12. Facility Type: Hotels and Motels

Revised December 2007

12.1 Challenges and Opportunities

The United States' 47,000 hotels and motels spend an average of $2,196 per available room each year on energy, an amount that represents about 6 percent of all hotel operating costs. The varied nature of the physical facilities and the activities that they host can make energy management especially challenging, whether the facility is a large convention hotel, part of a large national chain, or a small inn or motel. However, the opportunities for improved guest comfort, longer equipment life, lower operating costs, and an improved corporate image make pursing energy efficiency worthwhile. ENERGY STAR partners in the lodging industry have greatly reduced their expenditures on energy through measures such as lighting upgrades in guest rooms, lobbies, and hallways; occupancy-based guest-room energy controls; and the installation of energy-efficient water heating equipment, while still providing benefits for hotel guests, owners, operators, and shareholders.

Hotels and motels operate 24 hours a day, hosting guests and offering various services and amenities. Guest rooms, public lobbies, banquet facilities and restaurants, lounges, offices, retail outlets, and swimming pools fill the building or multiple buildings. Ice machines, vending machines, and game rooms may be scattered throughout. Laundries and kitchens are typically located on-site. The variety of services and amenities provided and the need to operate around the clock mean that lodging facilities present abundant opportunities for energy savings.

Building upgrades are especially demanding in hotels because there is never any downtime. Measures that are effective in other settings, such as occupancy sensing, time-clock control, and thermostat setbacks, must be implemented with great care in a hotel or motel so as not to detract from the experience of guests.

Nevertheless, the impact of rising energy costs (hotel utility costs increased an average of 12 percent each year from 2004 to 2006) and growing concerns about global warming are leading hotel operators to take action. Dozens of hotel operators are participating in the U.S. Environmental Protection Agency's (EPA's) ENERGY STAR buildings program. For example, Accor North America, one of the largest hotel chain owners and operators in North America, was recently recognized as an ENERGY STAR Leader by the EPA for achieving top energy performance, as signified by an average ENERGY STAR rating of 75 across its Red Roof Inn, Studio 6, and Motel 6 properties. Among the measures implemented by the participating hotels were the replacement of neon signs with light-emitting diode units, the swapping of compact fluorescent lamps for incandescent lamps, the installation of high-efficiency air-conditioning units, and the addition of attic insulation in older facilities. By introducing the energy performance rating to its portfolio, Accor is now better able to understand how its 900 properties stack up against each other and other similar hotels nationwide.

Hotels and motels throughout the U.S. are also recognizing that many of their guests are becoming more environmentally conscious and will support the hotels' efforts to cut energy use. For example, many hotels now offer guests the option of not having their sheets and towels laundered every night. Many hotels are also taking a proactive approach, realizing that a stay at an energy-efficient hotel can teach guests the principles of green and sustainable design from their lodging experience.

Keeping in mind the continual maintenance or improvement of guest comfort and satisfaction, which is the primary consideration in any hotel building project, the following items should be factored into energy-efficient upgrades:

- Thermal comfort has a big impact on guest satisfaction, and because individuals have different preferences, a responsive, controllable HVAC system is important.
- A sense of safety and security is important to the guest experience. Proper exterior lighting and adequate but not excessive lighting in hallways and stairways can enhance security. Efficient light sources, timers, and occupancy controls can make an efficient environment a secure one as well.
- Indoor air quality also affects the guest experience. Clean air free of mold, cleaning compounds, and smoke is not only healthier, it is more pleasant.
- The indoor acoustic environment should also be considered. Sounds from outside the building, interior hallways, and building equipment such as fans, boilers, and compressors can disrupt guests' sleep.

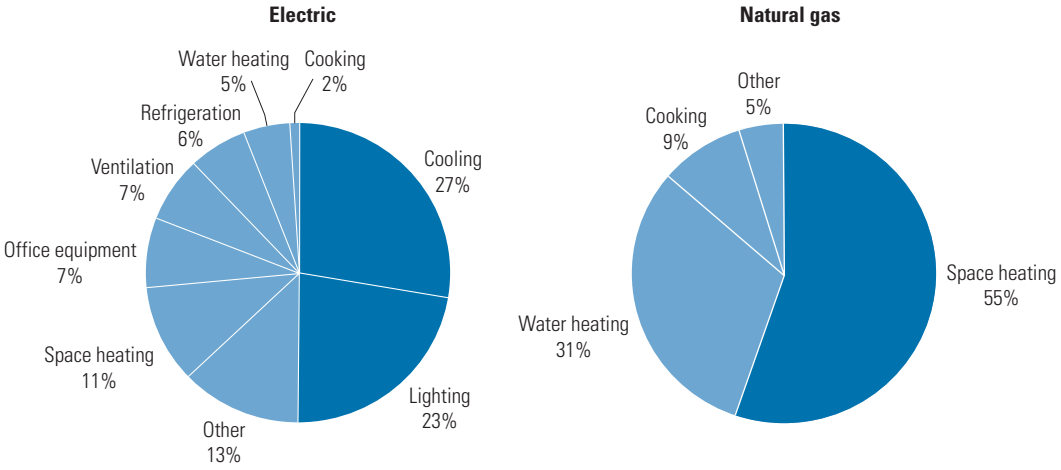
12.2 Energy Use Profile

Consider a hotel or motel's largest energy loads when planning a retrofit strategy. Typically, nearly 75 percent of a hotel's or motel's total energy use can be attributed to space heating, water heating, lighting, and cooling combined (see **Figure 12.1**). Cooling and lighting alone make up half of the building's electricity consumption.

Energy intensity in hotels and motels varies widely and is affected by climate, number of rooms, and types of on-site amenities. Energy intensity in hotels and motels can range from less than 15,000 Btu per square foot (ft^2) to over 300,000 Btu/ft^2 (**Figure 12.2**, page 4). Given this wide range and skewed distribution, it can be misleading to assess a hotel or motel facility's performance by looking at its average energy intensity alone.

Figure 12.1: Electric and natural gas end-use profile for hotels and motels

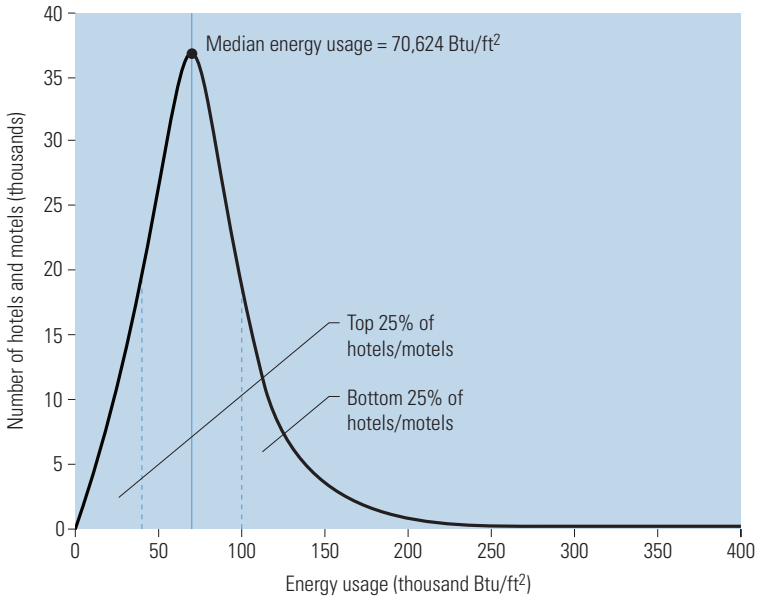
Most of the electricity consumed by hotels and motels is used for space cooling and lighting. Typically, space heating represents the largest use of natural gas in hotels and motels. However, each facility's energy profile is different, so these charts are not representative of all lodging facilities. Hotel and motel energy use will also vary depending on the types of amenities available.



Courtesy: E SOURCE; from Commercial Building Energy Consumption Survey, 1999 data

Figure 12.2: Distribution of energy intensity in hotels and motels

The median hotel or motel uses approximately 70,000 Btu per square foot (ft²) from all energy sources. However, many lodging facilities are significantly more energy-intensive than that.



Courtesy: E SOURCE; from Commercial Building Energy Consumption Survey, 2003 data

The EPA's national energy performance rating system is designed to provide a meaningful benchmark for hotels and motels. The rating system is accessible online as part of the EPA's free Portfolio Manager tool (www.energystar.gov/benchmark). It evaluates a hotel's or motel's energy intensity, normalizing for weather and operating characteristics. The rating is expressed on a scale of 1 to 100, signifying the percentile of performance. Hotels or motels that achieve a rating of 75 or higher are performing in the top quartile and may be eligible to earn the ENERGY STAR label. The rating serves as a standard of comparison against other hotels and motels, and it provides a way to measure progress after upgrades are implemented.

All upgrade projects should begin by establishing a benchmark rating. The relative ENERGY STAR performance ratings can help an organization to identify its best- and worst-performing facilities. Although any hotel or motel may benefit from retrocommissioning, operation improvements, and retrofits, it is usually most cost-effective to begin upgrade efforts with low-scoring facilities.

For more information, visit ENERGY STAR for Hospitality at www.energystar.gov/hospitality. For descriptions of hotels that have earned the ENERGY STAR, visit www.energystar.gov/index.cfm?fuseaction=PARTNER_LIST.showPartnerResults&partner_type_id=CIO&s_code=ALL.

12.3 Technical Recommendations

In the highly competitive lodging industry, room rates cannot be raised easily, so reducing costs can be a significant means of increasing margins and profits. After labor costs, energy expenses represent the greatest portion of the annual operating budget for hotels and motels. With energy costs rising, it makes sense to invest in building upgrades that can help keep these

costs down. The EPA estimates that each 10 percent reduction in energy use is equivalent to improving average room rate by $1.35 in full-service hotels ($0.62 for limited-service hotels).

Common reasons for initiating energy-related upgrades in hotels and motels include:

- Customer complaints
- Corporate sustainability policies
- Frequent equipment malfunctions and shortened equipment lifetime due to years of deferred maintenance
- Piecemeal additions to buildings and internal changes to existing spaces that have not been accompanied by corresponding changes to heating and cooling systems
- Previous attempts to reduce energy use by inappropriate measures, such as covering vents
- Major pieces of capital equipment or building elements, such as a boiler or a roof, that are nearing the end of their useful life

Following the staged approach that is advocated throughout this manual can reveal opportunities for saving on capital costs by "right-sizing" major equipment. After lighting and load reduction measures have been implemented, it may be possible to specify smaller heating and cooling equipment.

Many of the recommendations provided here offer not only energy savings but also maintenance savings. Please note that this should not be considered an exhaustive list of measures appropriate for hotels and motels. Operators and owners are encouraged to refer to the full guidelines presented throughout this manual when planning and managing a retrofit program.

Retrocommissioning

Energy savings and other benefits. Commissioning is a process during which engineers observe a building and perform a "tune-up" to ensure that its systems are operating efficiently and as intended. Commissioning typically takes place when a facility is first built; however, if a building has never been commissioned, then it is ripe for retrocommissioning, which entails a similar tune-up on an existing building. All buildings stand to benefit from regular recommissioning, which can then take place periodically throughout a building's life. Studies have shown that commissioning can save a typical 100,000-ft^2 hotel 10 to 15 percent of its energy costs, or roughly $20,000 per year. Savings typically result from resetting existing controls to reduce HVAC waste while maintaining or even increasing comfort levels for occupants.

In addition to saving energy, retrocommissioning can help hotels and motels reduce equipment downtime and keep maintenance expenditures in check. Another reason to retrocommission and regularly recommission lodging facilities is to create a body of documentation demonstrating that building systems are operating properly. Retrocommissioning is also an important tool for ensuring that a hotel's indoor air quality standards are met. Safety is another consideration if the fire alarm and smoke-detection systems are integrated with other building systems. Problems with low-voltage electrical systems such as lighting, alarm, and building-management systems are frequently identified during retrocommissioning.

Best practices. Some hotel owners are implementing guidelines and establishing standard contractual requirements to ensure that retrocommissioning and recommissioning are done properly and in a timely fashion. If hotel staff has sufficient expertise and familiarity with a building's systems, they may do these tune-ups, but otherwise, it may be advisable to outsource at least some of the work.

After initial commissioning or retrocommissioning, a hotel should be recommissioned every three to five years to maintain optimal performance. The precise timing will vary depending on the timing of changes in the facility's use, the quality and schedule of preventive maintenance activities, and the frequency of operational problems. Commissioning should also be performed after major remodels or additions.

Even if a hotel or motel was commissioned when it was first built, the building's use patterns may have changed over time, settings may have been altered, and equipment may no longer be functioning the way it should. If a facility appears to be using more energy than expected when compared with past performance or with other similar lodging facilities, recommissioning or retrocommissioning is a great place to start looking for energy-saving opportunities. Other signs that it is time for retrocommissioning include inadequate ventilation or a high volume of comfort-related calls from guests.

Tune-up opportunities. There are a number of easy measures that can reduce energy use in various areas of the hotel:

- *Peripheral and back rooms.* Make sure that HVAC settings in lobbies, offices, and other such peripheral rooms are at minimum settings during hours of low use.
- *Laundry.* Set laundry hot water to 120° Fahrenheit. This is a good temperature for all hot water uses outside of the kitchen, where codes are specific about water temperature.
- *Pools and hot tubs.* Make sure that all pools and hot tubs are covered after hours to diminish heat loss.
- *Housekeeping procedures.* Encourage housekeepers to turn off all lights and set temperatures to minimum levels after cleaning each room. Closing drapes when a room is unoccupied will reduce heat gain in the summer and heat loss in the winter.
- *Front desk.* Teach registration staff that they can help save energy costs by booking rooms in clusters, so that only occupied building areas or wings need to be heated or cooled to guest comfort levels. Rooms on top floors, at building corners, and facing west (in summer) or north (in winter) can be the most energy-intensive to heat or cool; therefore, consider renting them last.

CASE STUDY: Retrocommissioning a Marriott

The Los Angeles Airport Marriott, a 1,000-room facility, conducted a retrocommissioning program at a cost of about 22 cents per square foot, or roughly $125 per room. The project was conducted by a team of the company's own staff, including engineers and the regional vice president of engineering, with assistance as needed from an outside consultant. The project developed in-house expertise that will help maintain long-term benefits, which is a result that might not have been achieved if outside consultants had worked independently on the project. The project team developed 17 recommended measures for the hotel's air-handling units, chilled water plant, and other back-of-the-house systems. The average implementation cost for each of the 17 steps was slightly more than $7,500, and the average payback period was less than one year. The hotel saved $153,000 annually, and 30 percent of those savings came from a single adjustment to airflow from one air-handling unit.

Training and documentation. The benefits of retrocommissioning can be sustained through proper training of hotel maintenance staff. A retrocommissioning contract should always specify that maintenance staff will receive initial training and manuals. Multiple copies of manuals that document system warranties, instructions for operations, and maintenance requirements should be kept on-site and at corporate headquarters.

Training can cover topics such as equipment warranties and maintenance, operational schedules and setpoints, start-up and shutdown, emergency procedures, and an overview of air quality and comfort issues. Instruction can be provided at meetings, in special training sessions, or in printed manuals and videos of training sessions.

Integration with facility planning. Hotel owners who establish multiyear maintenance plans are more likely to fund maintenance needs continuously. A multiyear plan can be used for prioritizing projects (depending on the funding available) while keeping the longer-term impact of those decisions in perspective. This type of plan can be structured around the results of a complete retrocommissioning of select facilities as well as an assessment of the condition of all hotels in the chain. A typical facility condition assessment includes reviewing the age and condition of building components and then estimating their remaining expected lifetime and replacement costs. A number of resources are available to help hotels and motels assess their current operations and begin their investigation of energy-saving alternatives (see sidebar).

RESOURCES: Retrocommissioning

The following resources are available to help hotel and motel owners and managers assess how effectively they use energy and to help them investigate efficient alternatives:

American Hotel & Lodging Association

www.ahla.com

The American Hotel & Lodging Association (AH&LA) provides information on governmental and regulatory affairs, industry suppliers, media and public relations, and industry profile information. It has partnered with ENERGY STAR to launch an educational program called Good Earthkeeping, which helps hoteliers improve the energy and financial performance of their properties and demonstrate the environmental leadership of the hospitality industry.

ENERGY STAR Hospitality Benchmarking Starter Kit

www.energystar.gov/index.cfm?c=hospitality.bus_hospitality_bm_starter_kit

Hotels can assess energy performance with Portfolio Manager. This kit is intended to help users get started benchmarking, take the next steps, and assist in data collection.

Green Globe

www.ec3global.com/products-programs/green-globe/

Green Globe is a worldwide certification program for sustainable travel and tourism.

"Green" Hotels Association

www.greenhotels.com

The "Green" Hotels Association is committed to encouraging, promoting, and supporting ecological consciousness in the hospitality industry.

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Green Restaurant Association
www.dinegreen.com

The Green Restaurant Association, a national nonprofit organization, provides services in research, consulting, education, marketing, and community organizing on energy-related issues to hotel and motel operators and owners.

Green Seal
www.greenseal.org

Green Seal is dedicated to protecting the environment by promoting the purchase and use of environmentally responsible consumer products. It sets environmental standards and awards a "Green Seal of Approval" to products that cause less harm to the environment than other similar products.

International Association of Assembly Managers Inc.
www.iaam.org

The International Association of Assembly Managers is made up of members who manage or provide products and services to convention centers.

International Council on Hotel, Restaurant, and Institutional Education
http://chrie.org/i4a/pages/index.cfm?pageid=1

The International Council on Hotel, Restaurant, and Institutional Education was founded as a nonprofit association for schools, colleges, and universities that offer programs in hotel and restaurant management, food-service management, and culinary arts.

Portland Energy Conservation Inc.
www.peci.org

Portland Energy Conservation Inc. provides commissioning guidelines and services and promotes energy-efficient practices and technologies for businesses and individual consumers.

Lighting

Energy savings. Lighting represents almost a quarter of all electricity consumed in a typical hotel, not including its effect on cooling loads. Lighting retrofits can reduce lighting electricity use by 50 percent or more, depending on the starting point, and cut cooling energy requirements by 10 to 20 percent as well.

Best practices. Illumination requirements vary throughout a hotel or motel, depending on the type of space. **Table 12.1** (page 9) describes some of the recommendations of the Illuminating Engineering Society of North America. Outdoor nighttime light levels may depend on local ordinances, but can generally be fairly low, depending on the level of activity and the potential hazards.

Daylighting. Natural daylight has been shown to improve a hotel's indoor environment while reducing energy use and peak demand. Whenever possible, any lighting renovation should start by using daylighting as much as possible and reducing electric lighting accordingly. Good daylighting design will not introduce excessive heat gain, heat loss, glare, or uneven illumination. Midscale and upscale hotels can use daylighting controls in lobbies to improve lighting quality while reducing energy costs. For example, at the Mandarin Oriental

in New York, dimmers and daylight-harvesting sensors adjust the interior lighting levels in the restaurant, bar, and hotel suites in response to the intensity of natural light.

Daylighting is also an excellent strategy for other hotel areas. For example, at the Gaia Napa Valley Hotel in California, designers sought to maximize visual comfort while minimizing the use of electric lighting. In a corridor area they used a continuous clerestory (an upper portion of a wall containing windows for supplying natural light to a building) that wraps around all four wings of the hotel. Tubular skylights illuminate the lobby, hallways, and guest rooms. Trellises covered with vines shade the clerestory to protect corridors and rooms from excess solar radiation. The guest rooms feature windows of high-performance glass to reduce the contrast between outside and inside.

Electric lighting. A mixture of light sources can create a pleasing and comfortable environment that is suitable for a variety of tasks. Electric lighting should be coordinated with a daylighting scheme or adjusted in response to it. A blend of direct and indirect electric lighting can provide soft and uniform illumination.

In back-room areas such as kitchens and office space, incandescent and T12 fluorescent lamps can be replaced with compact fluorescent lamps (CFLs) or high-performance T8 lamps and electronic ballasts, a combination that can reduce lighting energy consumption by 35 percent. Adding specular reflectors, new lenses, and occupancy sensors or timers to a T8 fluorescent lighting system can double the savings. Paybacks of one to three years are common.

In guest rooms, CFLs are becoming the standard for table, floor, and reading lamps, and in recessed and vanity lighting in the bathroom. CFLs reduce energy use by two-thirds and yield savings of up to $20 per lamp per year. When the Doubletree Hotel in Sacramento, California, replaced its 60-watt incandescent desk lamps in guestrooms with new CFL lamps, it not only saved money but also enhanced its guests' experience: Regular customers welcomed the

Table 12.1: Illumination recommendations for hotels

Light levels for hotels and motels depend on the type of space under consideration and the activities being performed in it. The values below come from the recommendations of the Illuminating Engineering Society of North America (IESNA). In addition to light levels, it is also important to consider lighting quality factors such as color appearance, luminances of room surfaces, glare, and shadows.

Space type	Illuminance level (foot-candles)
Guest rooms	
General lighting	10
Bathrooms	30
Desks	30
Corridors, stairs	
General lighting	5
Front desk	
General lighting	50
Lobby	
General lighting	10
Reading and work areas	30

Courtesy: E SOURCE; data from *IESNA Lighting Handbook*

change, and complaints about inadequate desk lighting declined. Moreover, guests are using the brighter, more-efficient desk lamps in lieu of other lamps in their rooms, compounding the Doubletree's energy savings. These changes also resulted in labor savings because CFLs last longer than incandescent lamps, saving relamping time.

Many hotel public areas, including corridors and hallways, can use CFLs in wall sconces and in recessed downlights. A Michigan Marriott replaced its public-space incandescent lamps with CFLs and saved more than $40,000 in energy and maintenance costs. The historic Willard InterContinental in Washington, D.C., installed CFLs in common areas and guest rooms. The investment resulted in fewer complaints about lighting quality, and a six-month payback based on energy savings.

A number of hotel chains have implemented widespread CFL campaigns. One of the measures that helped Marriott International win the ENERGY STAR Sustained Excellence designation in 2007 was the installation of 450,000 CFLs. HG (InterContinental Hotels Group) announced that the Hotel Management Group, the company's American-operations division, will launch a new environmental initiative to replace more than 250,000 incandescent light bulbs with new energy-efficient CFLs in guest rooms at over 200 company-managed hotels across the Americas.

For parking lots and outdoor applications, high-intensity fluorescent (HIF) lighting is often the best choice rather than metal halide, mercury vapor, or high-pressure sodium lights. HIF lamps should be enclosed when used outdoors in cold climates. In parking garages, which often use inefficient high-intensity discharge fixtures, high-efficacy fluorescent fixtures can provide more even illumination with fewer fixtures.

In restaurants and lounges, LEDs (light-emitting diodes) are frequently used to create specialized lighting effects. Another measure that helped Marriott International achieve the award noted above was the conversion of all outdoor signage to LED and fiber-optic lighting. LEDs can also provide an accent to exterior arch elements and facades and can serve as nightlights in guest rooms. LEDs now illuminate the exterior of the Hard Rock Hotel & Casino in Las Vegas, providing more flexibility in creating lighting effects and cutting energy bills by $41,000 compared to the previous metal halide fixtures. Using LED exit signs is also a proven energy- and labor-saving measure that can pay for itself in one year.

Controls. For hotels, lighting controls typically consist of occupancy sensors and scheduling systems. Occupancy sensors save energy and also help to reduce maintenance costs by lengthening the relamping interval. Turning fluorescents off for 12 hours each day can extend their expected calendar life by 75 percent, to nearly seven years. In large restrooms, ceiling-mounted ultrasonic occupancy sensors detect occupants around partitions and corners. For hallways, a recommended strategy is to use a combination of scheduled lighting and dimming plus occupancy-sensor controls after hours. Guests may not like a totally darkened hallway, but dimming lights in unoccupied hallways and stairwells and then turning them up to full brightness when someone enters is a sensible approach. Occupancy sensors are also appropriate for meeting rooms and back rooms.

Some modifications to controls can actually increase guest comfort. Saunders Hotels' Comfort Inn & Suites Boston/Airport has reduced the amount of overnight lighting used in the guest hallways by half. The results are not only energy savings but also the unforeseen benefit of fewer noise complaints from other guests. As guests step off of the elevators late at night, with the reduced lighting levels, they seem to instinctively understand that it is "after hours" and are quieter, therefore disturbing other guests much less frequently.

Load Reduction

Energy savings. Load-reduction measures that reduce the operational time or intensity of hotel HVAC equipment while still maintaining a comfortable work environment can offer substantial savings. Plug loads from equipment such as computers and copiers represent about 7 percent of electricity used in hotels and motels. In addition, cooking accounts for about 9 percent of natural gas; water heating uses 5 percent of electricity and 31 percent of natural gas. Equipment purchases and operational measures for these uses can be very cost-effective. When purchasing these types of items, look for products that are labeled as "ENERGY STAR qualified" (www.energystar.gov/purchasing)—they will use 25 to 50 percent less energy than conventional models without compromising quality or performance. Not only do they offer significant return on investment because of these savings, many also feature longer operating lifetimes and lower maintenance requirements.

Best practices. The quickest and easiest way to implement load reductions in a hotel or motel is to ensure that equipment is turned off when it is not needed. This can be accomplished by encouraging housekeepers to turn off all lights and set temperatures to minimum levels after cleaning each room.

For hotel office spaces, a computer monitor can use two-thirds of the total energy of a desktop system, so it is important to power down monitors whenever they are not in use. The ENERGY STAR Power Management program provides free software that can automatically place active monitors and computers into a low-power sleep mode through a local area network (www.energystar.gov/index.cfm?c=power_mgt.pr_power_management). Whole-computer power management can save $15 to $45 annually per desktop computer; managing only monitors can save $10 to $30 per monitor annually.

For hotel pools, simply using a cover on a heated pool can save 50 to 70 percent of the pool's energy use, 30 to 50 percent of its makeup water, and 35 to 60 percent of its chemicals.

In the kitchen, food preparation equipment should not be turned on for preheating more than 15 minutes before it is needed; simply reducing the operating time of kitchen appliances can cut cooking-related energy consumption by up to 60 percent. Hot water waste should be reduced in kitchens, bathrooms, and fitness rooms; some measures to consider include automatic faucet shutoff, single-temperature fittings, and low-flow showerheads with pause control.

Equipment placement is also important. Do not install air-cooled refrigeration equipment in areas with poor air movement. For example, ice makers and cooled vending machines are often placed in rooms with little or no air for cooling, which reduces the operating efficiency of the units.

Efficient equipment procurement. A simple way to ensure that purchased equipment is energy efficient is for the corporate office to request that hotel purchasing departments or franchisees specify products that are ENERGY STAR qualified in their contracts or purchase orders. Additionally, the product recommendations for federal government procurement officials from the U.S. Department of Energy's Federal Energy Management Program (www.eere.energy.gov/femp/procurement) may be appropriate for items not covered under the ENERGY STAR program. ENERGY STAR qualified products that are relevant for hotels and motels include:

- Commercial refrigerators and freezers
- Commercial fryers

- Commercial steam cookers
- Televisions, DVD players, and audio equipment
- Computers and monitors
- Printers, fax machines, mailing machines, and scanners
- Copiers
- Vending machines
- Roof products

In its energy-efficiency efforts, the Saunders Hotel Group purchased ENERGY STAR–qualified products such as refrigerators, clock radios, and televisions for guest rooms and computers and fax machines for offices. These purchases helped Saunders, which was an ENERGY STAR Partner of the Year in 2005, reduce energy use by 11 percent, even after a decade of other energy-savings successes.

In hotel kitchen areas, intelligent, variable-speed hood controller systems can also significantly reduce energy costs. In appropriate applications, this technology yields a one- to two-year simple payback. A photoelectric smoke or heat detector determines when and how much ventilation is needed and activates the exhaust fan at the proper speed.

Water heating. More than many other facility types, water heating is a major load for hotels and motels. It accounts for a third or more of a hotel facility's energy consumption, some 40 percent of which is attributable to laundry and kitchen operations. Commercial heat pump water heaters (HPWHs) are two to four times more efficient than conventional water heaters, while also providing space-cooling capacity. In fact, they can cut water-heating costs up to 50 percent. However, before deciding to use HPWHs it is important to do a careful economic analysis—they are more expensive than conventional water-heating units, and their performance varies with climate. Direct-vent, sealed-combustion condensing water heaters and boilers with efficiencies higher than 90 percent are the next-most-efficient option. Condensing boilers operate very efficiently during periods of low water demand, unlike traditional hot water heaters, and they can also provide space heating. In general, installing multiple smaller water heaters provides better reliability, effectiveness, and efficiency compared to using one large hot water heater.

Hotels and motels can also use HVAC, shower, or laundry room heat-recovery systems to cut hot water expenditures. Hotels can obtain "free" hot water from their cooling and refrigeration equipment by using double-bundled heat exchangers in the chillers or a plate heat exchanger in the condenser-cooling loop. Gray water heat-recovery equipment used with showers saves 50 to 60 percent of water-heating energy with payback in two years. They also double or triple the first-hour capacity of water heaters. In addition, installing variable speed drive(s) on the hot water pumping systems will reduce pumping energy during periods of low hot water use.

In the hotel kitchen, prerinse spray valves are one of the easiest and most cost-effective energy-saving measures available. These devices use a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. They reduce water consumption, water heating energy, and sewer charges. Look for models with a flow rate of 1.6 gallons per minute or less.

Several options are available for hotel laundry operations. New efficient tunnel washers can reduce costs through labor and utility savings. Ozone laundering systems offer big savings by

using cooler water and much less of it; they also use less energy and detergent. Jurys Doyle Hotel Group spent $45,000 on an ozone system at its ENERGY STAR–labeled Boston facility. The system allows the use of cooler water, uses shorter washing cycles, and has cut detergent use by 30 percent, leading to a payback period of just 16 months.

For hotel swimming pools, indoor pool covers typically yield paybacks of one year; covers for heated outdoor pools and hot tubs may yield even better savings. Indoor pools require simultaneous heating and dehumidification. HPWHs can efficiently serve both of these needs: They heat water while producing cool, dehumidified air for the room housing the pool. Using an HPWH can reduce heating costs for gas- and electricity-heated pools as much as 40 and 80 percent, respectively. Low-temperature unglazed solar water heaters are an inexpensive approach that is well suited for swimming pools and spas in warmer climates. Glazed flat-plate collectors can provide higher-temperature water.

Building envelope. Outside the hotel, awnings, overhangs, light shelves, and windows with low solar heat gain coefficient (SHGC) help to reduce the amount of solar heat that comes in while still allowing daylight through. Light-colored roofing materials not only reduce cooling-energy consumption by 25 to 65 percent during the summer, they also extend roof life. Green roofs planted with grass and other vegetation provide excellent insulating properties, prolong roof life, reduce storm-water runoff, and offer an aesthetic appeal that could be valuable to a hotel or motel property. However, green roofs are expensive, and their cost-effectiveness is still being evaluated.

Retrofitting with new, high-performance windows can be prohibitively expensive, but installing reflective film inside existing windows can be a more cost-effective option. Energy savings from this film can be as high as 25 percent, and can result in paybacks of less than three years. Other window coverings such as shutters, shades, and draperies provide insulation benefits. This is especially true in summer months, when they reduce the amount of sunlight and heat entering rooms.

For lobby areas, revolving doors are the best choice for keeping wind and weather out. Check these doors periodically to ensure that there are no leaks along their edges or bottoms.

Air Distribution Systems

Energy savings. On average, ventilation systems consume about 7 percent of the electricity used in hotels and motels. Savings can be found by installing efficient fan motors and sizing the system to match the load (which may now be lower due to retrocommissioning, improved lighting, and load reductions). Even more savings are possible by using energy-recovery equipment and variable-speed drives.

Best practices. A hotel ventilation system must be designed, operated, and maintained to provide adequate fresh-air intake and prevent mold growth from unwanted moisture accumulation. It is possible to inadvertently supply insufficient volumes of fresh air. This may occur with scheduled ventilation and variable air-volume systems or may be caused by wind, stack effects, or unbalanced supply and return fans. Installing an outdoor-air measuring station that modulates the outdoor-air damper and the return damper is relatively simple and ensures sufficient fresh-air supply. Increasing ventilation to safe and comfortable levels will likely increase energy consumption and so should be combined with other energy-saving measures.

In warm months, it can also be effective to reduce outside-air intake, especially when humidity is high. Many facilities bring in too much outside air during warm and humid periods.

Often, insufficient ventilation air results from clogged intake screens that are difficult to access for inspection and cleaning. To prevent this problem, ensure that all HVAC system air-supply diffusers, return registers, and outside-air intakes are clean and unobstructed. Replace filters regularly. These measures to improve ventilation rates should not raise hotel energy consumption.

Similarly, economizers should be checked regularly to ensure that their dampers are functioning properly. Dampers that are stuck open could be letting in too much outside air, and ones that are stuck closed will not provide the benefit of free cooling.

Controlling mold. Mold and mildew damage to wallpaper, carpet, and other materials caused by high humidity levels is estimated to cost the lodging industry $68 million annually. Mold and mildew are caused by leaks in the building envelope in humid areas, oversized HVAC systems, poorly balanced air-handling systems, and insufficient moisture-removal capacity of vapor-compression HVAC systems. Desiccant HVAC and dehumidification systems excel at lowering humidity levels, improving indoor air quality, and increasing building occupant comfort. Two rooftop desiccant units handle the make-up air requirements for the lobby and hallways of the Park Hyatt Hotel in Washington, D.C., eliminating the need for a 100-ton rooftop chiller. Desiccant systems have low maintenance costs and can use a variety of fuels (waste heat, natural gas, or solar thermal energy) to lower peak electric demand, yet they may still be more expensive to operate than traditional HVAC systems, depending on local utility rates.

Add-on monitors and controls. Hotels can also use outdoor-air economizers with air-handling units, so that outdoor air can be used for free cooling during spring and fall or on cool summer nights when the humidity level is not too high.

In meeting rooms and other areas with variable occupancy, demand-controlled ventilation (DCV) systems can be used to reduce outdoor-air flows and the associated energy consumption during periods of low occupancy (see sidebar). DCV is most cost-effective for facilities located in a moderate to extreme heating or cooling climate and where existing HVAC systems do not use 100 percent outdoor air (such as those with evaporative cooling systems).

Large hotel casino facilities, which have very high ventilation demands, can use heat-recovery or energy-recovery ventilators that have balanced exhaust and supply fans and can meet all ventilation needs without creating drafts and air-pressure imbalances. Heat-recovery ventilators can feature efficiencies as high as 85 to 95 percent and can pay for themselves in roughly 3.5 years. Consider these units whenever air is continuously exhausted and make-up or ventilation air is required.

RESOURCES: DCV Design Tools

Several free tools are available to evaluate potential energy savings from demand-controlled ventilation:

- Carrier provides the Hourly Analysis Program (www.commercial.carrier.com/commercial/hvac/general/1,,CLI1_DIV12_ETI496,00.html?SMSESSION=NO)
- Honeywell has the Savings Estimator (http://customer.honeywell.com/Business/Cultures/en-US/Products/Applications+and+Downloads/Economizer+Logic+Module+(W7212)+Simulator+and+Demand+Control+Ventilation+Savings-Estimator.htm)
- AirTest offers the CO_2 Ventilation Control and Energy Analysis tool (www.airtesttechnologies.com/support/energy-analysis/)

A number of hotel systems can use variable-speed drives (VSDs), including variable air-volume systems, where they can adjust fan speeds according to operating requirements at different times of the day. VSDs should be installed on cooling-tower fans, continuously operating circulation pumps, and any constant-speed fans that only meet partial loads (for example, fans controlled with dampers). In kitchens, for example, fans can be linked to burners to reduce energy consumption during off-peak cooking periods. Be careful, however, not to cut exhaust to the point that kitchen odors permeate other areas of the facility.

Heating and Cooling Systems

Energy savings. Heating and cooling represent almost 40 percent of the electricity and more than half of the natural gas used by hotels and motels. Many hotels heat and cool rooms regardless of whether they are occupied. Hotels tolerate this waste because their preeminent concern is guest comfort, not energy use. However, used correctly, controls and efficient technologies offer the potential for as much as 50 percent energy savings without compromising guest comfort.

Best practices. Smaller hotels tend to use distributed systems that often run entirely on electricity, most commonly stand-alone package terminal air conditioners (PTACs). Efficiency criteria for PTACs are currently being developed through ENERGY STAR. They will appear on the ENERGY STAR New Product Specifications in Development web page (www.energystar.gov/index.cfm?c=new_specs.new_prod_specs). Meanwhile, high-efficiency equipment can be ensured by purchasing equipment at the efficiency levels established by the ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) Standard 90.1-2004, "The Energy Standard for Buildings Except Low-Rise Residential Buildings." This standard provides minimum PTAC efficiency requirements that are higher than those in the federal standards.

For larger hotels, new chillers can be 25 to 50 percent more efficient than equipment 10 or more years old. Auxiliary condensers used to preheat makeup water for centrifugal chillers can pay for themselves in less than one year. For central heating, installing two or more smaller boilers will meet space-heating demands more effectively and efficiently than one large boiler. Geothermal heating and cooling can be a good choice, especially if there is a nearby body of water for a heat source or heat sink.

This is also an excellent opportunity for hotels to capitalize on the measures taken in earlier stages to reduce loads and losses throughout the facility. Optimize savings from all building improvements by right-sizing heating and cooling equipment to meet actual needs, rather than relying on rule-of-thumb sizing estimates. Too often this equipment is oversized, which means the systems rarely operate at peak efficiency. Right-sizing offers first-cost savings, as well.

Controls. Hotel studies have shown that sold rooms are unoccupied for 12 or more hours per day. Hotel operators can link their energy management system (EMS), reservation system, and automated check-out system together to keep an unsold room ventilated but with minimal heating or cooling. A sold room can then be heated or cooled to a comfortable temperature an hour before a guest's scheduled arrival. Once the guests arrive in the room, they can then adjust the temperature as they like until they check out, when the HVAC system returns to the unsold mode. An EMS can enhance guest comfort while reducing energy costs by 35 to 45 percent, for a return on investment of 50 to 75 percent. New EMSs are so guest-friendly and effective that Cendant International, Starwood Hotels and Resorts, Hilton, and other chains are using them in their properties. Most EMSs can be used with central boiler/chiller systems or PTACs and are available with nightlights and wireless technology (requiring no additional electrical work).

Keycards that shut off all, or most, power-consuming devices when a guest leaves a room can also help reduce guest-room energy consumption. They have been used overseas for years, but have been slow to catch on in the U.S. However, with growing concerns about energy costs, that trend is starting to change. For example, the Westin Convention Center Pittsburgh installed a keycard system, which was consistent with the philosophy of the David L. Lawrence Convention Center complex of which the hotel is a part. (The Center has earned a gold Leadership in Energy and Environmental Design rating from the U.S. Green Building Council.) When a guest enters a room at the Westin, the keycard activates the entry light switch, the bathroom light, a pole light, and the HVAC system. When the card is removed from the room, power in the room automatically turns off. The hotel invested $120,000 in the system and reportedly recovered its investment through energy savings in just 10 months. Energy consumption dropped more than 10 percent in the first year with the system, and engineers expect greater savings in the future as they improve communications with guests about the benefits of the system.

12.4 Financial and Implementation Issues

One of the challenges for implementing energy-efficiency upgrades in lodging facilities is the way that capital improvement projects are typically funded. Minor projects—room redecoration, for example—are often funded through a small portion of gross revenues that is saved to an escrow account. Major projects, such as chiller replacement, are paid for directly by the owners through line-item allocations. Historically, this type of arrangement has often favored minor cosmetic projects that are highly visible to guests over mechanical improvements. However, with energy costs rising, the balance may be starting to shift. In fact, a recent study of the prospects for installation of integrated energy systems in hotels found that larger properties expressed a strong interest in working with energy service companies for the purpose of stabilizing energy costs.

Another complicating factor in the lodging industry is the fact that there is often no central procurement authority for energy equipment—each project and property is bid out separately. In addition, priorities for owners may lie elsewhere. For example, in bringing newly acquired properties up to corporate standards, leaving less funding available to address energy-efficiency improvements.

For property-level hotel decision-makers, lack of financing is often cited as the main reason they are unable to take advantage of energy-efficiency opportunities. Hotels are more willing to take on capital improvement projects when third-party funds are available. The importance of financing is also evident in the very short paybacks demanded by the lodging industry. The typical payback period needed for hotel decision-makers to consider an efficiency measure is about two years. The ENERGY STAR Cash Flow Opportunity Calculator (www.energystar.gov/index.cfm?c=tools_resources.bus_energy_management_tools_resources) can help hotel and motel managers calculate how much they can afford to invest in retrofits from the anticipated savings and whether it would make sense to borrow funds to finance building upgrades.

Hotel owners can also consider performance or shared-savings contracting, which provides a mechanism not only to fund energy-saving retrofits but also to cover deferred maintenance and capital renewal projects at the same time. Additionally, including ongoing maintenance in a performance contract can help to keep operating and maintenance costs under control and predictable. Having a long-term contract in place should ensure consistent funding for maintenance as well as providing an impetus for long-term strategic planning of equipment upkeep and replacement.

There are cases where the hotel ownership structure can be helpful in pursuing energy-efficiency upgrades. For example, many hotels and motels are franchise operations. On one hand, that structure can add layers of bureaucracy that make it harder to get approval for energy-efficiency measures that cost more than a certain amount. On the other hand, it enables projects to be designed centrally and rolled out to many locations, taking advantage of economies of scale. Franchisers may also have the ability to finance or arrange financing for the projects that they require franchisees to put in place. For example, Choice Hotels International has formed a strategic partnership with Panasonic to provide ENERGY STAR televisions designed specifically for the hotel market. Choice Hotels is the second-largest hotel franchise organization in the world; its family includes Comfort Inn, Quality Inn, Clarion, Sleep Inn, MainStay Suites, Econo Lodge, and Rodeway Inn. Choice Hotels expects its franchisees to purchase tens of thousands of these Panasonic televisions. The ENERGY STAR televisions draw only three watts of power or less when switched off, which results in an energy savings of up to 75 percent over conventional models. The TVs also feature energy-management circuitry that places the unit into a standby mode that helps reduce the energy wasted when guests fall asleep or leave the room unoccupied.

It is also crucial in developing an upgrade program to know how much energy is being used and where so that an economic analysis of efficiency measures can be performed. However, in many cases, hotel energy uses are ignored because the energy is not accounted for on an individual-operation basis. For example, hotel managers might not know how much it costs to maintain a pool facility or in-house laundry services, so they do not consider measures that could reduce energy costs in those operations. They believe it is an essential operation and must be maintained at any cost. As a result, they tend to overlook the potential savings from improving operational efficiency. For that reason, hoteliers are becoming more interested in energy information services, such as enhanced billing and consumption analysis.

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