Managing Energy Costs in Colleges and Universities

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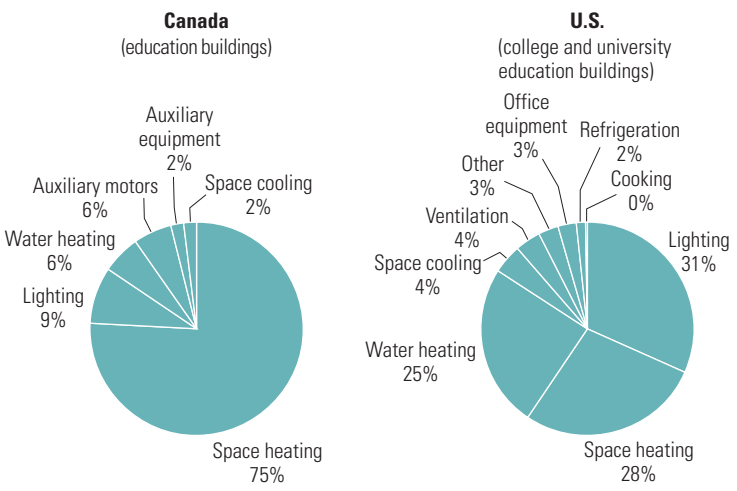
Colleges and universities in the U.S. spend an average of $1.10 per square foot (ft^2) on electricity and 18¢/ft^2 on natural gas annually. In a typical college or university classroom building, lighting represents 31 percent and space heating accounts for 28 percent of total energy use, making those systems the best targets for energy savings (see **Figure 1**).

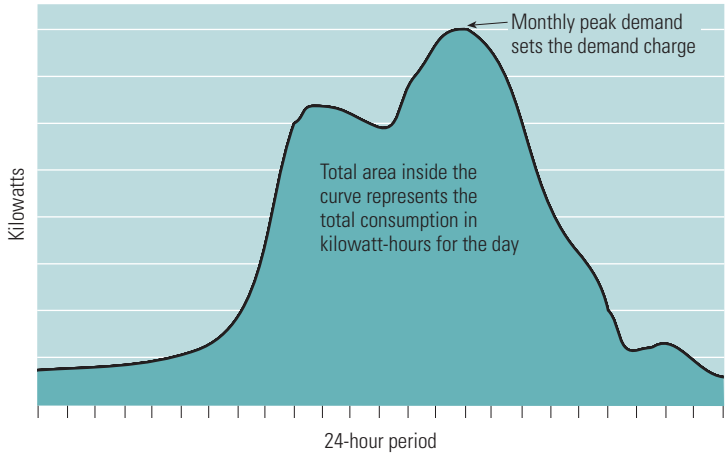
In order to better manage your building's energy costs, it helps to understand how you are charged for your energy use. Most utilities charge commercial buildings for their natural gas based on the amount of energy delivered. Electricity, on the other hand, can be charged based on two measures—consumption and demand (**Figure 2**). The consumption component of the bill is based on the amount of electricity, in kilowatt-hours (kWh), that the building consumes during a month. The demand component is the peak demand (in kilowatts) occurring within the month or, for some utilities, during the previous 12 months. Demand charges can range from a few dollars per kilowatt-month to upwards of $20 per kilowatt-month. Because it can be a considerable percentage of your bill, you should take care to reduce peak demand whenever possible. As you read the following energy cost management recommendations, keep in mind how each one will affect both your consumption and your demand.

Figure 1: Energy consumption by end use, U.S. and Canada



Source: Platts; data from Natural Resources Canada and U.S. Energy Information Administration

Figure 2: Diagram of a hypothetical daily load shape



Source: Platts

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.

Turning Things Off

Turning things off might seem too simple to make a significant difference, but remember that every 1,000 kWh that you save by turning things off equals $100 off your utility bill (assuming average electricity costs of 10¢/kWh).

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. The typical desktop computer, monitor, and shared printer draw about 200 watts. Most of the equipment sold today can be set to go into a low-power sleep mode after a period of inactivity. Unfortunately, most users don't 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 $30 or more to the annual energy bill. "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/indexcfm?c=power_mgt.pr_power_management.

Lights. Turn off lights when they are not in use. Occupancy sensors can help, but a less-expensive alternative would be recruiting "energy monitors" in each campus building to ensure that switches are off when the lights aren't needed and training custodial staff to do the same.

Laboratory vent hoods. Vent hoods are energy-intensive and should be turned off except when they are in use for experiments or material storage purposes.

Chilled-water drinking 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 for drinking fountains.

Turning Things Down

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

Building management systems. Make sure setbacks are coordinated with building occupancy—campus staff should schedule occupancy to optimize efficient energy usage. Check that HVAC systems are not set to overcool or overheat buildings. Identify buildings that are not used at night, because after-hour temperature settings in these locations can be adjusted for cost savings.

Water heaters. Reduce water heater temperature (consistent with health requirements) in buildings that do not have shower, laboratory, or cooking facilities. You may find that the water temperature is set higher than necessary for residential buildings.

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. The University of Canterbury, New Zealand, installed a peak load warning system consisting of orange lamps in every building. The lights flash when the university reaches or exceeds a preset demand level, notifying building occupants to turn off lights and equipment they are not using at that time. This $3,500 system reached payback in just two months and saves the university about $21,000 per year in capacity and demand charges.

The University of Colorado at Boulder posts monthly energy usage of several campus buildings on its Web site, so occupants can check to see how their building compares with others and to learn if usage is trending up or down. Another university distributed monthly energy usage data for the most energy-intensive buildings on campus (usually these house research laboratories), and it challenged the departments occupying those buildings to reduce their consumption. If, over a six-month period, a building's energy usage dropped by more than 10 percent, the department located there received a payment equal to 30 percent of the cost savings. Eighteen months after this program's implementation, the university cut its annual energy costs by about $300,000.

If you want to build awareness by putting building energy consumption data online, consider posting total monthly consumption *and* a benchmarking measure, such as kWh/ft^2. Other good awareness measures include placing stickers on light switches to remind

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people to turn off lights when leaving an area and mounting posters that instruct computer users to implement power-saving features for monitors.

Longer-Term Solutions

Longer-term energy-saving solutions should also be considered. Although the actions covered in this section require more extensive implementation and greater expenditures, they can dramatically increase the efficiency of your facility without compromising the learning environment. Ask your local utility's representative for more information about initiating such projects.

Commissioning

Commissioning is a process in which engineers investigate a building to ensure that its systems are operating appropriately and efficiently. Over time, system operations change, and buildings require tune-ups to maintain optimal performance. Studies have shown that continuously monitoring a building's energy systems can lead to reductions of 25 percent in annual energy bills. For the typical 50,000-ft^2 university building, that's equal to about $16,000 in savings per year! Savings primarily come from resetting existing controls to reduce HVAC waste while maintaining or even increasing comfort levels for occupants. Commissioning usually costs between 5¢ and 40¢/ft^2.

Efficient Lighting Upgrades

In classrooms and administration buildings, take advantage of daylighting where possible to reduce the need for electric light. But remember—proper design is critical to avoid glare and overheating. If your facilities use T12 fluorescent lamps, relamping with modern 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. Paybacks of one to three years are common. Compact fluorescent lamps (CFLs) can replace incandescent ones in many applications, reducing energy use by two-thirds and saving up to $20 per lamp per year.

Many college students use inexpensive torchiere lamps in their dorm rooms. There are several reasons to make sure that CFL-based lamps are provided to replace halogen units. CFL torchieres usually draw 40 to 75 watts and operate at 100° to 200° Fahrenheit (F), whereas halogen units draw between 300 and 500 watts and can reach temperatures of up to 1,100°F. Halogen torchieres can easily cause materials in a dorm room to ignite if they come too close to the halogen bulb. Standard incandescent torchieres solve the safety problems but do nothing to increase efficiency.

Efficient Water Use and Heating Systems

Low-flow faucets and shower heads as well as sink and shower controllers that automatically shut off after a certain length of time can help conserve water and energy used to heat hot water in recreation buildings. For dorms and recreation facilities, use instant water heaters instead of tank-type water heaters where appropriate.

Gray water heat-recovery equipment used in shower drains saves 50 to 60 percent of water-heating energy, with payback as rapid as two years in a household setting. Payback time can be even quicker in buildings with greater hot water usage, such as recreation centers and dorms. The drainpipe heat exchangers used for heat recovery 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 in showers, laundry machines, and dishwashers.

Boiler Retrofits

Savings from boiler retrofit projects can be big. Newer boilers feature a variety of efficiency improvements that can justify replacement of older boilers. Improvements include condensing heat exchange, sealed combustion, electric ignition, and fan-assisted combustion. Smaller

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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 air pressure flowing through them drops. Pressure drop increases over time, as does 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://labs21.lbl.gov/dg.html.

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.

Reflective Roofing

If a roof needs recoating or painting, consider white or some other highly reflective color to minimize the heat that is absorbed by the building. This change can often reduce peak cooling demand and cooling energy use by 15 to 20 percent. For a list of suitable reflective roof–coating products, check out the U.S. Environmental Protection Agency's Web site at www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products.

Life-Cycle Costs for Equipment Procurement

Who sets the rules for equipment procurement across your campus? The Board of Regents? The state? Individual schools and departments? Encourage those in charge to include consideration of energy costs and life-cycle costs in the procurement rules.

The Bottom Line

Almost all of the conservation measures discussed here represent good investments. Most will not only save money but also enhance both the learning environment and the comfort of your campus buildings.

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