Managing Energy Costs in Schools

Kindergarten through high school (K–12) buildings in the U.S. use an average of 10 kilowatt-hours (kWh) of electricity and 50 cubic feet of natural gas per square foot (ft^2) annually. In Canada, natural gas accounts for 43 percent of total energy consumption, followed closely by electricity at 42 percent. In a typical school building, space heating, cooling, and lighting together account for nearly 70 percent of school energy use (**Figure 1**). Plug loads—such as computers and copiers—constitute one of the top three electricity end uses, after lighting and cooling.

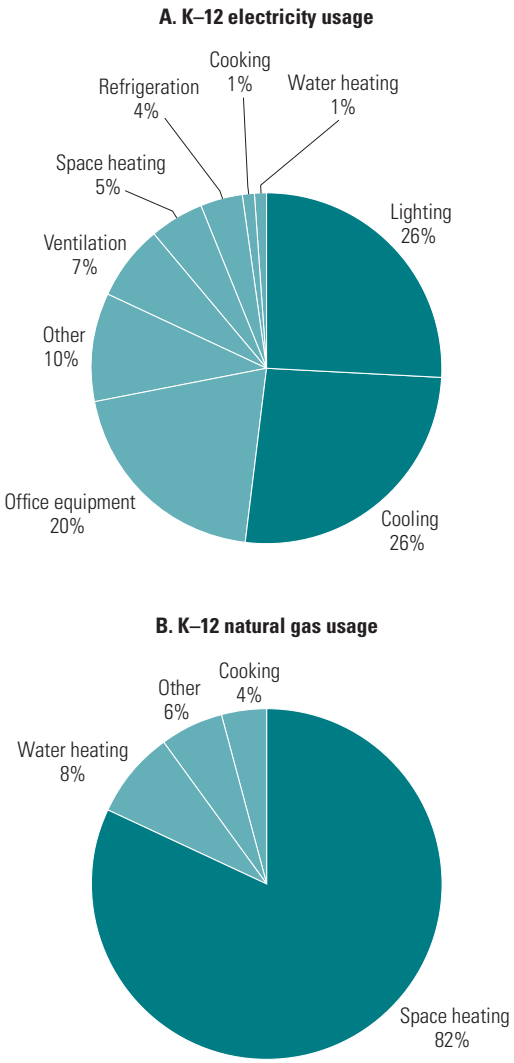
Educational facilities in the U.S. and Canada spend about US$16 billion on energy each year. Although energy costs account for only 2 to 4 percent of school district expenditures, it is one of the few expenses that can be decreased without negatively affecting classroom instruction. By implementing energy-efficient operations and maintenance strategies, and incorporating efficient equipment into retrofits, school districts can generate substantial energy cost savings while improving the physical environment of school facilities.

To better manage a 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: demand and consumption. The consumption component of the bill is based on the amount of electricity in kWh that the building consumes each 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 to upwards of $20 per kilowatt-month. If the electric bill for your school includes demand charges, you should reduce demand whenever possible.

Understanding your school's energy consumption in a given month can also help to control costs. Utilities can provide monthly data for a school district's use and analysis—and some utilities will also assist with the analysis.

Figure 1: K-12 energy consumption by end use in the U.S.

Data from the U.S. Energy Information Administration show that lighting and cooling account for 52 percent of electricity use (A) and that space heating accounts for 82 percent of natural gas use (B).



Quick Fixes

Tight facility budgets make low- or no-cost energy expenditure reductions especially important. Many schools can achieve energy savings of up to 25 percent through behavioral and operational changes.

Turning Things Off

The quickest and easiest way to implement load reductions is to ensure that equipment is turned off when it's not needed. This can be accomplished by recruiting student volunteers or custodial staff as monitors. Students can be enthusiastic ambassadors of a school's energy-saving goals, and an activity such as creating "turn it off" signs to place above light switches, for example, can be a fun and educational classroom activity.

Computers, printers, and copiers. These should be turned off when they are not in use as well as over weekends and holiday breaks. "Smart" power strips with built-in occupancy sensors can shut off printers and copiers when no users are present. Also, because a computer monitor can use two-thirds of the total energy of a desktop system, it is important that they employ sleep-mode settings—this can save as much as $75 per desktop system annually.

Lights. Lighting strategies are the easiest way to minimize energy consumption without any major expense. Simply turning off lights in unoccupied rooms can save from 8 to 20 percent on lighting energy.

Turning Things Down

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

HVAC temperature setbacks. If temperature is not controlled by an energy-management system, a programmable thermostat can increase energy savings and enhance comfort by automatically adjusting temperature to preset levels. It can also lower temperatures on weekends and holidays and can save up to $150 on energy costs per year.

Water heaters. Consider adding a timer to automatically shut off electric water heaters when the building is unoccupied. Installing insulation on hot-water pipes is a low-cost option that reduces heat loss, allowing for lower water-temperature settings.

Lighting controls. Automatic controls such as occupancy sensors, time controls, photosensor controls, and dimmers save energy and help to reduce maintenance costs. In large restrooms, ceiling-mounted ultrasonic occupancy sensors detect occupants around partitions. For hallways, a recommended strategy is to use a combination of scheduled lighting and dimming plus occupancy sensor controls after hours. Occupancy sensors are also appropriate for storage and faculty rooms.

Pool covers. The annual energy cost of maintaining an indoor pool can exceed $20,000. Pool covers can achieve energy savings of 50 to 70 percent by reducing the need to heat make-up water and by reducing humidity levels so that less energy is needed to ventilate and condition intake air.

Vending machine controls. Use occupancy sensors to power down vending machines when the area is unoccupied. They can save nearly 50 percent of the $170 to $250 in annual electricity costs to operate vending machines.

Cleaning and Maintenance

Regularly scheduled maintenance and periodic tune-ups can extend the life of school facility equipment and ensure proper operation.

Building envelope. All doors and windows should be periodically inspected for leaks. Caulking and weatherstripping leaks help minimize air infiltration and can reduce energy waste.

Lighting. Periodically cleaning light bulbs and fixtures with a dry cloth can increase lighting output levels that have been reduced by dirt and dust. Plastic diffusers that cover most lamps need to be periodically replaced as, over time, they can turn yellow and brown—significantly reducing light output.

Air conditioning (AC). Many AC systems use a dampered vent called an economizer to draw in cool outside air and reduce the need for mechanically cooled air. It is recommended that a licensed technician check actuator movement and setpoint, and clean and lubricate moveable surfaces, every three to six months to keep the system running properly.

Fans. Fan blades, bearings, and belts should be inspected at least once a year to prevent failure and maintain efficiency. During the inspection, fan blades should be cleaned, bearings should be checked for adequate lubrication, and belts should be adjusted and changed if needed.

Filters. Air filters should be changed every one to three months. More frequent filter changes may be required for AC units located next to highways or construction sites, or when the economizer cycle is being used.

Leaks. A leak in an HVAC rooftop unit can cost $100 per unit per year in wasted energy. On a quarterly basis, cabinet panels and ducts on rooftop HVAC equipment should be checked for leaks. A check should also be made to ensure units are secure, with all screws in place. On an annual basis, inspect all access panels and gaskets, particularly on the supply-air side, where pressure is higher.

Condenser coils. Cleaning the condenser coil is one of the most cost-effective maintenance steps that can be done on HVAC systems. A dirty coil that raises condensing temperatures by as little as 10° Fahrenheit can increase power consumption by 10 percent—resulting in about $120 in electricity costs for a 10-ton unit operating 1,000 hours per year. Condenser coils should at least be checked for debris on a quarterly basis and cleaned at least once a year.

Hot water systems. To maintain optimum efficiency and prevent waste, the burners of gas- or oil-fired water heaters should be tested and adjusted annually. Fixtures should be periodically flushed with hot water to control bacteria growth. Storage-type water-heater tanks should be flushed out annually to remove sediments that reduce heat-transfer efficiency.

Longer-Term Solutions

Although the actions covered in this section require effort, they can dramatically increase the efficiency of your facility. Ask your local utility's representative for more information about initiating such projects.

Retrocommissioning

Retrocommissioning is a process performed on facilities already in operation that identifies facility performance objectives, tests and verifies that those objectives are being met, and provides documentation of the process. The majority of the problems uncovered during retrocommissioning tend to concern HVAC systems—in particular, air distribution systems. At a typical 100,000-ft^2 school, retrocommissioning can uncover about $10,000 to $16,000 in annual energy savings. It can also reduce equipment downtime and keep maintenance expenditures in check.

Upgrading to More Efficient Lighting

Lighting retrofits can save as much as 30 to 50 percent of lighting energy, plus 10 to 20 percent of cooling energy. In addition, incorporating a design strategy that uses a mix of both natural and artificial light sources increases visual comfort and further reduces energy costs.

High-performance T8 fluorescent lamps with electronic ballasts are the best choice for most general lighting applications (such as classrooms, offices, multipurpose rooms, and cafeterias) and can reduce lighting energy consumption by 35 percent if they replace T12 fluorescents. Adding specular reflectors, new lenses, and occupancy sensors or timers can double the savings. In rooms where ceilings are more than 15 feet high (such as gymnasiums, auditoriums, and libraries), high-intensity fluorescent lamps are a better alternative to the high-intensity discharge (HID) lamps that are more commonly used.

Compact fluorescent lamps (CFLs) can replace incandescent lamps in a variety of applications, reduce energy

use by two-thirds, and save up to $20 per lamp per year.

An Energy Star–qualified light-emitting diode (LED) exit sign can last 25 years without lamp replacement, compared with less than 1 year for an incandescent sign. LEDs are also appropriate for gymnasium scoreboard applications.

Using Demand-Controlled Ventilation

Spaces like auditoriums, gyms, and cafeterias are generally ventilated as if they were occupied at full capacity. A more efficient option is to install carbon dioxide sensors that provide real-time monitoring of air quality and can enable demand-controlled ventilation. Demand-controlled ventilation manipulates an HVAC system to control the amount of outside air being supplied to a space based on occupancy. Less energy is consumed because the fans only run when outside air is needed.

The Bottom Line

All of the conservation measures discussed here will save money and enhance both the aesthetics and the learning environment of your school. Numerous resources are available that can assist you in creating optimal facility conditions.

Energy Star for K–12 School Districts: www.energystar.gov/index.cfm?c=k12_schools.bus_schoolsk12. Energy Star for K–12 School Districts provides case studies, technical guidelines, and energy benchmarking.

Natural Resources Canada: www.nrcan-rncan.gc.ca/com/. Natural Resources Canada offers a variety of data and statistics on energy use in schools, including *The Benchmarking Guide for School Facility Managers,* which helps facility managers calculate their schools' energy performance.

Explore New Ways to Heat and Cool Your School

If you are planning a comprehensive renovation of your school's heating and cooling system, consider some energy-efficient alternatives like evaporative cooling, geothermal heat pumps, and thermal storage.

Evaporative cooling can save 60 to 80 percent of cooling energy by reducing levels of compressor cooling. Most effective in warm, dry climates, evaporative coolers are generally not well suited for high-humidity environments. However, hybrid systems are available that include compressor-based cooling capabilities for times of high humidity. The best units utilize high-efficiency fans driven by variable-speed drives on premium-efficiency motors.

Geothermal heat pumps use the thermal stability of the ground to heat and cool a building. The energy consumption of geothermal heat pumps can be 25 to 50 percent less than that of traditional heating and cooling systems.

Thermal storage systems are appropriate where demand charges are high. They can be used to shift space- and water-heating loads to off-peak times and are most likely to be cost-effective where low off-peak electricity rates apply or where demand charges are high. In some applications, thermal storage systems can reduce heating and cooling bills by 25 to 70 percent.