Effective Integration of Demand Response and Energy Efficiency in Commercial Buildings

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ABSTRACT

To date, efforts to integrate energy efficiency (EE) and demand response (DR) in utility programs have met with administrative and implementation challenges. As of 2009 only three percent of 2,016 U.S. and Canadian EE, DR, and load management programs served both EE and DR purposes.[1] EE and DR historically have tended to be "silo-ed" within electric utilities—with goals not well-aligned between programs and barriers to moving funds between programs. Several innovative efforts are emerging to improve the effectiveness of demand-side management (DSM) program delivery, customer engagement, and customer satisfaction. Studying these efforts helps clarify opportunities to broaden these approaches and further maximize the value and cost-effectiveness of DSM programs.

Integrated DSM (IDSM) that programmatically combines EE and DR, with on-site generation, offers a win-win-win scenario. Utilities get more resources, more cost-effectively, with greater assurance of persistence. Customers get more economic value and ease of participation. Vendors can deliver services more efficiently. While early project results are encouraging, it is important to recognize the unique program design challenges that must be addressed.

This paper explores how recent projects and models reveal approaches to unlocking the value of the IDSM approach, providing examples of commercial building-focused utility IDSM initiatives, leveraging lessons from the industrial sector, and examining four key elements of integration in detail: service delivery, technical, incentives, and measurement and verification (M&V).

Introduction

DSM professionals have been talking about, and dabbling with, IDSM for nearly a decade. Ultimately, well designed integration of EE and DR can deliver a number of benefits for utilities from more cost-effective programs and resources, to more satisfied and continuously engaged program participants—each a key driver of the need to continue to push this approach. Despite the promise IDSM holds for DR and EE programs, significant barriers remain and little progress has been made with a few notable exceptions.

This paper peels back the layers of what truly constitutes IDSM, including:

- Service delivery integration: ability to assess both DR and EE opportunities in the field
- Technical integration: measures that enable / maximize both EE and DR

[1] 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>

- Incentives integration: inspiring customers to participate in both EE and DR while taking advantage of economies of scale
- M&V integration: avoiding customer fatigue while achieving rigorous verification

This paper also provides a look at current barriers to commercial building-focused IDSM programs.

Finally, this paper will explore some leading efforts to combine EE and DR, namely:

- NV Energy: efforts with Building IQ provide an example of integrated program design around technically integrated measures.
- Southern California Edison (SCE): industrial sector-focused efforts offers an example of service delivery and technical integration
- Pacific Gas & Electric (PG&E): buildings-focused efforts highlight specific barriers encountered when working with Commercial Real Estate owners such as the Irvine Company and CBRE.

Service Delivery Integration: Assessing Both DR and EE Opportunities

Service delivery integration enhances the ability to assess both DR and EE opportunities in the field. This includes:

- Facility audits
- Measure analysis to calculate EE savings, DR load reductions, capital investment required and ROI / payback period for end-use customer – including benefits from incentives available
- Detailed project plans
- Overseeing equipment installations and settings including software upgrades and programming as necessary
- Obtaining customer agreements to proceed on both EE and DR measures and programs
- Facilitating third-party evaluation, measurement and verification (EM&V) analysis

A simple, but nonetheless compelling driver of service delivery integration is avoiding redundant visits to facilities. As an implementer of both EE and DR programs for PG&E, EnerNOC has experienced this result due to both utility program silos and our own departmental silos established to support those programs. More recently we have worked with PG&E and SCE, as well as on our own, to integrate site visits and maximize the program benefits derived from those visits. We have also worked to extend this beyond just visits to include marketing outreach and all recruitment communications. While our work to accomplish integrated service delivery is by no means pervasive, largely due to program budget limitations, we have found some meaningful successes resulting in key benefits, including:

- Reduced cost of implementation resulting in reduced utility program costs and therefore more cost-effective programs
- Reduced cost to the end-user resulting in lessened barriers to implementation and higher customer satisfaction with program participation

- More EE and DR resources identified as a result of a more thorough review of facility opportunities than would be identified independently

Each of the case studies presented in the "Leading IDSM Efforts" section below present specific economic details of these benefits. While the ultimate value of integrating EE and DR efforts is impacted by the other integration factors described below—technical, incentives, and M&V integration—it is important to note that meaningful value occurs up front at the service delivery stage.

Technical Integration: Enabling / Maximizing Both EE and DR

Technical integration is the integrated use of DR and EE hardware and/or software for benefit of one or both programs. This involves instances when a piece of hardware or software can be used to improve the efficiency of a process or system while also enabling that process to participate in a DR event. Since some measures can support both EE and DR goals, ideally they would not be implemented for only one use, unless customer preferences or economics dictated otherwise. This is not to say that an integrated approach to service delivery should only enable technically integrated measures; independent measures could also be identified, assessed, and implemented.

Overall, implementing both technically-integrated measures and independent measures should maximize the benefits to customer and utility. Examples include lighting control systems, dimmable ballasts, energy/building management system installations, or enhancements to existing energy management systems and data analytics software in the commercial sector; fans, motors, drives, refrigeration, and control systems in industrial processes; and advanced SCADA systems and pumps in water and wastewater facilities.

There are a few important customer preference considerations to technical integration:

- Allow customer preferences to govern which measures are implemented: While purists might prefer to implement EE measures first in order to have a post-EE baseline from which to calculate DR, this can limit the customers' ability to act. Depending on capital investment budgets and equipment upgrade schedules, customers may need to proceed with DR measures first.
- Be flexible to customer equipment preferences: Customers have preferred vendors and pre-approved contracting mechanisms with those vendors so these preferences should be allowed to govern equipment decisions.

Incentives Integration: Inspiring Customer Participation

Effective incentives integration inspires customers to participate in both EE and DR while taking advantage of economies of scale. The combination of EE and DR incentives is a powerful tool for providing extra incentives for customers that can implement both. Service delivery integration and technical integration present opportunities for both the utility and the customer to reap project-related cost savings. The utility can use this extra value to offer more incentives to customers that agree to participate in both EE and DR, and still capture some portion of the cost-savings value. In designing a program to capture this value, utilities should be careful to not have different incentives for similar measures, providing clear signals to the market and to customers that they cannot "shop" programs.

There are a variety of approaches and components to consider in structuring integrated incentives. The main components include adding both a DR incentive and a time-dependent incentive structure.

Adding a DR Incentive

Adding a DR incentive for customers that sign up for participation in a DR program in addition to participating in industrial and commercial EE programs helps to engage customer interest and participation in IDSM programs. This incentive should be structured with the following three considerations in mind.

Provide an up-front enablement incentive. Providing an up-front enablement incentive can help motivate customers to action. It can support installation or enhancement of automation systems by enabling the customer to use the incentive to buy down measure capital costs. This enhanced "comprehensiveness" incentive should be available only to customers agreeing to participate in both EE and DR programs. The utility can maintain protection to ensure customers don't use this incentive and then abandon the DR program.

Provide some form of payment for capacity. In our experience, some form of payment for capacity is required to garner DR resources from the commercial and industrial sector. While this can be combined with some form of energy payment, a capacity payment is required to make it worthwhile for the customer.

Maintain the flexibility to leverage EE participation into a DR resource, and vice versa. For example:

- EE to DR: If a customer selects an EE program and will obtain incentives to install a building management system (BMS) or a more efficient controllable lighting ballast, the utility might require that the customer sign up for a DR program and that the equipment be programmed for DR participation in order for the EE incentive to be delivered. The added DR benefits to the customer could range from reduced energy bills through peak management and/or capacity and energy incentives.
- DR to EE: One of the advantages of a capacity payment for DR resources is that it provides the customer with cash. Consequently, obtaining DR incentives first can enable the customer to use those funds to pay for capital costs of EE measures. As noted above, a premium DR incentive might be made available for customers that sign up for EE programs at the time they sign up for DR.

Including a Time-dependent Incentive Structure

Including a time-dependent incentive structure can provide two important motivations to program participants.

Complete the project in a timely fashion. All programs, whether integrated or not, can suffer from long project implementation time frames. Integrated EE and DR programs can quickly get bogged down in longer time frames due to the added analysis and paperwork required to complete both EE and DR measures. Providing a tiered approach to earning incentives can address this. Specific milestones throughout the life of a project could drive customer and implementer payments. In addition, rewarding faster implementation promotes better coordination among customers, implementers, equipment vendors, M&V professionals, and the utility, and this should improve the economic benefits to each. Suggested milestones include:

- Measure identification and project commitment by the customer
- Completed measure implementation
- Measure savings verification and project completion

Each milestone payment could also be made time dependent. For example from enrollment to commitment, after an initial period of one to two months to conduct site assessments is complete, the customer has a set time to commit to some or all measures. For each month (or some duration to be determined) that passes after the assessment is complete, the incentive rate attenuates.

Maximize participation in both EE and DR programs. Some utilities that have implemented IDSM efforts have been careful to make sure customers do not sign up for DR, but then simply do not participate in events. For example PG&E instituted a split incentive for AutoDR enablement in 2014. Incentive Payments are made in two installments. In the first installment, the customer is reimbursed 60 percent of the total project incentive received after the successful measurement and verification test of the Auto-DR Measures. The second installment of 40 percent of the remainder of the total project incentive is reimbursed upon verification by PG&E of the customer load shed participation performance in the immediately following and full DR season. The customer receives 60 percent of the incentive upon agreeing to enable, and 40 percent based on event participation thresholds throughout the first year. NV Energy uses a declining service fee approach that includes a service fee with a risk premium that declines as DR participation is proven over several events.

M&V Integration: Avoiding Customer Fatigue While Achieving Rigorous Verification

The benefits from, and challenges to, an integrated approach to M&V, are similar to those of service delivery integration. Regarding benefits, integration should lessen the burden that reporting and M&V analysis present to the customer, decrease the cost of M&V to the utility and/or the implementer, and consequently deliver both improved program participant satisfaction and cost effectiveness.

Important aspects of capturing this realm of benefits include:

- Uses common data and an integrated analysis approach to minimize customer fatigue by minimizing the number of required on-site inspections and reducing required paperwork. Most current programs use different evaluators for EE and DR programs, which at least doubles the burden to the customer.

- Evaluators are gaining DR experience rapidly, it will be important for these professionals to develop approaches and skill sets to address integrated M&V projects and programs.

The last bullet above presents an as yet unaddressed challenge. In the current state of program M&V, it remains important to clearly segregate EE impacts from DR impacts and EE costs from DR costs. This is required to support cost-effectiveness analysis and help ensure kW and kWh savings are not double-counted. This may run counter to the premise of integrating DR and EE for higher overall program efficiency. The very nature of the integration makes it harder and more expensive to allocate specific costs and benefits to individual DR and EE buckets. And the IDSM program structure may both allow and benefit from a blending of costs and benefits.

It is also important to have evaluators with DR experience.

The Impact and Challenge of Silos

Most regulatory structures have different processes and staff for the approval and management of EE & DR programs. And therefore, most utilities develop EE and programs independently and with different staff. This creates problems.

First, regulators generally require different proceedings and separate funding for EE and DR. Each has specific rules, which can lead to inefficiencies in program implementation. For example, a utility may be implementing a direct load control (DLC) program and sending technicians to customer homes to install programmable thermostats or load control switches. Because the trip is paid for with DR funds, the technicians' activities while in the home are limited to DR actions. The technician may not perform EE-related actions, such as conducting an energy efficiency audit or providing compact fluorescent lamps. As a result, utilities must spend additional dollars to achieve EE rather than take advantage of already being onsite at a customer's home. Further, the customer has to deal with multiple visits from the utility.

The fact that programs are defined as either EE or DR, combined with strict regulatory evaluation rules, leads to focusing on only one kind of savings for each program. Because the distinction between EE and DR is not always black and white, the cross effects might be seen as impacting savings from a program of the other type. For example, suppose a customer is on a DLC program, which is DR. If the customer decides to install a high-efficiency air conditioner as a result of a utility rebate program, which is EE, the installation of the new air conditioner reduces the load impact for the DR program. Overall, the customer is now saving energy across all hours that the air conditioner operates, but the DR program is seeing a smaller effect.

Ultimately, the impact of these silos is that "credit" may not be given to conservation that occurs as a result of a DR program. Further, consumers who sign up for a DR program may also be participating in an EE program as well as taking actions outside of utility-sponsored programs. The silo effect inhibits a holistic view of energy management and maximization of the overall benefit to the utility, to individual customers, and to society from all programs.

Commercial Building-Specific Barriers to IDSM

The barriers to integration are not trivial. If IDSM is to flourish, five barriers, at a minimum, need to be effectively addressed: regulatory inertia; burdensome process; landlord-tenant relationships; expertise; and M&V.

Regulatory inertia. Under traditional utility regulation, DR has more appeal to utilities because there is less revenue erosion. Increased EE leads to lower revenue, which can be a problem. Under non-traditional regulation, in which utilities receive incentives for achieving EE targets and earnings are based on performance rather than revenue, these disincentives can be mitigated.

Burdensome process. The commercial building sector poses a real challenge to designing and deploying an effective IDSM program. Multi-tenant commercial real estate customers are great target customers, but they see program enrollment as a barrier to rapid and scalable deployment of DSM products and services. Lessons learned in recent work with a Southern California Edison (SCE) program[2] has shown a number of needs to overcome this barrier:

- Direct coordination between DR and EE programs is needed, as well as consolidation of incentive funding into a single "bucket" / program.
- One process / protocol for enrollment and approval of DSM projects. This means limiting the volume of administrative paperwork necessary to deliver projects into a program.

Landlord-tenant relationships. In addition to the bureaucracy created by separate and multiple programs, commercial buildings present the additional challenge of managing the landlord-tenant relationship as it relates to program participation and documentation. Utilities face legal restrictions that create irrational documentation requirements for buildings involving landlord tenant relationships. This creates an impossible barrier of forms requirements that effectively stops EE and DR separately, as well as any efforts to integrate implementation. The industry needs to consult with customers to review existing tenant lease agreements and identify minor modifications that enable tenants to authorize their property owner / manager to act on their behalf to participate in utility programs—helping to decrease paperwork and increase enrollment and delivery speed.

Expertise. Implementers need to be experts in both EE and DR sales and marketing, engineering, economics, and project management in order to be able to deliver the benefits of integrated programs to the customers. While this convergence nascent, it is gathering speed. Selling DR is a different value proposition than selling EE. DR is typically an opportunity for the participant to obtain cash in exchange for providing capacity and/or energy. In contrast, EE is typically an opportunity to obtain reimbursement for some portion of a capital investment that enables savings, whether it is through a light bulb or a BMS. This means the sales and marketing tasks for DR and for EE differ.

It is important to note, however, that program design can impact this difference, either bringing the value propositions closer or pushing them further apart. Further, implementers must become experts in the various program structures, rules, and incentives at play. Implementers also must provide effective representation of how a program participant can best take advantage of program incentives.

Currently, programs are separate—separate funding, separate staffs, separate forms, separate EM&V procedures and firms—and there is likely to be more degrees of separation than is readily apparent. This creates a bureaucracy that can be stifling to this convergence of expertise. In an ideal IDSM world, program structures will be integrated, the bureaucracy will be

[2] Southern California Edison "Monitoring Based Commissioning (MBCx) Program" program cycle 2010-13. The final report and review are in process and still pending and will not be complete till late this summer 2014.

reduced or simplified, and implementers will become experts in the substantive applications of EE & DR, and integrated program requirements and benefits.

M&V. Existing M&V protocols treat programs individually. Because of the importance of having unbiased and accurate estimates of program impacts, it may be easier and more familiar to program evaluators to keep everything separate. In this state, it remains important to clearly segregate EE impacts from DR impacts and EE costs from DR costs. This is required to support cost-effectiveness analysis and help ensure kW and kWh savings are not double-counted. This may run counter to the premise of integrating DR and EE for higher overall program efficiency.

The very nature of the integration makes it harder, and more expensive, to allocate specific costs and benefits to individual DR and EE buckets. And the IDSM program structure may both allow and benefit from a blending of costs and benefits. The M&V profession needs to develop an approach for truly streamlined, yet effective, M&V of programs implemented in an integrated manner.

Leading IDSM Efforts

So how can we move forward toward an integrated approach? Several suggestions have been made in this paper for addressing key barriers to integration, such as regulatory and utility silos, development of integrated expertise, and minimizing logistical complexity. In addition, this paper has raised some questions that need to be addressed such as developing an approach to integrated M&V.

This section provides a look at three leading utility efforts to address some of these barriers—providing short case studies of utility efforts to drive IDSM forward in their portfolio of EE and DR programs, developing a truly integrated approach to implementing EE & DR.

NV Energy

NV Energy is one of the industry leaders in driving forward efforts to integrate DR and EE programs. At a high level, NV Energy is pursuing a strategy of meeting DR mandates by first achieving as much DR that is truly integrated with EE program implementation before obtaining DR resources to meet any remaining mandate goals. This strategy should result in NV Energy building a more cost-effective program portfolio than if they pursued each separately.

One of the more innovative program aspects is their approach to commercial buildings. NV Energy is basically trading EE for DR – the EE incentives subsidize a facility investment in HVAC system optimization, but NV Energy requires that the customer also enable DR participation through the same system in order to obtain the EE incentives.

NV Energy is working with Building IQ, and energy management intelligence software vendor to deliver a program called mPowered by NV Energy. Building IQ deploys a Software-as-a-Service (SaaS) system that provides year round energy savings and enables demand response event participation. The technological components include:

- Predictive, adaptive, and continuous optimization of HVAC
- A continuously updated model of operations and thermal properties of each building and a consumption forecast using internal and external inputs such as weather forecasts and occupancy

- Optimized building performance for various objectives including minimizing daily energy consumption and maximizing load drop during demand response event hours

The software is an overlay to existing BMS that uses OpenADR communications via NV Energy's Demand Response Management System for DR event management.

NV Energy's efforts to integrate incentives afford customers an option to participate in one of two manners:

- Shared Savings Approach: NV Energy offers a performance-based "reverse" rebate. Under this approach, the participation risk is extremely low. The program guarantees 5 percent savings on annual HVAC energy consumption. Customers can choose to participate in a minimum of 5 DR events and share 50 percent of the value of the measured energy savings above the first 5 percent in savings; or customers can choose to participate in a maximum of up to 15 events and keep 100 percent of the value of measured energy savings.
- Declining Service Fee Approach: This method includes a service fee, with a risk premium. As the customer proves additional DR event participation, the fee declines.

Both approaches include incentive support if improvements to BMSs are required. The program has shown to date that the dollar value of HVAC optimization savings to the customer is higher than a typical dollar per kW capacity payment. For instance, if a 200,000 sq. ft. building can receive payment of $100 per kW for 100kW demand drop during a four hour event that equals a typical DR payment of $10,000 ($100 x 100kW). However, the value of the optimization savings is many, many times greater on an annualized basis.

A couple case studies illustrate the success NV Energy program is generating in engaging a typically hard to reach customer segment. The first is a pilot site leveraging NV Energy's headquarters building, the Pearson Building, prior to the program roll out to NV Energy's customers. The second is one of the premier resorts in Las Vegas that is extremely careful in how they approach any potential change to the building systems and services that provide their exceptional customer experience.

NV Energy Pearson Building. BuildingIQ was used for a pilot project in energy with a demand response attribute at NV Energy's headquarters building in Las Vegas, a 270,000 sq. ft. commercial office that houses corporate and administrative functions. BuildingIQ's Predictive Energy Optimization™ was implemented using existing building data, outside data such as weather forecasts and energy tariffs, and demand response signals to continuously optimize energy use for the building. The implemented solution provided NV Energy a daily reduction in the building's HVAC energy usage of approximately 12-14 percent, despite the lack of a modern BMS and limited HVAC plant capabilities. There were no adverse effects to occupant comfort. In addition, the utility received a demand reduction of 10-20 percent during moderate ambient conditions.

M Resort. The M Resort, located in Henderson, Nevada, is a four-star boutique hotel, casino and entertainment complex. The resort is spread over 90 acres of land on the southern edge of Las Vegas, in a desert climate where temperatures soar in the day and plummet at night, and contains

90,000 sq. ft. of gaming space, as well as meeting and convention space, seven restaurants, and a tower with 390 guest rooms. The owners were seeking a solution that would help them manage their energy budget.

M Resort joined NV Energy's mPowered Optimization program. The resort achieved 12 percent energy savings in HVAC energy in the first few months after implementation and is expected to see even larger savings in the near future based on results from other buildings in the region.

Southern California Edison (SCE)

SCE presents an example from their industrial programs that provides compelling lessons, and substantiates compelling economics, for integrating commercial building programs.[3] SCE recently added a DR funding mechanism and attempted to establish a process by which EE 3rd party program implementers could market, recruit, and implement IDSM projects. With this flexibility, EnerNOC, as an implementer of several SCE industrial EE programs, was able to secure multiple IDSM projects proving that "the whole is greater than the sum of the parts." i.e., that EE and DR delivers more, and does so more cost-effectively, if implemented in an integrated manner.

As an industrial program implementer, EnerNOC was working to market EE programs to the industrial sector. In pursuit of EE, the staff was performing technical walkthroughs and reviewing findings with customers. If there were alternate opportunities such as DR, information was passed on to the customer and the utility's account manager for follow up. However, most of the time an additional trip had to occur to further investigate the alternate findings making the process more complicated and adding to the delivery time, not to mention the additional resources and added cost that were necessary.

With the added DR funding mechanism, EnerNOC was able to identify and implement a total of five projects that were implemented as IDSM in the industrial sector as detailed in the table below.

Table 1. SCE projects implemented as IDSM in the industrial sector

Site	EE Measure	EE Savings (kWh)	DR Strategy	DR Load Shed (kW)
Site 1	Refrigeration Controls	999,126	Plant Shutdown	1,510
Site 2	Lighting	100,350	Equipment Shutdown	218
Site 3	Refrigeration Controls	38,458	Plant Shutdown	800
Site 4	Refrigeration Controls	128,341	Equipment Shutdown	103
Site 5	Refrigeration Controls	307,899	Equipment Shutdown	111

[3] Southern California Edison "Comprehensive Chemical Products Energy Efficiency Program" program cycles 2010-12 and 2013-15

By way of example, one specific project is detailed below.

The refrigeration system operated with ammonia and consisted of multiple refrigeration compressors, evaporators for their cold rooms and pre-cooling rooms, and multiple evaporative condensers. The refrigeration system was divided into two independent systems for what they called the east and the west side. During our recruiting phase, it was discovered that one of the systems had been upgraded control system while the other was limited and manual. The customer had received an EE incentive in the past for having installed an upgraded control system. The second system could benefit from a refrigeration control upgrade that would provide a 12-20 percent energy consumption reduction (EE). Additionally, the customer previously never participated in any DR programs because it was perceived as being "a headache" for them to manually bring down their load and the benefits did not justify this. EnerNOC conducted an integrated assessment, collecting all the relevant data and providing a feasibility study. Recommendations included installing a control system that would be capable of pre-programming DR load shed strategies (DR measures) and floating the head pressure based on the required refrigeration demand incorporating wet bulb temperatures (EE measures). The feasibility study included the estimated load shed, the EE kWh savings, and the estimated cost and payback based on energy savings, demand charge savings, and DR enablement incentives. Further, EnerNOC worked with the customer to establish DR strategies that would have the least impact to their operation.

The customer decided to implement the EE and DR measures as a combined project given the implementation cost savings and benefits that this would bring. If the customer had taken on the EE measures separate from the DR measures, the customer would have had to spend an estimated 25-40 percent more. Instead, the customer captured economies of scale through having the design, installation, commissioning and incentive packages completed at the same time. Further, the customer would have the flexibility to execute various DR strategies, depending on their day to day operation with minor effort.

From the utility perspective, if the projects would have been completed individually, we believe that the DR and EE incentives would have been more expensive. Rather, the Utility also leverages the economies of scale. Further additional benefits include the cost savings to the utility from compensating only one third party implementer, one reviewer that approved the EE and DR measures, and through expedited project implementation. In addition, the utility obtained EE annual savings of 40,000 kWh and a new customer participating in DR providing 800 kW that otherwise would not do so.

SCE's efforts in the industrial sector provides a detailed example of how integrated service delivery and technical integration can improve the value of DR and EE programs for all stakeholders – utility, customer, and implementer.

Pacific Gas & Electric (PG&E)

PG&E's case study on buildings offers insight into specific barriers encountered when working with commercial real estate owners such as the Irvine Company and CBRE.[4]

Over the past several years, California State University (CSU) has implemented dozens of monitoring based commissioning (MBCx) projects and load shed strategies for demand

[4] Pacific Gas & Electric Company "Monitoring Based Commissioning Program" program cycles 2010-12 and 2013-14.

response throughout its twenty three campuses.[5] These projects deploy a data-driven, comprehensive approach to demand-side management, combining continuous data collection and continuous diagnostics with traditional energy engineering in order to capture and manage energy use on an ongoing basis. Through these projects, CSU has reduced costs by millions of dollars, and typically recovers project costs within a few short years.

Since 2008, CSU has invested $3 million, resulting in average peak demand reduction of 3.5 MW, 10 million kWh of EE, and 600,000 therms of gas savings across 10 campuses. The projects enabled CSU to leverage more than $2 million in incentive funding from a strategic partnership between CSU and the California Investor Owned Utilities.

Ensuring persistence of this savings and reliability of the curtailable load motivated many campuses such as CSU Long Beach to invest in the EnerNOC energy intelligence platform.

CSU's demand management strategies include chilled water supply temperature resets, speed reduction on fans and motors, lighting reduction in commons areas, fountain pump shut-off, and pool pump cycling. Typical MBCx EE measures include supply temperature resets, lighting reductions, and VFD upgrades. The specific application of these measures differs per campus and per building. Generally, for DR, the applications involve increasing a previously set EE measure in order to drop load during an event. For example, the application of chilled water supply temperature resets for DR are typically more drastic and temporary than those set for constant EE savings; similarly, lighting reductions during a DR event may drop luminance levels down to ASHRAE/IESNA recommended minimums for emergency egress, whereas lighting dimming controls in an EE project will aim to reduce consumption with minimal impact to user comfort and functionality.

The execution of DR strategies also varies by campus and by building. CSU endeavors to find efficient methods of implementation that are replicable and scalable while still providing a solid return on investment. Most load is shed by campus facilities staff via the EMS and is either scheduled ahead of time with day-ahead notice or pre-programmed to hit certain levels when put into a load shed mode by facilities staff. The process is "semi-automated." Once a signal is received from the utility, in most cases CSU then essentially pushes a button to shed load without devoting time and staff to making wide ranging changes to buildings. In other words, there is one manual step in an otherwise automated process. More seamless automation is possible, and being considered, however, since assuring a positive, safe learning environment on campus is the highest priority for CSU facilities management, the campus staff retains ultimate control with override capabilities.

Projects are being executed in an integrated fashion, in part and holistically, as follows:

- Service delivery integration: DR assessment teams and EE implementation teams meet together on a campus by campus and building by building basis to review building assessments, develop curtailment strategies and EE measure analysis, and share operational insights that impact energy management opportunities. As EnerNOC and CSU work together to continually improve IDSM implementation, DR and EE services are being coordinated through a single account manager to ensure consistency and coordinated development, response, and service. Key lessons learned include:

    1. It is critical for implementers to offer customers the option to provide both EE and DR in a particular facility and ensure that opportunities do not go

[5] "UC/CSU/IOU Partnership Program for Energy Efficiency" program cycles 2006-09, 2010-12, and 2013-14.

unaddressed. Focus can often be diverted once a project is underway. Therefore, having the discussion of complete integration at the outset is crucial.

2. It is important to stay current with the energy usage of each facility involved in a project or under ongoing energy management. Campus population and academic schedules are often dynamic and as educational operation needs and patterns change, so do the requirements on building energy systems. Keeping current enables measures to continue delivering savings and providing accurate curtailment forecasts.

- M&V integration: Currently the DR and EE projects and the resulting savings are put through separate M&V efforts due to the fact that the utility program funding sources are separate. However, EnerNOC has recently begun to streamline some of the M&V tasks by leveraging the energy intelligence platform's ability to gather data, report results, and forecast energy usage and load reductions for both EE measures and DR events.

The application of sustainability policies and practices as they pertain to integrated demand management can be significantly advanced and institutionalized by the broad application of cloud-based energy management. This is because increasingly sophisticated EE and DR strategies can only be replicated and scaled up through technology-enabled means. CSU, as one of the largest higher education institutions in the world, continues to be a leader by partnering with technology companies in developing cost effective approaches to energy management.

Conclusion

Early efforts to implement EE and DR programs in an integrated fashion reveal that there is significant value to be obtained. Through a well-designed integration of service delivery, technical components, incentive structures, and M&V methods, utilities can capture increased cost-effectiveness and customers can realize lower cost projects with higher rates of return. Well-designed incentive structures can also encourage customer to participate in both EE and DR programs, increasing the cost-effective resource available to utilities and offering an opportunity to increase customer satisfaction with program participation benefits.