

are constantly in flux — and utilities don't have a good track record for responding quickly to external market forces, especially ones that change as fast as those in consumer electronics.

In a market like smart thermostats, utilities are much better served by offering customers as much choice as possible. By doing so, utility programs stand the best chance of capturing full market potential. BYOT models help facilitate this choice because utilities don't have to worry about device procurement and installation, but instead focus on back-end integration and provider partnerships. While neither of those tasks should be underestimated, the ability to shift focus away from procurement and installation provides utilities with the opportunity to offer customers more choices to meet their needs.

1.2.4 BYOT Disadvantages

The disadvantages of the BYOT channel can be summarized in the following ways:

- BYOT channel doesn't address all customer segments
- Program Management can be complex
- More susceptible to program liabilities that erode overall program value and cost-effectiveness
- Future program growth dependent on organic smart thermostat market growth

1.2.4.1 BYOT Channel Doesn't Address All Customer Segments

The BYOT program model is effective for recruiting and enrolling customers that already own a smart thermostat into a utility DR program, but it misses the key segment of the population that does not already have a smart thermostat. At a high level, a utility DR program should identify customers as one of two types: those that already own a smart thermostat and those that don't (yet). Market research suggests that current smart thermostat penetration in the US is likely in the 10 — 15% range. Thus, a BYOT-only model could be ignoring as much as 90% of the market's potential.

1.2.4.2 Program Management Can Be Complex

BYOT program models lend themselves to customer-friendly designs that can offer customers plenty of choice. This can lead to positive customer satisfaction and program uptake, but it will most definitely result in additional complexities and time needed to manage the program.

To illustrate this concept, imagine a utility BYOT program with three vendor partners. To deploy this program, the utility must develop and execute contracts with each vendor. The utility must then design and deploy three different enrollment tools, one for each vendor, because vendor A can't authorize devices from vendors B and C, and vice versa (versa?). When it comes time to market the program to customers, the utility must develop and coordinate not one but three email campaigns, one for each vendor. If the utility builds a program page on their own website, it must link to three different external websites. If the utility wants to provide customers with frequently asked questions (FAQs) or customer support from the manufacturers, this again means managing three sources of information instead of one. Once control season begins, the utility will have to dispatch three separate DR events, one for each manufacturer's devices. For the individual responsible for "pushing the button," this means learning how to use three separate software tools and processes. Once the DR event is over, the program must ingest data from three separate sources, which not only will collect and report data in different formats, but the time interval for collecting data will vary as well. Once the DR event is over, the resulting data will be in three different formats because there is no data-reporting standard for these tools. For example, one data set may report data in five-minute intervals while another only reports data when a change has occurred. Additionally, because there is no standard, there's no guarantee that each vendor will report the same data fields (e.g. indoor temperature, outdoor temperature, compressor runtime, etc.) So again, an individual will be responsible for normalizing each data set into a standard, comparable format, that can then be used for analysis and reporting.

Naturally, the market is actively trying to resolve problems like these for utilities. Providers like AutoGrid, EnergyHub, and Whisker Labs are just a few trying to manage those integration complexities by providing utilities with a single partner who can manage all others. The promise of a turn-key BYOT solution through a single vendor is very intriguing, but the devil's in the details. For a utility that's willing to give up full control of their program and allow their BYOT vendor to simply deliver capacity with no questions asked, there are solutions available. But for utilities that want some level of control for how the program is managed, or the ability/authority to affect changes across the program, these BYOT turn-key solutions have limitations. After all, each thermostat manufacturer is trying to differentiate their products from competitors. Further, there are no industry standards for things like back-end communications, enrollment tools, data collection frequency, control strategy options, or required data for M&V purposes. As such, there's only so much a single BYOT provider can do to normalize all those experiences into a singular, consistent experience for utilities and their customers.

1.2.4.3 More Susceptible to Liabilities That Erode Program Value and Cost-Effectiveness

Utility DSM programs live and die based on their cost-effectiveness, and because of this, utilities have historically deployed very tight program eligibility rules and thorough application processes. While great for maintaining a cost-effective utility program, it's not conducive for delivering a great customer experience. The BYOT model does offer customers a much better experience but doing so means the model is vulnerable to risks that could negatively impact cost-effectiveness. By designing a customer-friendly experience, security sacrifices are made that make it possible for ineligible customers to enroll, or for customers to take advantage of loop holes in the program. Whether it's intentional or accidental, it will happen more often with a BYOT program model than it would with the more traditional direct install model.

For example, let's say a BYOT program requires customers to live in a detached single-family home; customers in town homes or condominiums are not eligible. With a direct install program, an installer could confirm an eligible home type immediately upon arrival, but a BYOT program has no way of doing this. The program can require customers to confirm they live in an eligible home type, but that's not as dependable as an installer visiting the property. Another example could be a customer enrolling and un-enrolling in the program repeatedly to receive multiple upfront incentives. Systems can be built to catch scenarios like this, but it's nearly impossible to identify and predict all loopholes prior to customers finding them instead.

1.2.4.4 Future Program Growth Dependent on Organic Smart Thermostat Market Growth

As stated earlier, the BYOT model does not address full market potential. A BYOT program model alone cannot drive additional market growth and customer adoption. After all, BYOT models only target customers that have already adopted the technology. The growth of the smart thermostat market has been explosive over the last five years, but what happens if that growth flattens because the innovator and early adopter segments are fully saturated? Without a program design element aimed at lifting the market, BYOT programs' growth will be capped by the overall market's growth.

1.2.5 BYOT Alternatives

1.2.5.1 Direct Install

If BYOT represents one end of the utility program design spectrum, then the direct install model represents the opposite end of the spectrum. However, that's not entirely a bad thing. After all, the direct install model is a tried and true program model that's historically delivered for utilities. Furthermore, the BYOT model may not be the right fit for some utilities, thus it seems prudent to understand what a direct install model brings to the table, particularly compared to the BYOT model.

Direct install model advantages:

- **Confirmation of each installation —** a staple of any direct install program, utilities can rest assured that each installation is completed to all required specifications because a professional installer/technician completes each installation.

- **Confirmation of customer eligibility —** many of the program vulnerabilities can be avoided by having an installer on-site and verifying eligibility for each customer in person.
- **Solution for customer segment unable/ unwilling to install thermostat themselves —** the BYOT model misses an entire customer segment that wants a smart thermostat but is either unwilling or unable to install the thermostat themselves; a direct install model provides this segment with a viable solution.

Direct install model disadvantages:

- **Expensive —** as mentioned earlier, a smart thermostat direct install program can easily pay 2x -3x more to acquire participants based on device and installation costs alone.
- **Scheduling installation appointments is challenging —** installers must be able to enter customers' homes to complete a thermostat installation; this presents many challenges including coordinating with customers to provide access and further limits the total number of installations an installer can complete in a single day.
- **Hard to offer customers choices for devices —** direct install programs benefit from limiting the number of devices available through the channel; it's possible to offer multiple products through a direct install program but expect increased costs from installers and vendors as a result.
- **Lag time between program sign-up and thermostat installation —** for customers that want a smart thermostat right now, the direct install model can be frustrating due to the long lag time between when they sign up for the program and when the installation is completed.
- **Difficult to deliver in territories with dispersed populations — t**he logistics of a direct install model can be challenging for service territories covering large geographic areas or spread out populations; the more spread out the customers are, the more expensive acquisition costs will be.
- **Not a solution for existing installed base of smart thermostats —** ust like a BYOT model misses the market of customers that want a new smart thermostat, a direct install model doesn't provide program access to customers that already purchased and installed their own smart thermostat.

1.2.5.2 Self-Install

There's one customer segment that neither BYOT nor direct install models address particularly well: the segment of customers that don't have a smart thermostat already but would like one and are willing to purchase and install themselves. One could argue that a BYOT model provides these customers with an adequate solution, but there's a better option for these customers. The BYOT model targets customers that already installed a smart thermostat themselves, customers that made the decision to purchase without any additional offers. A self-install model provides a solution for customers that are on the fence for the purchasing decision. These customers are capable and willing to install thermostats themselves, but without an offer specifically designed to get them off the bubble, they won't take the action.

1.2.6 Conclusion

At a high level, utilities and smart thermostats seem destined to be together for the foreseeable future. Even though other "smart home" technologies have come and gone quickly — looking at your in-home energy displays — smart thermostats are five years old and the market is still growing. Some utilities may be skeptical of smart thermostats' value compared to the "ol' trusty" DLC switch, but one could argue that utilities don't have to pick one or the other. It's completely reasonable for a DR portfolio to include both as each technology and program design will appeal to different customers. Just because your portfolio is investing in a different technology doesn't mean all those switches in the field are going away.

Specifically, BYOT program models have a bright future for utility smart thermostat DR programs. There are numerous advantages to utilities deploying this program model, namely lower

customer acquisition costs, an engaged customer base to recruit from, ability to offer customers choices, ability to easily confirm active devices, and a viable solution to reach customers far and wide across service territories. BYOT program models can offer utilities a relatively quick and less expensive path to market if they want to engage with smart thermostats now, but keep in mind that BYOT models are not meant to be fully comprehensive and capture the entire market. If the goal is to enroll as many customers as possible, utilities must look at combining the BYOT model with other program models like direct install and self-install to provide a viable solution for all customers.

2.0 DEVICE / SYSTEM MANUFACTURERS

2.1 Encycle Perspective: Convergence of BYOT and IoT Connectivity Creates New DR Opportunities for Commercial Buildings

Commercial buildings account for a significant amount of the world's primary energy usage and a large percentage of carbon emissions. In the United States, energy consumed in 2016 by commercial and industrial buildings accounts for 51% of the overall end-user consumption[5], and according to the Energy Information Administration (EIA), the building sector is responsible for nearly half of the U.S. carbon dioxide (CO2) emissions[6]. For large commercial and industrial (C&I) building managers, many options exist to reduce consumption with numerous demand management (DM) and DR technology tools, but for the 95% of commercial buildings that fall into the small-to-medium enterprise category, opportunities to cut consumption and meet sustainability goals have been much more elusive.

Although a formidable segment when it comes to the potential for EE and DR savings, smaller businesses have historically lacked the funding, and/or the economies of scale needed to leverage the cost and energy-saving benefits of electricity demand optimization technologies. Another key barrier for greater participation is the lack of time available to small business owners/managers to learn about available DR technology and to then deploy it. As a result, small-to-medium enterprises have remained largely under-served and under-represented in terms of DR savings results.

That paradigm is shifting, however, as connected thermostats — coupled with cloud IoT connectivity — are bringing sophisticated, enterprise-level building control features, attractive paybacks, and ease of implementation to this high-potential market segment. In effect, BYOT plus IoT enable control strategies that could previously be implemented only by more expensive large building management systems.

5 Source: 2013 2030, Inc. / Architecture 2030

6 Source: U.S. Energy Information Administration / Monthly Energy Review, April 2017

2.1.1 Momentum from Residential Wi-Fi Thermostat Market Spilling Over to the Commercial Thermostat Market

The adoption rate of connected Wi-Fi thermostats in the residential market has experienced accelerated growth in recent years, and at an even faster rate than its commercial counterpart. The increased demand for IoT devices, including connected thermostats, in the residential space seems to be primarily driven by the desire for connectivity from homeowners using smart phone apps and, more recently, home-based voice control devices.

Enhanced interface options give homeowners the ability to connect and control every connected device in their homes, from appliances to lighting and temperature, simply by clicking a smart phone app or issuing a voice command. Connectivity is now expected from residential consumers and is becoming the norm with the proliferation of inexpensive home automation gateways and integrated, low-cost voice control. Facilities managers now expect the same capabilities from commercial thermostats and other devices installed in the business environment.

Figure 4 Thermostat. *Image courtesy Alamy.com*

2.1.2 The Emergence of Connected Thermostats and Their Benefits to Commercial Building Operators

Building automation is not a new concept; however, the use cases and cost of implementation are changing as IoT becomes a reality. Historically, for small-to-medium commercial building owners, there have been very few heating, ventilation and air conditioning (HVAC) control solutions capable of providing an attractive return on investment (ROI). This means many smaller commercial buildings are poorly controlled, uncomfortable, and waste more energy per square foot than larger commercial buildings with sophisticated energy management systems.

Today, however, building owners can now install their own thermostats and register them with the cloud service of their choice to enable sophisticated site and enterprise-level building control at a price point that was previously unattainable.

BYOT will greatly accelerate growth of such functionality. Take for example a small commercial facility with five to 10 HVAC systems. By installing connected Wi-Fi thermostats, building managers can now economically deploy group scheduling and advanced energy management through cloud-based control.

Keep in mind, connectivity alone does not make thermostats intelligent; however, connectivity does enable thermostats to coordinate with each other and communicate to cloud services, which, in turn, enables enhanced features, analytics and algorithms that cannot be performed at the local level by non-connected thermostats.

2.1.3 Customer-Selected Connected Thermostats Enable Participation in DR

The concept of BYOT allows business customers the flexibility to purchase thermostats based on the features and functionality that best meet the needs of their specific buildings. Thermostat operation can be further enhanced by their ability to connect to a variety of services such as weather feeds or energy management/building management services. With the flexibility to make their own choices, building owners are no longer limited to the thermostat options provided by their HVAC contractor, equipment manufacturer or local utility. Instead they have the option to choose from a wide range of features provided by a broad selection of thermostat manufacturers. As utilities begin to embrace the BYOT concept, we will likely see additional energy services and DR programs enabled across multiple thermostat brands.

Connectivity also allows building owners to enroll commercial thermostats in DR programs through OpenADR, utility sponsored DR programs or DR aggregators. Even smaller facilities with only three or four HVAC systems can be combined with other locations, allowing enterprise-level monitoring and scheduling across many locations. Low-cost, connected Wi-Fi thermostats not only bring the ability to participate in DR, but they can also include reporting to track participation and estimate site level kW reduction. In addition, these sites can now participate in automated DR programs that meet the requirements of mandates like California's Title 24. [OpenADR is now required in California as part of the Title 24 certification for Wi-Fi thermostats[7] and qualifies for LEED credits under LEED v4[8].]

By integrating numerous BYOT connected thermostats, automated DR is made possible for much smaller buildings and at a distributed level, allowing loads to be combined for multi-site aggregated DR.

2.1.4 Smart BYOT Thermostats Can Connect to Sophisticated Services that Provide Unique Benefits to Commercial Customers

As a next step, by connecting to the proper cloud service, smart thermostats can provide continuous DR, thus enabling long-term EE. As an example, commercial thermostats typically operate equipment in standalone mode, each thermostat controlling only a single HVAC system. This uncoordinated approach can easily increase a building's energy cost by creating unnecessary demand charges when multiple units cycle on and off at the same time. By operating multiple HVAC units as a coordinated group or cluster, building owners not only increase occupant comfort, but also lower energy consumption and peak demand charges.

Figure 5 Cloud Service Illustration. *Image courtesy CanStockPhoto.com*

7 Source: California Energy Commission / 2016 Joint Appendix 5 (JA5) - Technical Specifications for Occupant Controlled Smart Thermostats (OCST)

8 Source: U.S Green Building Council / LEED v4 for Building Design and Construction

Standalone thermostats control a single unit by regulating the temperature for a particular space or zone independently of the rest of the building and without consideration for the number of units currently in operation. By installing BYOT-connected thermostats and implementing a group control strategy, HVAC units can now communicate, collaborate, and make informed, intelligent decisions about precisely when and how they should be operating to achieve maximum efficiency. Even though each thermostat has limited information, a connected group has the intelligence to respond holistically by self-organizing and synchronizing themselves in a way that enables units to simultaneously detect each other, red-flag unnecessary consumption and automatically optimize electricity usage by controlling the aggregated whole as one unified, coordinated group.

Figure 6 HVAC Rooftop Units. *Image courtesy CanStockPhoto.com.*

Delivering cooling to the space when it makes the most sense based on cost, the unique parameters of each building and the comfort needs of building occupants will maximize energy savings and equipment longevity. Instead of operating in isolation, BYOT can enable continuous demand management with systems working intelligently together.

The strategy of group or cluster control also works very well if HVAC equipment happens to be oversized. When a building is constructed, or new HVAC equipment is installed, many factors are considered, including building usage, location, orientation, construction materials, number of windows as well as others to determine the proper size for adequate cooling. A cooling load calculation should be performed using industry accepted standards and procedures published by industry associations such as the Air Conditioning Contractors of America (ACCA). HVAC equipment sizing is not an easy process, so in many cases untrained installation contractors incorporate a "safety factor" they believe will ensure equipment can keep up with demand and that comfort is met during extreme conditions such as abnormal temperatures or maximum occupancy. This typically results in HVAC equipment that is over-sized to ensure sufficient capacity to cool the space during a record setting heat wave or the rare occasion when a building is used for a special event at maximum occupancy. Oversizing causes short-cycling, reduces equipment life, and results in occupant discomfort.

Often, HVAC contractors who aren't trained to use proper sizing standards apply what's known as the 1% rule; that is, HVAC capacity is set to maintain the temperature setpoint in all but 1% of the days per year. Thus, under normal conditions, the oversized equipment runs for a short period, quickly satisfies the temperature setpoint, but fails to remove the humidity or moisture in the space. This creates uncomfortable conditions, since occupants feel more comfortable at a higher temperature with less humidity than a lower temperature with high humidity. It also dramatically shortens the life span of equipment. Moreover, HVAC units do not reach full efficiency until they have been running for about 15

minutes, and they are usually locked out for at least a five-minute period after being turned off. Considering factors such as these is well beyond the capabilities of almost all energy management systems.

With oversized equipment, what are the options for correcting the situation? In the past, the primary solution was to replace oversized equipment with properly sized units. In today's landscape of connected devices, however, it is sometimes possible to solve these comfort issues without replacing equipment. Some units can be turned off by implementing a cluster control strategy using connected thermostats, while allowing adjacent units to run longer, preventing equipment short cycling, and reducing humidity in the space.

Think of it as a real-time virtual sizing of cooling equipment, allowing system tonnage to scale as the building heat load increases or decreases. This solution provides the best of both worlds, i.e., HVAC equipment scaling in both directions. This allows oversized capacity to kick in when needed during extreme conditions. However, during normal operation, oversized equipment can be throttled back in real-time using advanced algorithms running in the cloud. However, when providing incentives or rebates for new installation programs, it is best practice to require equipment be properly installed using appropriate sizing standards.

2.1.5 BYOT Offerings Enhance the Value of DR

By enabling customer choice, BYOT programs can also allow for a wider variety of DR programs. Thermostat vendors can offer different levels of DR depending on how much the customer is willing to tolerate. For example, a given DR program could offer double the payments for customers willing to handle a four-degree setback during DR events rather than a three-degree setback, or perhaps a maximum of four-hour rather than three-hour events. The DR program provider, by offering a selection of DR programs, allows BYOT providers to offer more value to their customers.

During a call for DR, thermostats typically respond by adjusting their setpoints by a few degrees (known as the "setback") during DR events. This can be an increase in setpoint for summer cooling DR events or a decrease in setpoint for winter heating DR events. This setback immediately reduces load at the start of a DR event, where the load increases later when the DR event ends, and the thermostat returns to its normal setpoint. Utilities are aware that immediately after a DR event (when DR setbacks are no longer needed), care must be taken to ensure the thermostat slowly ramps back to the original setpoint to avoid a sudden load spike that can cause the system to run at 100% capacity when it attempts to "catch up" and restore conditions back to the normal setpoint. Failure to slowly ramp up results in both a local and area wide DR rebound effect. When such a rebound effect occurs, commercial business customers may experience additional peak demand charges, and the utility will experience an artificial and avoidable peak in grid-wide load.

As a way of mitigating the rebound effect, thermostat or third-party cloud-based energy management systems providers can decide how simple or complex to make DR settings depending on their customers' willingness to understand or participate in different programs. For example, commercial customers are typically more sophisticated than residential customers in terms of understanding DR programs and how each zone in their buildings can tolerate DR setbacks. This allows thermostat providers to offer different DR applications for different types of customers, thus providing a richer environment of DR choices for all utility customers.

2.1.6 Conclusion: The Future of BYOT will Expand to Include Other Types of Loads

BYOT is opening DR opportunities and creating value for commercial buildings through affordable, internet-connected thermostats that can control and optimize HVAC loads. In the future, it's likely the BYOT concept will continue to mature and eventually become relevant to other devices and building loads. By connecting related systems such as EV chargers, onsite renewables, and energy storage, one can envision a complete ecosystem of energy-aware devices either consuming or producing electricity at various times — all working

together in unison for maximum efficiency while reducing demand on the grid. With the projected growth of IoT, smart buildings and smart cities, it's certain there are future applications that have not yet been conceived. It will be exciting to see what programs are developed due to the BYOT movement as well as what comes next in the evolution of Bring Your Own.

2.2 Nest Perspective: The Era of Connected Home DR Is Here

2.2.1 Setting the Stage: How and Why BYOT Will Impact Residential DR

Over the next 10 years, BYOT will change the way residential load management is done, with mass adoption of connected thermostats and broad use of sophisticated DR program designs. Though traditional load management programs will continue to provide value, portfolios will shift to be BYOT program driven simply because the value to the utility and to customers is so great.

By 2027, smart and communicating thermostats will become the norm for customers. How? With proven EE benefits[9] plus other customer programs that leverage connected thermostats, utilities will be able to offer meaningful rebates that allow consumer access to the products at little or no cost. Features will continue to improve, new products will open a broader customer base, and overall consumer interest in the connected home will move more mass. And technology integrations and sophisticated marketing techniques will reduce the barriers to rebate redemption and product adoption, further accelerating connected thermostat penetration in the market. In summary, we think device uptake will be significant, resulting in tremendous latent capacity for load management.

On the utility side, consistent focus on enhancing the customer relationship will mean that customer-friendly program designs will take center stage. The standardization of distributed resource management systems (DRMS) communications will make it easier for utilities to deal with a variety of devices, enabling them to provide choice while also delivering broad DR program engagement. There will also be a recognition of the potential for these devices to support customer engagement beyond DSM. Some of the same characteristics that make thermostats great tools for peak-shaving DR make them great for broader load management, from time of use programming to load shaping — and in 10 years, these program types will be prevalent. And with connected thermostats everywhere, the potential for micro-targeted load management activities opens up. There is even a scenario in which, over the next decade, connected thermostats become be a key component of grid planning and load balancing. The seeds for that change are being planted now.

2.2.2 Market Trends

In the earliest days of the connected home, some predicted rapid mass adoption. However, the market has followed a well-trodden path for new technologies: they appeal to early adopters, achieve a modest level of market penetration, and then face what's known as the early adopter chasm — a plateau preceding adoption by a mass audience[10]. This is where connected thermostats sit today. But we are poised for a shift. Consumers are developing trust in some newer brands in the space, and legacy brands have also jumped in, lending credibility to the category. And products at lower price points are starting to hit the market, making the technology accessible to a wider customer base. Growth numbers in connected home as a category are strong; McKinsey found a compound annual growth rate of 31% from 2015 to 2017, and notes that "this is expected to continue in the years to come."[11] Thermostats, as one of the core products in the category, will likely be a significant portion of those purchases.

9 Nest Labs, Energy Savings from the Nest Learning Thermostat: Energy Bill Analysis Results. Feb. 2015. https://nest.com/downloads/press/documents/energy-savings-white-paper.pdf

10 Crossing the Chasm, 3rd Edition: Marketing and Selling Disruptive Products to Mainstream Customers. Geoffrey A. Moore. 2014

11 http://www.mckinsey.com/spContent/connected_homes/index.html

Utilities also play a central role in the evolution of the thermostat business. As of the middle of 2016, over 30% of US households had access to a connected thermostat product or program through their energy provider — and that's just programs involving Nest[12]. In some cases, using a combination of out-of-the-box efficiency value and ongoing program enrollment, utilities are even able to offer rebates that lower the cost of a connected thermostat below the cost of a traditional one. For customers, that's quite compelling. For utilities, it means more potential BYOT participants for residential DR.

There is also broader energy market change. With EVs, solar and storage gaining traction, energy companies are developing new strategies for distributed energy resource management. Models like New York's Revising the Energy Vision (REV)[13] are investigating ways that load management techniques can reduce infrastructure needs. And expanded smart grid rollouts mean time of use pricing is poised to become more broadly deployed, with increasingly complex rate designs and choices. In many places, trends towards community choice aggregation and even deregulation mean shifts for the way utilities do business. Taken together, those trends mean that energy providers are increasingly focused on customer experience, and on targeted, controllable ways to manage load.

How do utilities see the market? A recently published study[14] of utility perspectives conducted by market research firm Zpryme and funded by Nest found that connected products, particularly thermostats, will be increasingly important to DSM portfolios generally and particularly important to DR programs.

- 93% of utility respondents say that utilities should play a role in the connected home.
- 92% believe that connected home energy programs will become even more important in the next 3 to 5 years, with over half predicting that shift will be very significant.
- 55% list DR programs as one of the top program uses for connected devices today.

When you combine the consumer trend towards purchase of connected devices with these perspectives from energy providers, it underscores the thesis that BYOT will significantly change the DR landscape.

2.2.3 Value: The Consumer Perspective

Given that they are quite new, why are BYOT programs likely to become the principal form of residential DR in the coming decade? Very simply, the model provides strong benefits for customers and energy providers and will become even more compelling as consumers become more interested in the connected home.

2.2.3.1 Thermostats: A Consumer-Centric Category Revolution

Driving the shift to BYOT thus far is the emergence of the smart thermostat as a highly desirable consumer product. A decade ago, a customer would only consider purchasing a thermostat when they needed one — when moving into a new home, undertaking a remodel, or replacing a broken device. Thermostats were unloved household products.

That all changed with the introduction of the new generation of connected thermostats. These devices can be controlled from a customer's phone, and in some cases are smart enough to program themselves. Many are designed to be beautiful and to delight customers; they help customers stay comfortable, and also save energy. Consumers talk about them on social media. They buy them as holiday gifts. It's a whole new thermostat world.

2.2.3.2 BYOT Makes DR Participation More Appealing

Customers who own a connected thermostat now can easily participate in DR. They don't need to fill out a lengthy form, get a new device, or schedule an install: they can just enroll with the thermostat on their wall. For Nest customers, enrollment can

12 Partners In Energy. Nest Blog, April 22, 2016. https://nest.com/blog/2016/04/22/partners-in-energy/

13 https://rev.ny.gov/

14 The Connected Home: Products and Programs to Empower Customers. Zpryme. August 2, 2017.

be as simple as signing into their Nest Account, verifying their home address, and acknowledging the program terms. It can literally take less than a minute.

Not only does the connected thermostat have the benefit of being inside the customer's home, and something people engage with regularly, many can be installed with ease by the customer. And unlike legacy residential DR equipment such as DLC switches, smart thermostats can help customers stay comfortable and save energy throughout the year. They also enable customer participation in a broader set of programs that can bring them value, through incremental energy savings, reduced usage during peak price windows, or earned rewards.

2.2.3.3 Energy Gets More Complex, Customers Seek Greater Simplicity

Trends in the energy industry are leading to more complexity for residential customers. People have expanding options for where they get their energy (and in the future, where they will be able to sell it). Customers are starting to face a dizzying array of new rate structures. And the advent of new technologies has led to a greater variety of utility-managed DSM programs that are marketed to any one customer.

People want products and services that can simplify their lives. As their energy decisions become more complex, we expect an even greater desire for devices that can solve multiple problems for them. BYOT programs benefit from these trends as they encourage customers to purchase devices that can be used to address a number of their energy, comfort and convenience needs, while allowing them to participate in a greater range of utility programs.

2.2.4 BYOT Value for Utilities

BYOT programs are a great improvement for customers over traditional DLC. But a key driver for a shift in the overall residential DR market towards BYOT programs is value for energy providers.

2.2.4.1 Lower Costs

The rapid growth of smart thermostats creates beneficial dynamics for utilities. The ease with which a customer can enroll their smart thermostat in a BYOT DR program translates directly to lower costs.

In a traditional DR program:

1. The program needs to be marketed to a customer
2. A program needs to offer customers a sufficient incentive to convince them to join
3. A device needs to be provided to the customer
4. The device needs to be installed by a professional
5. The device need to be maintained (and even replaced) over the lifetime of the program

If a customer already has a device that can participate, the last three costs disappear. The first two also go down considerably. Why? It's easier to market a program that's an add-on service to a product that the customer already engages with and likes. Programs can be marketed through existing device and app touchpoints. The technology enables highly personalized approaches to load reduction that shift or reduce kW while letting customers know they are still in control of their comfort, reducing concern about what DR program participation might mean. And the customer no longer needs to worry about scheduling an installation or being home for it.

Even if a customer does not have an eligible device already, bring-your-own (BYO) program costs should still be lower. This is because there is less for an energy provider to manage: connected thermostats can be easily found in retail locations, can often be installed by a customer, and since the customer owns the device, do not need to be maintained by the utility. Load control switches have never provided much value for the consumer, other than enabling them to participate in DLC programs. Older DR-connected thermostats may have some additional value beyond peak management, but consumers weren't putting them on their holiday wish lists. So, energy providers rolling out these

types of DR programs often have had to offer generous incentives and engage in expensive marketing campaigns. With the new generation of connected thermostats, utilities can reap the benefits of marketing done by manufacturers and retailers and take advantage of organic growth within the market.

One of the larger issues in BYOT programs is device choice. We anticipate that DR management platforms will continue to improve, enabling multiple devices to participate in programs without the need for many vendor-specific event management processes. That said, each technology integration can add cost to a program, and DR management systems come at a cost. These costs need to be balanced against the benefit of including products relatively few customers' desire. Marketing is also more difficult, since materials must be generic, covering a range of devices; some of the most compelling features of any one device are likely to be left out of communications.

As energy providers run pilot programs and program results are published, more information about customer preferences will be available. Early indications are that the majority of customers, when given a choice, gravitate to a very small set of products. Unless there is a large shift in customer preferences, the most likely outcome for large utilities is an "edited choice" model, where programs accommodate a small range of devices preferred by most customers. For smaller utilities, the complexity and cost of providing choice is more likely to outweigh the benefits since those costs will be spread over fewer customers, and we expect to see single-device programs with some frequency.

2.2.4.2 A Better DR Program

Older DR programs using one-way DLC devices (mostly paging switches and thermostats) have some challenges: They provide utilities with no visibility into the true load available at any given moment. They degrade over time due to device malfunction, removal, or disconnection. And most DLC switches only manage A/C consumption, limiting DLC to the summer months.

Thermostats enable a better DR program. They provide greater visibility. Because they are consumer-centric products, there are several built-in touchpoints to communicate with the customer about the program — in the mobile app, via a monthly home report email, or on the screen of the device itself. This allows for an immersive DR program experience for customers, and ongoing positive engagement. And it enables utilities to use DR programs to support overall customer satisfaction. A Nest survey of Rush Hour Rewards program participants found that more than half were happier with their utility provider after participating in the program.[15] That's right — their utility adjusted the temperature in their homes on peak days, and they were happier afterwards.

2.2.4.3 BYO Devices Can Do More

A thermostat isn't just a DR device. It's a platform for other offerings that can bring value. For utilities with EE goals, smart thermostats can also provide efficiency benefits. For example, independent studies showed that Nest saved US customers an average of 10% to 12% on heating and 15% on cooling.[16] Smart thermostats can also be used to help customer optimize their schedules and usage to time variant rates. For example, last year, Nest introduced Time of Savings to help customers save money on Time of Use rates. And Nest offers Seasonal Savings, an EE program running on Nest Thermostats that is a simple deployment over Wi-Fi. Other vendors provide a variety of offerings, too.

We believe that the future of energy programs is not "one product equals one program." Instead, a multitude of energy programs can be built on the smart devices customers are already purchasing for their homes. The presence of multiple benefits presents a business case for rebates that bring down the purchase price of smart thermostats, making them accessible to a greater portion of the market. And the more attractive the EE rebate

15 Nest Labs, Rush Hour Rewards White Paper. July, 2016. Pg 2.

16 Nest Labs, Energy Savings from the Nest Learning Thermostat: Energy Bill Analysis Results. Feb. 2015. <https://nest.com/downloads/press/documents/energy-savings-white-paper.pdf. Individual savings are not guaranteed.

and DR incentive are together the faster customers will move into these programs. It is not out of the question to think of a future world in which the EE and DR value of thermostats, combined with the downward trend in pricing, will lead to smart thermostats being free or nearly free. For DR, a larger installed base of devices simply means more latent capacity.

2.2.5 Conclusion

In this discussion, we've articulated a view of the future of a shifting residential DR landscape driven by the rise of successful BYOT DSM programs, utility focus on customer engagement and more sophisticated DER management, and a changing consumer appetite for connected products. We expect to see a strong cost effectiveness profile as rebate programs, technology innovation, and a general consumer trend towards connected products in the home result in a large installed base of ready devices that can run DR at a low cost. And because of the benefits to the consumer (comfort, convenience, savings) and to the utility (solid cost effectiveness, devices that can do more than just DR in one season, the potential for ongoing engagement, possible multiple programs enrollment, and impact on customer satisfaction), BYOT DR programs will become the norm.

What energy providers can do:

- Make sure that BYOT at scale is a part of your DR strategy; leverage compelling up-front incentives to encourage customers to install connected thermostats and enroll them in DR programs
- Keep it simple for you and for your customers by selecting a small set of thermostat options (go with the "edited choice" model)
- Look at thermostats as a platform: choose vendors that enable multiple value streams for customers and utilities

3.0 SOLUTION PROVIDERS AND PROGRAM IMPLEMENTERS

3.1 AutoGrid Perspective: The Future of BYOT Programs: From Thermostats To "Things"

More than 40 million US households will have a smart thermostat by 2020[17] and BYOT programs are fast becoming a staple of DR initiatives as utilities strive to manage, predict, and control flexible loads. In a report released in January 2016, Navigant Research predicted that the BYOT market would grow to $3 billion by 2020.[18] As the average price of smart thermostats drops, and adoption rates rapidly increase, BYOT programs will provide a cheaper and more customer-friendly alternative to traditional direct install programs, where a utility selects, purchases, and installs the thermostats.

As they support customer choice and give utilities the opportunity to deepen relationships with consumers who are increasingly becoming more tech-savvy and more eager to control their energy consumption, BYOT programs are sure to become increasingly popular. The same 2016 Navigant Research report projected that the number of US customers enrolled in BYOT programs would grow from 50,000 in 2016 to 20 million customers in 2020.[19]

While they are currently the most widely adopted smart home devices, smart thermostats are not the only connected assets that are changing the grid's infrastructure. Other customer-owned smart devices such as smart plugs, grid-connected hot water heaters, EV charging stations, and energy storage systems are also experiencing increasing adoption rates, fundamentally altering the grid and the relationship between energy providers and their customers. Like smart thermostats, these new connected assets can be ramped up and ramped down to shift or reduce peak usage, giving innovative utilities the opportunity to extend BYOT programs to many types of devices.

17 Parks Associates, "More than 100 million U.S. households do not have a smart home device." Parks Associates Research. May 3, 2017

18 Bring Your Own Thermostat Demand Response: Utility Technology Disruption Report. Navigant Research. Accessed Feb. 2018. https://www.navigantresearch.com/research/bring-your-own-thermostat-demand-response.

19 Id.

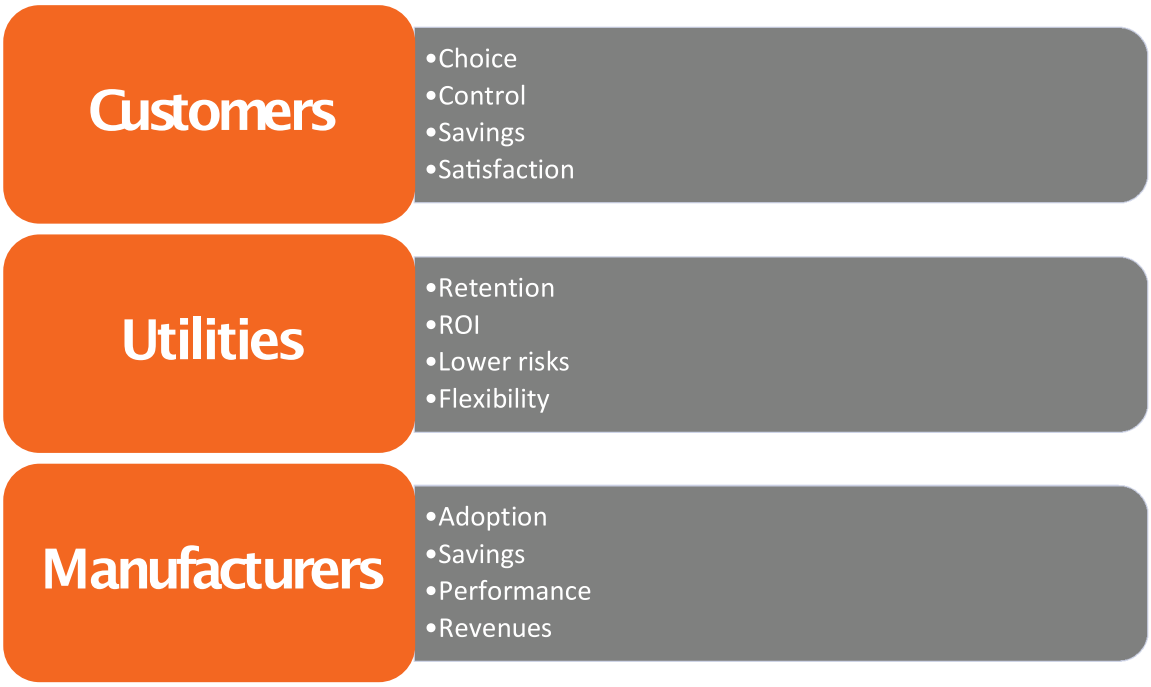


Figure 7 BYO Things Provides Options.

Many of the benefits offered by smart thermostats extend to these other connected assets, and utilities must design versatile and future-proof programs that can quickly expand to include multiple devices and customer types (Figure 7). Controlling more categories of customer-owned DER will allow utilities to co-optimize all types of DER (including thermostats) at the portfolio level, fully harness flexible capacity at the grid edge, create new value streams, and successfully transform their business models by offering new value-added services to their customers.

As the meaning of BYOT evolves from Bring-Your-Own-Thermostats to Bring-Your-Own-Things, expanded programs will deliver greater benefits not only to utilities, but also to their smart device partners and to their customers. For simplicity's sake, the acronym BYOT is used to describe these expanded Bring-Your-Own-Things programs for the rest of this article.

3.1.1 BYOT Programs Will Deliver Even Greater Value to All Stakeholders

While traditional direct install DR programs provide more control to utilities, the proliferation of expanded BYOT programs will demonstrate greater flexibility and deliver more value to all the stakeholders.

3.1.2 Customers Will Benefit from These Programs in a Variety of Ways

Expanded BYOT programs will deliver more choices and value to customers who can enroll all the smart devices they already have or want to purchase, rather than being limited to one or two brands, or to one or two categories of smart devices that have been pre-selected by their energy providers.

Incorporating more than one type of smart device in a BYOT program will allow utilities to provide flexible and targeted incentives to help customers reduce their costs of ownership. It will also allow customers to "stack up" savings from several assets, increasing the value of their enrollment in DR programs and maximizing the return on their smart energy technology investment. Furthermore, BYOT programs will provide additional financial benefits by giving customers the ability to bid their flexible resources into energy markets and generate new sources of revenue.

By streamlining the enrollment process for all smart devices in one program and on one platform, BYOT programs will also reduce the level of effort and

the amount of time required to take advantage of new utility programs. Speed and ease of use tend to increase program participation and customer satisfaction.

Finally, consolidating all assets in one BYOT program will allow utilities to better segment their customer base and offer more personalized, targeted, and flexible incentives. Savvy energy consumers will be able to leverage these new BYOT programs to better manage their energy use and reduce their environmental impact while saving money.

3.1.3 Bring-Your-Own-Things Programs Will Deliver Multiple Advantages to Utilities

By eliminating the need for direct installs, BYOT programs will reduce overall costs and require smaller initial investments than traditional DR programs. They will remove the need for utilities to bet on specific technologies and brands, lessening the risk of selecting products that do not get traction with customers and that can result in low enrollment rates, ultimately becoming stranded assets.

Working with several manufacturers and asset types will also allow utilities to provide more choices to their customers, boosting customer satisfaction, as well as program enrollment and event participation, and guaranteeing larger and more predictable load sheds. BYOT programs are often an entry point to other DR programs and help solidify customer relationships.

BYOT programs that include multiple assets will also leverage the marketing dollars and outreach efforts of multiple manufacturers, significantly reducing upfront investments for the utility. Combining all assets and customer types in one single program, rather than designing and managing programs for each asset class, will further reduce recruitment, enrollment, and program management costs.

Designing DR programs with several asset types will let utilities create "dispatch grade" programs that include large numbers of devices that can be co-optimized at the portfolio level. It will eliminate the risk of managing assets in silos and maximize the "network" effect of all the DER enrolled in the program. Utilities will be able to generate new revenue streams by aggregating more and a greater variety of DER and bidding them into energy markets.

3.1.4 Device Manufacturers Will Also Benefit from BYOT Programs

Expanded BYOT programs provide new avenues for manufacturers to market their products and increase their adoption rates. As they begin to share marketing expenses with utilities, they will significantly reduce their customer acquisition costs. The ability for their customers to generate additional revenues will make their products more desirable and cost-effective.

Another way for manufacturers to leverage BYOT programs will be to aggregate and monetize their asset portfolios by delivering flexible capacity to utilities or bidding it directly into energy markets. As more connected assets come online, BYOT programs will enable manufacturers to aggregate larger asset portfolios, providing more flexibility to utilities and generating new sources of revenue across the value chain.

By working closely with utilities to satisfy specific technical requirements, manufacturers can quickly improve their product design, performance, and integration options. Participating in expanded BYOT programs will allow them to significantly speed up that process so that they will be ready for new customer expectations such as the successor to app and voice control.

3.1.5 So How Can Utilities Design Successful and Future-Proof BYOT Programs?

A few simple program design rules can help utilities design successful BYOT programs that include not only smart thermostats but also other types of connected devices such as smart plugs, water heaters, energy storage systems, EVs and charging stations (Figure 8).

3.1.5.1 Keep It Simple

Given all the benefits that BYOT programs offer, launching a new program with multiple assets and customer categories may sound like a great idea to utilities ready to stack up multiple value streams and increase the overall ROI of their DR initiatives. But it can also complicate the initial program design and hide asset-specific issues. Some assets might perform better than others, some brands might be more successful than others; testing multiple assets at the same time is a lot harder than slowly adding new assets and brands to a smaller program.

Understanding the individual business cases for each asset and device manufacturer; as well as launching an initial program with a few devices will ensure the long-term success of a BYOT program. Adding new assets, devices, and customer types to a simple, successful BYOT program is easier than finding out what went wrong with a multi-asset program that failed.

Keeping the initial program simple and slowly adding new assets and customer classes is a way for utilities to guarantee the long-term success of their BYOT programs.

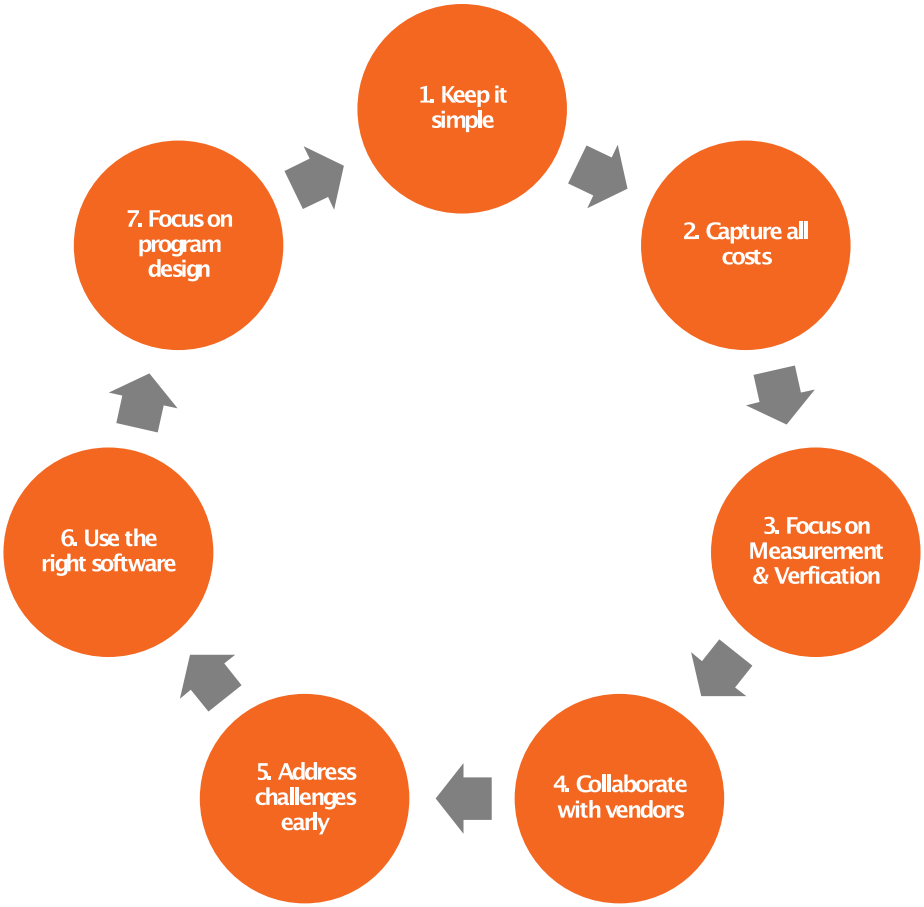


Figure 8 Seven Keys to Successful and Future-Proof BYOT Programs

3.1.5.2 Capture All Program Costs

While customers and manufacturing partners will bear some of the program costs, there are still many expenses that utilities need to include in their initial business cases: enrollment costs, program management costs, M&V costs, customer support costs, software costs, integration costs, etc.

Capturing all program-related costs for each manufacturer and asset type will help utilities launch programs with realistic ROI and eliminate "unexpected" surprises down the road.

3.1.5.3 Focus on M&V

Being able to measure the value of a BYOT program is crucial to the program's short and long-term success. To ensure success, utilities should:

- Identify and understand how to calculate the multiple value streams that their BYOT program delivers. Having a solid business case for each asset and manufacturer will allow utilities to design programs with a realistic ROI.
- Set a process to verify that the selected hardware works. Malfunctioning devices can dramatically reduce load shed and the value of a program.
- Put in place metrics that measure the efficiency of the customer incentives for each asset. Testing several incentives early is a good idea: pricing structure, rebates, behavioral incentives, etc.

Putting an M&V process in place will also help measure the program's ROI, improve the areas of the program that are not performing, and clearly communicate expectations to all stakeholders.

3.1.5.4 Collaborate with Service Providers and Manufacturers

Vendors play a big role in a program's success, so as programs expand to include more assets and partners, utilities will need to set clear expectations and provide all needed information to all their business partners. Sharing their M&V process and setting up communication processes that work for all parties will be key to ensuring the success of new BYOT programs.

Creating collaborative partnerships with their vendors will also allow utilities to leverage the device manufacturers' market knowledge and better understand customer expectations.

3.1.5.5 Address Recruiting Challenges Early

Segmenting their customer base and designing incentives that deliver value to each group of customers will help utilities maximize enrollment and ensure the success of their BYOT programs. Accurately calculating the costs of the incentives will also guarantee good returns on investment.

To deploy effective recruitment programs, utilities will also need to set up realistic and measurable weekly recruitment goals, and to think of alternative strategies that can quickly be put in place if weekly goals are not met. Sharing the enrollment results with their partners will allow utilities to readjust the messaging and incentives early in the campaign.

3.1.5.6 Use the Right Technology Platform

Flexibility management software that can manage and control all asset and customer types will help utilities design and run modular BYOT programs that can easily and cost-effectively be extended to enroll new customers and devices.

Integrating multiple asset categories, manufacturers, and customers in a single BYOT program will require utilities to invest in technology- and hardware-agnostic software that can optimize and control large and varied portfolios of distributed energy assets and DR resources from a single platform.

3.1.5.7 Focus on Program Design

Following steps 1 through 6 will allow utilities to design successful BYOT programs that:

- are simple and scalable;
- have a known and realistic cost;
- can be measured, verified, evaluated, and improved in real time;
- involve and leverage a wide range of partners and vendors;
- deliver value to all stakeholders; and
- can quickly and cost-effectively expand to new customers and devices.

3.1.6 Conclusion

The proliferation and accelerated adoption of new smart connected assets offer utilities a chance to deepen their relationships with and deliver value-added services to consumers who increasingly value choice, control, and cost savings. Thoughtfully designed BYOT DR programs that can easily expand to optimize and control large fleets of customer-owned smart devices — such as smart thermostats, smart plugs, energy storage systems and EV charging stations — will help utilities meet customer expectations and will play a key role in supporting new customer-centric utility business models.

In an increasingly distributed energy world, customer- and partner-friendly BYOT programs will also allow utilities to fully harness flexible capacity at the grid edge. Existing Bring-Your-Own-Thermostats programs are paving the way for expanded, multi-asset programs that are bound to become an important component of utility-wide flexibility management programs designed to integrate all types of DER, improve grid reliability, lower costs, and deliver cleaner electricity.

3.2 CLEAResult Perspective: Getting to Scale: Realizing the Potential of BYOT Programs

Smart thermostats offer a customer-centric opportunity for utilities to manage the load of their

residential customers. Today, 50,000 utility customers participate in utility-sponsored DR programs.[20] While this is an impressive figure, Navigant estimates the total market potential to be 20 million customers.[21] Bringing smart thermostat-based DR programs to scale is a great opportunity to meet multiple needs including capacity, load smoothing, peak demand, and overall reduction. In the near future, it's entirely likely that smart technology will allow utilities to manage multiple devices in the connected home. The smart thermostats, as the first piece of connected home technology to achieve market penetration, is probably the gateway technology to this eventuality. Smart thermostats are crucial to utilities' customer-centric future.

The BYOT (Bring Your Own Thermostat) program design eliminated the need to source and manage installation of devices. Doing so should simplify program design and allow for programs to scale easily. Because flexibility and customer choice are key factors for the success and continued development of BYOT programs in a fast-changing market, the programs themselves must be designed to adapt to technological changes and at the same time meet the diverse goals of the utilities in different markets.

Technology and market adoption will eventually drive the market and influence program design in favor of a BYOT design model. However, for programs to scale the following should be considered:

- Programs will be more successful if customers are offered flexibility around enrollment, commitment requirements, device offering, and incentive levels.
- Direct install program models can be used as an entry to customer engagement and set the stage for offering an opportunity to upsell other programs.
- Program designs should be focused on simplifying recruitment and ensuring ongoing participation.
- Programs will need to be customer-centric to scale.

The smart thermostat market continues to grow, both in terms of consumer adoption and available devices.[22] As smart thermostats move up the adoption curve, BYOT programs are likely to become more commonplace. But while these programs have been running since 2012 and have been discussed at length at industry conferences for several years, all but a handful of these programs remain in the pilot phase. Broad based deployments have not yet been offered. That said, uptake is improving as utilities are beginning to expand the funding and goals for these programs.

3.2.1 Designing Flexible Programs

For BYOT programs to attain the 10 percent market adoption predicted by Navigant[23], the key will be in offering programs that give customers retail choice and price point options. It is important that programs offer a wide array of thermostats with a range of capabilities. While early adopters may be willing to pay $250 for a smart thermostat, others may be challenged to pay $150 after a $100 rebate. Lower priced models may not offer all the benefits of a Nest or ecobee such as occupancy sensors, styling and learning algorithms, but if they have Wi-Fi connectivity and remote-control functionality, they should be able to participate in DR programs. Recently both ecobee and Nest have released lower priced alternatives, aimed at competing with lower priced alternatives from such brands as Honeywell, Emerson, Zen and Alarm.com. When it comes to BYOT programs, a larger selection of smart thermostats equals a larger market segment of existing thermostat owners who can participate. This also allows the customers purchasing a new thermostat to choose a price point, design and set of features that meets their specific needs.

20 Bring Your Own Thermostat Demand Response: Utility Technology Disruption Report. Navigant Research. Accessed Feb. 2018. https://www.navigantresearch.com/research/bring-your-own-thermostat-demand-response.

21 Id.

22 https://www.greentechmedia.com/research/report/energy-in-the-connected-home-2015

23 https://www.navigantresearch.com/research/bring-your-own-thermostat-demand-response

The incentive offered to entice participants to purchase the device should be adjusted to minimize costs and maximize enrollment. Finding that intersection can be complicated and may vary based on location, demographics, and program goals. Energy costs, average income levels, prevalence of energy programs and target demographics can all play into setting the precise incentive levels for a utility's BYOT program. A free, or highly incentivized, device makes a BYOT program easy to market, and results in low opt-out rates, but utilities may strand assets along the way.

3.2.2 Marketing and Customer Acquisition

The two potential BYOT program participants are those customers who have already purchased a thermostat, and those who would like to have one, but need a push in that direction. The latter group can be incentivized to purchase a smart thermostat through the program and install it themselves. The easiest to engage are those customers who are known to already have smart thermostats in their homes. Manufacturers working with the utility program know where their devices are located, who the customers are and how to reach them. In many cases they own and nourish the relationship.

Most manufacturers are willing to engage their customers and even provide outreach on a program's behalf. It's possible that early adopters of the technology are excited about their purchases and have a positive relationship with the manufacturer and are therefore more open to communication about the device from the manufacturer. The utility can leverage this positive relationship of the manufacturer by promoting the partnership. Manufacturers will often charge the utility a fee to enroll their thermostats in a BYOT program, an expense that must be considered when calculating cost effectiveness. Initial high enrollment rates may be a one-time bump that can be leveraged at the programs onset. However, the rest of the market still needs to be reached. This is the real challenge–and the greatest opportunity.

The second type of potential participant is the customer who's willing to participate, but who will need to purchase a thermostat and self-install it. This group requires a high level of education. It's important that the process is as easy and seamless as possible. Any administrative difficulty can result in the potential participant dropping out entirely. Retail marketing, whether it be online, or brick-and-mortar needs to be fast, easy and offer the customer choices. Not all thermostats are easy to install, and this should be taken into consideration when developing the hardware offering. A difficult installation process can result in a negative perception of the program. Assistance and education is key to moving customers through this stage to enrollment.

There will always be a segment that won't be willing to self-install but will be unwilling to pay for the expense of professional installation. This group requires a high level of education and perhaps installation. Offering an installation component to a program allows a BYOT program to reach more customers. Incentives can be adjusted to accommodate this audience segment, a decision the utility can make depending on the customer base, program size and goals and budget.

Kansas City Power and Light's program in Missouri offers three different participation channels, ensuring that all customer's needs are addressed. About 20 percent of their participants choose to have a thermostat professionally installed through the program. 80 percent receive their thermostat through the program and then install it themselves. Participation from homeowners who previously purchased a thermostat and then signed up for the program is a very small percentage of participants. Moreover, the utility has found that performing the thermostat installations, and having direct personal contact with individual customers presents an opportunity to market other residential programs.[24]

3.2.3 BYOT Benefits

One benefit of a BYOT program is that it can be significantly more cost effective than a direct install program. BYOT programs take advantage of a technology that is being quickly adopted and that customers are willing to obtain on their own.[25]

24 https://www.clearesult.com/insights/case-studies/kcpl-thermostat-program-case-study/

Targeting customers who already own the technology reduces marketing and acquisition costs, a historically large line item for residential programs.[26] Greater savings can be obtained by not having to roll a truck for installation. In theory, a BYOT program should have lower expenses, since they require no labor for installation, and they carry a smaller demand in terms of administration costs, work order management systems, office space and other resources.

Leveraging existing EE programs is another way to reduce the acquisition costs involved with BYOT programs. Customers with smart thermostats already installed through an EE program, or those who have already taken actions to improve the efficiency of their homes, are more likely to participate in BYOT initiatives.[27] The cost of acquiring new customers is high. Upselling existing customers is cost effective and intuitive. However, utilities haven't traditionally cross promoted programs due to the internal organizational structure of utilities and operational silos.

3.2.4 Moving Beyond System and Data Challenges

Many of the obstacles BYOT program face are not specific to smart thermostats or the bring your own component; rather, they are endemic to DR programs. Often, it is simply the problem of integrating hardware with software. The process of integrating DRMS with each thermostat manufacturer—and then with each individual model—is costly and complex. To circumvent these challenges, some utilities have focused on offering devices from, but this reduces options in terms of functionality and price. Integration should get easier as DRMS providers gain more experience and expand their portfolio of manufacturers they work with. With replication, the process becomes easier, but with each new thermostat model, DRMS integration needs to be revisited. At some point, utilities will likely insist that manufacturers offer a truly OpenADR compliant device or cloud-based device so that the integration costs of the DRMS become less prohibitive.

Another challenge is that of sharing data between the utility, the administrator and the DRMS provider. Utilities struggle with data sharing limits from third party administrators and technology providers, and the systems' ability to provide clean data sets in usable formats to third parties. With technology companies collecting vast amounts of personal data about customer preferences, habits, occupancy, systems, and real-time usage, there is a debate about who owns this data and how it can be shared between customers, utilities, and manufacturers. Without full insight into the data, it's difficult for utility providers to realize the true potential of BYOT programs. Solutions need to be reached that protect personally identifiable information, are secure, and yet allow for utilities and administrators to improve program design and maximize positive customer engagement.

3.2.5 Conclusion

Going forward it's likely there will be less of a need for direct installation of hardware as retail forces and technology adoption tip the market. There could be a point where the norm would be BYOT program designs, but that doesn't mean that utilities should follow that tract. As utility business models change and utilities' roles and relationships with their customer change, utilities will want to take every opportunity to act in the role of the trusted advisor and full-service coordinator.

- Offer an installation option to provide those 10 percent of the customer base who want it. Installation services will pay off as an opportunity for the utility to be the provider not just of energy, but of energy value and expertise.
- Offer different incentive levels in exchange for participation flexibility. Let customers choose how committed they want to be.
- Leverage marketing from other EE programs to reduce costs and offer a seamless customer experience.

25 https://www.greentechmedia.com/articles/read/smart-thermostats-start-to-dominate-the-market-in-2015

26 CLEAResult internal program data

27 CLEAResult internal program data

- Focus on the customer experience to retain customers and reduce opt-out rates.
- Use data insights to improve program design and maximize results.

Programs with flexible designs that consider consumer behavior will drive integrated energy options for homes and their occupants.

3.3 EnergyHub Perspective: BYOT — The Future of DR

Growing access to broadband internet service is playing a significant role in the adoption of connected thermostats. In 2016, 73 percent of U.S. adults used broadband internet in their home, compared to only 65 percent in 2012.[28]

As broadband has expanded into American homes, so too have connected thermostats. More than 40 percent[29] of thermostats sold to homes with broadband are internet-connected, and Parks Associates research estimates there will be connected thermostats in more than 40 million households by 2020.[30]

Considering the proliferation of connected thermostats, the growing number of people with affordable internet access, and the increasing penetration of digital technology in everyday life, a DR strategy that builds on these trends is vital for any utility looking to achieve programmatic success. Utilities must accept that BYOT programs don't simply have a role in the future of DR — launching and sustaining BYOT programs *is the future* of residential DR.

BYOT DR is already having an impact at scale for utilities today. Last year, Southern California Edison unveiled a plan using a BYOT DR program that aimed to supply up to 50 MW of DR to combat the effects of the Aliso Canyon gas shortage.[31] This is a clear indication that major utilities see BYOT programs as a reliable resource in the face of grid emergencies.

How will BYOT evolve from its early success? Utilities should plan for three realities:

- The dominance of the smartphone in digital marketing makes connecting with customers easier and more cost-effective than ever before.
- The continual expansion of device choice for customers greatly reduces the appeal of direct install programs that offer only one device choice.
- The inevitable impact of residential customer-owned DER, and IoT, will expand the types of customer-owned devices that utilities want to control beyond thermostats.

3.3.1 The Impact of the Smartphone on BYOT

Nearly two-thirds[32] of Americans own a smartphone. A recent study[33] from the mobile analytics firm Flurry shows the average consumer spends nearly five hours per day looking at their mobile device, with that figure steadily growing since 2013. This growth has created a unique opportunity for utilities to directly reach digitally inclined customers with BYOT DR program offers.

A smartphone-focused marketing campaign gives utilities launching BYOT DR programs access to multiple advertising avenues, including email, in-app offers[34], paid search, and social media. These platforms have the potential to engage utility customers in ways that have been unavailable to utilities in the past. In-app offers and social media show strong signs that they can drive recruitment and enrollment for BYOT DR programs.

28 Pew Research Center, "Internet/Broadband Fact Sheet." Pew Research Center. January 12, 2017

29 Parks Associates, "Over 40% of thermostats sold in 2015 will be smart thermostats." Parks Associates Research. July 15, 2015

30 Parks Associates, "More than 100 million U.S. households do not have a smart home device." Parks Associates Research. May 3, 2017

31 Walton, Robert, "SCE, Nest partner on virtual power plant to mitigate Aliso Canyon gas shortage." Utility Dive. September 16, 2016

32 Smith, Aaron, "U.S. Smartphone Use in 2015." Pew Research Center. April 1, 2015

33 Kesiraju, Lali; Khalaf, Simon, "U.S. Consumers Time-Spent on Mobile Crosses 5 Hours a Day." Flurry Analytics Blog. March 2, 2017

34 In-app offers allow consumers to purchase extra content or subscriptions while using the applications on mobile devices or computers.

3.3.2 The Advantages of In-App Advertising

One effective way to get in front of customers is through in-app offers within a connected thermostat's native app — commonly referred to as an interstitial. An interstitial is a full-screen advertisement (sometimes including a form) that populates on a user's screen based on certain criteria — in most cases the location of the user (by zip code) and the type of thermostat the customer is using.

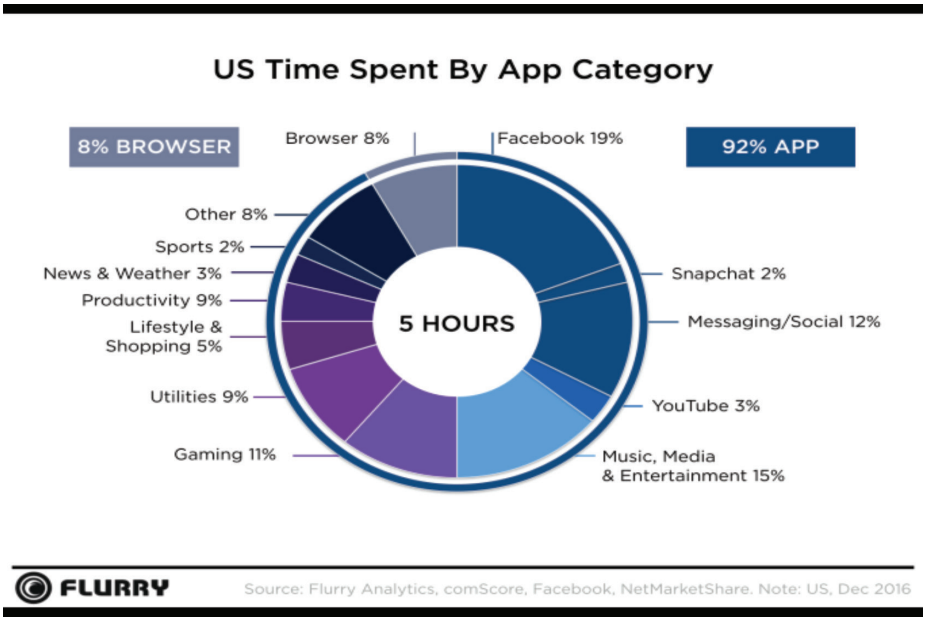


Figure 9 Typical Consumer's Smartphone Time.

The highest-functioning interstitials typically require no more than one click for a customer to sign up. Bringing a BYOT DR program offer directly to the customer through a native thermostat app is valuable for several reasons:

- Connected thermostat owners open their thermostat app about once a day, on average, according to internal EnergyHub program data.
- The customer who opens their native thermostat app is thinking about their energy use at that exact moment — they are fully engaged and more likely to accept an energy-related offer from the utility.
- The utility is offering the customer something of value that is likely to create a positive feeling for the customer.
- The offer requires little additional information and effort from the customer, so it is easy for them to click through to accept and get back to the app.

The ease of a simplified, one-click process, and the ubiquity of app use for connected thermostat owners, has led to mobile signups accounting for as many as two-thirds of enrollments in some of EnergyHub's BYOT DR programs.

3.3.3 Leveraging Social Media for BYOT DR Program Enrollment

As seen in the Figure 9 below, nearly 20 percent of a typical consumer's smartphone time is on Facebook.[35] Given the dominance of Facebook as a social media platform, wise utilities will construct and implement social media marketing campaigns to acquire customers for BYOT DR programs.

Facebook enables utilities to target users based on age, gender, zip code, interests ("Likes" on Facebook), and more. This granular targeting capability provides an opportunity for utilities to create relevant advertisements for customers that specifically appeal to each customer's interests when recruiting for BYOT DR programs.

Paid advertisements on Facebook often look very similar to common user posts on the network, which gives them an authentic look, as opposed to banner ads, which are placed off to the side of the Facebook

35 Kesiraju, Lali; Khalaf, Simon, "U.S. Consumers Time-Spent on Mobile Crosses 5 Hours a Day." Flurry Analytics Blog. March 2, 2017

timeline (or another website) and often ignored.[36] Facebook ads that offer consumers an incentive on a thermostat or a credit on their utility bill have a great hook. EnergyHub-led programs have yielded click-through-rates for social media advertising (the rate in which customers click on an ad and complete the associated action, known as CTRs) as high as 1.82 percent, better than the average CTRs in the technology (1.04 percent) and retail (1.59 percent) sectors.[37]

3.3.4 The Inevitability of Choice

American consumers today benefit from increased choice across almost every consumer goods category. As markets have shown in recent history — telecom, for instance — when customers are presented with a diverse set of choices, they are no longer happy with limited options. The same is holding true for connected thermostats. As more connected thermostats come to market and the price of those devices decrease, consumers have unprecedented access and choices, and no longer find it appealing to have only one option.

Utilities looking to scale their DR program need to respond to the customer's desire for choice by including many different types of thermostats in their program design. The concept of choice applies not only to types of thermostats, but to where consumers buy those thermostats. By ensuring a wide variety of thermostats are eligible for a BYOT program, utilities ensure consumers can purchase an eligible thermostat through the channel of their choice — whether it is through a retailer, an online store, a home security company, or an HVAC tradesperson.

Utilities with the most successful BYOT DR programs across the country have already realized the importance of customer choice. Some programs, such as New York State Electric & Gas and Rochester Gas & Electric's Smart Savings Rewards program or El Paso Electric's eSmart Thermostat Program, offer customers as many as eight connected thermostat options.[38]

3.3.5 Expanding the BYO Model into DER and the Connected Home

As the cost of EVs, residential solar panels, connected water heaters, and other DER continues to decline, utilities should expect to see many of these technologies follow an adoption curve similar to connected thermostats. By 2020, industry researchers at Parks Associates estimate there will be more than 40 million connected thermostats installed in the United States[39] while experts at Greentech Media project that domestic residential solar installations will account for nearly 30 percent of installed solar capacity by 2022.[40] Across all technologies, Navigant estimate[41] the global market of DER will expand from 109.9 GW in 2015 to 335.8 GW in 2024.

The transition from BYOT to Bring Your Own Device (BYOD) provides utilities with access to a wider portfolio of grid-edge assets for grid services. Flexible DER, including EVs, energy storage systems, grid-interactive water heaters, and other grid-edge devices, provide utilities with a variety of grid services, including frequency regulation, load shifting, and feeder congestion relief.

Utilities already managing successful BYOT programs are better equipped to launch BYOD programs that leverage the grid service potential of grid-edge DER as they become more common. Processes and platforms put in place for BYOT, as well as program design and management experience developed in launching BYOT programs, can be easily leveraged to build successful BYOD programs.

36 Nielsen/Sharethrough, "A neuroscience perspective: Assessing visual focus, message processing & the ability to strengthen associations through mobile native advertising." Nielsen/Sharethrough. 2015

37 Irvine, Mark, "Facebook Ad Benchmarks for YOUR Industry [New Data]." The Wordstream Blog. Originally published Q1, 2017.

38 EnergyHub, "Enroll My Thermostat" website used by EnergyHub clients for BYOT programs. EnergyHub. 2017

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3.3.6 A Look into the Future

A decade from now, a significant percentage of people in the United States will have some type of grid-edge device installed in their home — and the connected thermostat will be the most popular of those devices.

Customers will be able to easily enroll their devices in BYOT and BYOD grid service programs — some because they were served an advertisement on Facebook or another social media platform, and others because they received a solicitation in their device's app.

Leading utilities will be managing millions of customer-owned devices in BYOD programs, which will give utilities flexibility to provide various grid services, including DR, solar monitoring, load shifting, and more.

Progressive utilities will have laid the groundwork through BYOT programs to use the BYO concept to create a two-way relationship with customers who have all types of DER, allowing both parties to benefit.

3.4 Itron Perspective: Understanding the Role Bring Your Own Thermostats Play as Part of a Distributed Energy Resource Strategy

The proliferation of DER is a dominant topic among executives at electric utilities. In a recent Utility Dive study[42], "a whopping 84 percent of utilities predict that DER will also increase as part of their overall fuel mix." Technology evolution and catalysts like environmental regulations and customer optionality are inevitably pushing the landscape of the electricity industry toward a more distributed future.

> "The fast growth of [DER] is one of the most disruptive forces that has affected the power utility industry to date"- Navigant Research"[43]

When people hear the term DER, they typically think of residential customers putting solar panels on their rooftops, backup generation at large commercial and industrial customers or using batteries for storage. However, looking at the Electric Power Research Institute (EPRI)[44] definition of DER as "smaller power sources that can be aggregated to provide power necessary to meet regular demand" it sounds very much like residential or mass-market DR. As the DER landscape is changing so too is DR.

For decades, residential DR programs provided peak load reduction by remotely controlling the operation of HVAC systems as well as other high-energy-use appliances. The incentive for customers was most often a fixed payment in exchange for giving the utility the ability to control the appliances for a predefined number of hours per year. The utility installed a remotely controllable device, either a switch or a thermostat, at the customer's home that provided predictable load reduction with a known load shape for the duration of an event.

Over the past few years, customers have started buying Wi-Fi-connected thermostats that offer convenient web programming and potential opportunities for heating and cooling bill savings. These customer-purchased devices are reshaping DR program economics because utilities no longer have to purchase and install the equipment for customers (i.e., the upfront costs are significantly lower than the traditional model).

These BYOT programs also give utilities a tremendous customer engagement opportunity to provide value-added services to customers who own these devices. Customers have indicated they want

42 Utility Dive: State of the Electric Utility 2015

43 Navigant Research: DER Management Technologies 4Q 2016

44 EPRI Web site: Distributed Energy Resources

options when it comes to participating in utility energy management programs. BYOT programs are a perfect opportunity to give customers that flexibility. However, these customer-owned devices sometimes come with some use restrictions not found in direct install programs.

3.4.1 Understanding Resource Performance Requirements

As utilities look to use a portfolio of DER for improved grid management, more profitable energy trading and firming renewables, it is critical to understand how the resources work together to ensure a successful approach. Each DER has specific characteristics, such as dispatchability and durability that must be considered to understand how they best work in conjunction with each other.

For demand-side resources to effectively contribute to balancing, utilities require insight into the available load from various resources at any given time. It's also important to consider the amount of lead time required to dispatch the resource and the duration it can perform. Resources with less lead time are more flexible and hence more valuable than long lead time options.

Also, inherent in predictability is the shape of the load during the period of use and during the recovery period following an event when load snap-back will occur. For example, an aggregated demand resource that exhibits a net load reduction over some period of time—but does so with periods of high reduction combined with periods of low reduction, or even increased usage—would not be as valuable as a flat load shed throughout the event period, since these variations must be offset using fast responding regulation or similar high-value assets. Furthermore, some devices or offers to customers may present restrictions that hinder predictability of the load shape.

As an example, Wi-Fi thermostats have much simpler operating characteristics than batteries or solar. Also, Wi-Fi thermostats purchased by the consumer in a BYOT model perform differently than DLC switches and direct install thermostats. The ability of individuals to opt out of control events is much easier than with traditional DR resources. Additionally, working with a diverse set of vendor devices with different performance characteristics requires sophisticated software to manage. Once the utility understands each category of asset's characteristics, it can then develop strategies to best utilize them as part of a comprehensive DER strategy that provides maximum benefit to the utility and its customers.

3.4.2 BYOT Control Event Performance

Customers that join a DR program and receive a utility-provided, direct-installed device opt out of DR events less than one percent[45] of the time. In contrast, customers with a BYOT device opt out of DR events approximately 20 percent[46] of the time. In addition to only briefly curtailing load, customers who opt out of a DR event have an adverse impact on the performance of a control event because once they opt out, there is a "snap-back" to return the home to the selected temperature, which causes a near-term spike in energy use. To mitigate opt outs, utilities should implement incentive structures or other barriers that discourage this behavior. One method would be to only compensate customers for how well they perform during a control event. Another approach would be to implement a system that uses advanced analytics and machine learning for forecasting, which can provide superior insight into how these devices will perform, helping offset some of the limitations.

Utilities must make certain to have a strong grasp of each thermostat manufacturers' willingness to control their device owners' thermostat. The devices are controlled through the device manufacturers' head-ends, with some manufacturers offering control at a granular device level while others offer aggregated control with limited precision or options. These characteristics are best addressed and accounted for in a DR management system or

45 "Switches vs. Thermostats: What role does behavior play in terms of demand savings?" Cole Willis, Indianapolis Power & Light and Olivia Patterson, Opinion Dynamics, PLMA Fall Conference, April 5, 2017.

46 Id.

distributed energy resource management system with the ability to forecast potential available load.

3.4.3 BYOT and Other DER

The goal of a utility DER strategy is the profitable and reliable coordination of solar, storage and DR resources to optimize grid resources while taking into account customer comfort and efficiency. Since BYOT can have less predictable performance during control events, it's important to understand how DER can mitigate this. A software platform that can provide a view into how all assets are performing so the control event operators can course correct as needed is important.

3.4.3.1 Direct Install DR Devices

In a traditional DR program enabled by utility-purchased and installed devices, customer flexibility in opting out of events is often restricted. For example, customers may be required to call the program call center prior to or during a control event to opt out, which leads to opt-out rates below 1 percent.[47] Given the reliability of this resource, it can be used to offset any BYOT devices that underperform during a control event.

3.4.3.2 Storage

While storage is often criticized for being an expensive grid resource, prices are coming down and its flexible nature brings significant value. Storage provides several benefits for DR. In relation to BYOT programs, the number one benefit is the flexibility it can provide to compensate when there is a potential shortfall. This becomes particularly important if there are a substantial number of opt-outs early on during a control event, which can cause significant problems, as detailed earlier. The flexibility of storage to rapidly bring power back to the grid is a tremendous asset in this case.

3.4.4 Conclusion

It is imperative that utilities understand the impact of opt-outs on BYOT programs and how to work with a variety of devices that offer different levels of control. It is also important to understand that customer-purchased Wi-Fi-communicating thermostats have yet to achieve widespread adoption, so the BYOT model's ability to meet large-scale megawatt requirements is limited. As more customers buy them, as the devices themselves continue to evolve, and as new approaches to managing opt-outs are adopted, the scale and performance of BYOT programs will improve. In today's environment, however, utilities would benefit from including BYOT as part of a strategy that is comprised of other DER, such as direct install DR assets, solar, storage and EVs.

47 Id.

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AutoGrid builds software applications that enable a smarter Energy Internet. The company's suite of flexibility management applications allows utilities, electricity retailers, renewable energy project developers and energy service providers to deliver cheap, clean and reliable energy by managing networked distributed energy resources (DERs) in real time and at scale. AutoGrid Flex has more than 2,500 megawatts of DERs under contract with more than 30 global energy companies around the world. The world's leading energy companies including National Grid, Florida Power & Light, Portland General Electric, CPS Energy, and NextEra Energy, rely on AutoGrid applications to monitor, predict, optimize and control the operations of millions of connected energy resources. www.auto-grid.com

CLEAResult

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CLEAResult is the largest provider of energy efficiency programs and services in North America. Through proven strategies tailored to clients' unique needs and market dynamics, the combined strength of experienced energy experts and technology-enabled service offerings help CLEAResult change the way people use energy for hundreds of utility and business partners. Founded in 2003, CLEAResult is headquartered in Austin, Texas, and has close to 3,000 employees in more than 70 cities across the U.S. and Canada. CLEAResult is a portfolio company of General Atlantic, a leading global growth equity firm. For more information, visit clearesult.com.

Commonwealth Edison

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Commonwealth Edison Company (ComEd) is a unit of Chicago-based Exelon Corporation (NYSE: EXC), the nation's leading competitive energy provider, with approximately 10 million customers. ComEd provides service to approximately 3.9 million customers across northern Illinois, or 70 percent of the state's population.

Encycle

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Encycle has provided commercial, industrial and institutional consumers with sophisticated HVAC sub-metering and control solutions since 2008. Using its patented Swarm Logic® technology, it manages HVAC loads cooling 35 million square feet of space across hundreds of buildings in the U.S., Canada and Japan. Its demand management and demand response algorithms are all connected to the Encycle cloud, with certified OpenADR integration to many leading utilities such as NV Energy, Southern California Edison (SCE), Pacific Gas &

Electric (PG&E), Hawaiian Electric Company (HECO) and San Diego Gas & Electric (SDG&E). Encycle is firmly in the IoT and BYOT space, with Swarm Logic integrated with smart thermostat manufacturers such as Honeywell, Carrier, and Zen Ecosystems.

EnergyHub

Working with leading utilities, EnergyHub designed, developed, and popularized the BYOT model with utility customers and energy thought leaders beginning in 2012. No company manages more BYOT programs than EnergyHub, with more than 30 utilities using EnergyHub's Mercury DERMS platform to manage their demand response program.

Itron

Itron has been deploying demand response (DR) programs for more than 20 years. In that time, the company's proven expertise and innovative solutions have helped deliver successful collaborations with more than 500 leading utilities, including Pepco Holdings, Duke Energy and San Diego Gas & Electric. In the field, Itron has deployed 3 million energy management devices and enrolled more than 2 million customers in demand response programs. Through this experience, Itron has developed a deep understand of how to deploy successful demand response programs. A key differentiator for Itron is the experience running pay-for-performance demand response programs. The lessons learned from only being compensated if DR programs perform over time means that the company thinks about demand response like a utility committed to low rates and reliable service.

Nest

Nest is a leading provider of connected thermostats. We work with dozens of utilities in North America and around the world on demand response and energy efficiency programs. Today, millions of customers in the US have access to a discounted or no-cost Nest Thermostat through a utility program. In 2013, Nest launched a DR offering, Rush Hour Rewards. In 2017 we are running more than 35 Rush Hour Rewards programs for energy providers across North America. And in 2016 we launched Time of Savings, a time of use enablement solution that leverages the Nest Thermostat. We have deep experience working with utilities on both BYOT programs generally, but also broadly within the load management space.

Xcel Energy

Xcel Energy provides the energy that powers millions of homes and businesses across eight Western and Midwestern states. With its Wisconsin/Michigan headquarters in Eau Claire, Wis., the company is an industry leader in responsibly reducing carbon emissions and producing and delivering clean energy solutions from a variety of renewable sources at competitive prices. For more information, visit xcelenergy.com or follow us on Twitter and Facebook.