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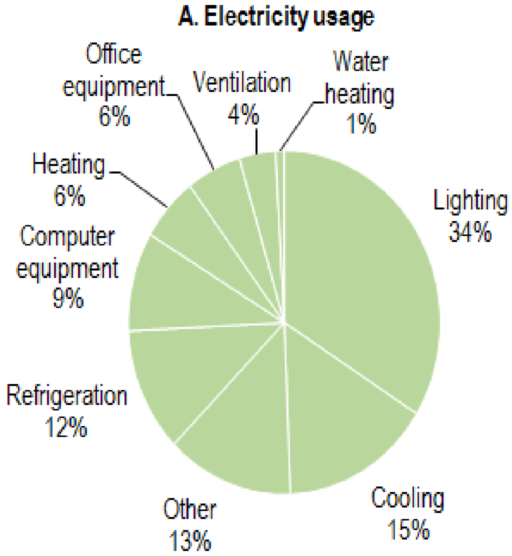
Managing Energy Costs in Small and Midsize Offices

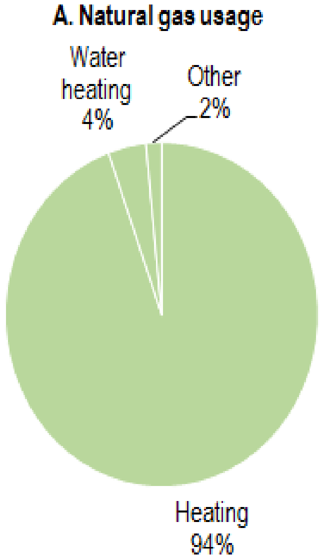
Small and midsize office buildings in the US (those under 100,000 square feet) use an average of 15 kilowatt-hours (kWh) of electricity and 38 cubic feet of natural gas per square foot annually. In a typical office building, lighting, heating, and cooling represent nearly 70 percent of total energy use (**Figure 1**), making those systems the best targets for energy savings. Energy represents about 19 percent of total expenditures for the typical office building, making it a significant operational cost deserving of management attention.

Average energy use data

Figure 1: Energy consumption by end use

Lighting, cooling, and refrigeration are the main electricity end-use categories in small office buildings (A); space heating dominates natural gas consumption (B).





Notes: Categories with values less than 1 percent are not shown.

Source: US Energy Information Administration

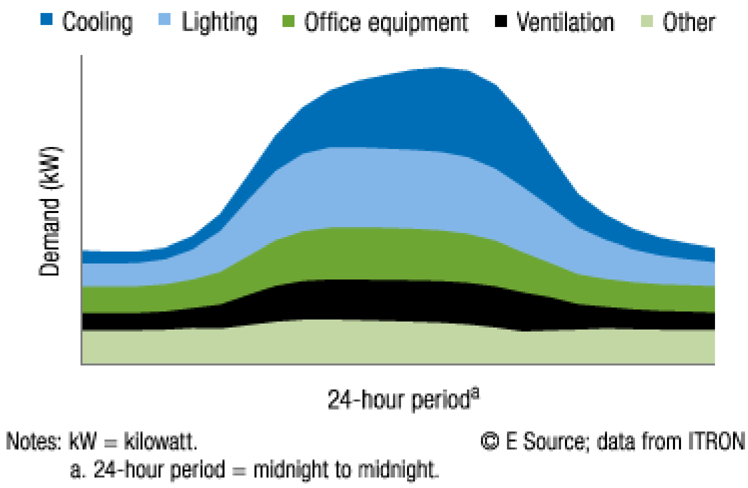
Top technology uses

- Heating
- Lighting
- Cooling

In order to better manage your building's energy costs, it helps to understand how you are charged for those costs. Most utilities charge commercial buildings for their natural gas based on the amount of energy delivered. Electricity, on the other hand, can be charged based on two measures: consumption and demand (**Figure 2**).

Figure 2: Load profile for a typical California office building

Hourly energy consumption data show that lighting and cooling present the largest opportunities for reducing peak demand charges in office buildings.



The consumption component of the bill is based on the amount of electricity, in kWh, that the building consumes during a month. The demand component is the peak demand—in kilowatts (kW)—that occurs within the month or, for some utilities, during the previous 12 months. Monthly demand charges can range from a few dollars per kW to upwards of $20/kW. Because these demand charges can be a considerable percentage of your bill, it's important to take care to reduce your peak demand whenever possible. As you read the following recommendations for energy-cost management, keep in mind how each one will affect both your consumption and your demand.

The conservation measures discussed here represent good investments. Most will not only save money but will also enhance both the aesthetics of your office and the productivity of your workers.

QUICK FIXES

this section

Many small office buildings can benefit from quick low-cost/no-cost energy-saving solutions such as turning things off, turning things down, and keeping up with cleaning and maintenance.

Turning Things Off

Turning things off seems simple, but remember that for every 1,000 kWh that you save by turning things off, you save $100 on your utility bill (assuming average electricity costs of $0.10/kWh).

Lights. Turn off lights when they're not in use. Properly installed occupancy sensors and timers can help to achieve this. A no-cost option is to simply train staff to turn off lights as part of their closing procedures (you can also help by identifying the location of light switches on a posted notice).

Computers and monitors. Computers and other electronic equipment are ubiquitous in small to midsize office buildings and can contribute up to 20 percent of overall energy consumption. You can gain significant energy savings by verifying that computer power-management settings are enabled on individual computers and monitors, forcing them to enter sleep mode after a specified period of inactivity. Effective power-management settings can cut a computer's electricity use roughly in half, saving up to $75 annually per computer. Although most computers are now shipped with some sort of power-management settings enabled, they may be disabled or made less effective by users or internal IT staff, and can often be made more rigorous to maximize energy savings. Some users may be concerned that automatic software updates will be inhibited if power-management settings are enabled, but that's not the case; updates can automatically begin to download when the computer awakens from sleep mode.

For more information, the US Environmental Protection Agency (EPA) offers detailed instructions on its Energy Star The Business Case for Power Management page.

Plug loads. The electricity used to power plug loads is the fastest growing segment of energy consumption in office buildings, and it's projected to stay that way in the coming years. Like computers, devices such as printers, fax machines, and coffeemakers often have energy-reduction settings that can yield substantial energy savings. Additionally, consider supplying employees with smart power strips with occupancy sensors, which are an easy way to shut off their often-forgotten energy-consuming devices such as personal printers, monitors, desk lamps, and radios.

Space heaters. Space heaters are energy hogs, drawing large amounts of power every time they're turned on. As a first step, plug heaters into power strips controlled by occupancy sensors. Also, recognize that the perceived need for individual space heating usually indicates poor HVAC system control.

Vending machines. Some refrigerated vending machines operate 24/7, using 2,500 to 4,400 kWh per year and adding to cooling loads in the spaces they occupy. Timers or occupancy sensors can yield real savings because they allow the machines to turn on only when a customer is present or when the compressor must run to maintain the product at the desired temperature.

Water coolers. The average office water cooler consumes about 800 kWh per year. Because much of this energy consumption happens when no one's around, a simple method of cutting energy waste is to attach a timer. Programming an office water cooler to only operate for 10 hours a day, 5 days a week, can greatly reduce its energy waste. In addition, when it's time to replace old water coolers, choosing an Energy Star–qualified model can yield large savings over standard models because they have thicker insulation, more-efficient cooling systems, and other efficiency-boosting features.

Turning Things Down

Some equipment cannot be turned off entirely, but turning it down to minimum levels where possible can save energy.

HVAC temperature setbacks. During closed hours, turn temperature settings down in heating seasons and up in cooling seasons. Programmable thermostats make temperature setbacks a reliable option.

Peripheral and back rooms. Make sure that HVAC settings in areas such as stockrooms, back offices, and other peripheral rooms that have intermittent and short-term occupancy are at minimum settings.

Window shades and blinds. During hot weather, solar shades or blinds can block direct sunlight and reduce cooling needs; in the winter, opening the blinds on south-facing windows will let sunlight in to help heat the space.

Building automation systems tuning. For office buildings that already have a building automation system (BAS), make sure that temperature setbacks are coordinated with building occupancy on a quarterly basis. Facility engineers or building maintenance staff can align the HVAC schedules in the BAS with expected occupancy to optimize energy usage. Identify buildings that are not used at night, on weekends, or for long periods of time (such as during holiday breaks), and adjust temperature settings in those locations. Also, check that HVAC systems are not set to overcool or overheat the building. For facilities with regular occupancy schedules but without a BAS, programmable thermostats can make temperature setbacks a reliable option.

Cleaning and Maintenance

Regularly scheduled maintenance and periodic tune-ups save energy and extend the useful life of your HVAC equipment. It's best to create a preventive maintenance plan that includes regularly scheduled tasks such as cleaning, calibration, component replacement, and general inspections. It's also a good idea to ensure that information on setpoints and operating schedules is readily available for reference when equipment is checked or recalibrated.

Check the economizer. Many air-conditioning systems (other than those in hot and humid climates) use a dampered vent called an economizer that draws in cool outside air when it's available to reduce the need for mechanically cooled air. If not regularly checked, the linkage on the damper can seize up or break. An economizer that's stuck in the fully open position can add as much as 50 percent to a building's annual energy bill by allowing hot air in during the air-conditioning season and cold air in during the heating season. Have a licensed technician check, clean, and lubricate your economizer about once a year, and repair it if necessary. If the economizer is still operating, have the technician clean and lubricate the linkage and calibrate the controls.

Check air-conditioning temperatures. With a thermometer, check the temperature of the return air going to your air conditioner and then check the temperature of the air coming out of the register that's nearest the air-conditioning unit. If the temperature difference is less than 14° Fahrenheit (F) or more than 22°F, have a licensed technician inspect your air-conditioning unit.

Change the filters. Filters should be changed periodically—every one to six months, depending on the level of pollutants and dust in the indoor and outdoor air. More-frequent changes may be required when an economizer is running because outdoor air is usually dirtier than indoor air.

Check the cabinet panels. On a quarterly basis (or after filters are changed), make sure the panels to your packaged rooftop air-conditioning unit are fully attached, with all screws in place and all gaskets intact so that no air leaks out of the cabinet. Chilled air leaking out can cost $100 per rooftop unit per year in wasted energy.

Clean the condenser coils. Check the condenser coils quarterly for either man-made or natural debris that can collect in them. At the beginning and end of the cooling season, thoroughly wash the coils.

Check the airflow. Hold your hand up to the registers to ensure that there's adequate airflow. If there's little airflow, or if dirt and dust are found in the register, have a technician inspect your unit and ductwork.

Encourage Energy-Saving Behavior in the Workplace

There's growing interest in workplace sustainability and engagement. Green teams, interactive energy-use kiosks, training classes, and competitions are emerging strategies to encourage behavioral change in the workplace. Preliminary studies show a range of savings from about 2 to 10 percent from behavior-change efforts.

LONGER-TERM SOLUTIONS

this section

Longer-term solutions should also be considered, especially for building owners who occupy their buildings. Although the actions covered in this section require more-extensive implementation and have higher costs, they can dramatically increase the efficiency of your facility and can often improve the working environment as well. Ask your local utility representative for more information about incentives for such projects. If you rent or lease your building and pay your own utility bills, discuss these potential efficiency measures with the building owner.

Lighting Measures

LED lighting. LEDs offer several advantages over conventional light sources, including high efficiency, long life, and superior control. These characteristics, along with falling prices, have made LEDs a viable solution for a growing number of office building applications, including exit signs, task lighting, recessed downlighting, and ambient lighting.

LED troffers offer promising benefits in the right applications. Fluorescent troffers are the most common type of lighting fixture found in US commercial facilities, accounting for 50 percent of existing luminaires. The best LED troffer products outperform their fluorescent cousins, but at a first-cost premium. Replacement options include new LED troffers, LED retrofit kits, or swapping fluorescent tubes for tubular LED products.

When buying LED-based products, ask for performance data based on standard tests performed by accredited laboratories. When comparing LEDs to other options, account for cost savings in both energy and maintenance; make sure that the LED solution will provide the quantity and quality of light that you need.

Fluorescent lamps. If your facility uses T12 fluorescent lamps or commodity-grade T8 lamps, there are several retrofit options. Relamping with high-performance T8 lamps and electronic ballasts can reduce your lighting energy consumption by 35 percent or more. Adding specular reflectors, new lenses, and occupancy sensors or timers can double the savings. Payback periods of one to three years are common.

Daylighting. Daylight can improve the ambience of an office and reduce the need for electric lighting. Dimming ballasts and daylighting controls can be used to reduce the amount of electric light used when daylight is present.

Lighting controls . Using energy-efficient light sources is only one part of the process of reducing the energy used by a lighting system. A well-designed control system will provide the right amount of light where and when it’s needed and can cut lighting energy use by 5 to 60 percent, depending on the baseline conditions and the control strategies used. In addition, using lighting controls may qualify you for participation in utility demand-response programs. Advanced control systems can also help lighting maintenance by signaling lamp outages and monitoring usage and output to indicate when they fall below required levels. Lighting controls typically offer daylight monitors, personalized controls, occupancy sensors, and automatic scheduling.

Smart lighting design in parking lots. Parking lots are often overlit—an average of 1 foot-candle of light or less is usually sufficient. Reducing light levels, installing more-efficient light sources, and adding controls can lead to big savings. The most common lamps used for outdoor lighting are high-intensity discharge (HID) sources —metal halide and high-pressure sodium. Fluorescent and induction lamps are also used in parking lots, but LEDs have become the most efficient alternative as their performance has improved and prices have come down.

In addition to high efficiency levels, LEDs offer long life, which reduces maintenance costs. They also distribute light more evenly and produce less light pollution and light trespass—properties that improve aesthetics and contribute to energy savings.

The US Department of Energy Better Buildings Alliance, on its Adopt High-Efficiency Lighting for Your Parking Structure page, provides more information, including a sample specification, some case studies, and information on the Lighting Energy Efficiency in Parking Campaign . The Alliance estimates that using LEDs can cut energy use by 40 percent or more, depending on the application. Dimming and occupancy-sensing controls can also add to energy savings in parking lots.

HVAC Measures

High-efficiency HVAC units. A highly efficient packaged air-conditioning/heating unit can reduce cooling energy consumption by 10 percent or more over a standard-efficiency commercial packaged unit. Single-zone variable-speed rooftop units (RTUs) can also significantly reduce cooling energy. Select equipment that has multiple levels of capacity (look for “compressor stages”) with good part-load efficiency.

Advanced RTU controllers. Retrofitting existing RTUs with advanced controllers improves functionality and offers potential for significant energy savings. Estimates and preliminary field test results indicate energy savings of 20 percent to over 50 percent with a typical payback period of one to four years. Energy-saving features can include variable or multi-speed supply fan control, demand-controlled ventilation, and improved economizer control. Additional features can include demand response, remote monitoring, and fault detection and diagnostics.

Variable refrigerant flow (VRF) systems. VRF systems provide heating and cooling for a building by circulating refrigerant to multiple small heat exchangers instead of circulating water or moving air through ducts. In theory, VRF systems can save energy compared to other HVAC options by providing improved zone control, recovering heat for simultaneous heating and cooling, operating at partial load, and having smaller associated duct losses. Manufacturers claim savings of up to 40 percent, but we’re not aware of any independent verification.

Demand-controlled ventilation. For office spaces that have large swings in occupancy, energy can be saved by decreasing the amount of ventilation supplied by the HVAC system during low-occupancy hours. A demand-controlled ventilation (DCV) system senses the level of carbon dioxide in the return airstream, uses it as an indicator of occupancy, and decreases supply air when carbon dioxide levels are low. DCV systems are particularly applicable to variable-occupancy spaces like indoor parking garages, auditoriums, meeting rooms, and cafeterias.

Reflective building roof coating. If the roof needs recoating or painting, consider white or some other highly reflective color to minimize the amount of heat the building absorbs. Cool roofs can often reduce peak cooling demand by 10 to 15 percent. For a list of suitable reflective roof-coating products, visit the Energy Star Roof Products website .

Energy analytics software. This software offers both single-building and portfolio analysis, allowing customers to pinpoint poorly performing systems or buildings. Identifiable problems may include malfunctioning or poorly tuned HVAC systems or whole buildings that are performing at subpar levels compared to their neighbors or other buildings in a portfolio.

Commissioning

Commissioning is the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's operational needs. Doing so can cut energy bills by 10 to 15 percent or more, and often provides a simple payback period of less than one year. When this process is applied to an existing building that hasn't been commissioned before, it's called retrocommissioning . When it's applied to a building that has been commissioned before, it is called recommissioning. Recommissioning is recommended every three to five years to maintain top levels of building performance. In another type of commissioning, ongoing commissioning, monitoring equipment is left in place to allow for continuing diagnostics.

Building Automation Systems

BASs , sometimes called energy management systems, save between 5 and 15 percent of overall building energy consumption and can also improve occupant comfort. Older or poorly maintained buildings can also benefit greatly from a BAS retrofit, sometimes yielding savings of over 30 percent. For existing bare-bones BAS systems, submeters and wireless controls can be added to provide more-robust information for setting baselines, benchmarking, troubleshooting, identifying areas for improvement, and evaluating performance. Recently, prices of submeters and wireless controls have dropped significantly, making them even more attractive data-acquisition tools to improve building performance.

Cloud- or Internet-Connected Thermostats

In smaller commercial buildings where even a bare-bones BAS system is too expensive, consider installing cloud thermostats , which offer BAS-like functionality at a fraction of the cost. Cloud thermostats enable programming and multistage scheduling via a wired or wireless Internet connection, have digital temperature sensors, and are able to store temperature settings and history. They also offer password protection for security, humidity control options, utility peak load management capabilities, and a wide variety of features ranging from sophisticated programmability to auxiliary inputs.
