Pacific Gas and Electric Company®

Pacific Gas and Electric Company

Emerging Technologies Program

Supplement to
Application Assessment Report # 0609

Occupancy-Based Guestroom Controls
San Francisco, CA

Issued: September 10, 2007

Project Manager: Wayne Krill
Pacific Gas and Electric Company

Prepared By: Erik Kolderup, John Arent, Asim Tahir
Architectural Energy Corporation

Occupancy-Based Guestroom Controls Evaluation Report
Table of Contents

This evaluation report is a supplement to Report #0609, *Marketable Technologies for the Hospitality Segment*. The full list of supplements follows:

- Occupancy-Based Guestroom Controls
- Hotel Bathroom Lighting Controls
- Laundry Ozone Generators
- Demand Controlled Ventilation
- Card-Key Guestroom Controls
- Efficient Electric Hand Dryers

List of Tables

List of Figures

Preface

The San Francisco office of Architectural Energy Corporation (AEC), an energy and environmental research, development, and design consulting firm headquartered in Boulder, Colorado, prepared this document for PG&E. The report was contributed to by Asim Tahir, and reviewed for technical quality and responsiveness by Erik Kolderup. Donald Frey assisted with final editing. Wayne Krill of PG&E provided guidance and input as project manager.

Please note that product and manufacturer names used in this report are proprietary and may be trademarked and copyrighted.

Acknowledgements

This project would not have been possible without the ongoing assistance of Steve Hutchison, PG&E's Hospitality Segment Program Manager and of Sharon Harris, Account Services Manager for major hotels.

The assistance of Jerry Eaton at the California Lighting Technology Center is most gratefully acknowledged.

0.0 Executive Summary

Occupancy-based guestroom controls are not a new concept. They have been available to the hospitality industry for many years.

These systems have become more efficient, reliable and user friendly because of recent advances in sensor accuracy, wireless communications and embedded logic in the controllers.

These control systems are **applicable in all hotel and motel guestrooms**.

The typical payback period is 3.4 years based on an average installation cost for basic systems of around $450 per guestroom and annual savings up to 1,100 kWh per guestroom. This payback can be reduced to 2.3 years with a $152 per guestroom incentive under PG&E's Standard Performance Contract program. Detailed saving calculations and assumptions are included in Section 3.2.

The factors affecting energy savings and cost effectiveness are hotel type, occupancy rate, climate, HVAC system type and efficiency, and the extent of control exercised by the system.

There are many vendors offering products and solutions using occupancy sensors to control guestroom lights and HVAC equipment. The capabilities and limitations of individual control units vary. Based on the range of product features and existing market share, the following products and vendors were investigated.

Table 0-1 summarizes capabilities of the products provided by each vendor. Detailed descriptions and product images are included in Section 2.1.

Table 0-1: Summary of Features Offered by the Evaluated Products

Product	**Intelligent logic** *(product has ability to learn from experience)*	**Centralized control capability** *(product has ability to control multiple systems from one location)*	**Amenity services** *(product can be used by housekeeping)*	**Control capability** *(systems the product controls)*	**Interface between room components** *(method system components use to communicate)*
INNcom	Yes	Yes	Yes	Lights, PTAC or Fan- coil	Wired
Onity	Yes	Yes	Limited	Lights, PTAC or Fan- coil	Wireless
Lodging Technology	Yes	Informational only	Limited	Lights, PTAC or Fan- coil	Wired
Energy-Eye	Yes	No	No	Lights, PTAC or Fan- coil	Wireless
Smart Systems	Yes	Informational only	No	PTAC	Wireless
Goodman DigiSmart	Yes	Yes	No	PTAC	Wired
Green Suites	Limited	Limited	No	PTAC or Fan-coil	Wired
PKOne	No	Yes	limited	Lights, PTAC	Wireless

PTAC = packaged terminal air conditioner, a "through-the-wall" type room air conditioner.

1.0 Evaluation Summary

In the absence of third-party studies verifying savings estimates for occupancy-based guestroom controls, percent savings estimates reported by manufacturers are used in this report along with an ACEEE estimate for typical energy consumption in guestrooms to determine the magnitude of energy saving potential. Average savings are expected be around 38% of the total guestroom energy usage.

The factors affecting energy savings and cost effectiveness are hotel or motel type, occupancy rate, climate, HVAC system type and efficiency, and the extent of control exercised by the system. It is recommended that third-parties conduct field studies on this technology to quantify the affects of these factors on savings potential.

Table 1-1: Summary of Technology Ranking

Criteria	Score (1 = poor, 10 = excellent)	Notes
Speed of Implementation	6	System components for some of the products communicate wirelessly, simplifying installation. A few products require wired connections between devices, which complicates the installation process.
Focus on Products	7	Product is well-defined and benefits are readily understood.
Demand Reduction	5	Moderate demand reduction; some opportunity for demand response with additional investment in centralized controls.
Cost Effectiveness	4	Significant initial cost with payback ranging from 2 to 4 years.
Persistence	6	Savings should persist over product life.
Customer Satisfaction	5	Customers may mistake occupancy sensor for cameras and be nervous about invasion of privacy.
Supply	5	Literature review indicated several manufacturers offering products with similar capabilities.
Market Size	7	Applicable to the majority of hotels and motels. Some products focused on controlling fan coil units and others designed to control PTACs.
Magnitude of Energy Savings	8	1,083 kWh annually per guestroom, depending on extent of control and climate.
PG&E Program	5	Savings are well-defined and technology is a mature product. Has been rebated by the Standard Performance Contract program and various third-party programs in the past.
Existing Installations	6	Various installations in nationwide hotel and motel chains, independent hotels and motels, and resorts.

2.0 Technology Overview

This report summarizes the status and potential market benefits of a system that utilizes occupancy sensors and embedded logic to control HVAC systems and lights in hotel and motel guestrooms. Many vendors offer products with a range of features and capabilities. Some of these products work well with fan coil units and others are designed specifically for packaged terminal air conditioners (PTAC). This report focuses on the common capabilities of these products. A list of vendors offering these controls is included in Table 2-1. Other control measures being evaluated and documented in separate reports are card-key based guestroom control systems, demand controlled ventilation for event spaces, demand controlled kitchen ventilation, and bathroom lighting controls.

Occupancy based guestroom controls use a combination of occupancy (motion) sensors and door sensors to determine whether or not the guestroom is occupied. When the occupancy sensor detects motion from a person in the guestroom, the controller locks into occupied mode operation. Some systems remain in occupied mode until a door switch is activated. This initiates a search sequence that looks for motion in the guestroom. While the system is in occupied mode, the guest has normal control of the guestroom temperature. Once the guest leaves the guestroom and a suitable period of time has passed, the HVAC unit is either shut off or the thermostat is set back; some systems also turn off lighting. Some products also set back the thermostat when they sense a window or patio door has been left open.

Guestroom energy controls have existed since the early 1980s, and recent advances in technology have increased the capabilities of these systems and lowered the cost. Currently there are several manufacturers offering a variety of products with a range of features.

2.1 Technology Description

Occupancy-based guestroom control technology is offered in many products from various manufacturers. Some of these are discussed here to illustrate the range of features. The list here is not exhaustive and there may be additional products available in the market. Certain products are designed to control packaged terminal air conditioners (PTACs), while others can control fan coil units or PTACs.

Table 2-1: Summary of Features Offered by the Evaluated Products

Product	**Intelligent logic** *(product has ability to learn from experience)*	**Centralized control capability** *(product has ability to control multiple systems from one location)*	**Amenity services** *(product can be used by housekeeping)*	**Control capability** *(systems the product controls)*	**Interface between room components** *(method system components use to communicate)*
INNcom	Yes	Yes	Yes	Lights, Drapes, PTAC or Fan-coil	Wired
Onity	Yes	Yes	Limited	Lights, PTAC or Fan-coil	Wireless
Lodging Technology	Yes	Informational only	Limited	Lights, PTAC or Fan-coil	Wired
Energy-Eye	Yes	No	No	Lights, PTAC or Fan-coil	Wireless
Smart Systems	Yes	Informational only	No	PTAC	Wireless
Goodman DigiSmart	Yes	Yes	No	PTAC	Wired
Green Suites	Limited	Limited	No	PTAC or Fan-coil	Wired
PKOne	No	Yes	limited	Lights, PTAC	Wireless

2.1.1 INNcom

INNcom has been offering guestroom energy management controls since the 1980s. Its product line includes a range of controllers, all offering some level of expandability to add features. This flexibility permits customers to design a system ideally suited for their facilities and budgets.

INNcom's e^4 Smart Digital Thermostat can be used as a direct digital control (DDC) thermostat, as a stand-alone in-room energy management system, or as the principal guestroom element of a facility-wide energy management network.

The thermostat can directly control both low voltage and line voltage HVAC equipment, including fan coil units (FCUs), packaged terminal air conditioners (PTACs) or other unit types. With the addition of a passive infrared (PIR) motion sensor and door switch, the e^4 becomes a stand-alone energy management system. It can also be networked to a centrally controlled energy management system, allowing the hotel to realize both local and remote control of guestroom HVAC equipment and devices. The status of guestroom occupancy can be reported to housekeeping, thus enhancing the efficiency of housekeeping services.

Figure 2-1: INNCom Smart thermostat with integrated occupancy sensor (source:http://www.inncom.com)

2.1.2 Onity

Onity provides a variety of devices for the hospitality industry, including electronic locks, in-room safes and energy management systems. Onity makes three versions of its SensorStat smart thermostat. The SensorStat 200X is a basic stand-alone unit that controls the HVAC unit by resetting the temperature setpoint when the guestroom is not occupied.

Figure 2-2: Onity SensorStat with integrated occupancy sensor (source:http://www.onity.com)

The SensorStat DDC has all the capabilities of the basic product; it also allows centralized control of all units in the hotel using Onity's innPULSE room management software. It uses existing telecommunication or cable television wire to communicate with a central control system, and may cost less to install than systems that require dedicated wiring to achieve centralized control.

The SensorStat DDC-Wireless uses radio frequency (RF) communication with the individual components within the guestroom and with the central control system.

Both the wired and wireless DDC systems offer a deep reset capability, which can reset the temperatures further when the guestroom is unsold, thus offering two levels of energy savings, depending on the sold or unsold status of the guestroom in the central room management system. All of these units are dedicated to controlling HVAC systems and a simple relay can be added to control lighting.

2.1.3 Lodging Technology Corporation

In 1980, Lodging Technology originated the occupancy based hotel guestroom energy management system concept. Their GEM System has programmable setbacks to maintain a management-selected, energy saving temperature while guests are out. The Guest-In-Room Detector (GRD) feature allows staff members, through the use of a hand-held GRD Scanner, to determine if rooms are occupied without knocking and disturbing guests. The GEM System is also applicable to offices, meeting rooms, and other areas that may be unoccupied for long periods of time.

The GEM Stat II is a fan coil digital thermostat with programmable energy management features such as temperature limiting (i.e. limiting the range of temperatures available) and unoccupied setbacks. GEM Stat II will directly replace any mercury bulb or mechanical thermostat of any voltage from 24v to 277v. GEM Stat models are also available for PTAC, heat pump, and split system units.

Figure 2-3: GEM System installed in a guestroom (source:http://www.energyvortex.com)

GEM Light is an infrared sensor-based guestroom lighting control system. The infrared sensor has a long-range and wide-angle lens to sense motion in a large area. It interfaces with standard contractor relays or with Lodging Technology Corporation's GE-RR7 pulse on/off relay. It accommodates auxiliary sensor inputs, and the selectable time-delay for switching off lights after the guestroom is unoccupied ranges from 30 seconds to 54 minutes.

2.1.4 Energy-Eye

Energy-Eye is a wireless guestroom control system. The main controller unit is wired to the thermostat, but occupancy sensors, door switches, and window position sensors can communicate with the controller using radio frequency communications. Communications are controlled using proprietary algorithms and electronics, so there is no danger of systems in adjoining rooms interfering with each other's operations. The controller allows the guest to set the thermostat while the guestroom is occupied. When the guestroom is unoccupied the unit sets the thermostat back to a management-programmed setback temperature and cycles the HVAC on and off to maintain the temperature. The product does not have capability for centralized controls.

Figure 2-4: Components of the Energy-Eye System (Source:http://www.energy-eye.com)

2.1.5 Smart Systems

Smart Systems International's energy control system consists of a digital computerized thermostat, plug-n-play PTAC controller, and a ceiling-mounted occupancy sensor. These components communicate wirelessly using RF signals. The system monitors guestroom occupancy and allows the temperature to drift to energy-saving levels when a guestroom is unoccupied. The system uses RECOVERY TIME technology to determine the temperature at which the guestroom should be maintained so that the PTAC can return the guestroom temperature to a guest's setpoint within minutes of their return. The manufacturer claims that this approach produces energy savings without great inconvenience to occupants. Because the equipment is wireless, it can be installed more quickly than wired systems, minimizing room downtime. Smart Systems' thermostats include programmable parameters that allow guests to adjust guestroom temperatures within ranges set by hotel management.

Figure 2-5: Smart Systems' PTAC controller, thermostat and ceiling mounted occupancy sensor (Source:http://www.2getsmart.com/)

2.1.6 Goodman DigiSmart system (Amana)

The DigiSmart PTAC unit, developed by Goodman Manufacturing under its Amana brand name, can be controlled by a wireless room control system. The DigiSmart control system consists of an in-room thermostat, occupancy sensor and PTAC antenna. The room components communicate with a web-based control platform comprised of Tridium's JACE controller driven by browser-based software built using Tridium's Niagara^{AX} platform. The controller and the

software work together to enable the DigiSmart Control to automatically discover all installed Amana brand PTAC units and wireless peripherals via a wireless mesh network. The DigiSmart EMS is programmed through either the remote thermostat or the platform controller, and the software offers numerous setback options. The property owner has complete control over unit settings and visibility of unit performance and operating conditions; and has the ability to view and check the PTAC in each guestroom from any computer via web pages and reports.

Figure 2-6: Components of the DigiSmart System Kit (source:http://www.amana-ptac.com)

Backward compatibility allows the control board to be added on to all Amana units produced since 1996. This may keep implementation costs low for existing Amana units. The implementation cost will be much higher for facilities with older Amana units or other brands, because the whole PTAC unit may need to be replaced. This product might be a good choice for new construction, existing hotels and motels undergoing major upgrades, or for end-of-life replacement of existing PTACs.

2.1.7 Green Suites – Guestat Programmable Thermostat

The Guestat programmable thermostat from Green Suites costs $75 for volume purchase and can achieve up to 15% energy savings for the guestroom HVAC. It is compatible with head pumps, fan coils, PTACs, and split systems. It achieves savings by allowing the management to set a low and high limit of comfort level, and does not exceed that range. The Guest only sees the temperature they want to set on the thermostat readout and not the actual room temperature. The thermostat has a single dry-contact input that accepts signals from sensors installed on patio doors or windows and can turn the HVAC unit off while a door or window is open. It can also take input from an occupancy sensor or the existing building automation system.

The system has not been tested in an existing installation with an occupancy sensor input. This unit lacks any embedded logic to ensure the system will not shut off due to a false negative when guests are in the room. The Guestat also allows demand-response capability with its four programmable time periods. At each time period, Guestat can be preset for the HVAC to go off or set back to a more energy efficient temperature. At these times, Guestat will display the actual guestroom temperature. If the guest notices a change in temperature during this period, they can press the warmer or cooler button and Guestat will go into occupied mode and return to the guest-selected temperature. Because of low occupancy during peak demand periods,

significant energy savings can be achieved and can potentially reduce peak demand charges by 15–20%.

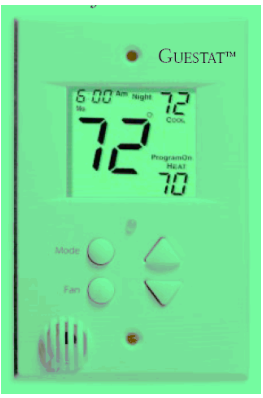

Figure 2-7: Green Suites' Guestat Thermostat (Source:http://www.greensuites.com/)

2.1.8 PKOne

PKOne is a centralized control system designed to achieve energy savings in unoccupied rooms without using occupancy sensors. It consists of software installed on the front-desk reservation system and wireless controllers in each guestroom. The EnergyMinimizer software constantly monitors the front-desk system looking for check-in or check-out activity. When a guest is checked in, it signals the wireless guestroom controllers to turn on the lights and the PTAC units in the guestroom. When the guest checks out, the system shuts the equipment down. The wireless control modules can also be configured to control any other equipment in common areas or conference rooms, from the front desk computer. This system does not employ a thermostat, so temperature setbacks are not possible. It can, however, turn off power to the fan motor in a fan coil unit.

The EnergyMinimizer software constantly monitors hotel electric demand. When demand reaches a preset point, it can cycle PTAC units and non-essential public equipment off for short periods of time. This continues until the peak event has passed. It then reverts to normal operation. The base price of the system is $11,500 per hotel plus another $100 per guestroom.

2.2 Where Occupancy Based Guestroom Controls are Applicable

Occupancy based guestroom control systems are applicable in all hotel and motel guestrooms. Energy savings vary, depending on the features of the product and guestroom occupancy. The range of expected savings is 15–38% of the total guestroom energy usage.

Some products offer additional functionality, allowing all guestroom controllers to be controlled from a central system. Centralized control may allow facilities to implement demand control by remotely turning the units off or resetting HVAC set points during the peak period. Energy savings are still realized with the guestroom controllers, even if the optional centralized controls are not installed.

Some products offer intelligent control in individual guestroom controller units that can be pre-programmed with varying temperature setbacks through the course of the day. If a reasonable

setback is programmed for the peak demand period, demand reduction can be achieved, even without central control.

In addition to hotels and motels, the occupancy based HVAC control is also well-suited for dormitories, and assisted living and healthcare facilities.

2.3 Market Readiness (Current Status)

Occupancy based guestroom control systems are mature products. They have been installed in numerous hotels and motels worldwide. The two manufacturers that have the greatest market share, INNcom and Lodging Technology Corporation, report combined worldwide installations of over 500,000 guestroom systems. Energy-eye reported that around 9,000 guestrooms are using their product nationwide. The Guestat from Greensuites is being used in about 10,000 guestrooms nationwide.

Other manufacturers have smaller market shares, and the trend seems to indicate that more manufacturers may enter the market in the near future.

The primary market barrier is the perceived impact on guest satisfaction.

2.4 Comparison to Related Technologies

Two related guestroom control technologies are **centralized reservation system controls** and **card-key based controls**.

A **centralized reservation control system** can take different forms, but a typical system integrates the guestroom reservation and check-in system with an energy management system (EMS). When a guest checks in, the reservation system notifies the EMS, which activates heating and cooling equipment in the guestroom. When the guest checks out, the EMS shuts off heating and cooling or sets back temperatures. These controls use traditional wired systems and need to be installed either during new construction or during a major retrofit. Normally, this type of system has lower potential for energy savings because it cannot capture the savings of a sold guestroom when the occupant is not in the guestroom. However, if used with an occupancy sensor the capabilities of these systems could match those of standalone guestroom controllers, but the implementation cost will be significantly higher.

Card-key based control systems are another technology with the potential to control HVAC and lighting equipment. These require the guest to insert the card key into a master switch to enable guestroom HVAC and lights. Some hotels and motels prefer this system, citing concerns that occupancy sensors may not detect a sleeping guest and shut down the HVAC. Card-key systems give the guest total control of the HVAC and lighting while a guestroom is occupied. While the problem of occupancy sensors not sensing a sleeping guest may have been an issue in the past, the advances in sensor technology and embedded logic in occupancy-based controllers have overcome this issue.

Hotels and motels that favor the occupancy based systems over the card-key systems indicate that the occupancy based systems are invisible to the guest because they do not require the guest to interact with the system.

A particular concern with card-key systems is that guests might use a spare key to keep the master switch enabled at all times to minimize their own inconvenience. This will essentially defeat the system and produce no savings. Card-key systems are popular in Europe and Asia, where the general public is more proactive in energy conservation and do not have a negative perception of card-key controls.

The Orchard Garden Hotel in San Francisco, California recently opened with card-key controls in all guestrooms; its sister facility, the Orchard Hotel (also in San Francisco), is being equipped with occupancy controlled sensors in guestrooms. One corporate owner choosing two different technologies for its two San Francisco hotels may indicate that each technology offers unique benefits that are applicable in specific situations.

3.0 Market Opportunity, Benefits, and Cost Effectiveness

3.1 Market Opportunity

The occupancy based control technology can be implemented in most hotel and motel guestrooms. The range of products allows great choice and flexibility to hotel owners to customize the solutions to their specific requirements and budgets. Owners can decide if they want to control just the HVAC system, just the lighting system, or both systems. They can also choose from systems that do not provide any feedback or outside control capability, systems that permit these activities at the front desk, and ones that permit guestroom status to be viewed and control to be implemented over the Internet. Some occupancy based control systems may be used with a variety of HVAC systems; others are for use only with specific types of equipment or manufacturers.

3.2 Average System Energy and Demand Savings

Guestroom energy uses can account for 40–80% of the total hotel energy consumption, depending on hotel size and type, location, and types of HVAC systems. Nationwide estimates for energy end use show that 80% of the guestroom energy use is for heating and cooling; the remaining 20% consists of plug loads and lighting.[1] This ratio is from a national study, and so may be different for hotels located in California.

Average annual vacancy rates for hotels in northern California and the central valley range from 25–35%. For hotels that typically leave HVAC systems in guestrooms running all the time and do not disable lights, this vacancy rate offers a significant opportunity for energy savings.

PKF Consulting reports an average 77% occupancy rate for hotels in northern California and the central valley[2]. This represents savings opportunities for the 23% of the rooms that remain unoccupied. Even when a guestroom is sold it may be unoccupied for part of the time. The amount of time guests spend in the room will be lower for hotels and motels used primarily for business travel while it may be higher for resorts or hotels and motels used primarily for vacation travel.

Energy savings estimates for this technology conducted by a third party were not located. Most manufacturers reported reduction in energy consumption without a clearly defined baseline. Average baseline energy use of a guestroom is estimated to be 2,850 kWh annually (ACEEE 2004). This baseline was applied to energy reduction data for various types of hotel stays reported by Energy-Eye. The average reduction was calculated to be 38%. Some of the occupancy types generated energy savings as high as 58%. A field study for card-key based guestroom controls reported about 43% savings (Lau 2000). Occupancy-based controllers should generate energy savings as great or even greater than card-key based room controls,

[1] "Technology: Energy management systems save hoteliers money" Whitford, M., Hotel & Motel Management Dec 1998.

[2] PKF Consulting is consulting firm providing services to the hospitality industry. The information was retrieved from their website at .http://www.pkfc.com

since card-key systems can be defeated by leaving a spare key or any other card in the receptacle.

Table 3-1: Estimated Energy Savings From Existing Case Studies

	Data	Source
Controlled components	Lights and HVAC	ACEEE *
HVAC efficiency	6.8 HSPF, 10 SEER	ACEEE *
Baseline energy (kWh/yr)	2,850	ACEEE *
Baseline peak demand (kW)	1.5	ACEEE *
Energy savings	38%	Average value for various types of hotel stays calculated from Energy-eye website data
Energy with occupancy sensor controls (kWh/yr)	1,767	Calculated
Peak demand with occupancy sensor controls (kW)*	1.4	ACEEE *
Energy savings per guestroom (kWh/yr)	1083	Calculated
Demand reduction per guestroom (kW)	0.2	ACEEE *
Cost savings per guestroom ($/yr)	$131	$0.12/kWh, $6/kW
Installation cost per guestroom ($)	$450	INNCom
Simple payback in years	3.43	Calculated
Estimated PG&E incentive available per guestroom ($) **	$152	Using SPC rate of $0.14/kWn for HVAC measures
Installation cost per guestroom after incentive ($)	$298	Calculated
Simple payback in years after incentive	2.27	Calculated

**ACEEE - Emerging Technologies Estimate (2004)*

***The maximum incentive that can be paid under SPC is 50% of the project cost up to a total of $350,000 per project site.*

3.3 Other System Benefits

Vendors report that most high-rise hotels have occupancy based control systems as a feature in their centralized guestroom control systems. This allows them to understand guestroom status at a glance. They can find out if a guestroom is sold or unsold. They can see whether a sold guestroom is occupied or unoccupied. They can audit the status of HVAC and lighting equipment and troubleshoot problems remotely, offering an overall higher level of convenience to hotel management. Some products offer additional features, such as occupancy status used by housekeeping services to know when to enter a guestroom without disturbing guests; and room service request notification and do not disturb notification used by guests. While these features do not have direct energy benefits, they may lead to a more pleasant service experience for guests.

3.4 Demand Response Capability

Some of the occupancy based control products have central control capabilities that could be used for demand response. Implementing this capability requires additional investment in software and communications. Hotels and motels have generally been reluctant to implement demand response measures in guestrooms due to concerns about inconveniencing guests. However, additional application of occupancy based control systems and evaluation of guest perceptions may overcome this reluctance.

3.5 Cost Effectiveness

Estimated costs for occupancy based control systems range from $300 to $450 per guestroom, depending on features of the system and the options selected.[3] These systems are typically less expensive to install during new construction than as a retrofit. Wireless systems are the most convenient to install as retrofits. Based on energy savings estimates described earlier, the simple payback period will range between three to four years without incentives, and two to three years with incentives.

3.5.1 Factors Affecting Cost Effectiveness

Although this measure is cost effective, there are several project-specific factors that will impact energy savings.

- Guest type – 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 produced by occupancy based sensors would thus be lower in leisure hotels, motels, and resorts than in hotels and motels that cater to business travelers.
- Hotel and motel location – hotels and motels in mild climates with low heating and cooling loads will have smaller savings than hotels and motels in more extreme climates such as the central valley or mountains.
- HVAC system type – the energy saved in hotels and motels with chilled-water fan coil units in each guestroom can be lower compared to hotels and motels with packaged terminal air conditioners (PTAC) in each guestroom. Since 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 and upscale hotels generally have fan coil units while lower end hotels and motels are more likely to use PTACs.
- Occupancy rate – lower occupancy generally increases the potential for energy savings. The occupancy rates of hotels and motels fluctuate due to various factors, including location, season, and economic conditions. PKF Consulting[4] reports an average occupancy rate of 77% for hotels in northern California and the central valley. Reduced occupancy rates will increase the potential for energy savings.

[3] *Jerry Eaton at CLTC quoting information provided by INNcom*

[4] PKF Consulting is consulting firm providing services to the hospitality industry. The information was retrieved from their website at .http://www.pkfc.com

4.0 Design Considerations

4.1 Implementation Issues

With the wide range of product choices available, owners can pick a solution that works best for their needs. The decision will be affected by factors such as type of facility, configuration of guestrooms, type of HVAC systems, need to control rooms from the front desk, need to view status of rooms from a remote location, etc.

There are three basic types of occupancy sensors:

- Passive infrared (PIR) sensors detect the movement of a heat-emitting body through their field of view. Wall box-type PIR occupancy sensors are best suited for small, enclosed spaces such as private offices, where the sensor replaces the light switch on the wall and no extra wiring is required. They should not be used where walls, partitions, or other objects might block the sensor's ability to detect motion.
- Ultrasonic sensors emit an inaudible (high-frequency) signal and use the Doppler principle to detect occupancy. They interpret a change in frequency as occupancy in the space. These sensors detect very minor motion better than most infrared sensors. They are well-suited for spaces such as restrooms with stalls, which can block the field of view of a PIR sensor, since the hard surfaces will reflect the sound pattern.
- Dual-technology or hybrid occupancy sensors use both passive infrared and ultrasonic technologies to minimize the risk of false triggering (systems turning on when the space is unoccupied). They also tend to be more expensive.

Avoid placing PIR sensors where they may be hit by direct sunlight (as under a skylight) because sunlight may trigger false positive readings. For suites or guestrooms where the sensor may not have a clear line of sight to occupants everywhere in the guestroom, multiple sensors might be necessary. Some of the controllers are capable of interfacing with multiple sensor types. Different vendors use different strategies for mounting sensors. Sensors can be mounted on the ceiling, wall, or at the corner of a guestroom where the ceiling and wall meet. Some products have an integrated sensor in the thermostat housing, which limits them to a wall mount. If the sensors are installed in the entrance foyer of the guestroom, the main living spaces of the guestroom can potentially be out of the sensor's line of sight. These types of installations might potentially defeat the intelligent logic that interlocks door cycling and occupancy sensor inputs to prevent false positives. For example, if there are two guests and one leaves the guestroom while the other is out of the sensor's line of sight, the intelligent controller may conclude that all occupants have left. The system would then go into an occupied operating mode. Testing to verify coverage and proper sensitivity setting should be part of the process of installing occupancy sensors. Most hotel and motel floor plans are comprised of repletion of a few types of guestrooms, such as single-bed, double-bed or suites. The testing should optimize the sensor installation parameters for each type of guestroom. Once installation is optimized for one room type, it should be fairly straightforward to replicate the installation in all similar guestrooms.

For hotels and motels that opt for the centralized control functionality it is imperative that the whole system be thoroughly commissioned following procedures similar to those used to commission building automation systems. Many high-end hotels prefer to install centralized control systems to take advantage of the additional functionality they provide. However, if not

thoroughly commissioned, the additional investment in a central control system will not produce the significant service benefits expected by hotel management.

4.2 System Persistence Risks

The primary risk of occupancy-based controls involves increased customer complaints due to false negatives, i.e. the HVAC and lights turning off when the guestroom is occupied. Occurrences of this type of failure have been mentioned in discussions with industry professionals, who pointed to some hotels and motels in which the occupancy based guestroom control systems were disabled because of excessive complaints from guests.

These anecdotal occurrences do not seem to be recent, and may be attributed to the limited capabilities of early occupancy based control systems. The accuracy and range of occupancy sensors has increased tremendously in the recent years. Most of the controls vendors have addressed this issue by adding door sensors and embedded logic to lock the system into an occupied mode once the door is opened and occupancy is sensed. The system will not go into unoccupied mode again until the door is cycled again and no occupancy is sensed immediately afterwards.

4.3 Codes and Standards

There has been an interest expressed by the California Energy Commission and the National Resources Defense Council to include hotel guestroom controls in the relevant energy codes. This has not yet happened. Latest information on California energy standards development is available on the Internet at http://www.energy.ca.gov/title24/2008standards/.

5.0 Energy Savings Opportunity in PG&E's Territory

The opportunity for energy savings can be estimated based on average system energy savings and estimates of the use of this technology in new construction and retrofits. A potential market impact is shown in Table 5-1, for an assumed 10% market penetration in PG&E territory. The overall potential is estimated to be 2,725 MWh per year and 508 kW per year. The product should be compatible with the majority of hotel and motel guestrooms. The CBECS database[5] shows that during 1990-2000, approximately 80 million square feet of lodging was built in the U.S. per year. Assuming that the fraction of lodging built in California is proportional to its population (may be higher, due to level of tourism in California), this amounts to 9.252 million square feet of new lodging construction in California per year.

[5] U.S. Energy Information Administration, 1999 Commercial Buildings Energy Consumption Survey: Detailed Tables, table B9.

Table 5-1: Potential Market Impact

Nationwide hotel construction estimate	80,000,000	ft^2 per year	CBECS database, table B9, 1990-2000[6]
California construction estimate	3,809,524	ft^2 per year	Assumption that PG&E territory per capita construction rate same as national rate
Guestroom construction estimate	2,857,142	ft^2 per year	Assumption that 75% of floor space is guestrooms
Guestroom size	450	ft^2	Assumption used in PIER evaluation for hotel bathroom lighting control[7]
Annual guestrooms added	6,349	rooms / yr	
Retrofit market	12,698	rooms / yr	Assumption that retrofit market is twice that of new construction
Market penetration	10%		Assumption
Incentive program length	2	Years	
10% market penetration	2,540	rooms	
Per room savings	1,083	kWh	Assuming a mix of business and leisure hotels, with energy reduction rates based on data from Energy-eye and baseline estimate from ACEEE[8].
Per room demand savings	200	W	ACEEE - Emerging Technologies Estimate (2004)
Annual PG&E energy savings	2,725	MWh/yr	Anticipated energy savings which can be achieved if 10% market penetration is achieved.
Annual PG&E demand savings	508	kW/yr	Anticipated demand reduction which can be achieved if 10% market penetration is achieved

[6] U.S. Energy Information Administration, 1999 Commercial Buildings Energy Consumption Survey: Detailed Tables, table B9.

[7] Siminovitch, M. 2003. Performance Analysis of Hotel Lighting Control System. PIER Lighting Research Program. Deliverable 4.2.1b. Contract 500-01-041. California Energy Commission. Aug. 2003.

[8] Sachs, H, et. al. 2004. Emerging Energy Saving Technologies and Practices for the Buildings Sector as of 2004. Report No, A042. American Council for an Energy Efficient Economy. Washington D.C. October 2004.

6.0 References

Lau, H. 2000. Field Performance of a Card Key Energy Saving System for Hotel and Motels. *Proceedings of the ACEEE Summer Study 2000.* American Council for an Energy Efficient Economy. Washington D.C.

Page, Erik, et. al. 1999. "Lighting Energy Savings Opportunities in Hotel Guestrooms", LBNL 1999.

Sachs, H, et. al. 2004. Emerging Energy Saving Technologies and Practices for the Buildings Sector as of 2004. Report No, A042. American Council for an Energy Efficient Economy. Washington D.C. October 2004.

Siminovitch, Michael, 2003. "Performance Analysis of Hotel Lighting Control System", PIER Lighting Research Program, Deliverable 4.2.1b, Contract 500-01-041, California Energy Commission, Aug. 2003.

Personal communication with Phil Kopp at Energy-Eye.

Product Websites:

Onity: http://www.onity.com

Smart Systems: http://www.2getsmart.com

Green Suites –Guestat: http://www.greensuites.com

PK-One: http://www.pkone.biz

Energy-Eye: http://www.energy-eye.com/

INNcom: http://www.inncom.com

Lodging Technology Corporation: http://www.lodgingtechnology.com/

Goodman / Amana DigiSuite: http://www.amana-ptac.com