Managing Energy Costs in Colleges and Universities

A typical 50,000-square-foot (ft^2) higher-education building in the U.S. uses more than $100,000 worth of energy each year. Energy-saving measures thus represent a substantial resource for freeing up funds that a college or university can use elsewhere. Moreover, an energy-efficient building can result in improved occupant comfort, academic performance, staff retention, and community support.

How Colleges and Universities Use Energy

In a typical college or university facility, lighting, ventilation, and cooling are the largest consumers of electricity, and space heating accounts for the vast majority of natural gas use (**Figure 1**). As a result, these areas are the best targets for energy savings. By implementing economical energy-efficiency measures, many colleges and universities have the potential to cut their energy bills by 30 percent or more.

Colleges and universities spend around $1.95 per ft^2 on electricity and $0.15/$ft^2$ on natural gas annually (assuming energy use of 18.94 kilowatt-hours [kWh]/ft^2 and 0.17 hundred cubic feet per ft^2, respectively). For a customized benchmark rating of your dormitory facilities, you can use Energy Star's free Portfolio Manager software at **www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager**.

Quick Fixes

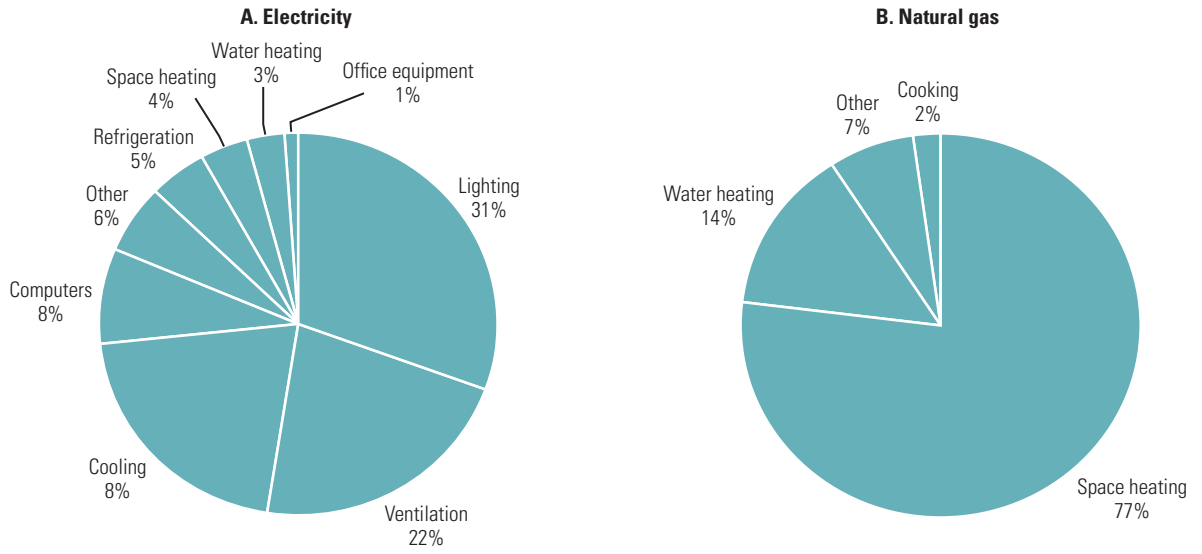
Many colleges and universities have tight facility budgets, so it's especially important to find low- or no-cost ways to reduce energy expenditures. Engaging students and faculty in energy conservation can save on campus energy bills. At many higher-education institutions, students are the biggest advocates for energy efficiency and will respond enthusiastically to educational initiatives and conservation pledge campaigns.

Turning Things Off

Turning things off might seem too simple to make a significant difference, but remember that every 1,000,000 kWh saved by turning things off takes $100,000 off your institution's utility bill annually (assuming electricity costs of $0.10/kWh).

FIGURE 1: Energy consumption in U.S. educational facilities by end use

Data from the U.S. Energy Information Administration show that lighting, ventilation, and cooling account for 74 percent of electric use (A) and space heating dominates natural gas use at 77 percent (B).



Note: Sum may not total 100% due to rounding.

Computers and office equipment. Computers and other electronic equipment have become ubiquitous in campus buildings and dorms in recent years, contributing dramatically to increases in energy consumption and cost per square foot. A typical desktop computer, monitor, and shared printer, for example, can draw about 200 watts of power. Most consumer electronics sold today can be set to go into a low-power sleep mode after a specified period of inactivity. Unfortunately, users rarely take advantage of this feature. Making sure that these energy-saving modes are enabled can produce significant energy savings. If a single monitor that draws about 100 watts is left on unnecessarily overnight and on weekends, it could add $40 or more to the annual energy bill. Multiply that by thousands of students and the impact is significant. "Smart" power strips with built-in occupancy sensors are available to shut off plugged-in devices like printers and monitors when no users are present. Get more tips and tools for computer power management from Energy Star at **www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_enterprises**.

Lights. Lights should be turned off when not in use, but many people forget to take this step. To ensure that switches are off when desired, two effective options are to install occupancy sensors or to recruit staff to serve as "energy monitors" in each campus building. Energy conservation–themed posters and stickers scattered around campus can be effective reminders, especially when designed as part of a larger energy-awareness campaign.

Laboratory vent hoods. Vent hoods are among the most energy-intensive equipment on college campuses and should be kept off unless they are needed for experiments or material storage purposes.

Pre-wash sprayers in kitchens. Pre-wash sprayers are used to remove food from dishes, utensils, pots, and pans before they are placed in a dishwasher. Although all low-flow sprayers are currently required to limit flow rate to 1.6 gallons per minute (gpm), many sprayers currently use up to 5.0 gpm. Given the small initial cost of low-flow valves, the payback for this measure is typically less than two months.

Water fountains. Water fountains don't really need to provide ice-cold water 24 hours a day unless it is required for health reasons. In most cases you can turn off the cooling systems in drinking fountains.

Turning Things Down

Some equipment cannot be turned off entirely but can be turned down to save energy.

Building management systems. Make sure setbacks are coordinated with building occupancy—each quarter or semester, facility engineers can interview campus staff to align HVAC schedules with expected occupancy to optimize energy usage. Identify buildings that are not used at night or on weekends, or for long periods such as during semester breaks, and adjust temperature settings in these locations. Also, check that HVAC systems are not set to overcool or overheat buildings.

Water heaters. Reduce water heater temperature (consistent with health requirements) in buildings that do not have laboratory or cooking facilities. You may also find that the water temperature is set higher than necessary for residential buildings. A maximum of 120 degrees in these types of settings is usually sufficient.

HVAC Operation and Maintenance

Regularly scheduled maintenance and periodic tune-ups save energy and extend the useful life of your HVAC equipment. Create a preventive maintenance plan that includes regularly scheduled tasks such as cleaning, calibration, component replacement, and general inspections. 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 in hot and humid climates) use a dampered vent called an economizer to draw in cool outside air when it is available, reducing the need for mechanically cooled air. If not regularly checked, the linkage on the damper can seize up or break. An economizer stuck in the fully opened position can dramatically inflate a building's energy bill by allowing in hot air during the air-conditioning season and cold air during the heating season. About once a year, have a licensed technician check, clean, and lubricate your economizer's linkage, calibrate the controls, and make repairs if necessary.

Follow a steam trap inspection and maintenance plan. Steam traps remove water from the steam distribution system once it has cooled and condensed in a radiator or other heat exchanger. Mechanical steam traps can become stuck open, which wastes heat. A single failed trap can waste more than $50 per month, and universities can have thousands of steam traps on a campus.

Sequence chillers on and off. Operators often run too many chillers for a given load. Because every chiller has a range of loading conditions wherein it operates most efficiently, turn some chillers off to keep the remaining operating ones in their most efficient zone—typically, above the 30 to 50 percent loading mark.

Operate multiple cooling towers to save fan power. Most chilled-water plants have excess capacity, and during low-load hours, one or more cooling towers aren't operating. To make the most of existing cooling towers, simply run condenser water over as many towers as possible, at the lowest possible fan speed, and as often as possible.

Encourage Energy-Saving Behavior

A number of colleges and universities are successfully using no-cost and low-cost public awareness campaigns to reduce energy use on campus. One popular—and effective—energy awareness program is the Dorm Energy Challenge, in which residence halls compete against one another to make the largest energy reductions or simply to improve their own energy performance. Other popular programs include "Green Crib Certified" awards for students with eco-friendly dorm rooms and "Eco Reps" programs to encourage peer-to-peer sustainable behavior in residence halls.

Longer-Term Solutions

Longer-term energy-saving solutions should also be considered. Although the conservation measures covered in this section require more extensive implementation and larger expenditures, they represent good investments for colleges and universities. Most will not only save money, but will also enhance the learning environment and the comfort of your buildings as well. Ask your local utility representative for more information about initiating such projects.

Commissioning and Recommissioning

Commissioning utilizes building inspection and systems testing to provide quality assurance and systematically improve the efficiency and operation of building systems. For a typical 50,000-ft^2 university building, commissioning can uncover around $17,000 or more in annual savings. In addition to providing energy savings, commissioning often increases comfort for occupants. The majority of problems identified tend to concern HVAC systems, particularly air distribution systems. If your building was previously commissioned, consider investing in recommissioning every three to five years. For more information, see "Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions" by Lawrence Berkeley National Laboratories at http://cx.lbl.gov/cost-benefit.html.

Efficient Lighting Upgrades

In classrooms and administration buildings, take advantage of daylighting where possible to reduce the need for electric light. Solar light tubes can be a cost-effective retrofit. However, proper design is critical when implementing daylighting in order to avoid glare and overheating. If your facilities use T12 fluorescent lamps, relamping with modern, high-performance T8 lamps and electronic ballasts can reduce your lighting energy consumption by 35 percent. Adding specular reflectors, new lenses, and occupancy sensors or timers can double the savings and yield short payback periods. Compact fluorescent lamps (CFLs) can replace incandescent ones in many applications, such as task and hall lighting, and can reduce energy use by 75 percent, resulting in savings of more than $30 per lamp each year.

Many college students use inexpensive torchiere (standing floor) fixtures in their dorm rooms, and there are several reasons to make sure that students use CFLs instead of halogen lamps. CFL bulbs usually draw 40 to 75 watts and operate at 100° to 200° Fahrenheit (F), whereas halogen bulbs draw between 300 and 500 watts and can reach temperatures up

to 1,100°F. Torchieres fitted with halogen bulbs can easily cause materials in a dorm room to ignite if they come too close to the bulb. Installing CFLs in torchieres solves these safety problems while dramatically increasing efficiency.

Efficient Water Use and Heating Systems

Low-flow faucets and shower heads as well as sink and shower controllers that automatically shut off can help conserve water and energy used to heat water in recreation buildings. For dorms and recreation facilities, instant (tankless) water heaters can typically be used instead of traditional tank-type water heaters.

Gray water heat-recovery systems can save 50 to 60 percent of water-heating energy when installed in shower drains, resulting in short payback times (especially in buildings with substantial hot water usage, such as recreation centers and dorms). The drainpipe heat exchangers also double or triple the first-hour capacity of water heaters. The equipment consists of a replacement section of pipe that diverts incoming cold water to a coil wrapped around the drain through which hot wastewater flows, heating the fresh intake water. These systems are effective only if hot water is needed at the same time that heated wastewater is generated—as is the case for showers, laundry machines, and dishwashers.

Boiler Retrofits

Savings from boiler retrofit projects can be significant. Newer boilers feature a variety of efficiency improvements that can justify replacement of older boilers before failure. Improvements include condensing heat exchange, sealed combustion, electric ignition, and fan-assisted combustion. Smaller boilers are more efficient than large ones, and grouping multiple smaller boilers not only allows staged operation of each unit at its highest efficiency point; it also provides redundancy. If a larger boiler is not ready to be retired, a smaller boiler can be added to serve the base heating load, reserving the larger boiler for additional heating as needed.

Laboratory Air Filtration

As filters accumulate dust, the airflow through them drops, causing resultant drops in air pressure. This increases the energy required to push air through the filter. Choosing filters rated for the lowest possible pressure drop will cost more up front, but this usually ensures lower energy costs because there is less resistance in the ventilation system. You can also save energy and lengthen the functional life of filters by "underrating" your system. That is, if you force less air through the filter than the maximum amount it is rated to handle (over a specified unit of time), it will last longer and use less energy. For more information, see "A Design Guide for Energy-Efficient Research Laboratories" by Lawrence Berkeley National Laboratories at http://ateam.lbl.gov/Design-Guide/.

Demand-Controlled Ventilation

Many auditoriums, gyms, classrooms, and cafeterias are always ventilated as if they were at full capacity. You can upgrade your system to adjust the ventilation levels based on occupancy. Demand-controlled ventilation systems manipulate an HVAC system to control the amount of outside air being supplied to a space based on occupancy, as measured by the amount of carbon dioxide present in that space. Less energy is consumed because the fans only run when outside air is needed.

Life-Cycle Costs for Equipment Procurement

Identify who is responsible for setting equipment procurement policies for your campus. Is it the Board of Regents or the state? Or individual schools and departments? Encourage those in charge to include consideration of energy costs and life-cycle costs in the procurement rules.

Resources

The Association for the Advancement of Sustainability in Higher Education (AASHE), www.aashe.org/resources/resource_center.php.

The College Sustainability Report Card (CSRC), www.greenreportcard.org.

Labs21, www.labs21century.gov/about/index.htm.

Energy Star for Higher Education, www.energystar.gov/index.cfm?c=higher_ed.bus_highereducation.