Integrated Energy Efficiency and Demand Response Programs

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Executive Summary

KEY TAKEAWAYS

- Despite multiple benefits for customers and grid operators, the number of utility integrated energy efficiency/demand response (EE/DR) programs is small.
- Rapid technological advances and utility industry transformation are creating new opportunities for integrated EE/DR programs.
- Residential smart thermostat programs are prevalent among current EE/DR offerings. They provide demand response (DR) capabilities along with home energy management.
- Organizational changes and supportive regulation will be needed to overcome barriers to integrated programs.
- The benefits of integrated programs include fully capturing the resources' value streams, more efficient administration, and a streamlined customer experience. Administrators should pursue these programs when the net benefits outweigh the costs of integration.

MOTIVATION FOR INTEGRATING ENERGY EFFICIENCY AND DEMAND RESPONSE

The electric utility industry is undergoing a fundamental transformation due to advances in technology, changing customer preferences, and market developments. The rapid growth of distributed energy resources (DERs)—including renewable generation and energy storage—is fueling this transformation.[1] As more renewable and other distributed resources become part of the supply and distribution systems, the grid needs greater flexibility so it can respond dynamically and reliably to meet customer demand at the lowest reasonable cost. Energy efficiency and DR both provide necessary grid services. While integrating them in the same utility program may reduce some value streams associated with each resource, it can also create new value streams and increase efficiencies and existing benefits.

BENEFITS OF INTEGRATED EE/DR PROGRAMS

Integrated EE/DR programs can benefit customers, program administrators, and system operators. Customer benefits include utility bill savings, easier program participation, increased resource and service options, and greater satisfaction. Integrated programs help program administrators increase impacts and reduce costs through more streamlined, coordinated communications and integrated services. Utilities and other grid operators benefit through reduced system costs, improved reliability, and optimized grid performance.

[1] *Demand response* encompasses various customer actions taken to reduce or shift electric load in response to signals or requests from a utility or system operator. This typically is done to provide load relief at a time of high system demand. *Energy efficiency* signifies measures and technologies implemented by customers that reduce the amount of energy used whenever the device is operated.

ENABLING TECHNOLOGIES

Several new technologies are facilitating the integration of energy efficiency and demand response programs. They include smart thermostats and Wi-Fi-enabled appliances and devices such as water heaters, refrigerators, clothes dryers, and air conditioners. This equipment allows utilities to simultaneously enroll customers in DR programs and provide energy efficiency incentives such as rebates for efficient appliances. Direct load control (DLC) switches and automated DR (ADR) for HVAC equipment remain critical for DR programs and therefore for integration. Finally, advanced metering infrastructure (AMI) supports integrated programs by enabling time-varying rate designs, customer targeting, and advanced feedback for energy management, which in turn enable new program and market models.

DEGREES OF INTEGRATION

Our review of 22 integrated programs shows widely varying integration levels. In order of increasing integration, they are

- A stated recognition of energy or demand reduction capabilities
- Cross-promotion of energy efficiency and DR programs
- Administrative integration, including leveraging energy efficiency, DR, and DERs for a targeted need
- A single program offering both energy efficiency and DR

We found few examples of programs at the highest integration level. Smart thermostat programs were the most prevalent type of program we reviewed, and we found examples of them at almost every integration level. Enabling customer's energy management was a common theme, showing up in smart thermostat programs, behavior/home energy report programs, and real-time energy management system programs. Most of the programs we identified as integrated are those serving residential customers. We identified only six programs focused specifically on the commercial or industrial sectors, and they fell across the full spectrum of integration.

REGULATORY AND POLICY CONTEXT

The policy and regulatory environment can be a strong driver for integrating programs. State or local policies such as energy efficiency resource standards (EERS) or spending requirements inform portfolio design. Both energy efficiency and DR can provide peak demand reductions, but the time, location, and nature of energy efficiency and DR—as well as how they fit into the taxonomy of load management—create different value propositions for the resources. Setting multiple goals and performance-based incentives for an integrated portfolio of energy efficiency and DR can ensure that utilities are appropriately incentivized to pursue both. Successful integrated programs can further influence this environment and facilitate the development of more supportive policies and regulation for greater EE/DR integration.

CHALLENGES

Program administrators may face several challenges as they try to implement integrated EE/DR programs. Most utilities have separate internal teams that work on DR and energy efficiency. Communicating and coordinating efforts between teams can be difficult, especially when each team has its own budget and is working toward its own goals. Evaluating integrated programs may also be problematic, as efficiency and DR typically have separate savings targets, budgets, and evaluation metrics and methodologies. For customers, efficiency and DR can seem to have diverse or conflicting objectives, and the difference between saving energy through efficiency measures and reducing demand at specific times can be confusing. Other customers may be concerned that efficiency will reduce their bill credits for shifting load during DR events. Enabling technologies such as AMI can add to this confusion if rollouts are delayed or subject to technical glitches.

CONCLUSIONS AND RECOMMENDATIONS

Rapid advancement and proliferation of grid-interactive technologies can help utility operators to reshape customer load profiles. Further, they can do so with little to no noticeable loss of the desired outputs and functions of electric devices and equipment, including those that provide lighting, cooling, or heating. Grid-interactive technologies can do all of this in a way that also delivers energy efficiency's bill savings, comfort, and health benefits.

However designing and implementing integrated EE/DR programs requires fundamental changes in the organization and in customer program operations. Program staff and resources must be consolidated, and additional supportive regulation and rate structures are needed.

To facilitate the growth of integrated EE/DR programs, we recommend the following:

- Build support for integrated EE/DR programs among regulators, customers, stakeholders, and program allies through education about their value and benefits.
- Address the potential conflict between energy efficiency and load shift compensation through program designs that fully capture the value of integrated EE/DR resources.
- Enact regulatory changes that support integrated EE/DR programs, such as rates and rate structures that reflect time-varying costs.
- Enact organizational changes within utilities and other program administrators that support implementation of integrated EE/DR.
- Develop industry guidelines, metrics, and practices for assessing integrated EE/DR program impacts, value, and cost effectiveness.
- Document and share results from integrated EE/DR programs.
- Pursue integrated programs when the net benefits (e.g., fully capturing the resources' value streams, more efficient administration, a streamlined customer experience) outweigh the costs of integration.

Introduction

The electric utility industry is undergoing fundamental changes in all aspects of producing, transmitting, and delivering power to customers. The traditional utility model is rapidly transforming. According to the Northeast Energy Efficiency Partnerships (2016), we are witnessing a "revolution in customer engagement" through a proliferation of connected devices including smart phones, smart thermostats (connected/learning), water heaters, heat pumps, energy management systems, advanced HVAC equipment and controls, and energy storage.

As more renewable and other distributed resources become part of the supply and distribution systems, the grid needs greater flexibility and ability to respond dynamically to meet customer demand reliably and at low cost. The grid will no longer be primarily a one-way flow of large, centralized power. An increasing number of customers can produce and provide electric resources into the grid through on-site generation (e.g., photovoltaics) as well as through demand management. At the same time, utilities and grid operators are facing the massive challenge of replacing or upgrading existing grid infrastructure, particularly as power demand flattens and, in some areas, declines.

Various smart technologies are giving customers and utilities new analytical and control capabilities and enabling two-way communications and interactions.[2] They also allow utilities to optimize system operation as power needs and supplies vary. This is especially important as a greater share of generation comes from variable sources such as wind and solar. Smart technologies include connected devices with energy efficiency and demand response (DR) capabilities; algorithms and software solutions using large data sets to optimize end uses; and low-cost sensors.

Through smart technology, grid operators can interact with and control customer equipment to an extent not previously possible. Operators can reshape customer load profiles with at most minimal loss of the desired outputs and functions of electrical devices and equipment such as those that provide lighting, cooling, or heating (Bronski et al. 2015). Concurrently, customers can take active roles in meeting their electric power needs by making choices about their supply and use of electricity. They can, for example, supply and support grid operations by integrating their on-site renewable energy production and electric storage from electric vehicles or home batteries. They can also automate choices and control selected end-use appliances and equipment in response to signals from the grid. At the same time, changes to customer rates and rate designs are introducing new options that better reflect the real-time costs and value of power production.

A flexible grid has great potential. One recent study estimates that residential demand's flexibility potential will be 88 gigawatts by 2023 (Holden 2018). Such flexibility is made possible by numerous technological advances that let grid operators control system loads in

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[2] Another term that ACEEE and other organizations use for smart technologies is *information and communications technologies* (ICT). Such technologies are central to what we call *intelligent efficiency* (Rogers et al. 2013). Not all ICT (smart) technologies are capable of being grid-interactive. And while many of these technologies are capable of such connected, interactive operation, utility programs using these capabilities are not yet widespread.

order to optimize grid performance, improve reliability, and lower system costs. They also give customers new capabilities to reduce both energy use and power demand. Some customers may agree to utility control to dispatch distributed resources as needed, while others may prefer to receive pricing or other signals and choose whether to respond or not. The flexibility provided by a dynamic, interactive grid can also increase the value of customer energy and demand savings.

Integrating Energy Efficiency and Demand Response

Energy efficiency and DR programs seek to modify customer energy use to lower costs, and both types of program are expected to grow rapidly over the next decade (Feldman et al. 2018). Energy efficiency programs have traditionally focused on reducing electricity use (total kilowatt-hours) without considering timing and physical location. DR programs, by contrast, seek to reduce or shift electric power demand (kilowatts) at specific times and, in some cases, at specific locations.[3] From a grid perspective, energy efficiency improvements that reduce load during electric system peaks are more valuable than those that occur during off-peak periods (Mims, Eckman, and Goldman 2017). Similarly, the value of savings can vary based on geographic location due to distribution constraints.

The grid's physical nature is changing as high levels of distributed energy resources (DERs) come online. This can create higher peak demand, contrasted with lower midday demand served by solar generation. Peak demand can drive the need for investment in local distribution equipment and transmission and generation infrastructure. Because meeting peak demand is so costly, electric system operators are increasingly interested in measures that can reduce load at peak times.

Both energy efficiency and DR can provide these peak demand reductions. The Lawrence Berkeley National Lab provides a framework for four different types of load management: shape, shed, shift, and shimmy. Utilities and system operators have long used energy efficiency measures and price signals to provide longer-term load shaping (*shape*) and have implemented load reduction measures to reduce peak demand (*shed*). DR typically looks like a *shift* measure, moving demand away from peak times of day. In addition, advanced DR techniques may offer fast, load-following demand shaping (*shimmy*) (Alstone et al. 2017).

The time, location, and nature of energy efficiency and DR approaches, as well as how they fit into the load management system, create various value propositions. This is especially true when greenhouse gas (GHG) reductions are quantified as a value stream for these resources because peak demand is often met through more GHG-intensive resources. Therefore reducing peak demand may have greater value for GHG reduction than reducing demand during off-peak times.

Energy efficiency has typically focused on energy savings and the value of usage reductions, but many measures also create value by passively reducing peak demand. This occurs

[3] While demand response generally seeks to reduce power demand, in regions with high penetrations of wind and solar, DR may be used to increase power demand in response to overproduction from these wind or solar resources.

largely through deferral of transmission and distribution infrastructure and by targeting equipment that contributes to high peak demand, such as residential air-conditioning units (Mims, Eckman, and Goldman 2017). In contrast, DR actively shifts demand away from peak times, but may not reduce demand overall. These resource characteristics create different value propositions and inherent incentives and disincentives for pursuing each resource. Similarly, pursuing resources in an integrated manner creates new opportunities for value, but also may reduce each resource's individual value compared to what might be possible if it were acquired on its own.

Program administrators typically approach and implement energy efficiency and DR programs separately rather than as integrated programs.[4] Yet ACEEE and other organizations, including the US Environmental Protection Agency, Lawrence Berkeley National Laboratory, and the Electric Power Research Institute, have long acknowledged the possible synergies and benefits of technologies and measures that reduce both energy use (kWh) and peak power demand (kW)(York and Kushler 2005; NAPEE 2008, Goldman et al. 2010; EPRI 2009). Some regulators also see these benefits; according to Hawaii Energy representatives, their regulators are explicitly asking for integration in their next program cycle (Brian Kealoha and Sehun Nakama, executive director, Energy Engineering, Hawaii Energy, pers. comm., March 1, 2019).

Integrated energy efficiency/demand response (EE/DR) programs provide services, technologies, and incentives to electricity[5] customers to reduce energy use (kWh) through improved energy efficiency and to reduce power demand (kW) as signaled by a utility or grid operator. Such programs combine two elements:

- Some type of improvement that reduces the energy consumed for a given end use (such as lighting, space heating, water heating, or air-conditioning) whenever the technology is in use.
- A control capability that can respond to remote or automated signals to shift or adjust the technology's operation; examples include cycling off an air conditioner for short periods or raising its set-point temperatures.

The types of technologies that are best suited to integrated EE/DR programs are those that can be cycled off or operated with reduced output with no appreciable impact on customer services or functionality. For commercial and industrial (C&I) buildings these technologies include lighting, energy management control systems, refrigeration/cooling equipment, and cooling storage. For residential buildings, the primary technologies are HVAC controls

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[4] *Demand response* is a specific type of load management in which customers respond (manually or automatically) to a signal (message, alert signal, or pricing) from a grid operator to modify their demand. *Load management* is an umbrella term that describes any type of customer actions or measures that modify their demand.

[5] Opportunities may be growing for natural gas DR and integrated EE/DR programs in response to fuel shortages and increasing constraints on natural gas infrastructure. For example, The Energy Infrastructure Demand Response Act of 2019 (introduced) would require the Department of Energy to carry out a pilot program on natural gas demand response technology. We do not include natural gas programs in the scope of this paper as examples are limited.

(thermostats), water heating, and grid-connected smart appliances.[6] An integrated residential air-conditioning program, for example, might provide incentives to customers to purchase high-efficiency units with grid-interactive controls. Such controls would enable the utility (grid operator) to adjust temperature set points and/or cycle off the unit to reduce or shift power demand to relieve grid congestion or peak demand. In such cases, a single program and associated customer contact provides complementary services that address both energy use and power demand (Potter, Stuart, and Cappers 2018).

Integrated EE/DR programs can serve as a foundation for grid-interactive efficient buildings that incorporate a portfolio of technologies to benefit customers and the grid. These integrated programs can build on energy efficiency programs and their market infrastructure and increase customer engagement with new technologies and services. Program administrators are increasingly interested in developing and offering integrated programs in order to realize their potential services, benefits, and cost savings for both customers and utilities. However there is limited information on both integrated EE/DR program prevalence and successful program designs. This report addresses this information gap by reviewing experiences with integrated EE/DR programs.

Research Objectives and Methodology

The goal of this research was to characterize the landscape of integrated EE/DR programs in the United States. We sought insight into how many integrated programs exist, how they are designed, and what types of customers they serve. We also investigated policies and regulatory environments that support and enable the development and implementation of integrated programs. A related research objective was to identify challenges faced in developing these programs. Last, we examined results achieved and lessons learned to date by integrated programs, as well as what benefits they provide to customers and the grid.

RESEARCH QUESTIONS

This study aims to answer several research questions:

- What are the potential services and benefits that market actors seek from integrating energy efficiency and DR programs?
- What examples are there of integrated EE/DR programs and what are the design elements of those programs?
- What results have programs achieved? To what extent do those programs deliver on the potential benefits identified?
- Are there program designs that have been particularly successful at achieving desired outcomes?
- Are there policies, regulatory structures, cost-effectiveness testing methods, business models or strategies, or rate structures that particularly support integrated programs?

[6] For information on smart appliances, see www.energystar.gov/products/smart_home_tips/smart_appliances.

- What barriers and problems are program administrators encountering in delivering integrated programs?
- What solutions have emerged to these barriers and challenges?

Methodology and Data

To answer these research questions, we reviewed existing research and experience with integrated programs. From the literature review and with input from key market actors, we identified and interviewed industry experts to find key research needs and to identify programs and resources to include in our project. These industry experts also provided input on broader market and policy trends and drivers for integrated program approaches. We also issued a call for program information via ACEEE communication channels.

To further identify successful program examples across multiple sectors, we reviewed 44 publicly available 2017 demand-side management (DSM) program filings from the 51 largest electric distribution utilities by sales across the country.[7] We reviewed only 44 filings because we could not find filings for all 51 utilities. The group of 44 included 41 investor-owned utilities, 2 municipal utilities, and 1 community-based nonprofit utility (Salt River Project). There were no electric cooperatives in the group. Also, because two of the utilities have programs fully administered by third-party administrators, we reviewed their administrators' filings. We reviewed filings for all programs that contained both an energy efficiency component and a load management or DR component. We also put out a call for examples of integrated programs and conducted primary research for additional program examples.

This group of utilities gives a good sense of the overall integrated program landscape; they delivered more than half of all electricity in the United States in 2015, were in 31 different states, and represented different ownership structures. However our review did not consider natural gas programs, independent market actors, or programs that fell outside the reporting scope for these utilities. Where necessary and possible, we conducted structured interviews with key contacts and program administrators to understand the details and structures of the programs we identified from the review and from the call for examples.

Where available, we gathered the following data:

- Energy (kWh) savings
- Demand (kW) savings
- Program costs and benefits
- Targeted customer class
- Number of participants and participation rates
- Supportive rate designs
- Applicable end uses

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[7] We determined that these were the 51 largest distribution utilities by electric sales in 2015 using ACEEE's *Utility Energy Efficiency Scorecard*, and all of the identified utilities remained in the top in 2017. Program filings or filings with program descriptions were not available for seven of the utilities. For more information on this methodology, see: aceee.org/research-report/u1707.

- Program design features: incentives and services
- Information about the policy and regulatory structures that might have facilitated or impeded the integrated EE/DR program

We ultimately found 22 programs that integrated energy efficiency and DR to some degree.

Benefits of Integrated EE/DR

Based on our literature review as well as past research, we identified the potential benefits of integrated EE/DR programs for stakeholders involved in the energy efficiency and DR markets, including the program administrator, the customer, the grid operator, and private market actors supplying EE/DR technologies and products. The potential customer benefits from integrated programs include:

- Lower rates, which resulted in bill savings (including for nonparticipants)
- Increased bill savings through DR payments, time-varying rates, and reduced energy use
- Increased overall program satisfaction
- Increased ease of participation through a single program contact for multiple services
- Increased ease of participation through a single, clear program entry point or enrollment process
- Lower program costs
- Fewer power outages (from increased grid reliability) (NAPEE 2008)

We presented this list of potential benefits and value streams to experts and program administrators to solicit feedback on which items were most important.[8]

Not surprisingly, the program administrator respondents were interested in delivering benefits to their customers. Multiple respondents emphasized their focus on the customer experience, including increasing financial savings, improving customer satisfaction with programs, and reducing call center calls. At least one respondent planned to seek every customer benefit we identified.

Integrated programs also offer utilities opportunities to combine and strengthen their recruitment efforts. They can achieve this through more consistent, unified messaging about the value proposition for reducing energy demand, including through DR, and can open new communication channels such as through an individual customer engagement portal. Such a portal can be an ideal medium for bundling other types of home services and consumer offerings and for encouraging active engagement with home energy use (Klingel 2014). These tactics increase program participation and satisfaction.

[8] See Appendix C for list of interviewees.

Program administrators might target benefits such as increased energy savings, greater DR market penetration (and associated wholesale market payments if applicable), and bill-reduction opportunities that otherwise might be lost (NAPEE 2008).

Administrators are also interested in the financial opportunities offered by integrated programs, including lowering program costs through coordinated marketing and delivery efforts, and earnings opportunities and shareholder value creation via performance incentives. Integrated programs also can simplify and unify data management and messaging—further lowering program costs (Klingel 2014).

Private markets supplying EE/DR technologies and products will see additional value from integrated programs through energy arbitrage and nonwires solutions (NWS) opportunities, as well as through wholesale aggregation.

Respondents generally agreed that grid benefits such as increased resource adequacy and transmission congestion relief would be important in the future, but that programs were not yet large enough to deliver these results, which are currently secondary to customer benefits and increasing participation. As integrated programs scale, system operators will generally see greater grid reliability; faster, more effective response to outages and other grid problems; increased availability of ancillary services (e.g., frequency and voltage support, ramping, and balancing); and heightened wholesale competition resulting in lower wholesale prices.

Many of these benefits are interdependent. For example, reducing customer demand can provide value to the grid by increasing resource adequacy and offsetting the need for generation resources. Reducing peak demand similarly reduces strain on the grid and can increase reliability (Relf, York, and Kushler 2018).

Enabling Technologies

Several new technologies are facilitating the integration of energy efficiency and DR programs. Smart and Wi-Fi-enabled thermostats, including those with device sensors and remote sensors, are becoming more prevalent. As the market grows and competition increases, the products are becoming more reliable, advanced, and cost effective (Stubbe 2018). We found that smart thermostat programs are the most common type of integrated program. Smart thermostats can help customers learn about energy-efficient behaviors (e.g., reducing heating and cooling during times when no one is home) and program those actions to happen automatically. The thermostats also allow for utility control, including pre-cooling features and temperature changes during DR events. Pre-cooling shifts cooling to off-peak times so that the need for cooling decreases during the DR event; it also limits negative customer comfort impacts.

Advanced metering infrastructure (AMI) presents another opportunity for integrated programs. AMI can be used to identify high-use appliances and behaviors that are ripe for energy efficiency rebates, provide personalized messaging to customers on how to reduce energy use, and enable DR participation. AMI's data granularity also creates opportunities for different market models and services, such as pay-for-performance programs or time-based incentives.[9] AMI penetration is increasing rapidly. Residential installations almost doubled in just five years (2012–2017), growing from approximately 38 million to almost 70 million (EIA 2018). AMI can provide additional benefits for integrating programs, including contributing granular data for consistent and accurate valuation and evaluation, measurement, and validation (EM&V) practices (discussed further below).

Direct load control (DLC) switches and automated demand response (ADR) also are critical for DR programs and therefore for integration. An increasing number of devices, particularly HVAC equipment, are becoming DR capable. For example, Energy Solutions works with manufacturers to make equipment DR capable at the point of sale for Southern California Edison customers (Christine Riker, associate director, Energy Solutions, pers. comm., April 24, 2019). This facilitates easy enrollment in DR and creates a larger pool of eligible customers for integrated programs.

Wi-Fi-enabled appliances and devices, including water heaters, refrigerators, clothes dryers, and air conditioners, are another emerging opportunity for integrated programs. Devices with Wi-Fi capabilities allow utilities to simultaneously enroll customers in DR programs and provide energy efficiency incentives such as rebates for efficient appliances. Because Wi-Fi capability is a prerequisite for many DR programs, the increasing availability of Wi-Fi-enabled appliances will increase program participation.

The ability to communicate with customers via mobile applications, including with push notifications, is another aid to customer education and awareness of DR events. These apps can include personalized messaging on energy usage and behavior as well as notification and opt-in/opt-out options for DR events.

Finally, websites that market energy-efficient appliances and devices are becoming more prevalent. Such websites allow utilities to offer bundles of devices at discounts to customers. The technologies included in these bundles enable customers to participate in energy efficiency and DR programs via dual or streamlined enrollment.

Degrees of Integration

Electric industry experience with integrated programs is limited. Previous research identified few integrated EE/DR programs (Evergreen Economics 2015). Our current study found that while the number of integrated EE/DR programs is growing, they are still not widespread. Where they exist, they comprise only a small share of the total portfolio of customer DSM programs.

We found 20 utilities (approximately 45% of the ones we reviewed) that ran a program with some degree of integration of DR and energy efficiency.[10] We identified a total of 22

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[9] Pay-for-performance programs establish contracts between customers and a service provider (utility or third-party) that pay customers for energy savings realized through increased energy efficiency on an ongoing basis. Time-based incentives vary according to the time of savings to reflect the cost of providing power at a given time.

[10] See Appendix B for a list of these programs.

individual programs run by these utilities and other utilities we found through additional research. Most of the 22 programs are residential, some focus on the residential and small business sectors, and a few focus exclusively on commercial customers.

Smart thermostat programs are the most prevalent type we found, as they can facilitate simple participation in energy efficiency and DR programs. Energy management is a common theme as well, showing up in programs featuring home energy reports, real-time energy management systems, and smart thermostats.

Although all the programs we identified offer some degree of integration, most focus on either the energy efficiency or DR element and operate as that type of program. The degree of integration stretches across a spectrum. At one end are programs with minimal integration of energy efficiency and DR. For example, a program promoting residential smart thermostats may have only some elements of integration and may primarily seek to improve household energy management and do little to make use of the devices' DR capabilities. At the other end of the spectrum, a program may fully use the capabilities of grid-interactive technologies in conjunction with comprehensive energy efficiency improvements. For example, a commercial building's retrofit program may install grid-interactive lighting and HVAC controls and take full advantage of their connectivity to manage building energy use and respond to grid signals to reduce or shift loads.

The various program integration levels frequently correspond to a hierarchy of DSM strategies. First, a utility needs to have the data to determine its peak demand period and which end uses are best targeted for reduction during that time. At that point, it might seek to deploy energy efficiency, which is a low-cost resource, followed by DR, and finally self-generation, which tends to be the most costly. Figure 1 illustrates this progression.[11]

[11] Forthcoming ACEEE research looks at the opportunities for bundling energy efficiency programs with other distributed energy resources such as solar photovoltaics and energy storage.

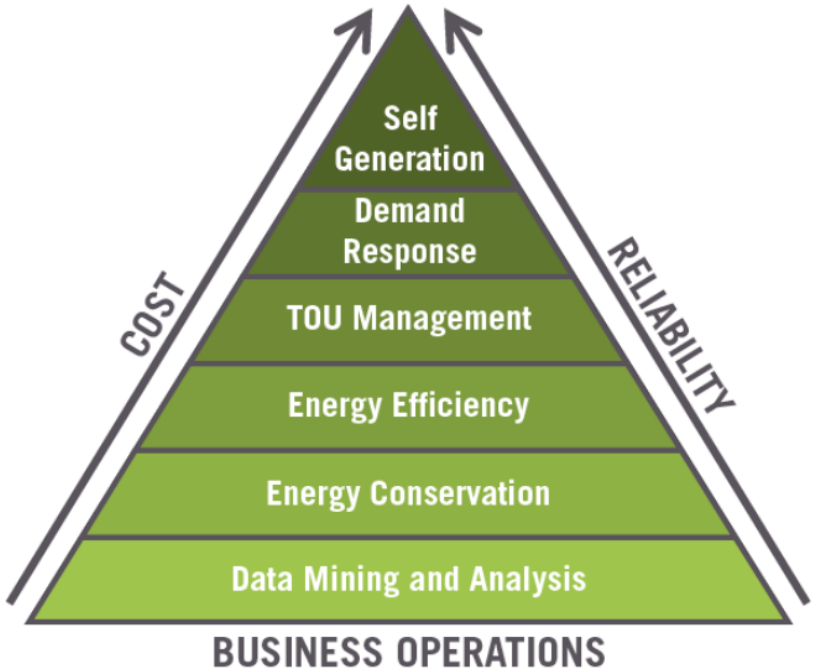

Figure 1. Possible elements of integrated EE/DR programs.
Source: Energy Solutions 2019.

Following are the four integration levels that we found among the EE/DR programs we reviewed; the levels are listed from weakest to strongest, with the number of programs at each level indicated in parentheses:

- Stated recognition of latent energy (kWh) or demand (kW) reduction capabilities (3)
- Cross promotion (5)
- Administrative coordination (7)
    - Leveraging energy efficiency and DR for targeted need (2)
- Single program (5)

Figure 2 shows these levels of integration.

Figure 2. Levels of program integration

Additionally, while they have not established specific programs, the California utilities and Oklahoma Gas & Electric (OG&E) have all conducted research on the benefits of and new approaches to integration. OG&E, for example, studied the cost efficiencies involved in low-income and multifamily energy storage systems acting as an energy efficiency measure and participating in DR programs.

In the following sections, we describe the five integration levels and programs we reviewed at each level. Appendix A contains case studies of four of these programs:

- BGE Demand Response Dynamic Pricing (cross promotion)
- ComEd Smart Thermostats (cross promotion)
- AEP OH Intelligent Home and Demand Response (single program)
- FCU Peak Partners (single program)

The case studies offer additional detail on program design, drivers for integration, results to date, notable challenges and success, and lessons learned. The studied programs either represent common, replicable program types or offer particularly important lessons. As a whole, they cover various regions and sectors and include both well-established and newer programs.

LEVEL 1. RECOGNITION OF ENERGY EFFICIENCY OR DR CAPABILITIES

At the shallowest integration level, several program descriptions state the dual objectives of reducing energy use overall and reducing or shifting peak demand, but the programs are not otherwise integrated.[12] These programs embed—but do not take advantage of—the integrated capabilities of the measures deployed. Typically, the programs are primarily focused but recognize the deployed measures' latent demand or peak demand reduction potential in the program description. Similarly, some DR programs recognize energy usage savings benefits as an additional program benefit without it being a primary objective. As table 1 shows, we identified three programs of this type.

Table 1. Programs recognizing latent energy efficiency or DR capabilities

Program administrator	Program description	Primary targeted customer segment
Commonwealth Edison (ComEd)	The Smart Buildings Operations Pilot is a real-time energy optimization program for large buildings that primarily focuses on energy reductions but with both energy and demand savings targets.	Commercial and industrial (C&I)
Duke Carolinas and Duke Progress	The EnergyWise Business program is a more traditional commercial HVAC cycling DR program but customers can also utilize the thermostat's EE capabilities.	C&I
Long Island Power Authority (LIPA)	The Home Energy Management program offers home energy reports with stated goals of reducing energy usage, increasing awareness of and enrollment in EE and DR programs, augmenting peak-hour energy savings, and increasing program satisfaction.	Residential

These are real-time energy management or behavioral programs (e.g., home energy reports) that aim to enroll customers in energy efficiency and DR programs. One of them (LIPA) also uses cross promotion.

While some utilities have reported demand savings from efficiency programs for many years, there is increasing interest in quantifying the peak demand reduction value of energy efficiency programs (Mims Frick et al. 2019). Programs that quantify both values could fall into this category of integration.

LEVEL 2. CROSS PROMOTION

Programs at this level integrate aspects of outreach, marketing, and education for separate DR and energy efficiency programs, but do not otherwise coordinate program delivery, budgets, utility contact points, or other elements. As table 2 shows, we identified five programs of this type.

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[12] If programs stated these goals but did not offer energy efficiency and demand response program elements with some degree of coordination, we did not consider them to be integrated.

Table 2. Programs that engage in cross promotion

Program administrator	Program description	Primary targeted customer segment
Baltimore Gas & Electric (BGE)	BGE offers multiple smart thermostat programs in which customers can enroll in all eligible EE and DR programs.*	Residential
Commonwealth Edison (ComEd)	ComEd offers smart thermostats as part of multiple program offerings and uses thermostats that are eligible for both EE and DR programs. The programs are cross-promoted, and ComEd is working to integrate the enrollment process through an online marketplace.	Both C&I and residential
Eversource Massachusetts	Administrators aim to facilitate enrollment in both EE and DR programs for technologies that are eligible for both.	Both C&I and residential
National Grid New York	This program promotes connected technologies in its Electric C&I Retrofit Program for the purpose of enrolling customers in DR programs.	C&I
San Diego Gas & Electric (SDG&E)	SDG&E's outreach promotes comprehensive energy solutions for understanding and managing energy usage, including with DERs, and runs a home energy report behavioral program that recommends EE and DR programs.	Residential

This type of program coordinates marketing or outreach events, or aims to enroll customers signing up for one program into one or more other programs. For example, BGE and ComEd both offer smart thermostats as a measure in many programs across their DR and energy efficiency portfolios, and aim to enroll customers in all programs for which they are eligible. SDG&E runs promotional events to make customers aware of all of its programs.

LEVEL 3. ADMINISTRATIVE COORDINATION

Administrative coordination involves a single point of contact multiple programs, coordinated internal management, or simultaneous program enrollment. It may also include cross promotion of programs. A single point of contact allows customers to get help or information on multiple programs from one source at the utility. A single internal contact or group managing the program means that one person or group leads multiple programs internally, which may include managing the budget, marketing, and general project management. In the coming years, multiple utilities are aiming to facilitate simultaneous enrollment, which allows customers to enter into multiple programs with a single application and thus reduces customers' time and administrative burdens.

As table 3 shows, we identified seven programs of this type.

Table 3. Programs with administrative coordination

Program administrator	Program description	Targeted customer segment
Consolidated Edison (ConEd)	ConEd coordinated direct load control DR and Bring Your Own Thermostat EE programs through dual-enrollment at the point of purchase.	Residential
Dominion Energy	Approved to begin in 2019, Dominion's program will offer rebates, education, and dual EE and DR program enrollment for customers who purchase smart thermostats.	Residential
Entergy Arkansas	Entergy Arkansas added smart thermostats that can participate in DR events to its Home Energy Solutions EE program in 2016.*	Residential
Oncor	Third-party providers administer Oncor's Commercial Load Management Standard Offer Program, and some simultaneously offer EE programs.	C&I
Pacific Gas & Electric (PG&E)	PG&E's integration efforts include offering smart thermostats with EE and DR capabilities and using a single contact point for multifamily programs.	Residential
Southern California Edison (SCE)	SCE's integration efforts include coordinating program administration on its website; coordinating integrated applications; and coordinating marketing, education, and outreach efforts.	Both C&I and residential
Xcel Energy Colorado	Xcel Energy Colorado's Energy Management Systems program offers incentives for both peak demand reductions and energy reductions.	C&I

* Appendix A offers a full case study of this program.

Some programs leverage energy efficiency, DR, and DERs for a targeted need. This might include multiple programs to acquire efficiency and DR resources, with all programs aimed at a unified goal. We include NWS programs here because the resources may be acquired through different channels, but they are used toward a single program's goal. To be implemented, NWS programs must be more cost effective than traditional wire solutions. This requires identifying all possible value streams that a traditional wires solution may provide, many of which are acquired through efficiency and DR. Our review identified only two NWS programs, although there are a few others in the United States, and energy efficiency and DR play a key role in them (Chew et al. 2018; Baatz, Relf, and Nowak 2018).

Table 4 lists the two programs we identified that leverage energy efficiency, DR, and other resources for a targeted need.

Table 4. Nonwires alternatives leveraging energy efficiency and DR for a targeted need

Program administrator	Program description
ConEd	Brooklyn Queens Demand Management (BQDM) is an NWS program that leverages customer- and utility-sited EE and DR resources solicited through an auction, along with other DERs, to offset the need for a new substation.
SCE	The Preferred Resources Pilot study has determined that the company may defer a new gas power plant by acquiring EE, DR, and other DERs.

LEVEL 4. SINGLE PROGRAM

As table 5 shows, we identified five examples of the highest integration level: a single program offering both energy efficiency and DR.

Table 5. Single EE/DR programs

Program administrator	Program description	Targeted customer segment
AEP Ohio	The It's Your Power program uses smart appliances and connected devices and an app to provide customers with energy management information as well as an in-home device that allows customers to participate in DR events.*	Residential
Ameren Missouri	Peak Time Savings is an early-stage program that saves energy through programmable and learning thermostats, while simultaneously enrolling customers in an automated DR program for cooling systems.	Residential
Fort Collins Utilities (FCU)	Peak Partners is a portfolio of DR programs employing programmable Wi-Fi thermostats and electric water heater controllers to reduce peak demand. The programs simultaneously offer programmable thermostats and energy monitors, creating energy savings throughout the day.*	Residential
NV Energy	The PowerShift Commercial Energy Services program uses a single program and a single appointment to offer rebates for energy-efficient equipment, energy assessments, and smart thermostats that can be enrolled for DR events.	C&I

Program administrator	Program description	Targeted customer segment
Water and power utility in Southern California	This program targeted households during peak times through calls and emails with a type of behavioral DR called a peak energy report. It also provided customers with home energy reports (HERs) with comparative energy usage information that encouraged energy-efficient behaviors.	Residential

* Appendix A offers a full case study of this program.

These programs frequently have simultaneous enrollment in energy efficiency and DR elements and offer one website for customer information about all options. All of these programs use smart thermostats as a key element, and three of them have additional technology components such as smart appliances and connected devices.

Regulatory and Policy Context

Several factors influence utility and program administrator program decisions and actions. Regulated utilities are required to spend customer funds prudently, keeping in mind cost-effectiveness constraints, savings targets, and other regulatory requirements. In addition, both regulators and program administrators operate within their state and region's policy environment. Policies such as energy efficiency resource standards (EERSs) and spending requirements inform portfolio design. Some utilities are also subject to cap-and-trade policies designed to limit carbon emissions by pricing each ton emitted. Utilities with these obligations are motivated to reduce compliance costs by incorporating less-carbon-intensive resources into their portfolios. Indeed, many of the industry experts and program administrators we interviewed said that GHG reduction policies were a key factor in their increasing integration of energy efficiency, DR, distributed generation, storage, electric vehicle, and other low-carbon-enabling technology programs.

Investor-owned utilities also work in the interest of their shareholders. For this reason, utilities must consider the business case for energy efficiency and other programs, including minimizing operating costs, recovering their program costs and decoupling profits from sales, and earning financial incentives on programs or creating cost savings in comparison with alternatives investments. Utilities also must meet regulatory standards and requirements in order to avoid fines that reduce their profitability. In restructured markets, utilities may maximize the value of resources cleared in wholesale markets, including energy efficiency and DR. These factors are major drivers for designing programs that maximize benefit-to-cost ratios. For example, BGE program administrators noted that their smart grid rate case was a strong driver for integrating their programs. Through integration, they believed they could make the meters more cost effective, which would make the proposal more attractive to regulators (Amanda Janaskie, manager, Energy Efficient Programs, Baltimore Gas and Electric, pers. comm., April 16, 2019).

Some utilities, such as electric cooperatives and municipal utilities, have ownership and oversight structures that do not include shareholders or regulators. Electric cooperatives are directed by members and act in accordance with their desires. Similarly, municipal utilities respond to the city council or another municipal agency that oversees their actions. These types of utilities sometimes have more flexibility to explore new program models or actions because they tend to be smaller and nimbler in their operations, and because their oversight bodies may have different goals and policy options than state utility regulatory commissions.

For example, as we highlight below, Fort Collins Utilities (FCU) in Colorado runs Peak Partners, a DR program that integrates elements of energy efficiency. The Peak Partners administrators said their actions are driven by three sets of needs: customer desires, utility functions, and city council policy goals. In particular, the city council has set a goal to reduce GHGs 20% by 2020, 80% by 2030, and 100% by 2050 (using a 2005 baseline). FCU programs must therefore achieve three goals: benefit the customers, benefit the utility, and meet the city's policy goals. Working with a small energy services team that covers energy efficiency, DR, distributed generation, storage, green buildings, and electric vehicles, the utility analyzes its programs on a portfolio level to determine whether they meet these three broader goals (John Phelan and Pablo Bauleo, Fort Collins Utilities, pers. comm., March 12, 2019).

While the policy and regulatory environment can be strong drivers for integrating programs, administrators have found that company goals and internal decisions that have led to successful integrated programs have in turn influenced regulators and policymakers. For example, Entergy Arkansas' regulators asked it to develop new strategies for delivering savings to customers. To address this and create benefits for customers and the utility itself, the company began to pursue integrated approaches. The commission has since indicated that the company should continue to pursue these integrated approaches, which are meeting the commission's needs (Heather Hendrickson, Project Manager, Entergy Arkansas. pers. comm., March 2019).

Regulators can help to create an environment for integrated programs by approving cost-effective investments in necessary communications and technology infrastructure, including advanced metering functionality. In cases where programs rely on a particular technology, program administrators should design the program to consider the adoption timeline within the program boundaries. For example, program administrators at AEP Ohio noted that

> The program would have been easier to implement if the AMI rollout was complete in our service territory, or at least had a significant start ahead of the program. This would have improved customer experience—customers wouldn't have to wait for AMI to join the program after hearing about it—and cost effectiveness of marketing would have been improved.

AEP Ohio also recommended a thorough test of all the AMI technologies before implementing the program (Deanna Gilliland, manager, Intelligent Home Programs, AEP Ohio, pers. comm., April 25, 2019).

CALIFORNIA'S INTEGRATED DEMAND SIDE MANAGEMENT PROCEEDINGS

One approach to a comprehensive policy and regulatory framework for integrated energy efficiency and DSM programs is California's Integrated Demand Side Management program (now called Integrated Distributed Energy Resources [IDER]). IDER provides funding for programs that take an integrated approach to DERs. In 2007, the California Public Utilities Commission required utilities to integrate DSM measures including energy efficiency, DR, advanced metering, and self-generation (California PUC 2019). The rulings were later updated to include all DERs, with broad regulatory goals of enabling customer choice and optimizing grid, customer, and GHG benefits (Baker 2017).

Regulators guided utilities to draw on existing funding sources (including energy efficiency and DR) to set budgets for integrated efforts such as marketing and outreach.[13] However utilities found it challenging to fund integrated projects with siloed funding streams (California PUC 2019). An omnibus process evaluation of the California investor-owned utilities' integrated DSM 2010–2012 programs and initiatives found many positive outcomes, such as increased promotion of integrated programs by account managers and effective trainings for contractors and implementers. The report also highlighted the difficulties and challenges the utilities faced in developing and implementing integrated programs, including unsophisticated tracking of integrated DSM accomplishments (Itron 2012). In 2014, the commission concluded that "statewide IDER efforts have had limited success" (California PUC 2019).

In response, the commission initiated an integrated DER proceeding (R-14-10-003) to address lessons learned and barriers identified from program experiences. In 2016, the commission adopted D16-12-036 to facilitate DERs deployment on a pilot basis to displace or defer investments in traditional distribution infrastructure. It included a competitive solicitation framework, a working group on cost-effectiveness testing, and a utility regulatory incentive (valuation) mechanism pilot. The commission also developed a distributed resources action plan and vision in 2016, and established a DER steering committee to oversee and sustain the effort.

The IDER proceedings provide clear direction to California's utilities and program administrators to prioritize integration. Regulatory requirements that have existed for more than a decade that require planning over the long term, with associated budgets and available external funding, are driving a market for integrated programs. Our interview with Energy Solutions, a company that implements programs in California, emphasized that available funding was critical to pilot and program development and implementation. California's utilities and the commission have continued their efforts and leadership for integrated DERs.

EARLY EXPERIENCE WITH INTEGRATED PROGRAMS IN NEW YORK

New York has been another leader and pioneer for integrating energy efficiency and DR. In the early 2000s, the New York State Energy Research and Development Authority developed and offered programs for C&I customers that sought both peak demand reductions and energy efficiency savings. ACEEE documented some of these early efforts in

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[13] Utilities are not required to spend EE funding on distributed generation projects, but they can use IDSM funding to pay for integrated marketing and other efforts.

our work with reliability-focused energy efficiency programs in the wake of the electricity crises experienced in California and other states (Kushler, Vine, and York 2002)

In recent years, New York has been engaged in a comprehensive review and analysis of its entire electricity sector with the objective of overhauling regulation and utility business models as well as operation and management of the electric grid. As part of this effort, called Reforming the Energy Vision (REV), the New York Public Service Commission (PSC) in January 2016 issued an order (14-M-0094) that directed the Clean Energy Advisory Council to develop a REV Energy Efficiency Best Practices Guide. One of the PSC's top recommendations was to use a pay-for-performance approach to energy efficiency and demand management incentives—that is, providing financial incentives to customers for both energy efficiency savings and demand reductions. REV also seeks innovative program and utility partnership ideas, including integrated DERs, through its REV Connect initiative.

New York has also increased its emphasis on the peak demand savings that energy efficiency programs achieve (New York PSC 2015). New York's distribution utilities are leveraging their marketing and administrative resources for combined DR and energy efficiency as a result of the PSC order. New York's proceedings on the Value of Distributed Energy Resources (VDER) also emphasize peak savings. These efforts aim to accurately compensate DERs based on the value streams they create in order to place them on more level footing with other resources and increase their penetration. Compensation is based on various factors, including the resource's energy value, environmental value, demand reduction value, and locational system relief value (New York PSC 2019). VDER currently does not cover energy efficiency and DR, but the Commission has stated that it aims to expand the types of covered resources in the future (New York PSC 2017).

OTHER STATES

California and New York's efforts to integrate energy efficiency and DR are examples of multipronged efforts led by regulators in collaboration with utilities and stakeholders. Utilities in other states—including Maryland, Pennsylvania, Massachusetts, Nevada, Connecticut, and North Carolina—have also created integrated EE/DR programs (Buckley 2016; Evergreen Economics 2015).

Challenges

Program administrators have long been and continue to be enthusiastic about integrated DSM's potential benefits, but they have encountered common challenges to widespread, and sometimes even targeted, implementation. Multiple program administrators noted that, while they hoped to tap into the multiple value streams from integrated programs, it has been difficult to operationalize those value streams for several reasons. This section describes some of the common challenges to implementing integrated EE/DR programs. Many of these challenges were identified long ago, but persist to this day. Our interviews with experts in the field confirm that these are major limiting factors for implementing integrated programs.

ADMINISTRATION

Integrated programs pose a number of administrative challenges. Coordination is a major one. Most utilities have separate internal teams that work on DR and energy efficiency. This adds steps to communicate and coordinate efforts across teams, especially when each one has its own budget and is working toward its own goals. Teams may have to take the time to look at each building holistically to find the most appropriate solutions, which requires deep coordination among program administrators (Potter, Stuart, and Cappers 2018). Integrated programs may also involve complex program requirements and multiple technologies that administrators as well as contractors will have to understand thoroughly.

Allocating budget to integrated programs may not be possible due to internal company policies or logistics. Transferring siloed budgets from one program to another may be difficult, and separate budgets can be particularly problematic if the funding cycles are not aligned. For example, if an integrated program relies on multiple funding streams, the whole program can be voided if one funding cycle ends. One of our respondents noted that his DR programs had a smaller budget than his energy efficiency programs, which made it difficult to scale the programs in step.

Further, combining budgets in utilities that have different incentives may encourage the pursuit of load management at the expense of energy efficiency. For example, advocates in some states have argued for lower company incentives for DR than energy efficiency because efficiency creates more lost revenues (Michigan PSC 2019). Like efficiency, load management programs may adversely impact a utility's growth and investment objectives. However load shifting improves system load factor, increases utilization of existing generation resources, and in most cases does not result in an overall decrease in energy sales to customers, making these programs more attractive to many utilities.

To address this potential barrier to integration, regulators should create multiple goals and performance-based incentives for an integrated portfolio of both energy efficiency and DR to ensure that utilities are incentivized to pursue both. For example, Massachusetts' energy efficiency resource standard has multiple goals that address overall objectives such as reduced carbon emissions, increased economic benefits, and fuel-neutral energy usage reduction targets. The state further set specific targets for annual energy usage reduction targets and peak demand reduction (Gold, Gilleo, and Berg 2019).

EVALUATING THE COST EFFECTIVENESS OF INTEGRATED PROGRAMS

A fundamental challenge is the lack of effective, standard practices for evaluating integrated programs' efficiencies and benefits. Cost-effectiveness evaluations continue to operate in silos for energy efficiency and DR programs, whether they are integrated or not. Regulated utilities are often required to meet energy and demand savings targets as defined in state-level energy efficiency resource standards, in other policies, or by the utility commission or utility itself. Targets for demand savings, energy savings, and other goals are typically separate from one another and have separate budgets; some are even tracked in separate utility proceedings. Integration can be a challenge for entities that have designated budgets for distinct savings goals (Potter, Stuart, and Cappers 2018).

Creating a new cost-effectiveness and evaluation framework for integrated EE/DR programs poses challenges because the nature of each program varies in fundamental ways. For example, DR programs may require more frequent review periods and a different methodology for calculating savings because DR events can vary in frequency, duration, and the number of customers willing to participate (Potter, Stuart, and Cappers 2018). Vine (2008) notes that evaluators of integrated programs must address many of the same issues faced in evaluating energy efficiency programs: baselines, additionality, gross savings, net savings, reliability, uncertainty, precision, and persistence. However these elements may be measured and evaluated very differently for each program type, so a megawatt of load reduction may be valued differently in an efficiency program than in a DR program.

Traditional cost-effectiveness rules can hinder the development of integrated programs because they do not allow administrators to count benefits achieved from program synergies. When measuring values for efficiency and DR separately, administrators struggle to understand whether the programs achieved more because they were delivered together and achieved increased customer awareness, for example. To design effective and cost-effective programs, administrators must understand how the interactive effects of coordinated delivery affect the value of metrics such as energy and demand savings and measure lives. Allocating value according to the different sources and beneficiaries of that value can be important to ensuring accurate alignment of incentives and funding, although doing this may increase evaluation and administrative costs.

Faced with these challenges, none of the program administrators we interviewed had developed unique cost-effectiveness frameworks for integrated programs. Instead, they relied on traditional methods for both DR and energy efficiency measures—even for integrated programs. At best, they are expanding and adapting existing energy efficiency protocols to DR and other customer energy programs.

While efforts to update cost-effectiveness testing and advancements in EM&V practices are gaining traction across the country, traditional cost-effectiveness tests are still widely used (ACEEE 2019). The 2017 *National Standard Practice Manual* (NSPM) provides a framework for developing cost-effectiveness tests that align with the state or jurisdiction's policy goals. This framework helps stakeholders identify energy efficiency's relevant costs and benefits, and thus more accurately capture its value. The NSPM is currently being expanded to include additional DERs such as DR. In particular, it will aim to address the question of what the value is when "multiple DERs are assessed and optimized relative to a fixed set of alternative resources" (NESP 2019). This effort will help to quantify efficiencies of integration for cost-benefit analyses of energy efficiency and DR.

Additionally, AMI, grid-interactive buildings, building energy management systems, and smart devices can help enable more granular and consistent valuation practices by providing data to capture time and locational impacts of energy efficiency and DR resources (Nowak, Molina, and Kushler 2017). This can help open new program models—such as pay-for-performance programs, DER aggregation, and competitive procurement—that allow third-party actors into the market. Advancements both technologically and with new policy frameworks may help to relieve the consistent valuation issues across DERs while quantifying the additional benefits of integration itself.

CONFLICTING OBJECTIVES

Energy efficiency may cannibalize the potential for DR. Reducing overall energy use with energy efficiency can reduce peak power demand and thus the potential amount of load to be shifted or reduced with DR (York and Kushler 2005; Potter, Stuart, and Cappers 2018). For example, reducing overall demand for the building can mean that there is less available demand to call on for demand reduction events. Similarly, replacing an existing inefficient commercial lighting system with an energy efficiency system would reduce the load available to be reduced by DR measures.

This can create a barrier to participation in integrated programs. Customers may be concerned that energy efficiency measures will reduce their bill credits for shifting load during DR events. This may be especially true for C&I customers with large loads and DR potential.

Experience is not conclusive on this effect. An evaluation of the early California integrated DSM efforts found that integration can reduce the anticipated DR impacts relative to a DR program without efficiency (Itron 2012). In contrast, another study showed that a Southern California utility demonstrated additive peak demand reductions during a two-month period in the summer of 2014 with its combined peak energy rebates (behavioral DR) and home energy reports (energy efficiency). Out of 14,100 households, customers with one or the other program had an average of 3.8% (DR) or 2.1% (energy efficiency) peak load reduction, while those with a combined program had an average of 6.8% peak load reduction. These results show that energy efficiency and DR can complement each other and yield additive peak load reduction (Brandon et al. 2018).

TECHNOLOGY

Administrators also face challenges with technology itself. For example, they may try to implement their programs before the technology is ready, such as before an AMI rollout is complete or before manufacturers have worked out the kinks with DR-enabling technologies on HVAC equipment. In some cases, introducing AMI has been problematic due to the technology’s poor performance; in other cases, its limited availability has increased program costs.

COMMUNICATIONS

Many of our respondents reported challenges related to communication strategies. Saving energy through energy efficiency improvements is fundamentally different than shifting or reducing demand at very specific times. While such efforts can be complementary, customers may not understand the differences, leading to confusion and reluctance to participate in programs. In addition, upfront marketing can cause problems if the language is too technical, the rebate and credit structures are unclear, or it is not evident to customers which programs they are enrolling in.

Lessons Learned

Our interviews yielded a number of lessons learned and recommendations to facilitate the growth of integrated EE/DR programs. Similar points are found in Potter, Stuart, and Cappers (2018).

Administration

The design and implementation of integrated EE/DR programs require much better coordination of program staff and resources. Utilities and other program administrators should make organizational changes to reduce bureaucratic hurdles and consolidate and integrate staff, funding, and other resources. Ideally, utilities should dedicate funding for integrated approaches and individual programs, but in any case they should distribute administrative costs across departments. Also, it is important to note that fully integrating funding streams for energy efficiency and DR may not make sense given the different inherent incentives utilities must pursue in DR versus energy efficiency strategies. However allocating funding for piloting integrated approaches and for specific programs can help to identify the benefits of doing so.

Another key is to formalize coordination among formerly separate teams. Several program administrators we interviewed had recently made internal changes to create a single team that delivers energy efficiency, DR, and DER programs together.

Effective integrated program design can address the potential conflict between energy efficiency and compensation for load shifting by offering customer and vendor incentives that fully recognize the value of a packaged EE/DR bundle. Programs should also look at buildings holistically, devise a particular strategy that will achieve optimum results, and communicate its benefits to the client.

Technology

AMI can be a critical foundation for integrated EE/DR programs as it can provide important time-of-use feedback to customers. Effective communications and thorough testing of AMI or enabling technologies can support a smooth program rollout.

Program administrators should frequently evaluate market options, customer preferences, and program design to ensure they are using the best available technologies. New products that are more cost effective or that have additional capabilities may come to market. As such new options become available, program administrators may want to allow customers to participate in “bring your own device” programs that allow any brand of smart thermostat, battery, pool pump, or water heater that they choose to buy. However these programs may require new contractor and customer training initiatives.

Communications

Programs should create a positive customer experience through effective communication, simple processes, and knowledgeable contractors. Clear, proactive communications help create a positive customer experience and reduce the burden on utility call centers. Targeting, segmentation, and regularity are the keys to effective communication. Messaging must be relevant to targeted customers and be effective in motivating them to act. Utilities can use AMI data for usage-based segmentation. They can target customers with promising usage patterns and avoid spending marketing efforts on those whose consumption—and in some cases, production—does not match the offerings. In any case, noneligible customers should definitely not receive marketing.

Many program administrators stressed the importance of reaching customers where they are and understanding various sales channels. For example, one program administrator noted that their team had success reaching customers through multiple channels, including working with manufacturers, via an online marketplace, through instant coupons at big box stores, and through direct installations via contractors. Multiple channels provide more opportunities to layer on new measures and programs as well as to integrate enrollment.

Regular communication with participating customers is vital to maintain their interest and engagement. Customers need regular feedback about their programs and the credits they will receive. Text messages and push notifications are very effective for some customers, while others may need to be reached by email or mailings. Simple messages with nontechnical language are critical for customer engagement. This is particularly true in communications about DR events, since not giving customers adequate advanced notice may increase opt-out for integrated programs.

Contractors that provide program services also need to communicate effectively with customers. Dedicated and knowledgeable contractors can educate customers about the technology and the program. Once contractors are in the customer's house or building, they should identify all possible program opportunities and be able to explain clearly the benefits of suggested changes.

Conclusions and Recommendations

Integrated EE/DR programs can build on existing knowledge, technology, and experience in working with utility customers to understand and manage their energy use. The overall motivations are the same---to reduce costs and increase customer value, while also improving grid flexibility and efficiency for utilities and grid operators. Integrating energy efficiency and DR is crucial to maximizing customer value from both energy and demand savings while optimizing grid management and resources. However utilities may face different motivations for pursuing energy efficiency and DR depending on system resources, market conditions, timing, and location. Such differences can be addressed by supportive regulation that aligns incentives with both utility and customer motivations and benefits.

The design and implementation of integrated EE/DR programs requires fundamental changes in the organization and operation of customer programs. For example, utilities can consolidate staffing and also work for related, supportive regulation and rate structures to help them better capture integration's value. Rapid advancements and proliferation of grid-interactive technologies allow utility operators to reshape customer load profiles with little to no noticeable loss of desired outputs or functions of electric devices and equipment, such as those that provide lighting, cooling, or heating. Further, they can reshape customer load profiles in a way that also delivers energy efficiency's bill savings, comfort, and health benefits. To facilitate the growth of integrated EE/DR programs, we offer the following recommendations:

- Build support and understanding for integrated EE/DR programs among regulators, customers, stakeholders, and program allies by educating them about integrated programs' value and benefits.
- Address the potential conflict between energy efficiency and compensation for load shift through program designs that fully capture the value of integrated EE/DR resources.
- Enact regulatory changes that support integrated EE/DR programs, such as rates and rate structures that reflect time-varying costs.
- Enact organizational changes within utilities and other program administrators that support implementation of integrated EE/DR.
- Develop industry guidelines, metrics, and practices for assessing integrated EE/DR program impacts, value, and cost effectiveness.
- Document and share results from integrated EE/DR programs.
- Pursue integrated programs when the net benefits (e.g., fully capturing the resources' value streams, more efficient administration, a streamlined customer experience) outweigh the costs of integration.

We encourage utilities and other program administrators to work on these recommendations with regulators, grid operators, and other stakeholders. Doing so can improve the integration of EE/DR programs available to all types of customers and thereby realize multiple benefits for customers, utilities, and grid operators alike.

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Appendix A. Program Examples

Here we highlight five program examples and offer information on each program's history and design, measurable results, and challenges and successes. We also offer lessons learned to provide insights into what made these program models particularly successful. Our aim in choosing these case studies was to capture programs from different sectors, including common types with replicable models and those that offer important lessons.

BGE: Quick Home Energy Check-Up with PeakRewards

In 2017, BGE rolled out a cross-promotional pilot that included the PeakRewards demand response (DR) program and Quick Home Energy Check-up (QHEC) program. BGE found that customers were satisfied with the simultaneous delivery of both energy efficiency and DR in the pilot, so it continued the approach in 2018. QHEC schedules appointments for single-family customers wishing to enroll in the PeakRewards program. Currently, technicians install the Ecobee 3 Lite smart Wi-Fi thermostat and energy efficiency measures such as LED bulbs, pipe insulation, and faucet aerators, Technicians also assess energy efficiency measures such as insulation, heating and cooling systems, lighting, and appliances. The smart Wi-Fi thermostat lets customers schedule heating and cooling, and use their smart device to control their home temperature when they are away. Customers can also participate in control season DR events from June 1 through September 30.

Program Performance

Table A1 shows the program's measurement and verification results from 2017 to 2018.

Table A1. The pilot program's 2017–2018 measurement and verification results

Budget ($)	Actual spending ($)	Savings goal (MWh)	Actual savings (MWh)	Demand savings goal (MW)	Actual demand savings (MW)	Eligible customers	Participants	Average participation
46,300,000	6,962,746	15,797	1,062	284	330	1,094,301	804,966	73.6%

Source: BGE 2018

Successes

A primary driver for integrating the PeakRewards and QHEC programs is to increase customer satisfaction, a key performance indicator for Exelon, the utility's parent company. To meet this goal, BGE improved customer communication by using delivery channels that were impactful and relevant to the entire customer base. BGE found that customers were also satisfied with the shorter time commitment required in having one appointment for both programs. This creates cost savings for BGE, which can reduce the number of truck rolls associated with these programs.

BGE's integrated program taps into multiple value streams. Customers increase their bill savings through reduced energy use, DR payments, and beneficial rates. For example, BGE also has a residential peak-time rebate program with more than one million customers with smart meters enrolled. Customers with smart meters can participate in both programs and receive the higher of the two credits on event days. The integrated approach reduces the chance of outages and increases grid reliability for customers. BGE's cross-promotional structure and streamlined management and marketing leads to lower program costs. Table A2 shows the structure of BGE's smart thermostat programs.

Table A2. BGE residential smart thermostat programs

Program element	Optimization track*	Non-optimization track
One-time sign-on bonus	$75–$125**	$50–$100
Annual customer bill credits	$50–$100**	$50–$100
Cost of thermostat	No additional cost	No additional cost
Sources of information/education	• bgesmartenergy.com • BGE QHEC Program • BGE Home Performance with Energy Star (HPwES) • BGE HVAC Program • BGE New Homes Concierge Program • BGESavings.com • bgemarketplace.com	• bgesmartenergy.com • BGE QHEC Program • BGE Home Performance with Energy Star (HPwES) • BGE HVAC Program • BGE New Homes Concierge Program • BGESavings.com • bgemarketplace.com

*The optimization program track uses data from the customer's smart thermostat to automatically make adjustments that are customized for their home. **Bonus and bill credits depend on the cycling level selected for the optimization track. *Source:* BGE 2018.

Challenges and Lessons Learned

BGE conducts frequent question-and-answer sessions, performance evaluations, and weekly meetings to support technicians who required additional education and training to properly install DR technologies and conduct QHEC services. For accountability, technicians are required to send pictures of their installations to a supervisor and are financially responsible for incorrect installations (Amanda Janaskie, manager, Energy Efficient Programs, Baltimore Gas and Electric, pers. comm., April 16, 2019).

ENTERGY ARKANSAS: HOME ENERGY SOLUTIONS

Entergy Arkansas integrated DR into its Energy Efficiency Home Energy Solutions offerings with an advanced thermostat DR pilot measure in 2016. Entergy Arkansas conducts home energy assessments and installs efficiency enhancing measures such as ductwork and home leak sealing, ceiling insulation, LED lighting, advanced power strips, water heater jackets, low-flow showerheads, and aerators at no out-of-pocket cost for qualifying customers through its original Home Energy Solutions program. For customers who choose to participate in the advanced thermostat DR pilot measure, a thermostat is installed by a qualified technician at no additional cost.

Entergy Arkansas utilizes Ecobee smart thermostats for this pilot as both an energy efficiency and a DR measure. Customers can use web-based tools to customize comfort settings and track energy savings. They can also participate in DR events throughout the control season, lowering their energy usage at peak times. The control season for this program is June 1–September 30. On average, three to five events occur each season; events take place on non-holiday weekdays between noon and 7:00 p.m. for up to four hours at a time (Heather Hendrickson, Entergy Arkansas, pers. comm., May 22, 2019).

Home Energy Solutions Program Performance

Table A3 shows program performance for the Home Energy Solutions program; the DR measures were incorporated in 2016.

Table A3. Home Energy Solutions program's measurement and verification results 2013–2017

Budget ($)	Actual spending ($)	Savings goal (MWh)	Actual savings (MWh)	Demand savings goal (MW)	Actual demand savings (MW)	Participants
8,659,482	4,329,741	4,011.00	13,935.56	2.30	5.23	6,431
11,269,924	11,216,692	15,811.00	16,642.35	6.10	5.56	8,058
15,696,615	11,025,851	23,973.00	25,204.63	8.01	7.21	8,956
15,097,877	14,042,588	25,612.00	24,842.38	9.00	8.54	7,090
11,798,620	11,736,577	22,638.74	25,757.46	10.44	10.12	7,733

Source: Entergy Arkansas 2018

Successes

The Home Energy Solutions smart thermostat DR pilot measure deploys 1,500 units per year. Customers reduced energy usage at times of peak demand by allowing Entergy Arkansas to communicate with the devices; for participating in the program, the customers received DR incentives of $25 per year. Customers can also customize comfort settings, track energy savings, and control room temperature from anywhere. During peak events, customers can lower energy usage. They can also use auto-away functionality to potentially lower usage while not at home. An Entergy Arkansas customer survey with 605 participants who had received the Ecobee thermostat showed that 77% were very satisfied with the overall program experience; 82% were very satisfied with the Ecobee thermostat compared to their old thermostat; and 97% are more likely to participate in other energy efficiency opportunities due to their experience with the Ecobee thermostat (Heather Hendrickson, Entergy Arkansas, pers. comm., May 22, 2019).

Entergy Arkansas employed a temperature rise control and demand reduction strategy with one-hour pre-cooling. Customers found this easy to understand, and they were relieved that there was a limit to how high the temperature would rise in their homes. In addition, pre-cooling led to deep and immediate demand reduction. According to Entergy Arkansas' data, pre-cool and non-pre-cool strategies yielded identical immediate savings at the start of an event. However homes that had a 2-degree pre-cool had 16% greater kW savings in the fourth hour of an event than homes that did not pre-cool (Heather Hendrickson, Entergy Arkansas, pers. comm., May 22, 2019).

Another major benefit was effective customer messaging and increased program participation. Program administrators found it easier to communicate with customers about this measure and program, because they no longer had to explain the difference between energy efficiency and DR. Instead of using technical language and explanations, they marketed the advanced thermostat DR pilot measure and Home Energy Solutions program in clear and positive terms. They promoted customers' ability to lower energy use during peak demand times by allowing Entergy Arkansas to communicate with the device in those response events. They also conveyed the program's potential to improve the environment by relieving transmission congestion during high peak times as well as deferring the need to build a power plant.

Challenges and Lessons Learned

Entergy Arkansas accomplished effective customer marketing, communication, and education. It learned that messaging is critical to increase customer participation. Instead of advertising the advanced thermostat measure with technical language, they highlighted for customers positive outcomes such as the ability to lower energy usage, improve the environment, and monitor and control their home's temperature from anywhere using smart devices or computers. Entergy Arkansas provided support and education materials to alleviate customer challenges. Qualified installers left behind frequently asked questions (FAQ) sheets, quick response (QR) codes, and survey materials. Entergy Arkansas' call center also followed up with customers a few days after installation with a welcome call. Customers can contact the call center with any questions or concerns as long as they are enrolled in the program. Entergy found that the best time to send out DR event communication was the evening before an event, using the customer's chosen mode of communication, so that customers could plan ahead.

Entergy Arkansas also learned the importance of providing education and training for its installers and call center representatives to support them with the new high-tech smart thermostat measure. It also required that trade allies engage in installation and customer communication training sessions to add smart thermostat knowledge and installation skills for connected devices to their HVAC installation expertise. For an additional accountability measure, installers are required to take a photo of the device after they have installed it (Jonathan Hoechst, Keith Canfield, and Heather Hendrickson, Entergy Arkansas, pers. comm., April 17, 2019).

AEP OH: INTELLIGENT HOME AND DEMAND RESPONSE

AEP Ohio launched the Intelligent Home and Demand Response pilot in November 2016 and rolled out the full-scale program in May 2017. This program gives single-family residential home owners the ability to view their electricity usage in real time and better understand opportunities for savings, including DR events. This program consists of a free mobile app, an in-home device called Energy Bridge, and connected equipment and devices. The Energy Bridge gives customer real-time energy usage data and serves as a hub for customers to control smart devices, such as smart thermostats, EV charging, water heating, and pool pumps through the IT'S YOUR POWER℠ app. The app also includes a smart device store with eligible devices for the Intelligent Home and Demand Response program. To participate, customers must have an AMI electric meter, a smart phone, and a Wi-Fi connection to use the Energy Bridge. Customers can earn a $20 credit toward the app's smart device store by participating in at least 10 DR events during the May–September control season.

Program Performance

Table A4 shows program performance for 2017. Because AEP Ohio made program changes throughout the startup year it did not report energy or demand savings data.

Table A4. Program measurement and verification results from 2017

Budget ($)	Actual spending ($)	Savings goal (MWh)	Actual savings (MWh)	Demand savings goal (MW)	Actual demand savings (MW)	Participants
3,000,000	3,044,300	Did not count savings in 2017	—	Did not count savings in 2017	—	8,511

Source: AEP Ohio 2018

Table A5 shows the program's 2018 savings and participant breakdown.

Table A5. Program results by segment for 2018

Group	Participants	Active	Estimated daily energy savings (kWh)	Estimated % savings	Annualized total	Estimated total energy savings (MWh)	Total peak demand savings (kW)
App	21,792	19,040	−0.17	−0.01	—	—	—
Energy Bridge + app	9,260	8,395	0.23	0.01	84	332	52
Thermostat + Energy Bridge + app	2,031	2,031	0.57	0.02	207	237	505
Total	**21,792**	**21,790**	—	—	—	**569**	**557**

Participation numbers account for the quantity of devices installed at each household. Non-DR demand savings are derived using a 1.37 coincidence factor. *Source:* Ward 2019.

Table A6 shows the total program savings for 2018.

Table A6. Program results for 2018

Metric	Total MWh savings	Total kW savings
Estimated total Savings	569	557
Double-counted Savings	64	10
Total	**504**	**547**

Non-DR demand savings are derived using a 1.37 coincidence factor.
Source: Ward 2019.

Figure A1 breaks down savings and participation results by engagement level.

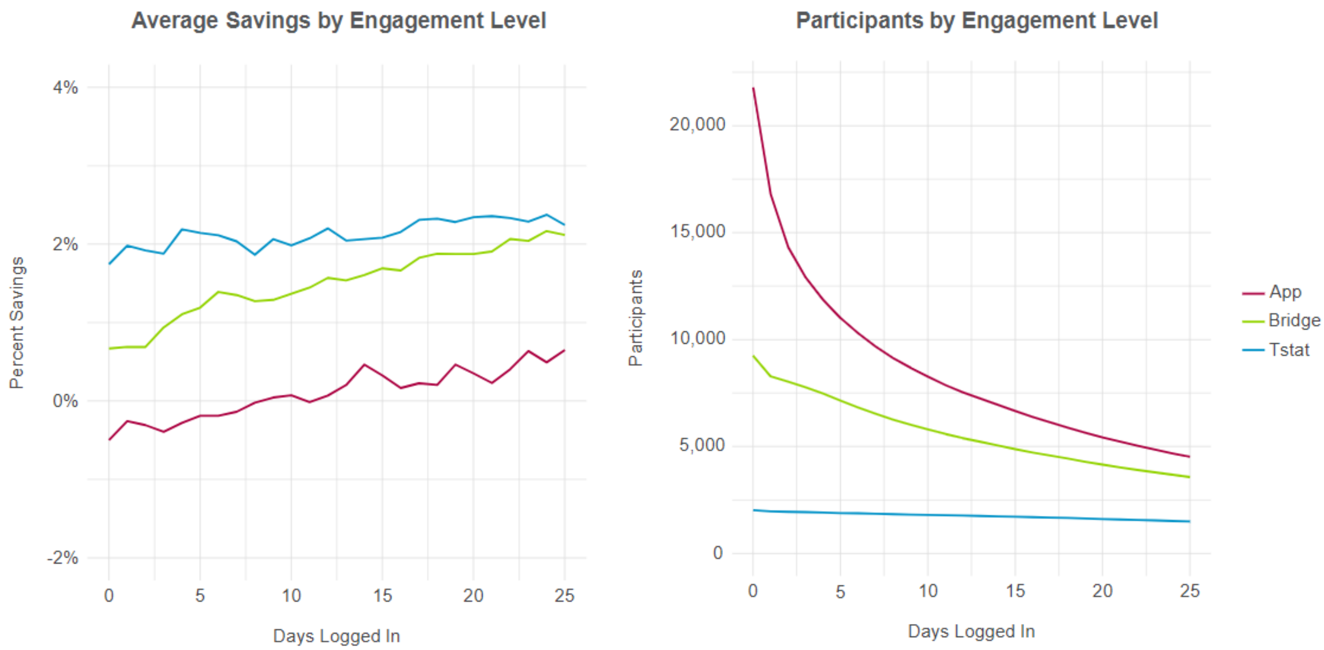

Figure A1. 2018 savings and participation by engagement level. *Source:* Ward 2019.

Drivers and Successes

AEP Ohio created this program in response to customer desires to better understand how to save energy. The Intelligent Home and Demand Response program is designed to increase customer satisfaction by addressing this need with real-time energy usage information and by giving customers a more connected home. The IT'S YOUR POWER app has increased ease of participation in energy-saving programs and has helped increase customer satisfaction, bill and energy savings, and education. AEP Ohio reduced program costs through streamlined marketing and management, which also led to increased program participation and satisfaction. This program complements AEP Ohio's ongoing AMI deployment efforts in that AMI program participation increases the eligible population for the Intelligent Home and Demand Response program.

Challenges and Lessons Learned

The program's target population is currently small because residential customers must have AMI to participate. AEP Ohio had planned to roll out an AMI program prior to the launch of the Intelligent Home and Demand Response program. However AMI deployment was delayed until four months after the Intelligent Home and Demand Response program launch, and the deployment did not fully reach the planned footprint. This made it difficult to grow the integrated program. Despite this barrier, more than 4% of the target population enrolled and participated in the program. Interviewees noted that this program would have been easier to roll out if an AMI rollout had been started (or completed) prior to launching the program because it would have created a larger eligible population. Additionally, knowing which customers would be eligible at which times would have allowed for more cost-effective, streamlined marketing.

Advances in AMI technology during the program's pilot stage created additional challenges. A new meter available in 2017 behaved differently than previous meter generations, and it did not connect, or bind, customers' Energy Bridges to their smart meters. After months of troubleshooting and bind failures, AEP Ohio was able to build in automated integration of the technologies. This challenge created customer satisfaction issues early in the program and potentially led to loss of participation, but it taught administrators the importance of testing AMI technologies before rolling them out. The program is improving and evolving, and AEP Ohio intends to add new features that will increase engagement with energy-saving behaviors. It also plans to launch a small-business solution pilot and to explore the possibility of an interface with AMI. (David Tabata and Deanna Gilliland, AEP OH, pers. comm., April 30, 2019).

FORT COLLINS UTILITIES: PEAK PARTNERS

The FCU Peak Partners initiative is a long-running portfolio of DR programs that use programmable Wi-Fi thermostats and electric water heater controllers to reduce peak demand. The thermostats and home energy monitors (available through the public library) also let customers view and manage their energy usage and create energy savings throughout the day. This portfolio is targeted at residential customers, but the utility has a commercial DR element to program as well, using OpenADR. In 2019, the portfolio launched a "bring your own thermostat" pilot, which was quickly fully subscribed. The program offers a free installation of a no-cost controllable thermostat that can be accessed remotely via an online portal. The customer is automatically enrolled in DR events, which are called less than 10 hours per month. The program is focused not only on peak demand reduction, but also on more granular daily load shifting. For DR events, the utility uses a 50% cycle for the thermostat and a 100% shutoff for the water heater. FCU also uses pre-cooling strategies with capable thermostats.

For customers participating with electric water heaters, FCU offers three levels of savings: basic, default, and aggressive. These indicate the increasing amounts of time the water heater is controlled. The program also works in conjunction with the time-of-day (TOD) electric rate, which was deployed for all residential customers in October 2018. The TOD rate is revenue neutral and uses a three-times off- to on-peak price differential. Customers realize about 5% savings in their annual utility bill through their controlled DR-enabled water heaters.

A website for the portfolio allows customers to self-enroll in the thermostat program, provides information on how to use each piece of technology, and offers additional information on energy conservation and DR. It also allows customers to access their Peak Partners thermostat dashboard.

Starting in mid-2019, this portfolio of resources began being tested to support renewable integration operations by dispatching short events to respond to variability in solar and wind generation. This demonstration is in collaboration with Platte River Power Authority, FCU's generation and transmission partner.

Drivers and Successes

FCU is a municipal distribution utility with regulatory oversight by the City Council of Fort Collins. The utility acts within the policy environment set by the City Council, which includes a 2% annual efficiency portfolio savings target and goals to reduce GHG emissions 20% by 2020, 80% by 2030, and 100% by 2050, based on a 2005 baseline. The utility therefore designs its programs to align the priorities of customer needs, council policy goals, and utility operations.

FCU's structure allows it to integrate its programs more easily than some other utilities. The City Council's priorities encourage innovation and flexibility while maintaining best practices for reporting and evaluation. Additionally, FCU designs and reports on its programs at the portfolio level, which gives it more flexibility with program budgets and cost effectiveness. FCU program administrators noted that being a small utility also has advantages for integration. For example, they have an Energy Services team that covers energy efficiency, DR, distributed generation, green buildings, carbon accounting, and electric vehicles. They also noted that when they go into customer premises, they make sure to assess for any programs that the customer may be eligible for, including water efficiency measures.

Program Performance

The Peak Partners program has been successful at meeting its goals, with more than 1,500 thermostats and 2,000 water heaters enrolled. This represents approximately 50% of the eligible water heater population. FCU is running 15 time-of-day events per week and, after eight months of operations with 2,000 participants, it has had only one report of a loss of hot water. Customers have been satisfied with the program, which was an important goal; FCU has found that more than 75% of respondents were likely or very likely to recommend Peak Partners to a friend.

The program has also achieved energy and demand savings. For typical dispatch times and large populations (more than 200 units), the utility has observed population average curtailable loads in the range of 0.9 to 1.3 kW per air-conditioning unit and 0.3 to 0.5 kW per water heater (John Phelan and Pablo Bauleo, Fort Collins Utilities, pers. comm.. March 12, 2019).

Challenges and Lessons Learned

Because it is structured as a municipal utility, FCU's program administrators noted fewer challenges than other program administrators. However they did note that they've faced some technological challenges, mainly in the difficulty of integrating dissimilar distributed energy resources (DERs) into a single, unified software platform.

Some of FCU's model elements are replicable for other programs. Administrators note that the TOD rate has helped them to bring all of the program's elements together, particularly the daily load management strategy, which creates savings for customers. FCU has also seen particular value from the program's operational efficiencies and recommend that administrators do everything they can when they have a touchpoint with the customer. This may include direct installations, education, or enrollment in additional programs. The utility also plans to add new DERs—such as storage and electric vehicles—to the program.

Appendix B. Details of Integrated Programs

Table B1 shows all the programs identified as having some element of integration based on a review of 44 utility demand-side management (DSM) reports, a call for examples, and additional research. The table includes a program description and our interpretation of the program's integration level.

Table B1. Integrated programs

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
AEP OH	It's Your Power	This program uses smart appliances and connected devices and an app to provide customers with energy management information (EE), as well as an in-home device that allows customers to participate in DR events.	Single program offering both EE and DR	AEP OH 2019b	www.itsyourpowerohio.com
Ameren Missouri	Peak Time Savings	Ameren Missouri is in the early stages of developing integrated EE/DR programs for single-family customers. Customers with qualifying thermostats will save energy through programmable learning thermostats and will be simultaneously enrolled in an automated DR program for cooling systems.	Single program offering both EE and DR	Ameren Missouri 2018	www.amerenmissourisavings.com/peaktime

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
BGE	Smart thermostat programs	BGE offers multiple smart thermostat programs (three residential and one for small business). For example, customers can receive a free smart thermostat for enrolling in the utility's PeakRewards DR program, and all qualified thermostats are eligible for the "optimization tract" that achieves ongoing energy savings. The programs ensure that customers with qualifying thermostats can enroll in all eligible EE and DR programs.	Cross-promotion	BGE 2018	www.bgesmartenergy.com/residential/smart-thermostats
ComEd	Smart thermostat programs	ComEd offers smart thermostats as a part of multiple program offerings and uses thermostats that are eligible for both EE and DR programs. The programs are cross-promoted. The utility is working to integrate the enrollment process through an online marketplace.	Cross-promotion	Ampong and Kunkel 2019	www.aceee.org/sites/default/files/pdf/conferences/eer/2017/Stoll_Session2C_EER17_Oct_31.pdf
ComEd	Smart Buildings Operations Pilot	This is a real-time energy optimization program for large buildings that primarily focuses on energy reductions. Implementers provide building operators with both energy and demand savings targets.	Stated recognition of latent energy or demand reduction capabilities (real-time energy management)	Bailey, Thacker, and Hill 2019	blogs.edf.org/energyexchange/2017/09/12/pilot-program-will-use-data-to-transform-the-efficiency-of-chicago-buildings

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
ConEd	Brooklyn Queens Demand Management Nonwires Solution Program (BQDM)	BQDM is an NWS program that leverages customer- and utility-sited EE and DR resources solicited through an auction, along with other DERs, to offset the need for a new substation.	Leveraging EE, demand response, and other DERs for a targeted need	Con Edison 2018a	www.coned.com/en/business-partners/business-opportunities/brooklyn-queens-demand-management-demand-response-program
ConEd	BYOT/DLC	ConEd is coordinating its direct load control DR program and its Bring Your Own Thermostat EE program through dual-enrollment at the point of purchase.	Administrative coordination	Con Edison 2018b	www.nyrevconnect.com/utility-profiles/consolidated-edison
Dominion Energy	Smart Thermostat Program	Dominion Energy's Smart Thermostat Program, approved to begin in 2019, will offer rebates, education, and dual EE and DR program enrollment for customers who purchase smart thermostats.	Administrative coordination	Dominion Energy 2018	www.scc.virginia.gov/docketsearch/DOCS/3I3501!.PDF
Duke Carolinas and Duke Progress	EnergyWise Business	Duke offers its EnergyWise Business program in North and South Carolina. The program is a more traditional commercial HVAC cycling DR program. The program description states that customers who choose to use a smart thermostat for the program rather than a direct load control switch can also utilize the thermostat's EE capabilities, such as by setting schedules and receiving energy conservation tips and communications from Duke.	Stated recognition of latent energy or demand reduction capabilities	DEC 2018	www.duke-energy.com/business/products/energywise-business

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
Entergy Arkansas	Home Energy Solutions	In 2016, Entergy Arkansas added smart thermostats, which can participate in DR events, to its Home Energy Solutions EE program.	Administrative coordination	Entergy Arkansas 2018	www.entergy-arkansas.com/your_home/save_money/ee/home-energy-solutions
Eversource Massachusetts	Delivery Pathways for Residential Direct Load Control Offerings	The Massachusetts 2019–2021 EE plan states that administrators will aim to facilitate enrollment in both EE and DR programs for technologies that are eligible for both.	Cross-promotion	Mass Save 2018	ma-eeac.org/wordpress/wp-content/uploads/Exh.-1-Final-Plan-10-31-18-With-Appendices-no-bulk.pdf
Fort Collins Utilities	Peak Partners	Peak Partners is a portfolio of DR programs employing programmable Wi-Fi thermostats and electric water heater controllers to reduce peak demand. The program simultaneously offers programmable thermostats and energy monitors to create energy savings throughout the day.	Single program	Call for examples	www.fcgov.com/utilities/residential/conserve/energy-efficiency/peak-partners
LIPA	Home Energy Management Program	LIPA's Home Energy Management behavior program offers home energy reports with the stated goals of reducing energy usage, increasing awareness of and enrollment in EE and DR programs, augmenting peak-hour energy savings, and increasing program satisfaction.	Stated recognition of latent energy or demand reduction capabilities, cross-promotion	LIPA 2018	www.psegliny.com/aboutpseglongisland/legalandregulatory/-/media/D0B169FF6D7A494CAD80B0079B7D78A4.ashx

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
National Grid New York	Electric C&I Retrofit Program	National Grid's C&I retrofit program has outlined a goal for 2018–2020 to promote connected technologies for the purposes of enrolling customers in DR programs.	Cross-promotion	National Grid 2017	www.nyrevconnect.com/utility-profiles/national-grid
NV Energy	NV Energy PowerShift Commercial Energy Services —Integrated Energy Efficiency and Demand Response (EE/DR)	NV Energy's PowerShift program offers customers multiple savings opportunities through a single program and a single appointment. This includes rebates for energy-efficient equipment, energy assessments, and smart thermostats that can be enrolled for DR events.	Single program offering both EE and DR	Nevada Power 2016 DSM Report	www.nvenergy.com/save-with-powershift
OG&E	Research study: Storage for Low Income/Senior/ Multifamily DR/EE	OG&E conducted a research study on the cost efficiencies for low-income and multifamily energy storage systems to act as an EE measure and to participate in DR programs.	Research	OG&E 2018	occeweb.com/pu/EnergyEfficiency/2017OGEOKAnnualReportOGEADMReport.pdf
Oncor	Commercial Load Management Standard Offer Program	Third-party providers administer Oncor's Commercial Load Management Standard Offer Program and can simultaneously offer EE programs.	Administrative coordination	Oncor 2018	www.oncoreepm.com/load-management-program.aspx

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
PG&E	Integrated Demand Side Management	PG&E offers multiple programs with elements of integration as a part of California's statewide Integrated Demand Side Management (IDSM, now IDER) initiative. The company has offered smart thermostats with EE and DR capabilities, conducted research on how to use smart thermostats to allow other technologies to participate in DR events, and has established a single contact point for multifamily programs. These efforts span multiple programs, including the Zero Net Energy Builder Demonstration program and the commercial EE program.	Administrative coordination	PG&E 2018	eestats.cpuc.ca.gov/EEGA2010Files/PGE/AnnualReport/PGE.AnnualNarrative.2017.1.pdf http://eestats.cpuc.ca.gov/Views/Documents.aspx
SCE	Integrated Demand Side Management	SCE offers multiple programs with elements of integration as a part of California's statewide IDSM (now IDER) initiative. The company has worked to coordinate program administration on its website, offering audit tools for small business and residential customers; coordinating integrated applications; and coordinating marketing, education, and outreach efforts.	Administrative coordination	SCE 2018	eestats.cpuc.ca.gov/Views/Documents.aspx?annual

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
SCE	Preferred Resources Pilot Program	SCE's Preferred Resources Pilot study has determined that the company may defer a new gas power plant by acquiring EE, DR, and other DERs.	Leveraging EE, DR, and other DERs for a targeted need	SCE 2019	www.sce.com/about-us/reliability/meeting-demand/our-preferred-resources-pilot
SDG&E	Local IDSM ME&O—Local Marketing (EE)	SDG&E offers multiple programs with elements of integration as a part of California's statewide IDSM (now IDER) initiative. The company has conducted extensive outreach to promote comprehensive energy solutions for understanding and managing energy usage, including with DERs, and has run a home energy report behavioral program that recommends EE and DR programs.	Cross-promotion	SDG&E 2018	eestats.cpuc.ca.gov/Views/Documents.aspx?annual
Water and power utility in Southern California	Study on social nudges	This program targeted households during peak times through calls and emails with a type of behavioral DR called a *peak energy report*, and also provided customers with home energy reports with comparative energy usage information that encourages energy-efficient behaviors.	Single program offering both EE and DR	Brandon et al. 2018	www.pnas.org/content/116/12/5293

Program administrator	Program name	Program description	Integration level	Reference	Additional resources
Xcel Energy CO	Energy Management Systems	Xcel Energy Colorado offers an Energy Management System and consultation and rebates to commercial customers. Incentives are available for peak demand reductions and energy reductions. Both electric and natural gas customers are eligible for the program.	Administrative coordination	Xcel Energy 2018	www.xcelenergy.com/programs_and_rebates/business_programs_and_rebates/equipment_rebates/energy_management_systems

Appendix C. Interviewees

Table C1. List of interviewees

Organization	Interviewee	Interview date
Lockheed Martin Energy	Regina Montalbano	2/20/19
Hawaii Energy	Sehun Nakama, Brian Kealoha	3/1/19
Peak Load Management Association	Rich Philip, Ed Thomas	3/4/19
OpenEE	Carmen Best	3/12/19
Lawrence Berkeley National Lab	Mary Ann Piette	3/13/19
Rocky Mountain Institute	Matt Jungclaus	3/15/19
Smart Electric Power Alliance	Brenda Chew	3/26/19
National Renewable Energy Lab	Ramin Faramarzi	4/2/19
Fort Collins Utilities	John Phelan, Pablo Bauleo	4/12/19
Baltimore Gas and Electric	Leigh Jarosinski, Amanda Janaskie	4/16/19
Entergy Arkansas	Heather Hendrickson, Peter Griffin, Keith Canfield, Jonathan Hoechst	4/17/19
Energy Solutions	Christine Riker	4/24/19
AEP Ohio	Deanna Gilliland, David Tabata, Vrushali Joshi	4/25/19
Commonwealth Edison	Jacob Stoll	4/25/19
United Illuminating	Alysse Rodrigues	4/29/19