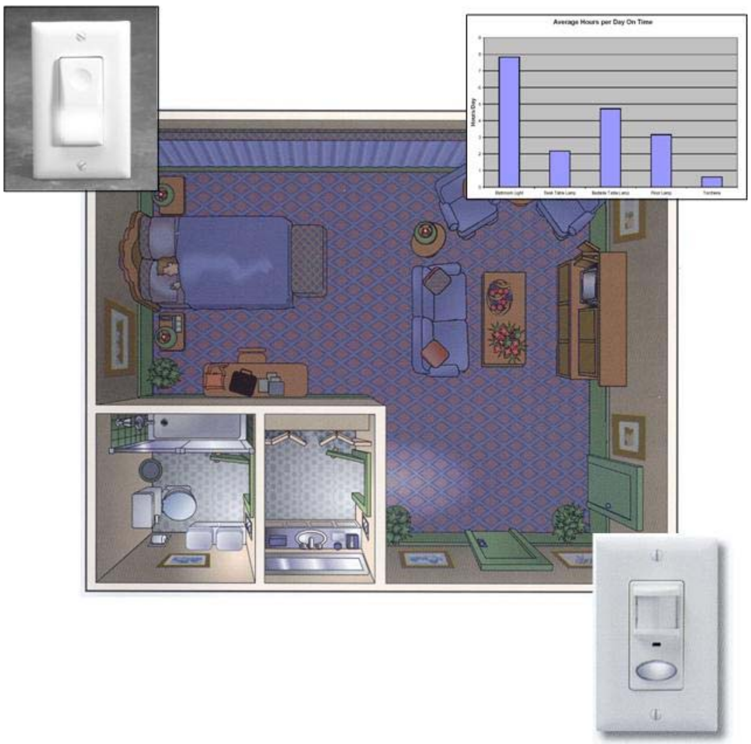
Occupancy Sensor Nightlight Wall Switch for Hotel Guest Room Bathrooms

ET 04.06 Final Report



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Disclaimer

ABBREVIATIONS AND ACRONYMS

CBECS	Commercial Buildings Energy Consumption Survey
CEC	California Energy Commission
CPUC	California Public Utilities Commission
CTZ	California Thermal Zones
DEER	California Database for Energy Efficiency Resources
DSM	Demand Side Management
EE	Energy Efficiency
EEM	Energy Efficiency Measure
EIA	U. S. Energy Information Administration
EUL	Effective Useful Life
kWh	kilowatthour
LBNL	Lawrence Berkeley National Laboratory
LED	Light Emitting Diode
OSNL	Occupancy Sensor LED Nightlight
PIER	Public Interest Energy Research
SMUD	Sacramento Municipal Utility District
SPDT	Single-Pole, Double-Throw
UL	Underwriter Laboratories

FIGURES

TABLES

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EXECUTIVE SUMMARY

This Emerging Technology Assessment project found that wall switches with a built-in occupancy sensor and nightlight significantly reduces the lighting usage in hotel guest room bathrooms. For example, the assessment's field tests found that the measure reduced the frequency of long bathroom lighting turn-on periods, greater than 2.5 hours, by 72 percent. The data analysis found that long turn-on periods averaged seven hours before the measure installation. After the measure installation, the long turn-on periods averaged 4.3 hours, a reduction of 38.7 percent.

The assessment established that the annual energy savings varies with the guest room's occupancy rate. The data analysis found that the baseline lighting usage decreases as the average room occupancy rate increases. This effect is mainly due to bathroom lights left turned on when the guest room is unoccupied. After measure implementation, the trend changed to the lighting usage increasing as the room occupancy rate increases. The annual energy savings for the bathroom lighting fixtures in the assessment project averaged 163 kWh per year. In addition, the assessment generated 24-hour load profiles that allowed for an estimate of the peak demand reduction. The assessment estimated a 7.3 percent reduction of peak demand. The peak demand reduction for the bathroom lighting fixtures in the assessment project averaged 15.9 watts. Both the annual energy savings and the peak demand reduction depend on the installed fixture wattage controlled. This assessment did not attempt to ascertain the average installed bathroom lighting wattage in California that is controllable. Hence, the project's averages are not appropriate deemed values. However, the methodology presented in this report can be used to establish a set of deemed values after a statistically valid average of the controllable installed lighting wattage is determined.

The project's field experience suggests one primary improvement to the evaluated hardware product: a version that functions as a true single-pole, double-throw switch replacement. This would simplify the retrofit of guest room suites with two switches that control the bathroom lights. One manufacturer of occupancy sensor nightlight wall switches indicates that a new product line with this capability would be available in the Fall of 2009.[1] Finally, as retrofits of high-efficiency lighting in bathrooms occur, the energy savings the measure contributes diminishes due to the lower connected wattage. This creates a situation of lost energy savings opportunities. Hence, wall switches with integrated occupancy sensors and nightlights should be packaged and promoted as an integral part of high efficiency lighting retrofits for hotel room bathrooms.

INTRODUCTION

A hotel is an eclectic collection of different types of facilities under one roof: guest rooms, atriums, restaurants, conference centers, laundry facilities, mechanical rooms, offices, exercise and swimming facilities, etc. Guest rooms include sitting and sleeping areas where energy is used for space conditioning, lighting, televisions, internet access, etc., and bathrooms. Hotel common areas, such as hallways, atriums, and foyers, use energy for lighting and space conditioning. Laundry facilities use large amounts of hot water, while restaurants and food preparation areas require energy for cooking as well as hot water. Many hotels have business centers with computers and internet access. The hospitality and lodging industry consumes close to 69 billion kWh of electricity annually in the United States according to the Energy Information Administration (EIA) 2003 Commercial Buildings Energy Consumption Survey (CBECS).[2] With over 52 percent of that electricity used for either indoor or outdoor lighting, lighting improvements and controls are among the primary areas for energy efficiency in this segment. Figure 1 shows the end use breakdown for typical U.S. hotel facilities derived from the 2003 CBECS study. Since the CBECS basis is a nationwide sample of hotels, individual facilities will differ considerably depending on climate, facilities, primary space heating fuel, etc.

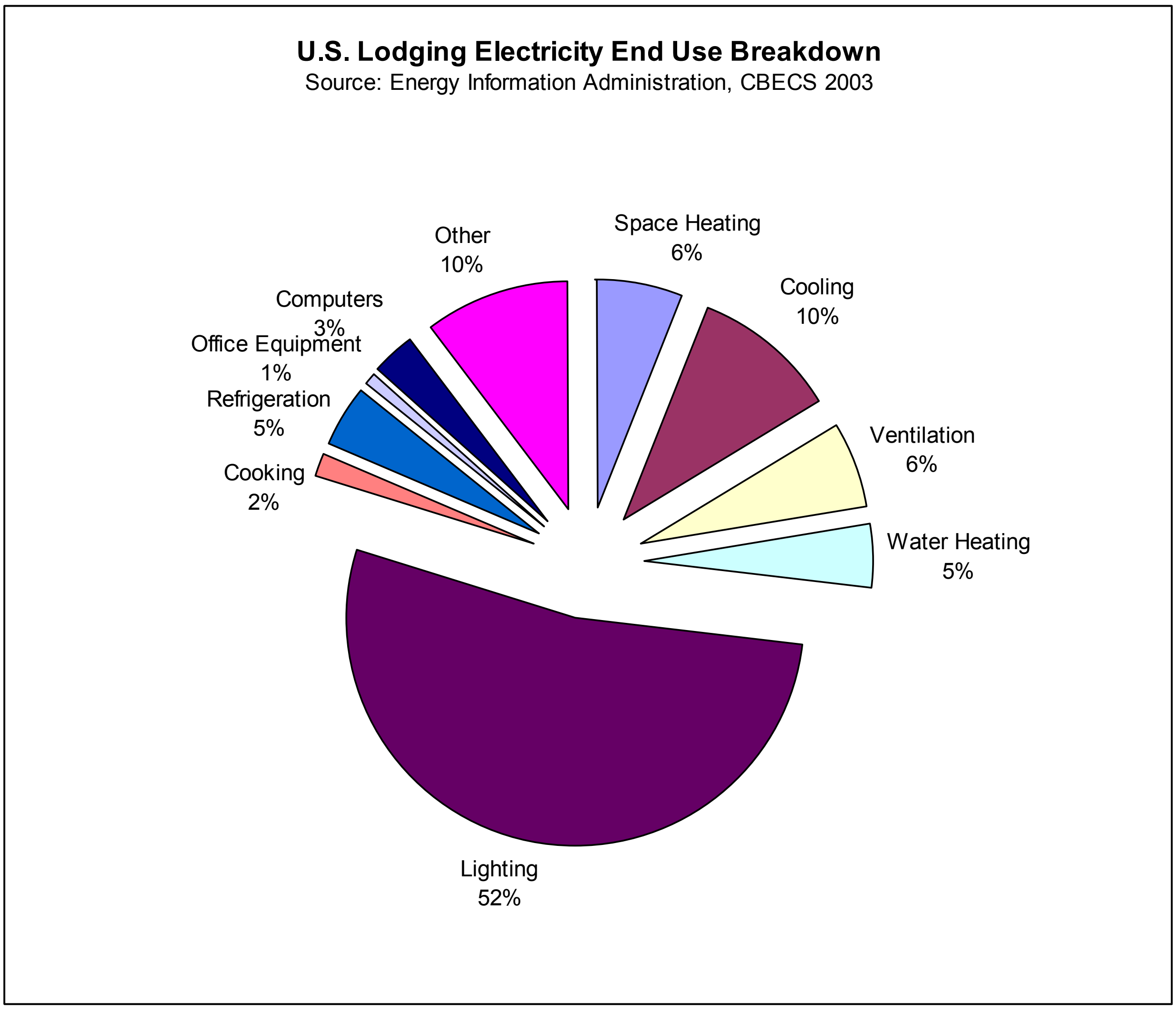

FIGURE 1. ELECTRICITY END USE BREAKDOWN FOR TYPICAL U.S. HOTELS

As Figure 1 shows, lighting is the largest electrical end use in the segment. In an E Source multi-client study, hotel general managers stated that they could cut their energy costs through cost-effective energy efficiency upgrades,[3] and at hotels where steps towards improving energy efficiency occurred, lighting upgrades were the most common action.[4]

In 1998, researchers from the Lawrence Berkeley National Laboratory (LBNL) undertook a scoping study to identify specific energy savings opportunities in hotel guest rooms.[5] The most significant finding was the high usage of bathroom lighting as shown in Figure 2. The study found that bathroom lights burning for fours hours or more represented only eight percent of the total number of times the lights were turned on. Yet, those long periods accounted for close to 63% of the total energy usage, as shown in Figure 3, of the bathroom lighting fixtures.[6] Based on these findings, the study concluded that bathroom occupancy sensors could provide significant savings. Both the LBNL research study and the E Source multi-client study caution that hotels are reluctant to implement energy efficiency improvements, even if they save money, if they believe the improvements may affect the quality of the guest room environment and adversely affect guest satisfaction.

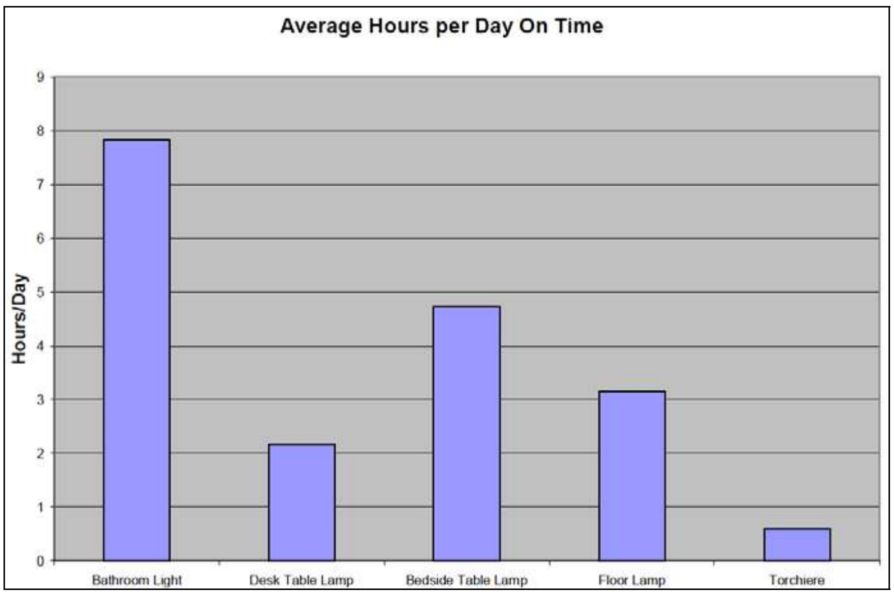

FIGURE 2. GUEST ROOM AVERAGE OPERATING HOURS FOR VARIOUS FIXTURES

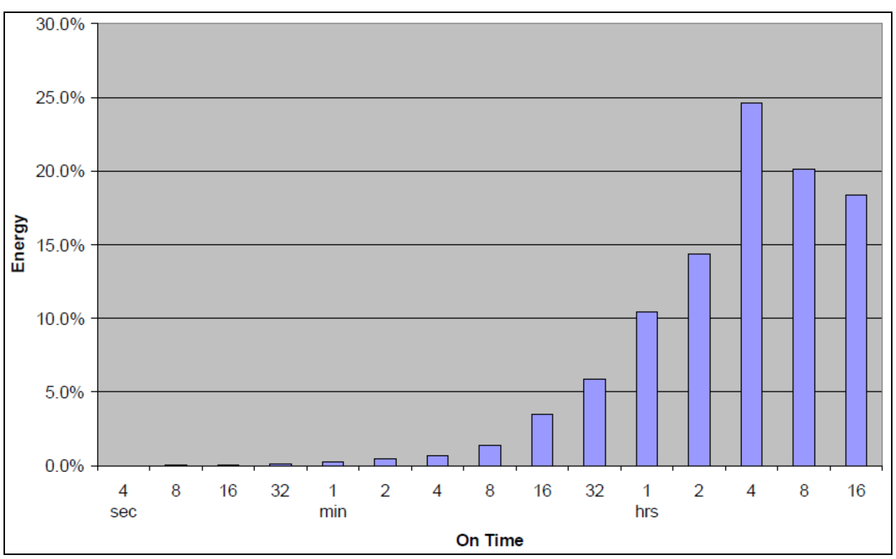

FIGURE 3. DISTRIBUTION OF BATHROOM FIXTURE ENERGY USAGE AND LENGTH OF TURN-ON

BACKGROUND

In 2003, LBNL together with the Sacramento Municipal Utility District (SMUD), Double Tree Hotels, and Watt Stopper/Legrand, formed a partnership to study the impacts of a new light switch with an integrated passive infrared occupancy sensor and a Light Emitting Diode (LED) nightlight.[7] The new product targets the potential energy savings in hotel room bathrooms identified in the 1998 LBNL scoping study. The product development effort and field impact study received funding from the California Energy Commission's (CEC) Public Interest Energy Research (PIER) Program.

The LED nightlight occupancy sensor lighting switch was aimed at reducing the bathroom fixtures "..infrequent periods when they are left on for very long periods of time… utilizing longer [*occupancy sensor*] timeout setpoints…" The built-in LED nightlight automatically turns on when the light switch is off. This feature aims to eliminate the need for guests to use bathroom lights as a nightlight. The PIER sponsored field study measured the lighting usage in 15 guest room bathrooms in the Double Tree Hotel in Sacramento, California, over an eight-month period.[8] The LBNL researchers selected the specific guest rooms to cover the different conditions present at the hotel. HOBO® light loggers recorded the on/off state of the bathroom fixtures in the 15 guest rooms. In five guest rooms, two additional loggers were installed for four months to allow for data crosschecking. Due to clear data errors in the rooms with single loggers, the PIER study based their findings on only the five rooms with redundant loggers.

In addition, the researchers requested that the hotel maintain 100 percent occupancy of the five rooms with redundant loggers during the study period. Four of the rooms were very near 100 percent occupancy and one had an occupancy rate near 80 percent.[9] The study observed that the room with the lower occupancy rate had a larger baseline usage and a lower measure usage, yielding close to 70 percent energy savings compared to the 46.5 percent overall average of the five rooms. The study states that either after a guest or housekeeper visit the bathroom lights may remain turned on until the next room visit. With the retrofitted Energy Efficiency Measure (EEM), that condition would not occur and hence the higher savings. The PIER study states that the effect of occupancy rate "..remains a very important open question that merits further investigation."

The PIER study corroborated the findings of the LBNL scoping study that most of the guest bathroom energy usage is from the infrequent periods when the lights are left turned on for very long time periods.[10] Figure 4 illustrates the PIER study savings results.

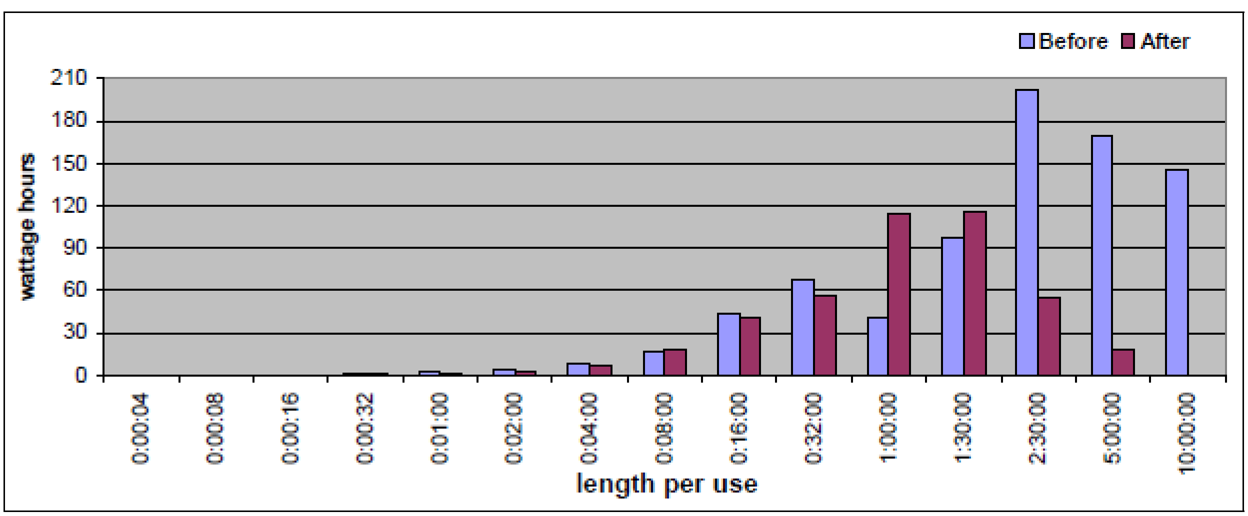

FIGURE 4. PIER STUDY AVERAGE ROOM SAVINGS RESULTS

ASSESSMENT OBJECTIVES

This Emerging Technology Assessment project expands the field-testing of the PIER-sponsored Occupancy Sensor LED Nightlight (OSNL) wall switch. The PIER study results are based on only five rooms in one hotel. This project expands upon the number of hotels and rooms tested to increase the statistical significance of the results. Also, the project aims to determine the relationship between the energy savings and the room occupancy rate.

The average room occupancy rate is one of the primary measures of financial health in the hospitality sector. Room occupancy rate is defined as the percentage of rooms occupied by a guest in any given time period. One of the main goals for any hotel is to maximize occupancy. From 1988 through 1998, national hotel occupancy rates fluctuated between 61 and 73 percent.[11] However, in the two major California lodging markets, Los Angeles and San Francisco, occupancy rates trended higher than the national averages, 77.0 and 90.9 percent respectively in 1997, and 75.2 and 87.5 percent in 1998.[12] Thus, given the importance of occupancy to the hospitality sector, the higher California occupancy rates, and the dependence of the energy savings on room occupancy as observed in the PIER study, this assessment project establishes the relationship between the energy savings and room occupancy.

In addition, the assessment seeks to determine parameters that are important to both Demand Side Management (DSM) forecasting and Energy Efficiency (EE) Program planning such as the:

- Average Hourly Baseline and Measure Usage Profiles,
- Average Peak Demand Reduction,
- Average Retrofit Costs, and an
- Estimated Measure Life.

Lastly, this assessment report discusses the project's field experiences as it relates to the market barriers the measure faces.

PRODUCT EVALUATED

This assessment project evaluated the commercial version of the product that was the subject of the PIER study: Watt Stopper's Passive Infrared Nightlight Wall Switch Sensor shown in Figure 5. At the time of the assessments field tests, there was another commercial product available, also shown in Figure 5, from Sensorswitch™: the SensorLite™ switch. The basic features and functions of the two products are similar. Aesthetics and customer choice were not part of the assessment. Hence, a single commercial product in the field tests sufficed, and the energy savings and demand reduction results apply to all products with the same basic functions.

FIGURE 5. AVAILABLE COMMERCIAL PRODUCTS

The Passive Infrared Nightlight Wall Switch Sensor, Model WN-100, is an occupancy sensing wall switch with an integrated LED nightlight. The built-in passive infrared occupancy sensor detects the difference between the infrared energy, i.e., heat, from a human being in motion, and the background space. The occupancy sensor enables the switch to turn off the connected lighting fixtures after a preset amount of time after the sensor ceases to detect motion within the space. The LED nightlight provides ample nighttime illumination and turns on when the switch turns off the controlled fixtures. In-house measurements determined that the wall switch draws about 0.5 watts on average.

The wall switch design is primarily for use in hotel room bathrooms to replace existing light switches. The occupancy sensor has a coverage range of 180° and a maximum coverage area of 300 square feet. The wall switch is rated to serve up to 500 watts of incandescent, linear fluorescent, and compact fluorescent loads, i.e., it is compatible with electronic ballasts. The wall switch may be field set for either Manual-ON or Automatic-ON operation of the controlled lighting fixtures. The occupancy sensor time delay is field adjustable to 15 minutes, 30 minutes, one hour, and two hours. The factory default settings are Manual-ON with a time delay of one hour. The LED nightlight is available in one of three colors: white, blue, and amber. The wall switch is Underwriter Laboratories (UL) listed for both the U.S. and Canada, and warranted for five years.

FIELD MONITORING AND TESTING

One objective of the assessment was to increase the total number and diversity of hotel types, compared to the PIER study, in the field tests. The lodging industry may be classified into segments[13] as summarized in Table 1. Based on this classification, the hotel in the PIER study could be part of the Luxury segment. This assessment project enlisted four hotels to participate: one Luxury site, two Upscale sites, and one Midscale site. Two of the hotels were near major airports: one in Irvine close to the John Wayne-Orange County Airport (SNA), and another in El Segundo near the Los Angeles International Airport (LAX). Another hotel was close to sports and entertainment venues (Honda Center, Angel Stadium, Disneyland, etc.) in the city of Orange. The fourth hotel was located in Costa Mesa near major retail, performing arts, and large business offices, i.e., South Coast Plaza, Orange County Performing Arts Center, South Coast Repertory Theatre, etc.

TABLE 1. LODGING INDUSTRY SEGMENTS

SEGMENT	EXAMPLE BRAND
Deluxe	Ritz-Carlton
Luxury	Marriott
Upscale	Embassy Suites
Midscale (with food and beverage service)	Courtyard by Marriott
Midscale (without food and beverage service)	Hampton Inn
Economy	Fairfield Inn
Budget	Microtel Inn and Suites
Extended Stay, upper	Residence Inn
Extended Stay, lower	Extended Stay America

Each hotel assigned 10 guest rooms, selected by hotel staff, to take part in the project for 40 rooms total. Several of the guest rooms were suites (sitting room, bedroom, and bathroom) with entrances to the bathroom from both the sitting room and bedroom. Ten of the guest room bathrooms had single-pole, double-throw (SPDT) light switches, i.e., three-way switches that allow controlling the light fixtures from two locations. One guest room was for wheelchair access and the bathroom had two lighting circuits. Table 2 summarizes the lighting and fixture types as well as the total wattage targeted for control.

TABLE 2. SUMMARY OF GUEST ROOM BATHROOM LIGHTING

NUMBER OF ROOMS	LIGHTING TYPE AND FIXTURE	CONTROLLED WATTAGE
9	Linear Fluorescent, Ceiling Mounted	198
1	Linear Fluorescent, Ceiling Mounted (Second circuit had 130 watts)	34
10	Incandescent, Wall Mounted Fixture	380
1	Modular Compact Fluorescent, Two Wall Mounted Fixtures	100
2	Modular Compact Fluorescent, Two Wall Mount Fixtures	104
7	Modular Compact Fluorescent, Two Wall Mount Fixtures	52
10	Linear Fluorescent, Ceiling Mounted	244

HOBO® light loggers, model H06-002-02, recorded the usage both before, i.e., the Baseline period, and after the measure installation, i.e., the EEM period. These small, battery-powered loggers check every half a second with their built-in light sensor for the light to be either on or off, and record in memory the time it changes state. Initially, the project replaced the loggers every two weeks; downloaded, reviewed, cleansed, and synchronized the data; and imported it into a Microsoft Access database. The short replacement schedule minimized, as much as possible, data loss and corruption due to inadvertently placing a logger too close to the ballast in a fluorescent fixture. The project used a longer replacement schedule after some confidence in the logger location for each fixture was established. Overall data collection was over a nine-month period, March through December. Although the data collection at the hotel sites began within a few days of each other, the data collection at each site ended on widely different dates.

TABLE 3. DATA COLLECTION SUMMARY

HOTEL SITE	AVERAGE OCCUPANCY	PERCENT OF TIME LIGHTS ARE TURNED ON	HOURS MONITORED	TOTAL ENERGY USAGE
BASELINE CASE				
Costa Mesa	82.2%	19.9%	13,248	986 kWh
El Segundo	83.1%	23.4%	49,464	730 kWh
Irvine	74.8%	26.7%	15,720	729 kWh
Orange	84.2%	20.8%	44,424	2,194 kWh
ENERGY EFFICIENCY MEASURE CASE				
Costa Mesa	74.7%	13.3%	20,400	1,029 kWh
El Segundo	75.9%	14.7%	14,112	151 kWh
Irvine	71.6%	14.4%	18,168	476 kWh
Orange	94.4%	9.3%	864	20 kWh

The main reason behind the different data collection lengths, as summarized in Table 3, is that each hotel site installed the OSNL wall switches on different dates. Some sites stayed close to the requested project schedule, while others lagged behind. As part of the project, each hotel's onsite engineering staff was to install the OSNL wall switches. The experiences related to this aspect of the project are in the Market Barriers discussion. The Baseline data collection encompassed 40 rooms, while the EEM period collected data from 29 rooms. The Costa Mesa and Irvine sites installed the OSNL wall switch in all of their test rooms. The El Segundo site installed eight and the Orange site installed only one. All the installed OSNL wall switches used the default factory settings of Manual-ON and one-hour delay.

The Baseline period collected valid data for 122,856 room-hours, i.e., an average of about 128 days for 40 rooms. Based on an assertion in the PIER study that each hotel stay is between one to two days,[14] the Baseline period potentially had about 3,413 guest-stays in the test rooms. Likewise, the EEM period collected valid data for 53,544 room-hours. The EEM period potentially had close to 1,487 guests-stays. Thus, the data collected over the complete length of the project represents the usage pattern of about 4,900 guests, and taken together, portrays well the average usage pattern of hotel guests.

The project instructed each hotel's staff not to alter their guest room assignment procedure to allow capture of normal occupancy patterns. The Engineering Manager at each site was the onsite contact for the project during the data collection period. At three sites, the Engineering Manager and staff obtained the occupancy data for each room from their hotel back offices. At the fourth site, front desk personnel provided the occupancy data. Most of the data provided was the total number of days a room was occupied during the logger monitoring period, i.e., between the install and removal dates of the logger for each guest room. However, the Costa Mesa site tracked the daily occupancy of each guest room and provided this detailed data to the assessment project. This made the comparison of the daily on/off trends to the occupancy data possible. A pattern of late-night and early-morning lights-on correlated well with the daily occupancy data. The pattern allowed the assessment to verify and correct the occupancy data of all the hotel sites.

BASELINE AND MEASURE PROFILES

Load profiles are an important part of the life-cycle cost analysis of energy efficiency measures. They are also essential for calculating the measure's peak demand reduction. Since lighting energy usage is directly proportional to the operating hours, using the percentage of lights that are turned on allows for a generalized usage profile independent of wattage. To generate the necessary hourly profiles, the analysis grouped the Baseline and EEM logger data into hourly bins for each day of the week. The resulting 7-day, 24-hour profiles representing the percentage of lights turned on are shown in Figure 6 for the Baseline case and Figure 7 for the EEM case.

Both the Baseline and EEM load profiles show peak usage during the morning and a smaller peak in the late evening. Each day of the week is slightly different. However, the morning peaks for Tuesday, Wednesday, and Thursday are the highest and occur at 7:00 A.M. The morning peaks for Sunday, Monday, Friday, and Saturday are lower and occur one hour later at 8:00 A.M. The late evening peaks all occur at 9:00 P.M.

Figure 8 shows only the average Baseline and EEM load profiles in a single chart. This chart clearly shows that the OSNL wall switch saves energy throughout the day, and reduces both the morning and late evening peak demands. For comparison purposes, Figure 9 reproduces the average profiles created by the PIER study.[15] The assessment's profiles are smooth because they are hourly averages derived from a large set of data. The PIER study profiles are jagged because they represent 10-minute averages derived from a smaller dataset.

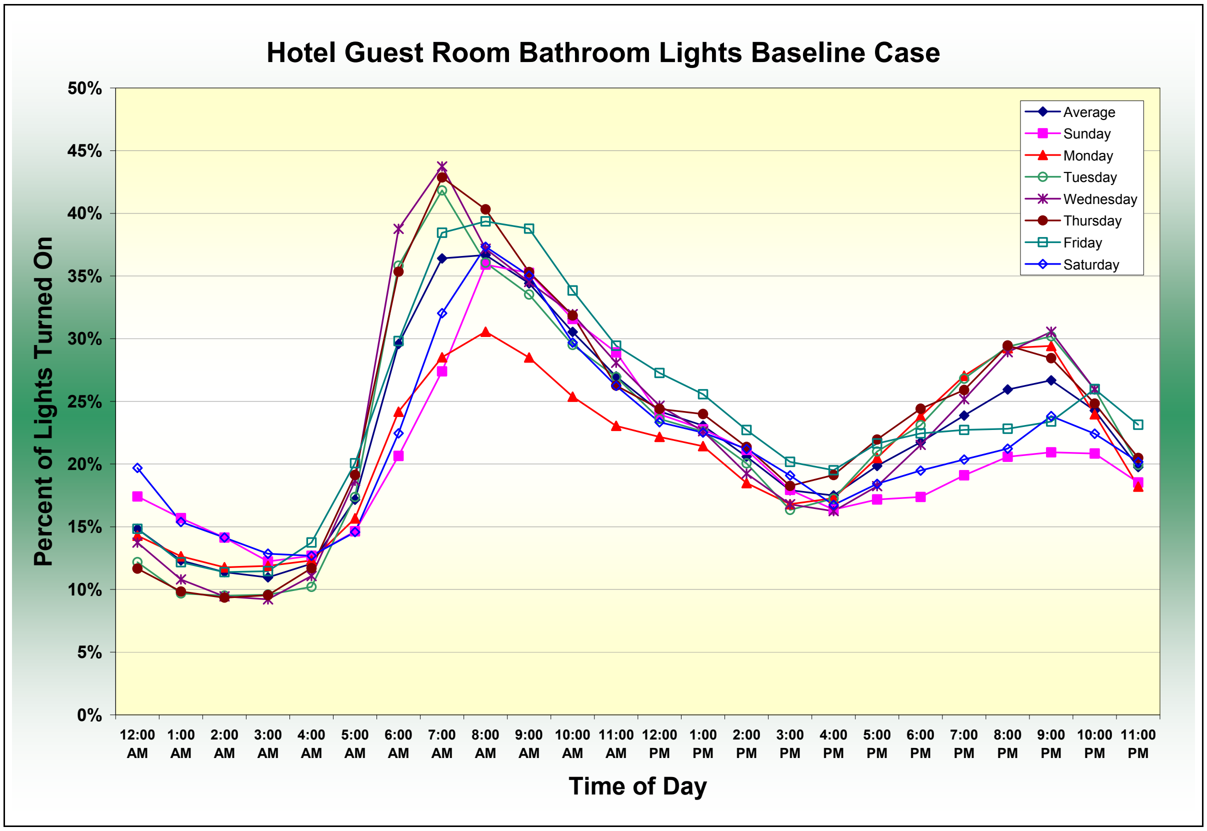

FIGURE 6. BASELINE 24-HOUR LIGHTING LOAD PROFILES

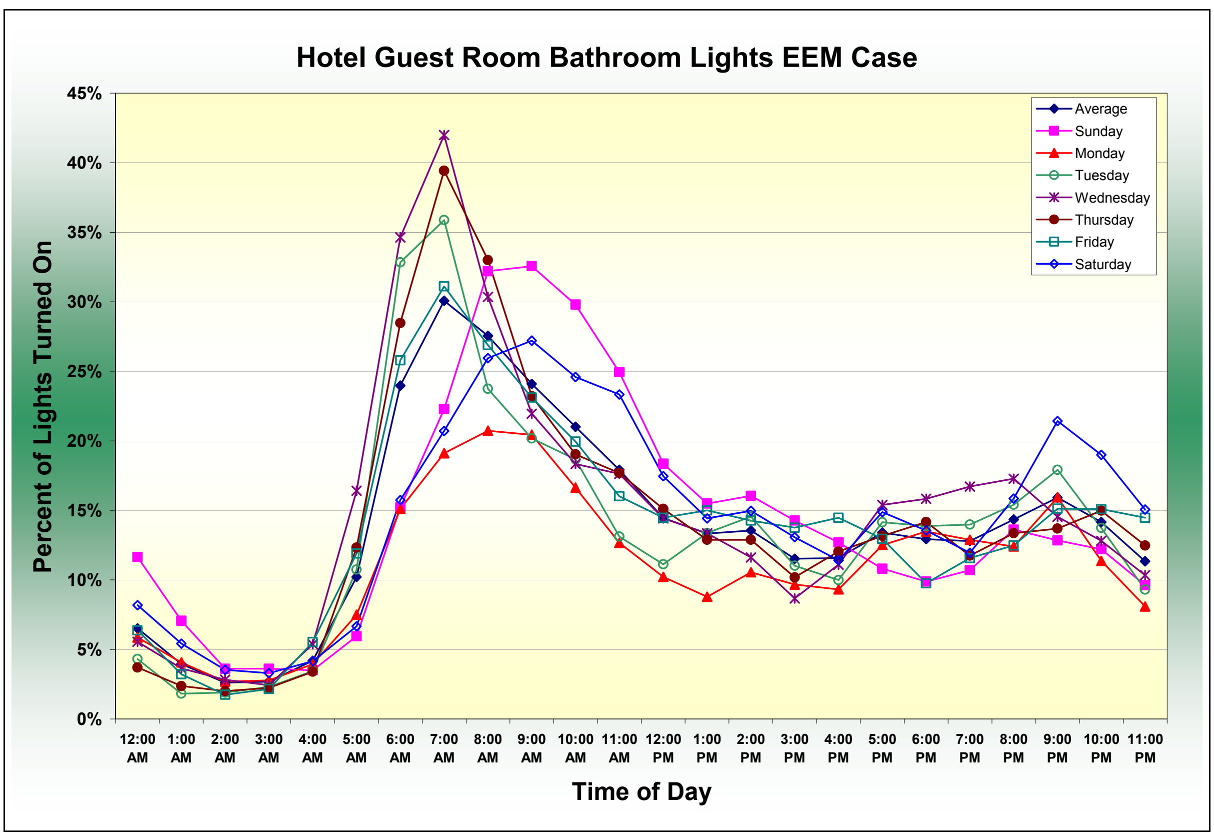

FIGURE 7. EEM 24-HOUR LIGHTING LOAD PROFILES

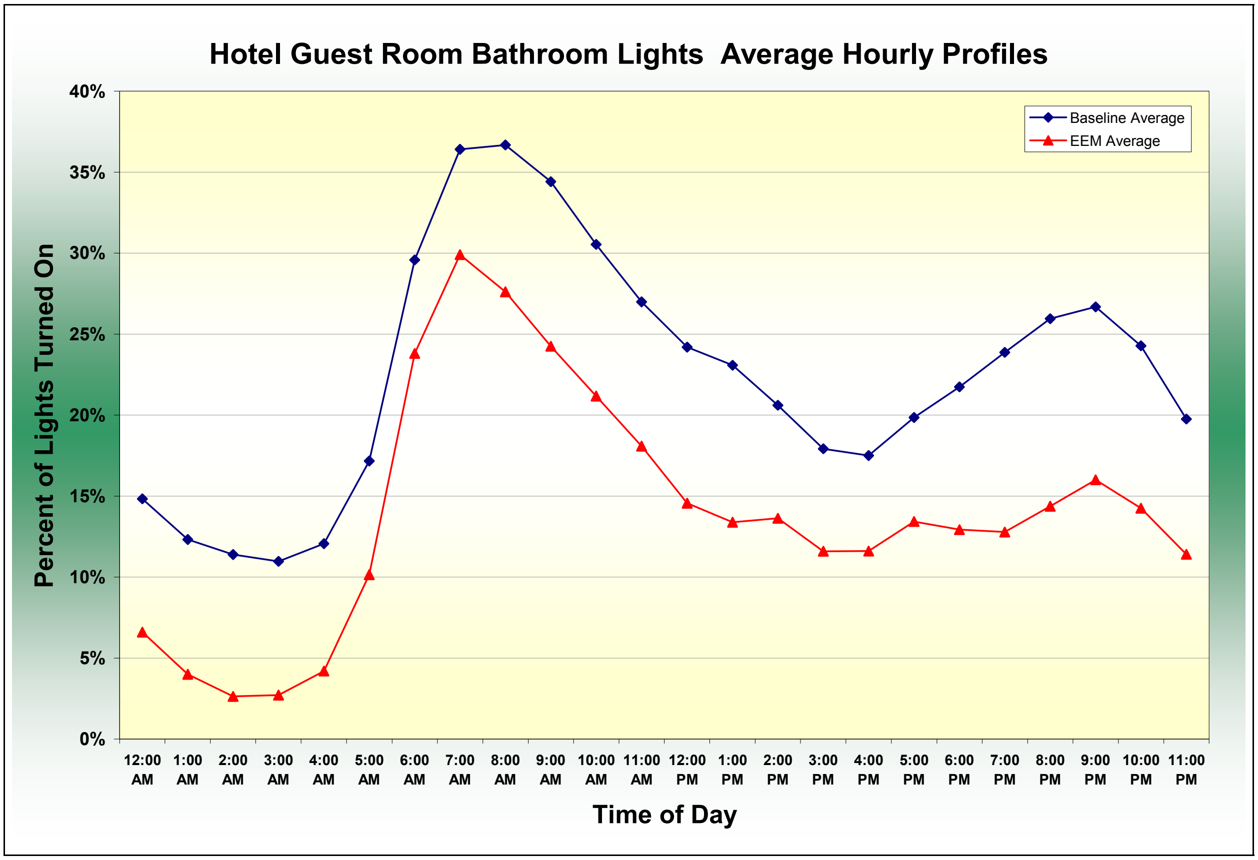

FIGURE 8. AVERAGE 24-HOUR LIGHTING PROFILES

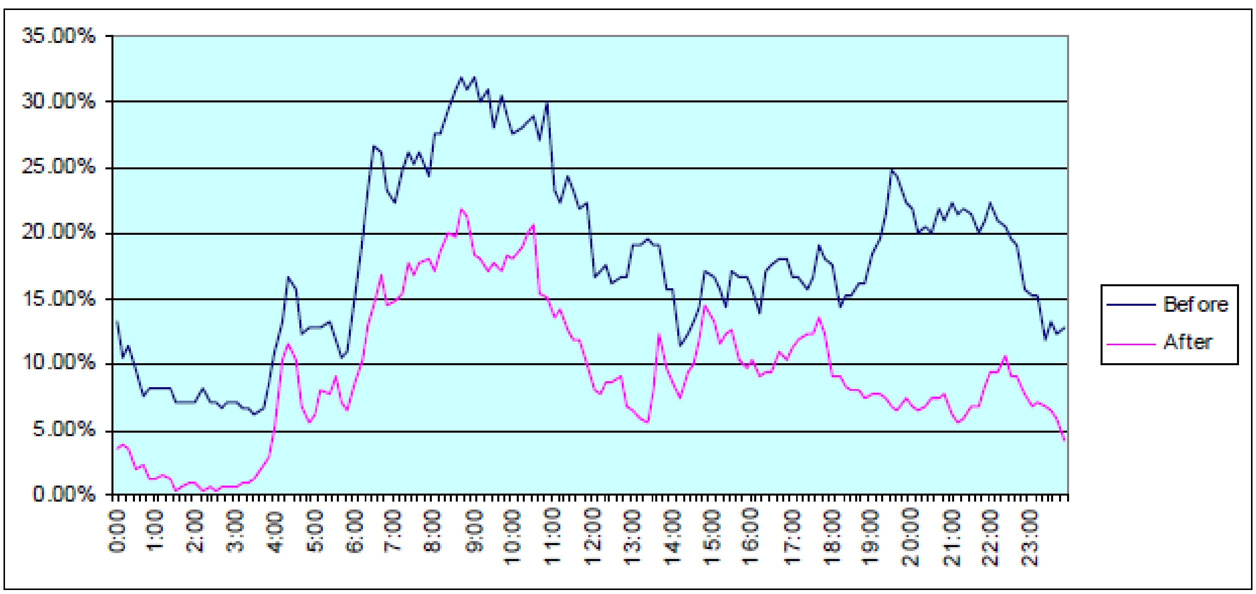

FIGURE 9. PIER STUDY AVERAGE 24-HOUR LIGHTING PROFILES

ANNUAL ENERGY SAVINGS

The OSNL wall switch saves energy by reducing the amount of time the controlled bathroom lighting fixtures are on, i.e., an energy conservation effect. The 24-hour profiles in Figure 8 show the reduction in usage, but the plots do not convey the dependence on the room's occupancy rate. Figure 10 shows a scatter plot of each bathroom's average percent of time that lights are on, both Baseline and EEM cases, against the room's average occupancy rate. Linear trendlines drawn through the data points represent the best statistical curve fits.

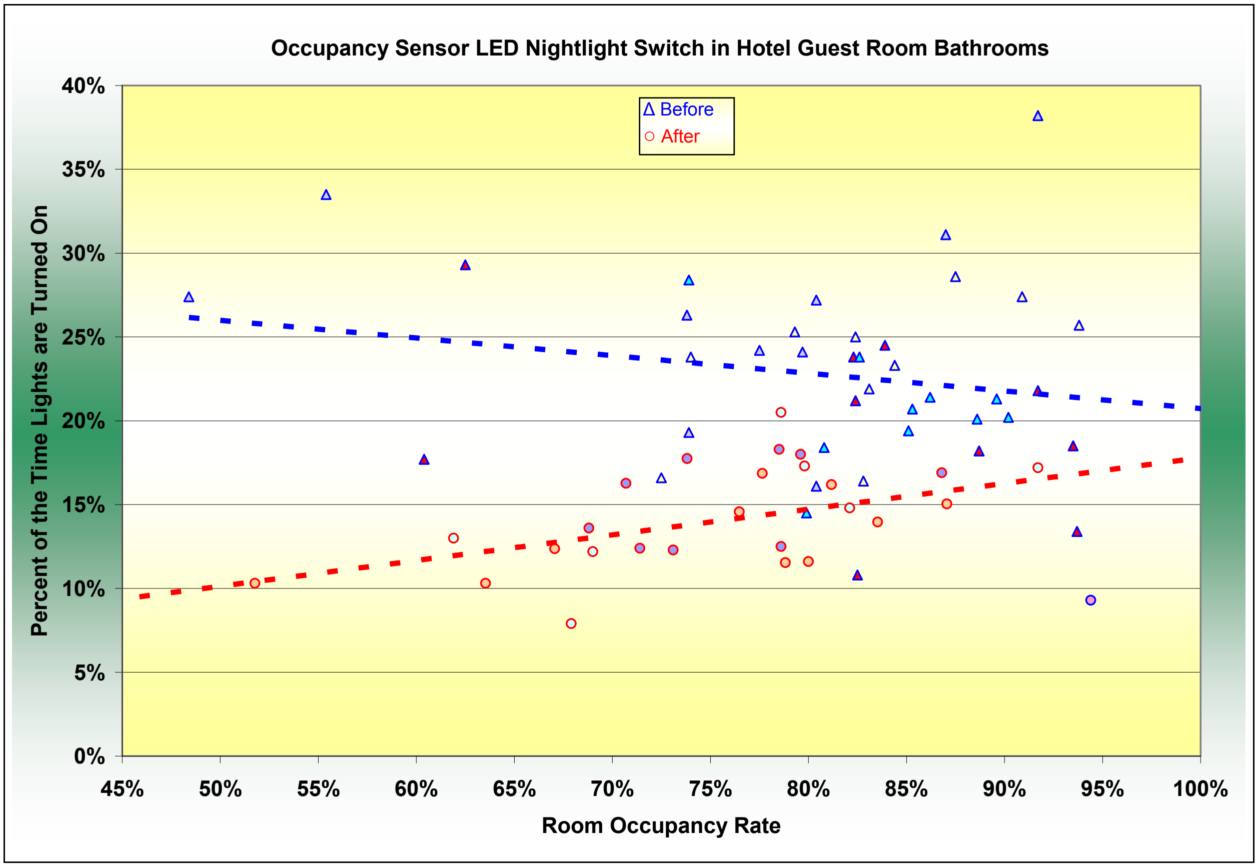

FIGURE 10. BATHROOM LIGHTING USAGE AS A FUNCTION OF GUEST ROOM OCCUPANCY

The Baseline data, the triangles in Figure 10, show a large degree of scatter about the best-fit linear trendline. The scatter is an indication of the randomness inherent in the lighting usage. The OSNL wall switch lowers the trendline and the EEM data, the circles in Figure 10, exhibit less scatter. This is an indication that the OSNL wall switch reduced, in a small degree, the randomness of the lighting usage.

The percent light-on data in Table 3 cannot be used to estimate the annual energy savings due to the differences in the room occupancy rates. For example, the Costa Mesa site Baseline lights-on percentage is 19.9 percent and the EEM lights-on percentage is 13.3 percent. At first glance, this appears to be a 33.3 percent usage reduction, but the occupancy for the two periods is different, 82.2 and 74.7 percent respectively. The occupancy rate must be the same value in both cases. The average of the Baseline and EEM occupancy rates provides a common basis: 78.4 percent. The linear trendline plots in Figure 10 at 78.4 percent occupancy rate yields 23 percent for the Baseline and 14.5 percent for the EEM, resulting in the correct usage reduction estimate of 37 percent.

Figure 11 presents a more comprehensive chart of the percent usage reduction. Using this chart and Equation 1, the annual energy savings estimates for each hotel site were calculated. Table 4 summarizes the data and results.

$$AES\left[\frac{kWh}{year \cdot room}\right] = (CW - WS)\left[\frac{watts}{room}\right] \times \frac{BDOH\left[\frac{hours}{day}\right] \times 365\left[\frac{days}{year}\right] \times PUR\ [\%]}{1{,}000\left[\frac{watts}{kilowatt}\right]} \quad \text{[Equation 1]}$$

where, *AES* is the annual energy savings,
CW is the total wattage of the controlled lighting fixtures: Costa Mesa 380 watts, El Segundo 67.2 watts, Irvine 181.6 watts, Orange 244 watts, and Average 218.2,
WS is the OSNL wall switch power draw: 0.5 watts,
BDOH are the Baseline daily operating hours, and
PUR is the percent usage reduction.

TABLE 4. ESTIMATED ANNUAL ENERGY SAVINGS PER ROOM

HOTEL SITE	AVERAGE OCCUPANCY	PERCENT USAGE REDUCTION	BASELINE AVERAGE DAILY OPERATING HOURS	ANNUAL ENERGY SAVINGS (KWH/YEAR)
Costa Mesa	78.4%	37.0%	4.8	245
El Segundo	79.5%	36.0%	5.6	49
Irvine	73.2%	41.9%	6.4	177
Orange	89.3%	26.1%	5.0	116
Overall	77.8%	37.6%	5.4	163

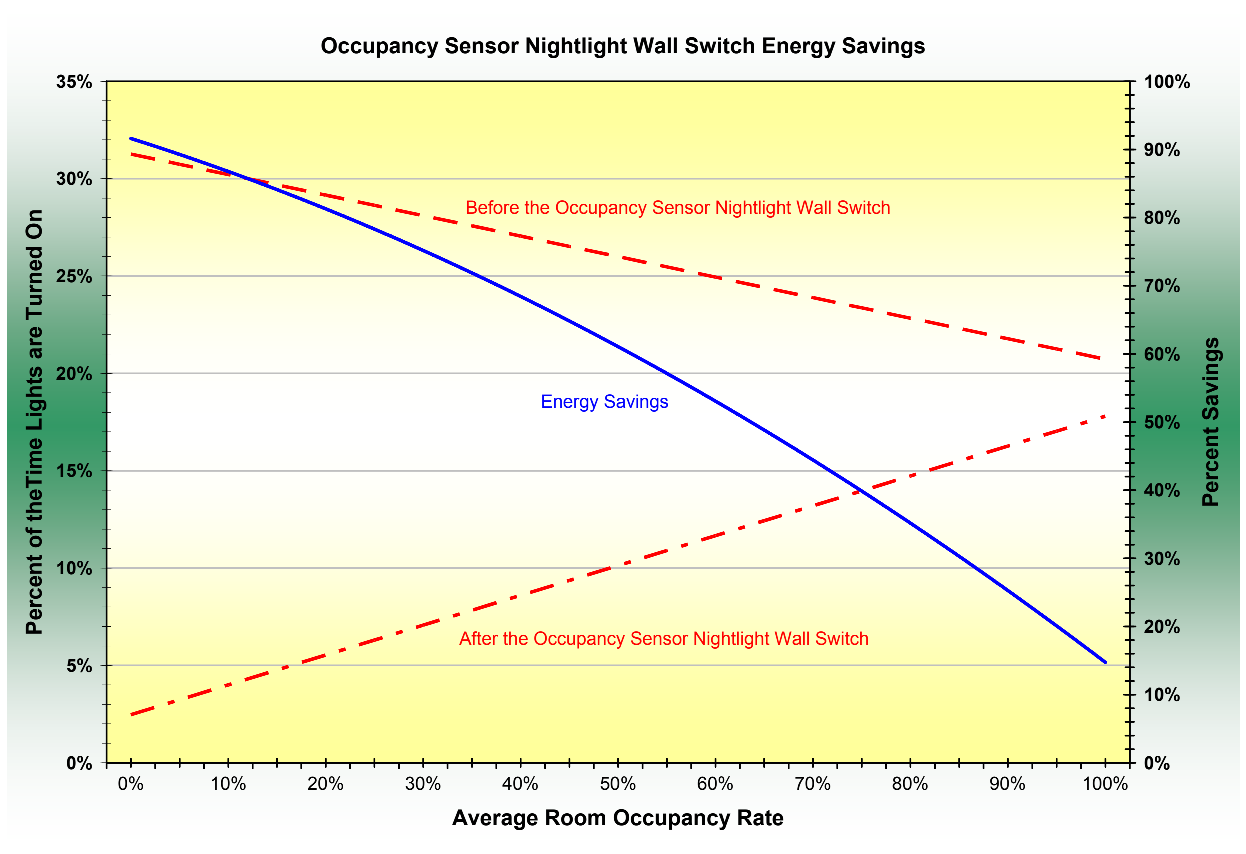

FIGURE 11. PERCENT USAGE REDUCTION AS A FUNCTION OF GUEST ROOM OCCUPANCY

PEAK DEMAND REDUCTION

Interim Order 1 in the California Public Utilities Commission (CPUC) Decision 06-06-063 adopted the Database for Energy Efficiency Resources (DEER) definition of peak demand for Energy Efficiency purposes in California:[16]

> "..the average grid level impact for a measure between 2 p.m. and 5 p.m. during the three consecutive weekday period containing the weekday temperature with the hottest temperature of the year."

The average peak demand for the Baseline and EEM cases are estimated using the 24-hour profiles in Figure 6 and Figure 7 and applying the DEER peak demand definition. Figure 12 shows the results for the Baseline case along with a sample chart of one of the three-day heat wave periods. The estimation procedure is as follows:

- The 7-day hourly profiles are spread across a 365-day calendar year in an Excel workbook using 1991 as the base year;
- The DEER assigns a start-day for the three-day heat wave to each of the 16 California Thermal Zones (CTZ).[17] Only 12 of these dates are unique with four dates repeated twice. The start days are along the top of Figure 12. The Excel workbook averages the 2:00 P.M. to 5:00 P.M. hours for three consecutive days, to produce a nine-hour average for each of the unique time periods; and
- The 12 three-day heat wave values are averaged, with double weighting for the four repeated start-days highlighted in green to produce the final estimated peak demand for the test case.

The average peak demand estimates for each three-day heat wave are shown along the top of Figure 12 for the Baseline case with the overall average, 18.1 percent, listed under the "Average" heading. The EEM case average peak demand, 10.8 percent, is shown in Figure 13. Thus, the peak demand reduction percentage is the difference between the Baseline and EEM peak demand percentages, i.e., 7.3 percent. Using Equation 2, the peak demand reduction for each site and the overall project were estimated. Table 5 summarizes the results.

$$PDR\left[\frac{watts}{room}\right] = \left(CW - SW\right)\left[\frac{watts}{room}\right] \times 7.3\% \qquad \text{[Equation 2]}$$

where,

PDR is the peak demand reduction per room,
CW is the total wattage of the controlled lighting fixtures,
WS is the OSNL wall switch power draw: 0.5 watts.

TABLE 5. ESTIMATED PEAK DEMAND REDUCTION PER ROOM

HOTEL SITE	CONTROLLED WATTAGE	PEAK DEMAND REDUCTION (WATTS REDUCED/ROOM)
Costa Mesa	380	27.7
El Segundo	67.2	4.9
Irvine	181.6	13.2
Orange	244	17.8
Overall	218.2	15.9

Baseline Profile		Monday	Wednesday	Monday	Monday	Wednesday	Monday	Tuesday	Monday	Tuesday	Monday	Tuesday	Monday
DEER 3-day heat wave begin dates:	Average	12-Aug	21-Aug	26-Aug	22-Jul	17-Jul	15-Jul	30-Jul	9-Sep	3-Sep	23-Sep	24-Sep	30-Sep
Average Watts:	18.1%	17.6%	19.3%	17.6%	17.6%	19.3%	17.6%	18.3%	17.6%	18.3%	17.6%	18.3%	17.6%

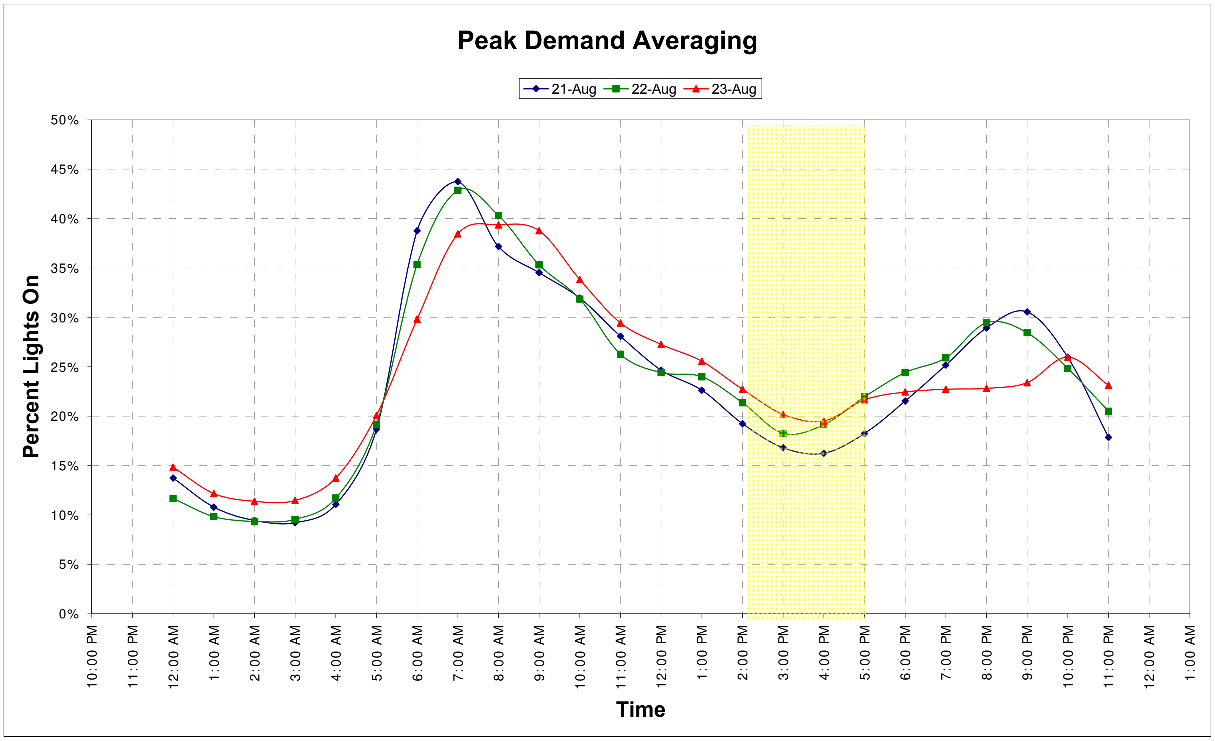

FIGURE 12. BASELINE AVERAGE PEAK DEMAND

EEM Profile		Monday	Wednesday	Monday	Monday	Wednesday	Monday	Tuesday	Monday	Tuesday	Monday	Tuesday	Monday
DEER 3-day heat wave begin dates:	Average	12-Aug	21-Aug	26-Aug	22-Jul	17-Jul	15-Jul	30-Jul	9-Sep	3-Sep	23-Sep	24-Sep	30-Sep
Average Watts:	10.8%	10.4%	11.9%	10.4%	10.4%	11.9%	10.4%	11.0%	10.4%	11.0%	10.4%	11.0%	10.4%

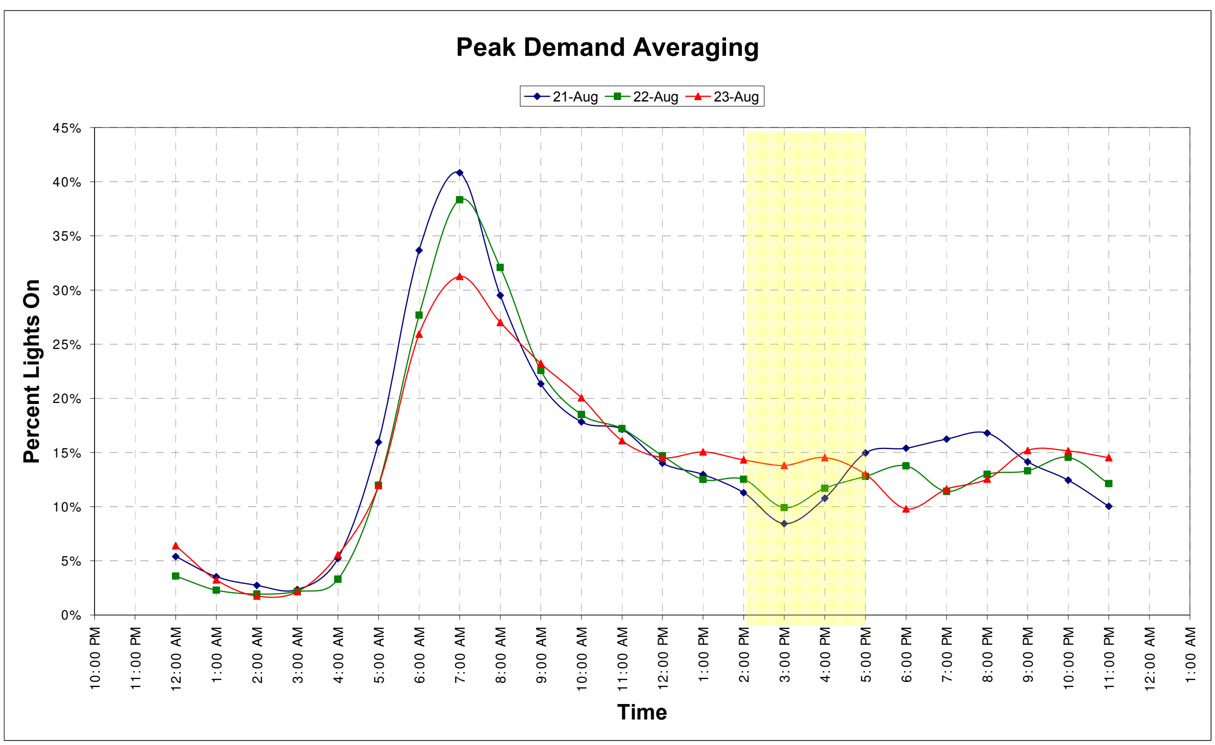

FIGURE 13. EEM AVERAGE PEAK DEMAND

MEASURE COSTS

The Watt Stopper WN-100 Passive Infrared Nightlight Wall Switch Sensor has a retail list price of $58 and volume orders may retail as low as $38. Installation is straightforward for replacing a single-pole, single-throw light switch, requiring about 15 to 30-minutes of labor. If either neutral wiring is not present, or SPDT wall switches are present, then the measure installation incurs additional time, material, and labor costs.

MEASURE LIFE

The OSNL wall switch is a new product. There is no study of the measure's Effective Useful Life (EUL). Therefore, a recommended EUL value may be based on either existing measures of similar function, or the most limiting service life component in the new product. The OSNL wall switch is a composite of a light switch, occupancy sensor control, and a LED light source. The service life of light switches exceeds the maximum 20-year EUL limit set through CPUC EE policy. The DEER assigns an eight-year EUL to occupancy sensor measures (Measure ID-D03-003) and a 16-year EUL to LED Exit Signs (Measure IDs D03-860 through D03-863). Hence, based on the most limiting component, occupancy sensors, this assessment study recommends an eight-year EUL.

MARKET BARRIERS

The hospitality industry, principally the luxury segment, places the guest experience above all other considerations. One hotel executive put it most succinctly: "Anything that saves money and sacrifices comfort is totally unacceptable."[18] Another hotel manager stated:

> "There are many engineers and managers who get really irritated when somebody comes in and talks about their wonderful widget and how much money it will save, without demonstrating any comprehension of how it will affect guest comfort or the aesthetic appeal of the property. That's a good way to get weeded out."[19]

If the hotel manager believes that the OSNL wall switch will inconvenience guests by turning off the bathroom lights prematurely, the measure will not be installed. It is paramount that the sensor delay time is long enough to avoid guest inconvenience. The PIER study concluded that a sensor delay time less than one-hour would not increase savings significantly.[20] None of this assessment's hotel test sites conveyed any guest complaints about bathroom lights turned off prematurely with the default one-hour delay. Thus, the sensor delay should not be set lower than one-hour. In addition, if the bathroom aesthetics is neither preserved nor enhanced, or the electrical installation is too problematic, the hotel staff will oppose the measure and not install it.

The original assessment project plan called for installing the OSNL wall switch in 40 rooms, but only 29 installations took place. Some of the issues related above either canceled or delayed the installation of OSNL wall switches for the project:

- At one hotel site, higher priority items kept the small engineering staff from installing the EEM for several months and lost two of the OSNL wall switches,

- Another site required three-way wiring to replace SPDT switches which proved difficult for the onsite hotel staff and their electrical contractor, and
- Also at the same site, customized mirrored faceplates for the OSNL wall switch were required, and hotel staff could not alter the mirrored wall without breakage.

CONCLUSIONS AND RECOMMENDATIONS

This Emerging Technology Assessment confirmed the primary finding of the PIER study: the OSNL wall switch significantly reduces the lighting usage in hotel room bathrooms. The PIER study report states that close to 65 percent of bathroom lighting energy usage is attributable to instances where the lights are turned on for long periods of time, i.e., greater than 2.5 hours.[21] The PIER field tests reduced those instances by 80 percent. This project's field tests reduced the frequency of long turn-on periods by 72 percent.

The assessment data analysis found that long turn-on periods averaged seven hours before the measure installation. After the measure installation, the long turn-on periods averaged 4.3 hours, a reduction of 38.7 percent. In addition, the assessment found that super-long turn-on periods, i.e., several days in length, persisted. The maximum turn-on length before the measure retrofit was 3.8 days. After the retrofit, it was 2.3 days. Possibly, the super-long periods with the OSNL wall switch installed are due to pets kept in the bathroom during long guest stays. The assessment project confirms the PIER study observation that their recorded average baseline operating hours of 4.4 hours per day was low.[22] This assessment's hotel sites averaged 5.4 hours per day as summarized in Table 4.

The assessment found that the annual energy savings varies with the guest room's occupancy rate as shown in Figure 11. The data analysis found that the baseline lighting usage decreases as the average room occupancy rate increases. This effect is mainly due to the bathroom lights left turned on when the guest room is unoccupied. After the OSNL wall switch installations, the trend changed to the lighting usage increasing as the average room occupancy increased. The annual energy savings for the bathroom lighting fixtures in the assessment averaged 163 kWh per year. The data analysis created averaged 7-day, 24-hour load profiles that allow for an estimated peak demand reduction. Based on the DEER peak demand definition, the analysis estimated a 7.3 percent reduction. The peak demand reduction for the bathroom lighting fixtures in the assessment averaged 15.9 watts.

The project's field experience suggests two possible improvements to the OSNL wall switch:

- Provide capability to function as a true SPDT light switch replacement and simplify the retrofit of hotel guest room suites with two switches that control the bathroom lights,[1] and
- Provide the capability to adjust both the sensitivity and coverage of the built-in occupancy sensor. This capability would have solved a problem observed at one site: the bedroom entrance to the bathroom allowed the occupancy sensor to detect the bedroom occupants, and contributed to the lower savings recorded for these particular guest room suites.

Finally, when high-efficiency lighting retrofits of existing guest room bathrooms occur, the savings from an OSNL wall switch diminishes due to the reduced fixture wattage. This represents a lost energy savings opportunity. Hence, the OSNL wall switch should be packaged and promoted as an integral part of ongoing high-efficiency lighting retrofits for hotel room bathrooms.

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