Centralized Guest Room Controls

SCE DR12.40

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EXECUTIVE SUMMARY

Guest comfort is at the core of the hotel business strategy. Hotel operators are usually reluctant to participate in traditional Demand Response (DR) programs that limit air conditioning usage due to the possible negative impact on guests (which reflects in revenue). The hospitality market's overriding concern and need for customer satisfaction requires that guests have the ability to override the DR event, which would reduce the overall value to the utility.

To address this challenge, SCE conducted a technical evaluation and field test of an innovative solution that could have the potential for facilitating DR responsiveness without sacrificing guest comfort.

It appears that a hotel employing a centralized guestroom controls in the form of a Property Management System (PMS) integrated with the Energy Management System (EMS) could be effective with proper outreach and education, able to drive a shift in the hospitality market to DR for grid reliability. The combined impact of the technology being allowed to function as designed and the educational outreach program may provide the energy and demand savings required to make the investment in the centralized guestroom controls more compelling.

This project demonstrated that for a hotel having a high occupancy rate, the technology costs are significant and may not warrant investment in centralized guestroom controls. If the hotel management is willing to allow for deeper setbacks when as soon as a room becomes vacant, higher energy efficiency potential may be attained.

In this project, hotel management did not allow for setbacks due to the increased recovery time resulting in limited energy efficiency setbacks and DR potential, thereby limited the opportunity to fully implement the strategy.

ABBREVIATIONS AND ACRONYMS

AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASHRAE	American Society for Heating, Refrigeration, and Air Conditioning Engineers
BTU	British thermal unit
CFM	Cubic Feet per Minute
COP	Coefficient of Performance
DB	Dry Bulb
DR	Demand Response
EMCS	Energy Management and Control System
Emerging Products	A Customer Service Division of The Southern California Edison Company
Hz	Hertz
KW	kilowatt
LBA	Pound of dry air
LBW	Pound of water vapor
NI	National Instruments
OA	Outside Air
PSI	Pound per square inch
PTAC	Packaged Terminal Air Conditioner
RA	Return Air
RTU	Roof Top Unit
RTD	Resistance temperature devices
SA	Supply Air
SCE	Southern California Edison
SHR	Sensible Heat Ratio
V	Volts
WB	Wet Bulb

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INTRODUCTION

Demand response (DR) is recognized as being an environmentally-friendly way of improving grid reliability, reducing greenhouse gas (GHG) emissions, and helping to improve the efficiency of energy generation and distribution systems. Often this is accomplished by limiting the operation of air conditioning systems during hot days when the electrical grid is near peak capacity, so that the electrical energy demand is reduced, and the reliability of the grid is improved.

In the past, DR programs have posed a challenge for hotels for participation. How to reduce energy consumption by not reducing comfort or affecting the guest experience? However, with recent advances in automated building energy management and control systems (EMCS), DR participation has been proven easier to implement and promises to be more effective at balancing the guest's comfort with that of electrical grid reliability.

The largest electricity end uses in hotels and motels are:

- Space cooling and heating
- Lighting
- Kitchens and Food preparation
- Office computers and support equipment
- Refrigeration systems
- Water heating

Facility operators in other building types, such as commercial buildings, typically reduce HVAC and lighting loads of occupied areas during DR events.

Due to the nature of the hospitality business, it can sometimes be difficult to reduce certain loads, especially in guest rooms. However, hotels and motels can still reduce loads by adjusting cooling setpoints and reducing lighting in common areas, such as atriums and empty conference and meeting rooms. Hotels and motels are occupied around the clock, so occupancy tends to be highest at night.

Regardless of occupancy pattern, hotel electric loads, such as lighting and HVAC, tend to run at full capacity throughout the day; providing multiple opportunities to curtail loads. Additionally, because guests are typically not in the hotel in the mid-afternoon (a typical time for a DR event) guests may not notice the effects of electrical load reductions, particularly to their unoccupied rooms. This gives hotels more flexibility when reducing loads through a DR strategy.

One approach to facilitate participation in DR for hotels is to target unsold and unoccupied rooms for load shedding through the EMCS. Load shedding can be implemented strategically, transparent to guests; maintaining guest comfort typical with other non-DR hotel facilities.

The EMCS can be programmed to intelligently rotate the load, running HVAC units in alternating shifts to reduce peak KW usage without impacting room temperature and comfort.

Guest comfort is at the core of the hospitality business strategy. Hotel operators are usually reluctant to participate in DR events due to the possible negative impact on guests which can be reflected as declines in revenue. The hospitality market's overriding concern and need for customer satisfaction allows for guests to override the DR signal parameters.

It appears that a hotel employing a centralized guestroom controls in the form of a Property Management System (PMS) integrated with the Energy Management and Control System (EMCS) may only be effective with proper outreach and education to drive a shift in the hospitality market to DR for grid reliability. The combined impact of the technology being allowed to function as designed and the educational outreach program may provide the energy and demand savings required to make the investment in the centralized guestroom controls more compelling.

This project studies the opportunity of employing demand response strategies to hotel guest rooms through an integrated PMS/EMCS interface.

Background

A centrally controlled Energy Management System (EMS) can save more than just energy. It can also be used to shape the demand curve that can result in lower peak demand charges. The demand response guidelines of how peak-demand charges are being applied drives the implementation of DR. Large energy consumers, such as hotels, not only pay for their electrical energy consumption (kWh charge) but also for the peak electrical demand during the billing period (peak demand charge in KW).

A peak-demand situation is a relatively short time period where it is recognized that the power grid or the hotel load is approaching an atypically high electrical demand situation. Having the ability to load-shed on demand can have a financial benefit; as an offer to lower energy cost or other form of rebate provided a large power consumer is supporting the curtailment on multiple occasions during the year as requested from the electric utility DR program scheduler.

Through a PMS/EMCS integrated control strategy, the peak-demand load can be distributed into the building where the individual guestrooms, depending on rented and occupancy state can reduce its load by widening the temperature control bands to which the room is being controlled to. While this conserves energy in the short-term, the rooms will recover later when the peak-demand situation is being removed, so overall energy savings is not the intended result. The targeted result is that the energy demand of the guest rooms be controlled within a set time domain, thereby shaping the energy load profile of the hotel to align with a DR event.

As the peak-demand situation (DR event) abates, guest rooms will be allowed to recover their normal energy management settings. However, if all rooms can recover concurrently, the building would be faced with a post-peak electrical demand spike. To avoid this situation, the PMS/EMCS systems employ a feature to gradually return to a comfort temperature by applying building-wide randomization with the incorporation of guestroom specific information such as occupancy and/or guest usage of the thermostat.

Technology/Product

Emerging Products, conducted a study at two hotels in the Southern California service area utilizing two brands of occupancy controlled guest room thermostat products. The primary objective of this assessment was to compare the energy use and demand response capability of the emerging technology with the existing technology.

The adoption of advanced control systems in the hotel industry has been slow due to high labor cost of installing systems, maintaining the post installation integrity of the system, and lack of verified energy savings. The introduction of wireless versions may make advanced controls easier to install and more economically feasible.

Previous analysis of energy used in hotel rooms utilizing advanced occupancy-based control systems has demonstrated energy savings. Energy use was measured in two hotels, one with packaged terminal air conditioning units and one with fan coil units, in roughly equal numbers of rooms with conventional thermostat control and advanced controls. Savings were observed in heating, cooling and fan energy use.

Most of the energy savings occurred during unoccupied hours. This is expected, as the controls are nominally the same during occupied hours, and the primary benefit occurs when the occupants have vacated the room. Individual behavior tends to drive energy use in hotel guest rooms. In most cases, there was a relationship between energy use and temperature in the rooms with advanced controls, showing that the impact of occupant behavior is minimized.

Thermostats that use occupancy information to reduce energy consumption have been used in hotels. Some examples include a thermostat with a built-in motion sensor. Other approaches use a different proxy for occupancy, such as using a key card inside a hotel room to keep lights on and to enable conditioning systems. The technology is advancing toward much more sophisticated adaptive control techniques, and is being applied more broadly than hotels.

This system can utilize an advanced mesh network technology integrated into the thermostat, this can extend a gateway wireless signal to every thermostat in your building. The entire Energy Management Solution (EMS) includes a network of commercial Internet programmable thermostats which use IEEE 802.15.4 mesh wireless communication protocol to reach a wireless gateway. The wireless gateway connects to the building's wide area network (WAN) over a TCP/IP connection.

Access and control of EMS is through a web based management tool which sits on a cloud server and accessible either locally or remotely via the Internet. Since each thermostat acts as a wireless repeater, thermostats installed throughout a building or complex can act as a mesh network. One gateway can support up to 2,000 thermostats, therefore, only one gateway is usually needed for an entire site.

Figure 1 below shows a sample of a product with PMS/EMCS system integration and Demand Response capability.

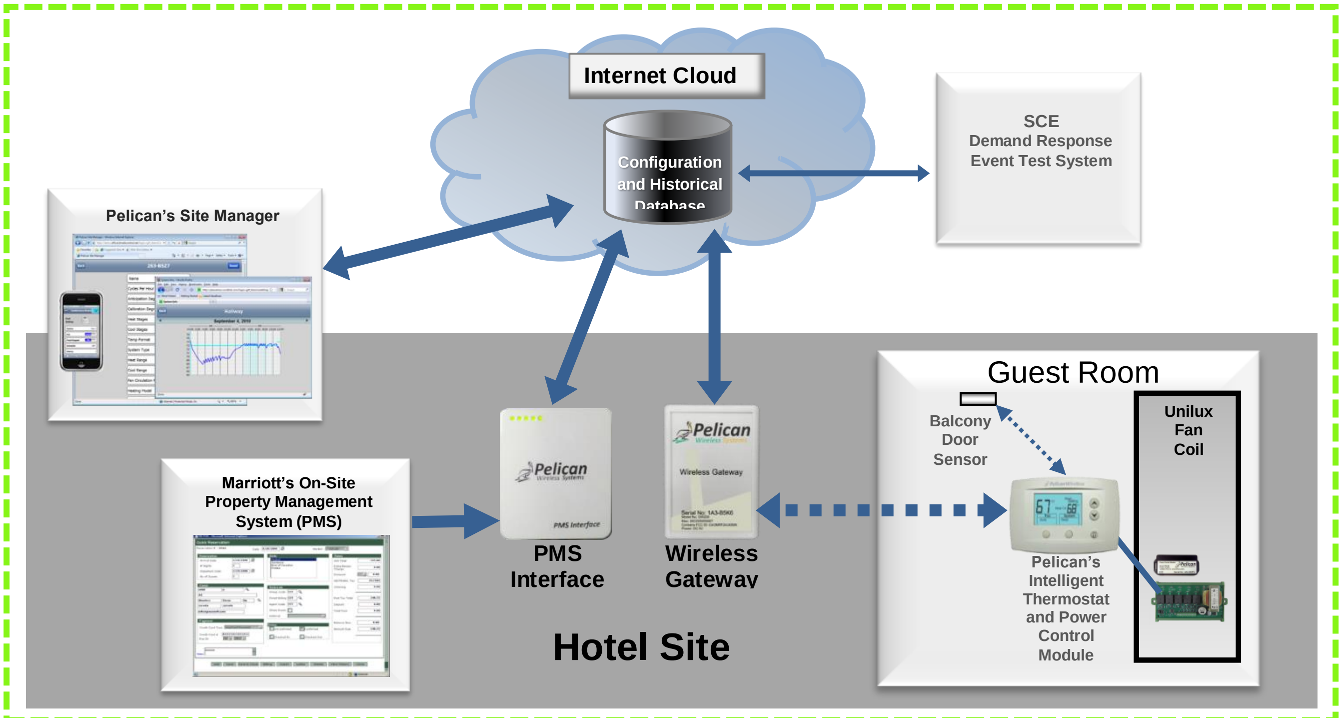

FIGURE 1 DIAGRAM OF A CENTRALIZED GUESTROOM CONTROL SYSTEM WITH DEMAND RESPONSE CAPABILITY

DEMAND RESPONSE CAPABILITY

Savings opportunities depend on how often a sold guestroom is unoccupied. Some types of guests spend more time in their room than others. For instance, guests that are traveling for leisure typically occupy a room for more hours than business travelers. The potential savings of the guest room control may therefore be lower in leisure hotels, motels, and resorts, than in hotels and motels that cater to business travelers.

Hotels and motels in mild climates with low heating and cooling loads can be expected to produce smaller DR savings than hotels and motels in more extreme climates such as the deserts or mountains.

From an HVAC system perspective, the DR energy saved in hotels and motels with chilled-water fan coil units in each guestroom can be expected to be lower compared to hotels and motels with packaged terminal air conditioners (PTAC) in each guestroom. This DR savings discrepancy is because fan coil units are served by central chiller and boiler plants, their system efficiencies are higher than PTACs. The type of HVAC systems typically varies by hotel type. High-rise, upscale hotels, and motels generally utilize fan coil units. Economically priced hotels and motels are more likely to use PTACs.

Lower occupancy generally increases energy savings. The occupancy rates of hotels and motels fluctuate due to various factors, including location, season, and economic conditions. PKF Consulting (a firm of management consultants, industry specialists, and appraisers who provide a full range of services to the hospitality, real estate, and tourism industries) [i]reports an average occupancy rate of 77% for hotels in Northern California and the Central Valley of California. Reduced occupancy rates will increase the potential for energy savings.

PMS integrated thermostats have the potential to produce energy savings in this relatively untapped market. More research is clearly warranted to better understand the interactions between HVAC systems, lighting systems, and the impacts of occupant behavior on energy savings and DR.

In the example below (Figure 2), the hotel achieved a noticeable load reduction by participating in a DR program. During a DR event, the hotel's facility manager dims or turns off lights in unused areas of the hotel, such as conference rooms, and increases thermostat setpoints by 2° Fahrenheit (F).

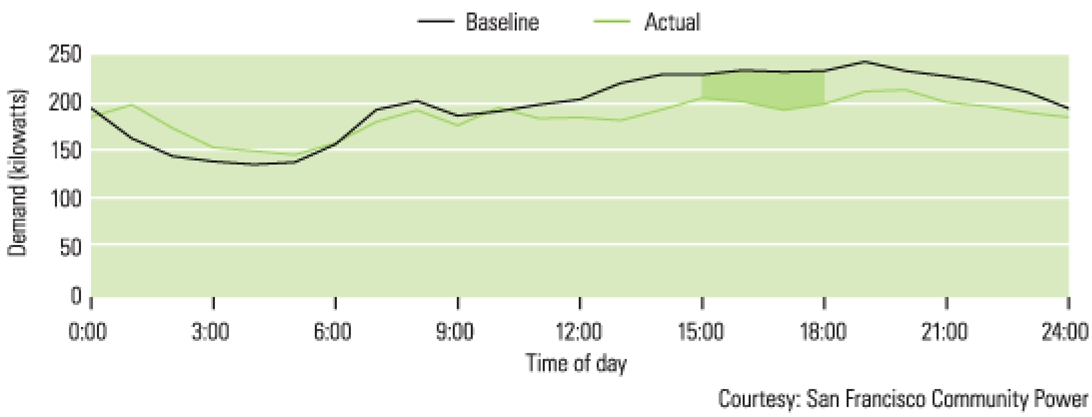

FIGURE 2 SAMPLE OF DEMAND CURTAILMENT IN A HOTEL

Automated Demand Response (ADR): describes demand response programs where a third party (e.g. utility or aggregator) can control customer's load for DR purposes. ADR involves installation of advanced control and communication programs where an automated signal from the dispatcher (e.g. utility) triggers a pre-defined response from the customer's end-use

Open Automated Demand Response (OpenADR) is an open and interoperable information exchange model and communication standard. OpenADR standardizes the message format used for ADR controls, gateways, and energy management systems to enable standardized communication of price and DR signals between customer facilities and utilities, Independent System Operators (ISOs), or Energy Service Providers.

ASSESSMENT OBJECTIVES

TECHNOLOGY/PRODUCT EVALUATION

TECHNOLOGICAL OVERVIEW

The control products tested in this study are retrofit thermostat products that include occupancy sensing using a passive infrared sensor incorporated into the thermostat or mounted on the ceiling. All the systems studied also use a magnetic door position sensor that communicates wirelessly with the thermostat. When the system identifies that the door is opened, it will search for an occupant. Once the thermostat senses the occupant, it assumes the room remains occupied until door is opened again, at which time another search is conducted. When the system concludes the room is unoccupied it puts the HVAC system in an energy conserving mode.

While the room is occupied the guest has control over the thermostat and room temperature. This is accomplished differently by the two products tested. These products are also capable of networking to a front desk system and more complicated whole building control, including demand response, although these features were not tested in this study. In two rooms at one hotel, an occupancy sensing automatic off light switch was also installed.

The market entry of centralized guestroom controls integrated to the DDC may provide the mitigation of the risk hotel owners and managers believe are inherent in deep energy saving temperature adjustments. The system claims to deliver optimum energy savings without compromising guest comfort. When a room is occupied, the temperature selected by the guest is maintained in the systems memory. Once the room is unoccupied, the thermostat temperature is adjusted to energy saving setpoints.

The PMS/EMCS is continually performing calculations that evaluate how far each guest room’s temperature can drift from the guest’s preferred temperature setting to maximize energy savings. This type of hotel guest room control system may provide more opportunity for hotels to participate in DR programs since management can have confidence in a quick recovery time.

TECHNICAL APPROACH/TEST METHODOLOGY

FIELD TESTING OF TECHNOLOGY

The following plan was designed to quantify energy savings between test guestroom and baseline guestrooms. The room and supply temperatures were measured and used along with unit power to determine the mode of operation (i.e. fan/cool/heat).

The power used during cooling periods for all guestroom HVAC units were plotted against outdoor air temperature to develop a linear fit between cooling power and outdoor air temperature. Cooling energy consumption was calculated using the same fit for all units along with the outdoor air temperature and cooling run time. The total cooling energy use data for each day was then grouped (by temperature bin) by average daily outdoor air temperature and compared between data groups (bins) to determine energy savings.

The groups of guestrooms were chosen to, as much as possible, be matching in room orientation and floor number. All guestrooms have a door switch that disables the air conditioning and heating when the door is open to an exterior. The occupancy sensor was disabled in the rooms for the baseline test so that the thermostats functioned like a manually controlled digital thermostat.

Weather data was obtained from a local weather station.

MONITORING PLAN

Guestroom Energy Management System - Programmable Wireless DDC Thermostats

Monitoring equipment deployed to study energy use of the HVAC system in all guestrooms under study. The equipment used to discern occupancy through sensors, interior conditions (temperature/humidity), HVAC status and energy consumption of the HVAC system. The following general procedure to calculate energy use:

1. Energy use will be calculated only for the sample of rooms under study and not for the entire hotel. For the hotels with FCUs (which circulate hot and cold water to the individual rooms) typical central plant efficiency will be assumed based on available plant design specifications (if available); otherwise, nameplate data of equipment.
2. All data will be evaluated for inclusion in the data set. Additional data of the test systems will be excluded if the system failed during the study.
3. The energy use of baseline and test rooms will be aggregated into one data set for the two groups in each hotel. The rooms are assumed to be identical and data is assigned only to a group (baseline or test) and not a specific room number.

4. Energy use per room day is calculated in cooling, heating, and fan modes.
5. Average occupancy over the study period and the percentage of energy used during occupied and unoccupied times will be determined.
6. The outside temperature dependence per room day of HVAC energy use in cooling, heating, and fan modes will be determined.
7. The energy use per room day will be used to the estimate annual energy use for a typical meteorological year in the climate zone for the hotel and additional climate zones.
8. Basis of testing is side by side comparison of multiple vendor controls installed in rooms directly adjacent to "control rooms" having the existing thermostats.
9. Install all required M&V and or metering devices to accurately measure room fan coil energy consumption;
10. Metering intent: measure the actual Btu consumed by the fan coils and the kWh used by the fan.
11. Base assumptions are; CT to measure fan energy
    a. Supply and Return air temperature sensors.
    b. Air velocity to be converted to CFM to determine heating or cooling load values.
12. Hotel and SCE engineer will pre- select "micro-climate" guestroom areas. (With differing sun and external loads)
13. Local climate data will be collected and stored concurrently with the actual test period
14. All multi-vendor testing should run concurrently to negate any weather based comparison issues.
15. Rooms selected should be of same type, view category etc. to ensure similar occupancy patterns.
16. Door contacts or lock interface may be included in test scope if documented in advance.
17. Property management interface and resulting rented, unrented, occupied and unoccupied set back controls may be included in test if documented and approved in advance.
18. Occupied, unoccupied state data will be provided by the host hotel, if requested in advance.
19. The Control data shall be obtained in an additional (adjacent) room with an existing /old stat
20. New thermostat programming must utilize the same occupied and unoccupied settings
21. Setbacks to be submitted to and approved by Hotel Operator
22. The same room occupancy data gathered in the HVAC study will be correlated to lighting use. Occupancy status in the bathroom will be unknown and not correlated to bathroom lighting use.

Monitoring equipment was also deployed to study lighting usage in one hotel. The fixtures monitored include lamps by the bedside, on the desk, in the entry area, in a separate sitting area, and the bathroom vanity.

TABLE 1 TEST PROTOCOL (GENERAL PARAMETERS)

Control Status	**Room Status**	**Check-In Status**	**Test Protocol**
Normal	Occupied	Checked-In	- Guest Controlled - No setback - Arrival setting of 72°F (default setpoint)
Normal	Unoccupied	Checked-In	- Maximum setback of 4°F not to exceed 76°F - Guest Opt-In for time based setback of 4°F
Normal	Unoccupied	Checked-Out	- 12:00am to 12:00pm (night) set point up to 82°F - 12:01pm to 11:59pm set point up to 78°F
Demand	Occupied	Checked-In	- Cooling mode temperature 2°F above set point
Demand	Unoccupied	Checked-In	- Cooling mode temperature 2°F to 4°F above set point
Demand	Unoccupied	Checked-Out	- Cooling mode set point of 82°F - Check-In event arrival setting of 74°F

NOTES: Guest setting ranges will be limited: Cooling 68°F – 86°F, Heating 56°F – 74°F. Thermostat temperatures calibrated to match SCE measurement equipment. Ghosting will not be allowed - Thermostat will attempt to satisfy guest setting (or setback setting). Balcony door sensors will disable the thermostats while the door is open for more than 10 minutes.

DISCUSSION

The PMS/EMCS control setpoints are nominally the same during occupied hours, and the primary benefit occurs when the occupants are gone. Individual behavior tends to drive energy use in hotel guest rooms. In most cases, there was a relationship between energy use and temperature in the rooms with the centralized guestroom controls, showing that the impact of guest behavior during occupancy is minimized.

While the available data were limited, these technologies have the potential to produce energy savings in this relatively untapped market, and more research is clearly warranted to better understand the interactions between HVAC, lighting, and the impacts of occupant behavior on energy savings. The networking capabilities of these systems would facilitate such research, and enable more advanced optimization and demand response. Networked systems would also allow hotel management to identify equipment malfunctions quickly at the system level and assure that expected energy performance is being met.

The key challenges for demand response center around establishing reliable control strategies and market frameworks so that the demand response resource can be used optimally. One of the greatest challenges for demand response is the lack of experience, and the consequent need to employ extensive assumptions when modelling and evaluating this resource

Another technological obstacle is the development of standards and protocols so that all components of this complex system are harmonized, and efficient communication can be achieved across the system. The greatest remaining challenge for demand response is to develop accurate control and market frameworks to ensure that this diverse and geographically distributed resource can be optimized.

Information technology systems remains a major hurdle in networked control systems. In 2012 a disclosure of the security flaws found in one of the largest electronic door locking system provider’s locks caught many hoteliers by surprise. Although this was a breach in the lock’s firmware, the awareness heightened due to the breaches at major retailers and financial institutions. One obstacle during this evaluation was the reluctance of the hotel’s IT department to allow for external integration into the PMS/EMCS systems fearing data breaches.

CONCLUSIONS

This project provided clarification of the actual energy efficiency and DR potential of such a system. The project demonstrated that the climate zone and occupancy pattern of the hotel plays large role in energy savings and demand reduction. More importantly, the temperature range parameters allowed by hotel management drives the energy efficiency potential of the PMS/EMCS. Further, allowing customers to override load shed during a DR event impedes financial justification for the EMS.

Based upon the results of this assessment, it appears that the contribution of the centralized guest room controls integrated with the PMS/EMCS offers energy efficiency potential but not as significant as expected unless rooms go unsold longer than seventy-two hours. The real potential of the PMS/EMCS is the ability to shed load during peak demand periods and participate in the utility DR programs.

An effective DR strategy for hotels and motels are segmentation among business units to capture a greater portion of available potential. Unoccupied hotel rooms and ancillary areas are prime candidates, especially if controllable through a central energy management system. Many utility programs already capture savings from conference rooms or convention space and theaters as they are good targets for DR. Using a PMC/ECMS system, energy managers can coordinate with booking and event scheduling to pre-cool guest rooms in anticipation of use if a load reduction event is needed that day.

While the ability to shed the entire HVAC, load is attractive per kW reduced, there are inherent concerns as to the ability for the hospitality market to actual participate and contribute the load to be shed.

Many concerns for successful application of this technology center on:

- What percentage of air conditioners or fans will be running during the peak period or DR event?
    - If the unit is not running, credit cannot be taken for the power reduction.
- What percentage of rooms will get the signal from the PMS/EMCS?
    - We found that some rooms lost connection during a DR event, and therefore did not receive the signal.
- Will guests override the signal?
    - Our monitoring was not interfered by guests. However, the ability to override exists and could negate any DR participation.

Additional Benefits:

- PMS/EMCS systems can include HVAC units that may be malfunctioning, alerting engineering resources to be deployed selectively and proactively while ensuring continuity of comfort. Predictive maintenance takes preventative maintenance one-step further by using sensor data to recognize hazardous trends and alert the appropriate maintenance personnel before the issue escalates.

- Facilitate logical demand-response capability by automatically balancing the load across a specified number of units.
- Communicate with Property Management Systems to integrate data points from the complete building infrastructure for total building control.
- Monitor system performance reports to track unusual occupancy statistics, and identify equipment that has declined in efficiency

PMS/EMCS systems promise improved programmability and control through a web portal, energy savings through better programming and remote access, and real-time and historical energy use data to facilitate better system management.

This project demonstrated that for a hotel that has a high occupancy rate, the technology costs are significant and may not warrant investment in centralized guestroom controls. If the hotel management is willing to allow for deeper setbacks when as soon as a room goes unsold, higher energy efficiency potential may be greater. In this project, hotel management did not allow for setbacks due to the increased recovery time and resulting in limited energy efficiency setbacks.

RECOMMENDATIONS

In areas of the country where tourism is a significant portion of the local economy, hotels, resorts, and casinos often contribute to a large portion of the system load. Their participation in DR programs creates an opportunity for significant benefits in terms of alleviating capacity constraints and helping other facilities maintain operations. In this respect the PMS/ECMS systems offer the potential for substantial DR program and market impacts.

Although there is significant potential, few hotels are willing to implement these load flexing strategies due to concerns for their patrons' comfort if services are reduced. Future studies should attempt to develop strategies to assure hotel participants and operators that comfort is not significantly compromised, and that guests may willingly cooperate under emergency or extenuating circumstances. Future studies could link the PMC/ECMS system to real-time hourly pricing information from the utility to demonstrate opportunities to reduce load and overall energy use.

A significant barrier to future strategies for technology adoption is the lack vendors and system developers supporting open DR protocols. Ideally, the controls architecture or solutions for hotels and motels should be open, and standard. One such option for education and outreach is the advocacy that the OpenADR Alliance provides. The Open ADR alliance was formed to build on the foundation of technical activities to support the development, testing, and deployment of commercial open standards for DR programs. By participating in the OpenADR Alliance it enables all PMS/ECMS developers to participate in automated DR, dynamic pricing, and electricity grid reliability programs offered by utilities. OpenADR alliance members also provide stability and confidence in the product as robust cybersecurity is an important component of the OpenADR certification.

The study team encouraged the vendors to participate in the OpenADR alliance certification process, with one vendor completing the certification. The vendor stated significant resources were poured into this action and achieved the OpenADR2.0a certification, they did not pursue OpenADR2.0b certification as there was no business case to do so. The cost of certification along with internal resource constraints represented a challenge to encouraging enhancement of these systems for DR program participation. That will need to be addressed going forward.

Recommended actions in the future include:

- Utilities provide a framework of what a reasonable implementation would be so that future studies may be designed to fully investigate this technology. Increased financial benefits are a consideration to encourage both vendors to market their product for DR and for hotel operators to see a benefit from participating. Future tariffs and their effect on the hotel bottom line?
- Future studies should seek to study methods to improve equipment networking capabilities on network reliability and security to enhance acceptance of hotel owners to employ technology.

- Improvement should focus on the quality of the controls information on screen. The interface on the device itself was not user friendly, and the web interface was difficult to access and not intuitive to navigate. The design of the thermostat used in these systems did not provide much information or feedback to the user about why it was in the set mode. Future opportunities should allow for reinforcement of the actions of the user in DR events.

Evidence from the, admittedly limited, field tests, suggests that PMS/ECMS systems posed substantial usability issues for the market segment. The technology studied in this report is promising and deserves a more detailed study with a chance of developing more thorough strategies for DR in guest rooms.

Overall, though, PMS/ECMS systems with advanced thermostats are an underutilized resource for future grid DR opportunities. Utility and state government programs can lend their credibility to the technology and put greater resources behind training the broader market of integrated PMS thermostat contractors.

Program administrators can accelerate these market transformation outcomes by, incentivizing expanded installations that include lighting and other energy-consuming equipment, encouraging HVAC contractor business model transformation to include PMS/ECMS thermostats through training and conferences, or requiring that incentivized installations provide data back to the program so that it can develop an industry-wide database.

DR technologies have a ways to go for overall market acceptance in many sectors, but especially so in the hospitality arena. These sorts of actions are important to ensure that PMS/ECMS systems are installed at a much higher rate, but that those units installed are maximally utilized so that the technology can achieve its full potential.