Integrating Energy Efficiency and Demand Response: Employing Advanced Technologies to Unlock Operational Efficiency in Commercial Buildings

Carmen Baskette Henrikson and Kristin Brief, EnerNOC, Inc.

ABSTRACT

This paper presents three case studies on commercial buildings that are using advanced monitoring and control technologies to implement integrated energy efficiency (EE) and demand response (DR) strategies. We will conclude with key lessons learned and approaches to scale these integrated EE and DR applications from individual commercial building implementation to an integrated utility program.

While both EE and DR are categorized under the same "demand-side" umbrella, there are few examples where the two are actively promoted as an integrated customer offering. Research establishes that integrating EE and DR can generate substantial value by increasing the demand-side resource potential while reducing overall administrative and implementation costs.

Advancements in metering and smart grid technologies afford opportunities for a shared EE and DR technology platform. Monitoring-based commissioning (MBCx), which generally refers to the combination of retro-commissioning, ongoing commissioning activities, and real-time monitoring to ensure savings persistence, provides an example of how EE and DR can be integrated in commercial buildings. The case studies presented in this paper discuss the EE application of MBCx combined with DR to evaluate the benefits of using an integrated energy management platform to achieve greater operational efficiencies in commercial facilities.

Introduction

Energy efficiency and demand response fall under the same demand-side umbrella. EE is the sustained reduction in energy consumption (kWh) achieved either by replacing older products or equipment with more efficient ones, or making operational changes to improve specific system or equipment scheduling efficiency. DR is the temporary reduction of customer demand (kW) in response to electric system conditions such as high system load, transmission or distribution congestion, elevated power prices, or system emergencies. While research has shown that there is a clear link between EE and DR, the two offerings are rarely promoted to commercial, institutional, and industrial customers as an integrated product or service. For example, based on a study completed in December 2009, out of 2,016 U.S. and Canadian EE and DR programs evaluated, only 56, or less than 3 percent, were identified as serving both EE and DR purposes (EPA 2010).

There are both historic and structural reasons that EE and DR programs are typically promoted separately. For example, many utilities have a long history of offering EE programs and products, whereas outside of industrial interruptible tariffs and residential load control programs, DR program offerings for commercial and institutional customers have been relatively limited until recently. Although related, EE and DR have fundamentally different impacts on how utilities and grid operators manage their systems. Generally, EE can help offset or defer the need for new baseload generation, while DR can help to avoid the need for new peaking power plants or transmission and distribution infrastructure. In many cases, the funding sources for EE and DR are separate. As a result, utilities have separate EE and DR departments with distinct goals and budgets, thus creating a barrier to integrated efforts between the two groups. Consequently, EE and DR have developed independently over time and generally remain separate today.

Despite the lack of EE and DR integration today, when packaged together, EE and DR can generate substantial energy and peak demand savings, in many instances more efficiently than each alone. For example, an integrated solution can lower transaction costs by reducing the number of different contact points with which a customer needs to interface for its demand-side management needs. In addition, marketing costs for an integrated program may be lower than the costs of marketing each program independently. Participation in DR has been found to often lead to greater adoption of EE because DR can increase a customer's awareness of its energy usage (King 2005). Another key opportunity for reducing EE and DR delivery costs is the ability to use advanced technologies to enable EE and DR at a customer's facility simultaneously. Providing customers with integrated demand-side management leads to more efficient or "smarter" facility operations.

With the advancements in today's metering and smart grid technologies, there is a significant opportunity to realize both EE and DR together through a shared technology platform. Using the same technology platform for multiple purposes minimizes resource costs. Monitoring-based commissioning (MBCx) provides one example of how EE and DR can be integrated in commercial buildings. MBCx generally refers to the combination of retro-commissioning, ongoing commissioning activities, and real-time monitoring to ensure savings persistence. Under MBCx, monitoring and control technology is installed to capture energy usage data from interval meters, as well as to interface with building or energy management systems (BMS/EMS). This data is used to create benchmarks and identify efficiency measures that enhance building operations on a continuous basis.

The MBCx infrastructure can easily be coupled with control technologies to simultaneously enable the building to provide DR. In addition to improved persistence for operational efficiency measures, ongoing monitoring allows for more accurate measurement and verification of energy savings and peak demand reductions required for utility programs. In some cases, DR can precede an MBCx application where customer revenues from participation in a DR program can offset the costs of implementing MBCx or reducing the payback installing EE measures identified through MBCx. While the DR opportunity has the potential to be reduced in this case, the ongoing and persistent energy savings of a more efficiently operating facility can far outweigh lost DR revenues.

This paper will present three case studies on commercial buildings that are implementing both EE, through MBCx, and DR using a common management platform to leverage advanced monitoring and control technologies. We will conclude with a discussion of key strategies for the scaling of these approaches from individual commercial building implementations to full scale utility programs.

Commercial Building EE and DR Integration and Case Studies

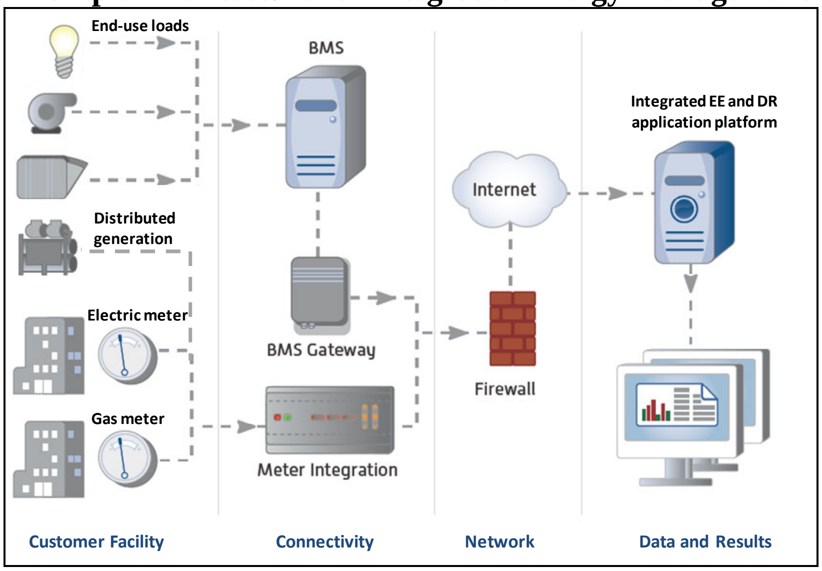
In this section, we describe the advanced energy management platform that enables an integrated EE and DR offering to commercial customers. We then present three case studies at commercial facilities.

The Integrated Energy Management Platform

Figure 1 provides an illustration of the architecture of the advanced energy management platform that enables EE and DR integration in each of the case studies presented in this paper. Using a series of gateway devices connected to the utility meter and the BMS, real-time information on total facility energy usage, the usage of specific end-use loads, and distributed generation operational data is collected and transmitted securely over the Internet. [1,2]

In today's market, there are many types of advanced monitoring and control devices that can create a bridge from multiple data sources throughout the facility to a common energy management platform. However, several key challenges for all facilities exist including but not limited to ensuring data integrity and security and the often higher integration costs of new versus established technologies. It is important to note that the architecture illustrated in Figure 1 *does not* presume additional technology capabilities from advanced metering infrastructure (AMI), but the overall approach could certainly be enhanced if integrated with AMI.

Figure 1. Example Architecture for Integrated Energy Management Platform



Source: EnerNOC, Inc.

The common technology platform allows for these data sources to be used for both the control and management of temporary reductions (DR) and the identification and monitoring of sustained energy reductions (EE). The platform enables the customer to view its meter data around the clock in real-time on a secure, web-based interface, including during DR events. Figure 2 shows an example of "DR event performance view," which enables the customer can self-manage its load reduction strategies.

---

[1] The facility's BMS must be BACnet-enabled to properly connect to the gateway device and transmit data at predetermined intervals, typically 5-minutes. BACnet is a standard ASHRAE data communication protocol for Building Automation and Control Networks (www.bacnet.org; www.ashrae.org).

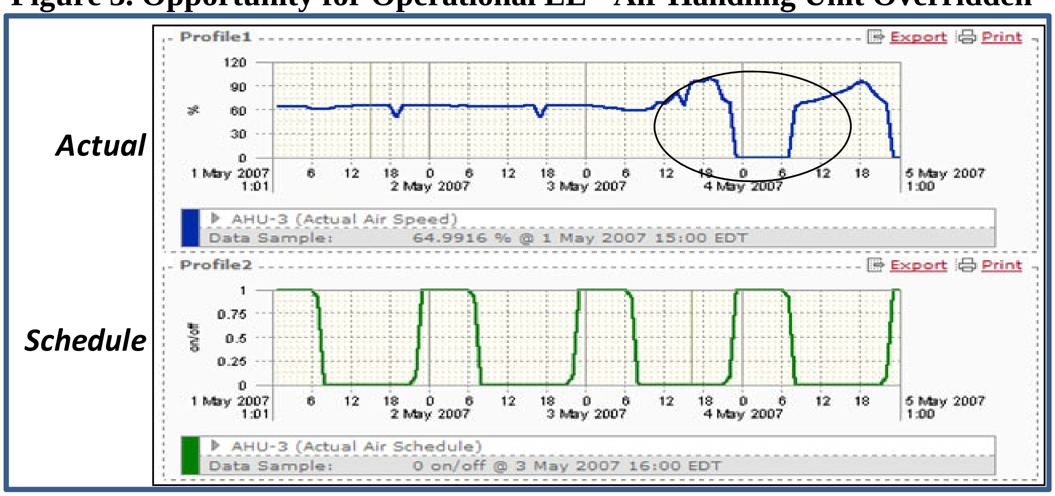
[2] The facilities in each case study installed an Echelon iLon device at the utility meter to collect KYZ pulse output data in 5-minute intervals.

Figure 2. Example DR Performance View

Source: EnerNOC, Inc.

Similarly, the common energy management platform enables MBCx by filtering and analyzing data from the BMS for anomalous consumption. Figure 3 illustrates an example of an anomaly discovered through data visualization using the MBCx approach. In this example, an individual air handling unit (AHU) (profile 1) was not operating according to the scheduled program (profile 2, where 0 represents "on" and 1 represents "off") because the system was continually overridden by occupants using the space during off hours. This finding was a no-cost opportunity to improve building efficiency.

Figure 3. Opportunity for Operational EE - Air Handling Unit Overridden



Source: EnerNOC, Inc.

Sharing a common technology platform for EE and DR allows the customer the ability to not only view DR performance during an event, but also examine the detailed performance of facility operations on an ongoing basis. By integrating their EE and DR strategies, a customer can program their DR load curtailment plan directly into their BMS to automate performance when dispatched from the energy management platform. Additionally, new operational EE actions, including work-scheduling or policy changes can be identified as a result of repeated DR participation.

Commercial/Institutional Facility Case Studies

The first case study is a university campus in California, the second is a large commercial property in New York City, and the third is a large hospital complex in Illinois. Each project highlights the achievements to date of integrating EE and DR while identifying opportunities for further integration of demand-side resources behind the customer meter.

Educational Facility: California State University; Northern California

Facility background. California State University Monterey Bay (CSUMB) campus is one of 23 California State Universities. CSUMB was established in 1994 and serves approximately 4,000 students. It is located on the site of the former Fort Ord Army base and many of the 64 buildings on campus were converted from former military facilities. The total campus building area is approximately 1.2 million square feet. As described below, CSUMB's participation in EE preceded and facilitated its participation in DR.

Energy efficiency. Since 2005, CSUMB has been actively participating in EE programs supported by the University of California (UC), California State University (CSU), and Investor-Owned Utility (IOU) Energy Efficiency Partnership (www.uccsuiouee.org). This Partnership Program is a statewide EE program designed to realize cost-effective energy and demand savings in higher education. As a result of CSUMB's proactive participation in the Partnership Program, as of 2009, nearly all campus buildings are on a energy centralized platform, and each building has received at least one but in some cases as many as three EE project upgrades.

In addition to implementing traditional retrofit and retro-commissioning EE measures, beginning in 2008, CSUMB implemented a pilot MBCx Express program at four campus buildings that total over 115,000 square feet of conditioned space, or about 10% of the total campus building area. The MBCx Express program facilitated the enablement of real-time energy metering at the targeted buildings and enables the ongoing *remote* analysis of key BMS data. Upon implementation, engineers and analysts have been able to review the data and mine it for additional EE opportunities.

As of 2009, the combined results of these projects have reduced CSUMB's annual energy intensity from 12.5 kWh/sq ft to 9.57 kwh/sq ft (a 24% decrease) and from 0.54 therms/sq ft to 0.40 therms/sq ft (a 26% decrease).

Demand response. In 2009, CSUMB enrolled in a Pacific Gas & Electric (PG&E) DR program. The same energy management platform supports the campus' participation in both MBCx and DR. The campus has an automated DR plan where the curtailment strategies have been programmed directly into the BMS sequence of operation using standard Demand Limiting Load Rolling (DLLR) features. The DLLR feature in the BMS allows for continuous management of the campus load against a relatively high maximum demand; DLLR dispatches load curtailments from a pre-programmed priority list to maintain campus demand below this target. During a PG&E DR event, a signal is automatically sent to the BMS which engages the "Load Rolling" feature of the DLLR and dispatches loads from the list to drop 100 kW from the then-current kW demand. While the facilities department is automatically notified via text message of DR events, this approach is fully automatic and requires minimal (if any) campus staff time. CSUMB's DR load curtailment is relatively small and as such this automated approach would likely not be cost-effectiveness on its own without a shared technology platform.

Key technologies. Employed on-site:

- BMS: Johnson Controls Metasys 4.1
- BMS Gateway: Gridlogix
- End-use data points collected: approximately 1,000
- Meter device: Echelon iLon

Successes. A key linkage between EE and DR is the installation of real-time electric metering. This metering allows precise testing and quantification of each load programmed into the DLLR priority list. The system can then dispatch *just enough* load to precisely meet the target, as opposed to using more of a "shotgun" approach. This metering was so successful that campus has expanded it to additional buildings in order to discover additional dispatchable loads.

CSUMB is currently in the final stages of verifying and compiling savings achieved from the *MBCx Express* project. During the course of the project, CSUMB has achieved energy savings by implementing several categories of EE measures, including:

- Revising the operating schedule of HVAC equipment
- Calibrating hot water valves
- Installing HVAC occupancy sensors
- Revising the operating schedule
- Repairing the outside and return air dampers
- Justifying conversion of former Library from Constant Volume to VAV
- Justifying retrofit of VFD's to Gym main floor air handlers

By the end of 2009, the MBCx Express pilot program had identified an additional 535MWh and 165 therms energy savings with an associated $62,000 cost savings.

Challenges and lessons learned. The extensive technology deployment requierd to collect detailed use data, coupled with on-site commissioning activities, resulted in the MBCx project spanning over the period of both actual and planned building retrofit projects. Additionally, at least one building participating in the program changed its primary function (from a library to a student center facility). Each of these changes had a direct impact on the data and savings results, and limited the total savings that could be claimed by the campus under the program. The key take-away from this case is the understanding that the technology platform made available through the implementation of current EE and DR strategies must continue to be a tool for the campus to both support the maintenance of energy savings achieved, and identify new opportunities for greater savings regardless of any future on-site changes.

Commercial Property: Morgan Stanley/Hines Partnership; New York, New York

Facility background. Morgan Stanley's global headquarters are located in downtown New York City at 1585 Broadway in a 42-floor commercial office building constructed in 1990. The building is nearly 1.5 million square feet of conditioned space with operating schedules varying by floor. There are four dedicated mechanical floors and the remaining floors contain offices, financial trading spaces, and data centers. Several of the floors operate on a 24-hour/7-day per week schedule. Two tenants occupy the building's office spaces. As is typical for commercial office buildings, the majority of end-use loads consist of cooling, lighting, and office equipment. There are also significant data center server loads in the building. Morgan Stanley's participation in DR at this building preceded and facilitated subsequent implementation of the MBCx EE project.

Demand response. Since 2007, Morgan Stanley has participated as a 1.1 MW DR resource under the New York Independent System Operator's (NYISO) Special Case Resource (SCR) program.[3] In addition, Morgan Stanley participates in Consolidated Edison's (ConEd)'s Distributed Load Relief Program,[4] which is a distribution-level program designed to address local constraints in New York City. This site has participated in over nine DR events since initial registration.

Energy efficiency. Morgan Stanley decided to implement an MBCx solution in 2009, after completing a comprehensive retro-commissioning project that same year. With MBCx, Morgan Stanley sought to ensure the persistence of these savings.

Key technologies. Employed on-site:

- BMS: Siemens
- BMS Gateway: Cisco Mediator
- End-use data points collected: approximately 9,000
- Meter device: Echelon iLon

Successes. With MBCx to date, Morgan Stanley has identified over 53 actionable EE opportunities resulting in savings of over $100,000. These savings are above-and-beyond the retro commissioning efforts. Types of savings indentified include:

- Lights on the trading floor were not turned to night setback mode during the evening hours. *Savings: 214 MWh and over $34,000 annually.*
- Fan systems were over-cooling a space by about 5°F. *Savings: 68 MWh and over $10,000 annually.*
- Air conditioning unit was operating at night when it should not have been. *Savings: 5 MWh and over $700 annually.*

[3] http://www.nyiso.com/public/markets_operations/market_data/demand_response/index.jsp
[4] http://www.coned.com/energyefficiency/dist_load_relief.asp

While not achieved to date, the integrated technology platform now operating at this building, affords Morgan Stanley the ability to continue to identify both new EE measures and automated load curtailment opportunities for future nomination into the SCR program.

Challenges and lessons learned. Specific challenges associated with the gateway technology installation included identification and resolution of network security concerns and maintaining customer data integrity. In this case, the challenges were overcome during MBCx deployment by working in close coordination with the customer, the BMS vendor, and the gateway device provider to address security and data integrity issues. Going forward, both new and alternative technologies must be continuously evaluated to effectively mitigate challenges of this nature.

A key lesson learned at Morgan Stanley is that following traditional retro-commissioning projects, building engineers cannot reasonably be expected to monitor and manage such large amounts of facility data. The use of the advanced MBCx technology is simply another tool that affords them more precise management of both operational EE and DR. To that end, this MBCx application has given Morgan Stanley the ability to manage its cooling loads at much greater levels of granularity.

Healthcare/Hospital: Northwest Community Hospital; Arlington Heights, Illinois

Facility background. Operating since 1959, Northwest Community Hospital (NCH) is a large hospital campus, situated to the northwest of the Chicago metropolitan area. The NCH campus is 840,000 square feet, comprised of 13 buildings and operates on a 24-hour, 7-days per week schedule. NCH is currently constructing a new patient care facility and applying for LEED certification.[5] As is typical with a hospital facility, NCH's energy load is driven by lighting, cooling, and medical equipment operations.

Demand response. Since 2008, NCH has participated as a 4.5 megawatt DR resource in the PJM Interconnection's Emergency Load Response Program (ELRP),[6] by shifting load onto two diesel backup generators.[7]

Energy efficiency. Building on the success of its DR activities, in 2009, NCH engaged in an MBCx service to further enhance its energy management capabilities. Payments from the ELRP have in part helped NCH to fund MBCx.

Key technologies. Employed on-site:

- BMS: Johnson Controls
- BMS Gateway: Tridium JACE
- End-use data points collected: approximately 5,000
- Meter device: Echelon iLon

[5] http://www.usgbc.org
[6] http://www.pjm.com/markets-and-operations/demand-response.aspx
[7] NCH obtained all necessary environmental permits to run their generators during DR events.

Successes. The early results of the MBCx process have identified over $300,000 of potential energy savings through primarily operational, low- and no-cost measures. Examples of savings measures indentified include:

- Reduce air handler run time when the surgery room is not in use. *Savings: 103 MWh and $7,700 annually*.
- Turn off 125 outdoor alcove spotlights when there is adequate daylight. *Savings: 32 MWh and $2,500 annually.*
- Reduce lighting in day-lit areas like the cafeteria, the main lobby, and various hallways *Savings: 22 MWh and $1,600 annually.*

Challenges and lessons learned. One of the primary challenges at NCH, which is not uncommon, was the lack of interoperability of the multiple technologies and systems required to aggregate facility end-use load data onto the energy management platform. Interoperability is a recognized barrier to implementation of advanced, or smart grid, technologies and this challenge has been overcome through close coordination among individual technology vendors and concerted determination by the energy platform vendor. While NCH has been participating in DR by shifting load onto its onsite generators, the next steps are to evaluate and facilitate more sophisticated load reductions through the BMS. This challenge has not yet been overcome primarily due to the highly sensitive nature of end-uses in a hospital facility but enabling NCH with the granularity of energy use data through MBCx is expected to allow for greater optimization of facility operations.

The Opportunity for Full-Scale EE and DR Integration

There is substantial opportunity for EE and DR savings in the commercial and industrial sectors – the three case studies detailed in this paper are just the tip of the iceberg. A 2009 Electric Power Research Institute (EPRI) report suggests that the commercial sector's EE potential is in the range of 170 TWh, which is more than double the 75 TWh potential identified in this same report for residential EE potential (EPRI, 2009). EPRI also indicates that together EE and DR have a maximum achievable potential to reduce summer peaks by 218 GW in the commercial sector by 2030 (EPRI, 2009). It is important to find solutions for the challenges associated with meeting the varied needs of these segments.

Integrated EE and DR programs can help to achieve total potential in a more efficient manner. However, according to the Environmental Protection Agency, less than five percent of EE programs have dual-purposes or integrated components. (EPA, 2010) Existing integrated EE and DR programs have focused, for example, on integrated audits, efficient lighting control and air conditioning, and incentives for technology enablement. However, there is an opportunity to move beyond these limited applications and pilot projects and make integrated EE and DR the standard. Employing new and advanced technologies through a full-scale program implementation is often more expensive than tested EE measures, as such this approach may be applicable to larger customer to be a truly cost-effective alternative. Over time, however, and as a result of more widespread program implementations, similar applications could be rolled out for smaller customers.

There is no silver bullet to successful integration at a full-scale program level. Program implementers should focus on three areas: 1) choosing the right resource delivery mechanism; 2) engaging in effective marketing & sales strategies; and 3) developing and deploying the right technology solutions.

Resource Delivery Mechanisms

Customer receptivity to integrated EE and DR programs is in part influenced by the "delivery mechanism," or the way in which the customer is approached with the offering. We describe three major categories of delivery mechanisms, and highlight some of the advantages and disadvantages of each. Ultimately, the delivery mechanism chosen will depend on the utility's goals with respect to EE and DR and the utility's propensity to work with third parties.

- *Utility as an EE/DR provider*: In some cases, utilities manage EE and DR programs internally. While these programs can involve multiple departments and multiple funding sources, utilities can develop a marketing strategy that delivers an integrated product to customers. For example, some utilities use the account management staff to "sell" all EE and DR offerings to customers, which is one means of integration because it ensures that large customers have a single touch point for all utility demand side offerings. In addition, utility programs are predictable and consistent across customers. While this can be effective, a constraint of this approach is that many utilities have a limited number of account management staff to educate customers about the program. Another important point to note is that due to regulatory restrictions, a utility may have limited, if any ability, to customize an offering for a given customer. For example, a large industrial customer can either opt in or out of an interruptible tariff and cannot negotiate the terms of this contract.
- *Partnership between utilities and third parties*: It can be effective for a utility to engage a third party to assist in enrolling customers in EE and DR programs. Under this construct, utilities generally have a greater ability to focus on particular customer segments to offer comprehensive services. In addition, in many cases, utilities can offer unique solutions to a given customer depending on that customer's particular needs. Challenges associated with this approach arise when programs can only be designed as single product/service to match funding sources, contracting processes, and measurement and verification requirements. In addition, utilities cannot protect customers from any issues that may arise in third party contracts.
- *Direct Services*: In some cases, companies are set up to engage customers directly in EE and DR programs, irrespective of any utility program, incentive or subsidy. These business models are effective only so long as the customer value proposition for the services (e.g., the benefit) exceeds the cost, taking into consideration any perceived risk. Of course, EE and DR programs outside the scope of utility offers are not subject to regulatory oversight, and reporting requirements are limited. In general, this delivery mechanism is highly flexible, but the costs of implementation can be a major obstacle for customers.

Table 1. Delivery Mechanisms for Integrated EE and DR

Delivery Channel	*Utility*	*Third Party Partnerships*	*Direct Services*
Customer Access	**Medium** - A utility has direct access and an existing relationship with all customer accounts in its service territory	**High** - A utility has direct access and an existing relationship with all customer account information in its service territory; the outreach effort is bolstered when additional third party resources are able to do customer outreach	**Low** - Third parties offering services outside of the utility's realm must rely on their own lead generation methodologies to generate demand for services
Financial Offering	**Limited flexibility** - Equal tariffs across all customers	**Some Flexibility** - Third parties can offer unique programs depending on specific needs but may be hindered by regulatory requirements	**Maximum flexibility** - Outside of utility offerings so no regulatory or reporting requirements
Customer Touch	**Single point of contact -** Utility is a single point of contact for the customer	**Can be multiple points of contact -** Customer may be touched multiple times by the utility and/or vendor; utility may choose to represent vendor as a utility employee	**Utility has no contact** – Vendors approach customers in free marketplace
Challenges	Utility's ability to reach commercial customers will be limited by the size of its account representative staff	Coordination between utility funding sources; Typically, partnerships are run as single-product programs	Full implementation costs can be a major barrier to customer adoption

The three customers described in the case studies have successfully used some combination of utility or internal funding sources to implement an integrated EE and DR approach on a common technology platform. These are examples of "first movers" and other examples are relatively limited. Two general strategies for enhancing integration efforts are discussed in this section, including: 1) customer targeting and education, and 2) advanced technology development and deployment.

Targeted Customer Marketing and Education

One clear advantage of the integrated EE and DR approach to demand side management is that customers are able to devise one energy management plan to optimize both energy and demand usage. A "one stop shop" for energy management products and services could significantly increase the reach and impact of EE and DR resources. In addition, in many cases, payments from DR participation can help finance EE investments.

To see widespread adoption of integrated EE and DR programs, program implementers will have to:

1) Coordinate across delivery channels, including utilities, third party DSM providers, local government and agencies, trade associations, and other stakeholder groups;
2) Develop an integrated marketing and outreach approach, including appropriate educational materials and a single point of contact for both EE and DR
3) Institute a training program for those involved in the program, including utility staff, third party DSM providers, and contractors.

In addition, as is the case with standalone EE and DR programs, in an integrated program, customer segmentation is key. Customer systems and operations are unique across building types and climate regions and highly dependent on the primary activities of the facility. It's important to develop marketing and sales strategies that uniquely addresses the needs of varying customer segments. Effective messaging will differ across industries. For example, a marketing campaign may focus on food quality and buyer experiences when targeting grocery stores, guest comfort when targeting hotels, or patient care for hospitals.

Advanced Technology Development and Deployment

Today's reality is that commercial buildings use multiple metering and control devices to assist with facility operations. These devices are made by different manufactures and have different functionalities. Fortunately, there have been advancements in energy management platforms and gateway technology that enable complex commercial energy data to be aggregated in a centralized system. Developing such common platforms for managing dual or multiple demand side resources is critical to the success of integration efforts.

The California Statewide EE Strategic Plan establishes demand-side integration as a key goal, with the objective for customers to "…realize increased energy savings at lower cost through the implementation of a menu of DSM options." (CPUC, 2008) Additionally, one of the four strategies for achieving the integration goal is through new technology development, where "a major effort is needed to develop new technologies and systems that enable multiple DSM options and provide synergy across DSM program types." (CPUC, 2008)

Given these early efforts to integrate, it is clear that the support of utilities and regulators to promote integration either through incentives, tariffs or educational programs can further accelerate customer adoption. In the meantime, although not required, the deployment of advanced metering technology will be a key step as this will likely be the point of interoperability between the utility meter network and the customer's facility network. The interoperability capabilities of advanced meters will be an early driver in the development of new gateway technologies to bridge between the customer and utility networks. This bridging between disparate networks is a critical component of a truly smart grid.

Conclusion

This paper presented three case studies where commercial customers are currently implementing integrated EE and DR strategies. These customers are engaging in comprehensive facility energy management via an integrated energy platform. They are using this platform to improve operational efficiency, maximize and ensure the persistence of EE savings, and implement reliable DR strategies. These benefits are beginning to be realized at the facility level as a direct result of newly-available monitoring and management technologies.

Now is the right time to focus on the opportunities and challenges with behind-the-meter integration of energy management strategies. Customers are motivated to reduce operating costs and manage their environmental impacts. At the same time, utilities, regulators, energy service companies, and technology companies are tackling the challenges of moving to a smart grid. With coordination, these combined interests should lead to greater demand-side integration at commercial facilities, dramatic cost savings for customers, improved results for utilities, and more efficient use of our energy resources.

References

[CPUC] California Public Utilities Commission (2008). **California Long-Term Energy Efficiency Strategic Plan**. September 2008. <www.californiaenergyefficiency.com>

[EPRI] Electric Power Research Institute (2009). **Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S**. (2010-2030). Technical report no. 1016987.

King, C., and D. Delurey (2005). **Efficiency and Demand Response: Twins, Siblings, or Cousins?** Public Utilities Fortnightly 143(3).

[EPA] National Action Plan for Energy Efficiency (2010). **Coordination of Energy Efficiency and Demand Response**. Prepared by Charles Goldman (Lawrence Berkeley National Laboratory), Michael Reid (E Source), Roger Levy, and Alison Silverstein. <www.epa.gov/eeactionplan>