Managing Energy Costs in Congregational Buildings

Data from the Department of Energy indicates that congregations in the United States spend between $0.25 and $1.30 per square foot ($ft^2$) annually on energy. These expenditures include about 4.5 kilowatt-hours (kWh) of electricity per ft^2 and about 41,500 Btu/ft^2 of other energy sources, primarily for heating and hot water (**Figure 1**). Congregational buildings are similar to commercial buildings, although facility specifics, including occupancy levels, hours of operation, and scope of services (from daily or weekly worship to soup kitchens, hostels, and computer training) can vary widely. In addition to a worship area and staff offices, your congregational building may include a cafeteria, bookstore, social and educational meeting rooms, high-end multimedia audiovisual systems, and, perhaps, full theater capacity for thousands of congregants. Some efficiency measures can be implemented with little or no investment by managing the spaces in the building. For those improvements requiring a larger initial outlay, many can pay for themselves quickly and, if planned well, can enhance the comfort of your building.

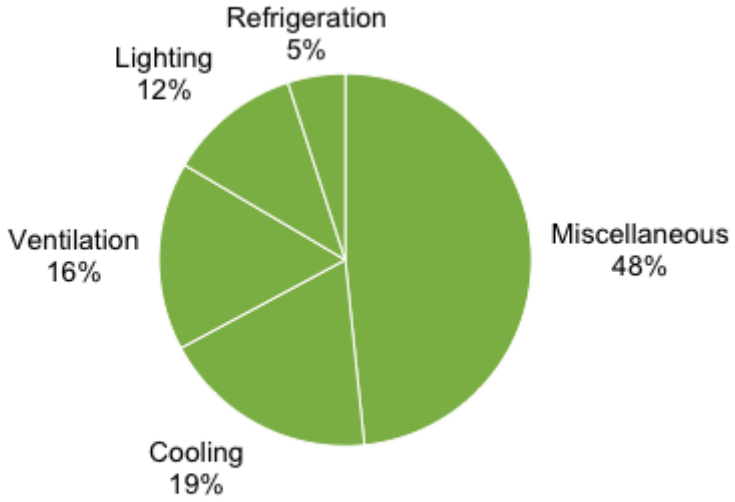
Average energy use data

Figure 1: Energy consumption by end use

Although cooling and ventilation represent significant electrical loads in congregational buildings, miscellaneous plug loads—likely including such things as amplified musical instruments, audio-visual equipment, and microphones—consume the most electricity in

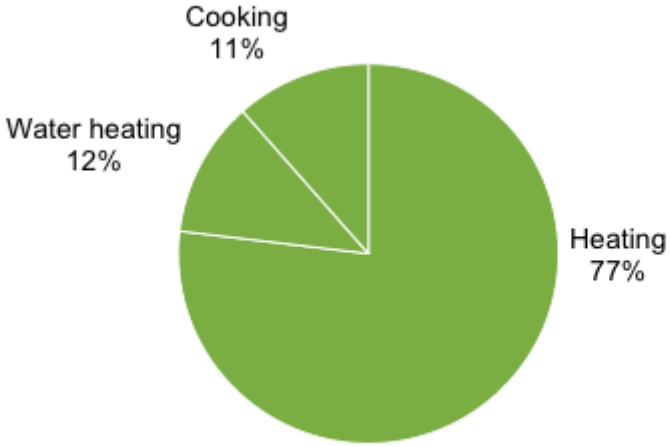
houses of worship. And where natural gas consumption is concerned, space heating is far and away the largest energy consumer.

Electricity end uses in congregational buildings



Notes: Heating, office, cooking, computer, and water heating end uses each represent less than 5 percent of total consumption and are included in "Miscellaneous" uses.

Natural gas end uses in congregational buildings



Notes: Cooling and miscellaneous uses represent less than 5 percent of gas end use and are not shown here.

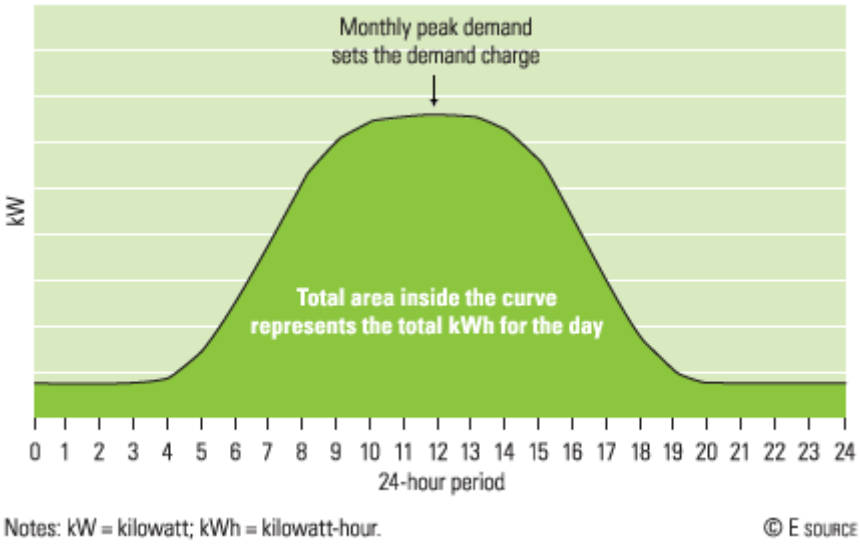
Top technology uses

- Heating
- Cooling
- Ventilation & Air Handling

In order to better manage your building's energy costs, it helps to understand how you are

charged for those costs. Most utilities charge their commercial customers for 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 kWh that the congregation consumes during a month. The demand component is the peak demand in kilowatts (kW) 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 peak demand can be a considerable percentage of your bill, you should take care to reduce it 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 2: Diagram of a hypothetical daily load shape



Notes: kW = kilowatt; kWh = kilowatt-hour. © E SOURCE

QUICK FIXES

this section

Your congregation likely relies on members, volunteers, and paid staff to fund, operate, and maintain your buildings. Your budget and many of your buildings' operations may be overseen by committees or multiple people within the congregation. Turning things down and off and properly maintaining equipment are quick fixes that members, volunteers, and staff can do. In addition to these low- or no-cost energy-expenditure reductions, take steps to simplify your building’s systems and to make them transparent. That is, ensure that controls for water, lighting, heating, and cooling are easily accessible and usable by all. Label all panels and switches. Educate broadly about your building’s energy usage. Brief

your congregation on how to use the systems you have—such as programmable thermostats—and on the importance of turning things off and down. You might even consider posting energy bills to raise awareness.

Turning Things Off

Turning things off seems simple, but remember that every 1,000 kWh you save by turning things off equals US$100 off your utility bill (assuming average electricity costs of 10 cents/kWh). Turning things off is your congregation's number-one priority to save energy.

Lights. Turn off lights when they are not in use. Occupancy sensors can be cost-effective, but a less-expensive alternative would be to post reminders to ensure that switches are off when the lights are not needed and to train custodial staff to also switch off lights. Be sure to turn off lights in parking areas when the lot is not in use or light is not needed for security. Turn off lights in lobbies, entries, and vestibules that may already have ample daylighting.

Plug loads. Plug loads are electrical devices such as computers, task lights, and fans that are plugged into electrical outlets. Plug loads like microwaves, computers, and televisions may continue to draw power even when the appliance is turned off. For maximum energy savings, unplug these appliances. Computers may be used daily in staff offices and should employ sleep-mode settings when the machines are not in use. The typical desktop computer, monitor, and shared printer draw about 200 watts, with the monitor alone drawing about 100 watts. Computers should be turned off at the end of the workday. Use a "smart" power strip that will automatically turn off plug loads (such as monitors, printers, copiers, and audiovisual equipment) when they're not in use. A "smart" power strip has an occupancy sensor or a programmable timer that turns equipment on and off. Other "smart" power strips, designed for computers, have a master outlet for the computer: when the computer is turned off, all other equipment plugged into the power strip is also turned off.

Vending machines. Disconnect the ballasts for advertising lights in vending machines. The lights not only cost money to run, but they add heat to the refrigerated compartment. Turning off a vending machine light can save about $100 a year! For more information, see our article on vending machine energy savings .

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. Use programmable thermostats to adjust temperature settings when educational, meeting, and office spaces are not in use. These thermostats are far more reliable than manual operation of your heating system. Purchase thermostats that can program a week's regular meeting times. For unscheduled activities, post clear operating instructions for members, volunteers, and staff.

Heating and cooling for occupancy. Certain parts of a congregation—like your worship space—are only used during specific times of the day or week. Make sure that HVAC settings are at minimum levels during non-use periods.

Water heaters. Where possible, turn down water heaters on low-occupancy days. Bathrooms and kitchens used primarily during worship services are particularly good targets for lowering water temperatures.

Cleaning and Maintenance

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 nearest the air-conditioning unit. If the temperature difference is lower than 14° Fahrenheit (F) or higher than 22°F, have a licensed technician inspect your air-conditioning unit.

Perform regular maintenance. Your rooftop air-conditioning unit will perform better if you do routine checks on a regular basis. Filters should be changed on a monthly basis—or more often if you are located next to a highway or construction site where the air is much dirtier. At the beginning and end of the cooling season, thoroughly wash the coils. Check them quarterly for man-made or natural debris and wash as necessary. And on a quarterly basis, make sure the panels are fully attached with all screws in place, and verify that gaskets are intact so no air leaks out of the cabinet. Chilled air leaking out can cost $100 per rooftop unit per year in wasted energy. For more information, see our article on maintaining packaged rooftop units .

Check airflow. Hold your hand in front of air registers to ensure that there is adequate airflow. If there is little airflow or if dirt and dust are found at the register, have a technician inspect your unit and duct work. Trim or move shrubs away from cooling equipment.

Direct airflow. If not all spaces in your building are used, or there is uneven occupancy and

use, direct forced air to where it is needed by closing and opening vents. If you heat with a warm air furnace and some rooms overheat while others are too cool, call in a qualified heating contractor to balance the distribution of heated air. Another way to balance warm air flow is to cover the metal discharge grilles in rooms that overheat.

Close vents. In place of air conditioning, many older buildings have natural ventilation systems to remove hot air in the summer. Be sure to close these vents in the winter or they will exhaust air that your congregation has paid to heat.

Use an economizer. Many air-conditioning systems use a dampered vent called an economizer to draw in cool outside air, when it is available, to reduce the need for mechanically cooled air. Have a licensed technician check, adjust, clean, and lubricate your economizer each year. One stuck in the open position will allow too much hot air in during the air-conditioning season and too much cold air in during the heating season. That can add up to 50 percent of your annual HVAC costs. If necessary, adjust the outdoor intake setting on your economizer.

Use desiccants for cooling. In humid regions, use desiccants in the air conditioning system to remove moisture from the incoming air. Air that has been dehumidified requires less energy to cool than humid air. Desiccants also contribute to a drier, cleaner, and more comfortable environment.

Water use and water heating. Insulate your hot water pipes by wrapping the first 3 to 6 feet of hot water supply with pipe insulation. Fix leaky faucets, showerheads, pipes, and toilets.

Monitor and measure. Use a device like a Kill A Watt ™ to meter electricity usage in appliances and office equipment before and after turning them down and off to demonstrate and encourage savings. Visit your building in the very early morning hours to note temperatures, lights, and sounds; then take measures to reduce unnecessary overnight energy usage. Monitor energy usage by reading meters morning and night or by using a data logger to record measurements of temperature, relative humidity, light intensity, and amperages.

LONGER-TERM SOLUTIONS

this section
Energy Audits

A comprehensive energy audit can identify the most cost-effective improvements to congregational buildings and the energy-consuming equipment they contain. The Interfaith Coalition on Energy , an organization dedicated to working with congregations to reduce the costs of operating their facilities, provides energy audits to congregations. Other organizations familiar with the unique characteristics and energy requirements of congregational buildings are The Regeneration Project of California and its affiliate state-based Interfaith Power & Light organizations.

Commissioning

Commissioning is a process in which engineers check and tune up building systems to ensure that they are operating appropriately and efficiently. If possible, choose engineers with expertise in commissioning congregational buildings. Studies have shown that continuously monitoring a building's energy systems can lead to reductions of 10 to 15 percent in annual energy bills. Savings typically 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 cents per square foot.

Lighting

Upgrade to more-efficient lighting. Compact fluorescent lamps (CFLs) can replace incandescent lamps in many applications, reducing energy use by two-thirds and yielding savings of up to $20 per lamp per year. Also consider "task-ambient lighting," that is, reducing ambient lighting for a general area and focusing light on tasks in work spaces.

Fluorescent lamps. If your building uses T12 fluorescent lamps , relamping with modern T8 lamps and electronic ballasts can reduce your lighting energy consumption by as much as 35 percent. Adding specular reflectors, new lenses, and occupancy sensors or timers can double the savings. Paybacks of one to three years are common.

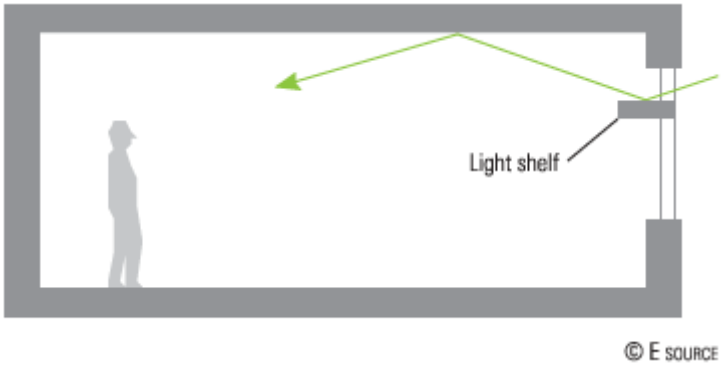
LED lights. Use light-emitting diodes (LEDs) for exit and other signs in your building. LED exit signs can last 15 years. LED holiday lights are also now available in a variety of colors and designs from retailers. LEDs use far less energy, last multiple times longer than other light sources, and are more durable.

Daylighting. Take advantage of daylighting where possible to reduce the need for electric light—proper design is critical to avoid glare and overheating. Light shelves, installed high on the inside or outside of a window, will shade and prevent glare in the bottom six feet of

a floor, which is where most staff work. The shelves also reflect daylight up onto the ceiling, which indirectly illuminates a room (**Figure 3**).

Figure 3: Increase daylighting with light shelves

Light shelves reduce glare and reflect sunlight onto the ceiling, distributing daylight further into the building.



Daylighting sensors. Install light sensors—a type of daylighting controls —in offices, bathrooms, kitchens, and worship areas to turn on lights in the space only when daylight is insufficient.

Occupancy sensors. Install occupancy sensors in bathrooms, utility closets, and other less-used spaces to control lighting in response to movement. Occupancy sensors may also be suitable for other building spaces such as staff offices. In addition, occupancy sensors can be used to control plug loads. Plug load sensors range from devices that control a single electrical outlet or piece of equipment to devices that control multiple outlets or a power strip, and they can work together with other sensors. Built-in occupancy sensors can shut off plugged-in devices like printers, monitors, and copiers when nobody is present.

Smart lighting design in parking lots. In its Lighting Handbook, the Illuminating Engineering Society of North America recommends that parking lots be lit at an average of 1 foot-candle or less of light, but most parking lots are designed with far more lighting than that. Using lower-wattage bulbs can actually increase the safety of your lot: An overlit lot can be dangerous to drivers if their eyes cannot adjust quickly enough in the transition from highly lit to dark areas. When designing lighting for a new parking lot, consider using low-wattage metal halide lamps instead of high-pressure sodium lamps in fixtures that direct the light downward. Even with a lower wattage, a congregation could safely use fewer lamps if this choice is made. Metal halide is less efficient than high-pressure sodium in conventional

terms, but it puts out more light in the blue part of the spectrum, which turns out to be easier for our eyes to see under low-light conditions.

Photocells and timers. Install lighting controls such as photocells or timers on outdoor lighting. A photocell control will turn on a light at dusk and turn the light off when the photocell detects daylight.

HVAC

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. Select equipment that has multiple levels of capacity (compressor stages) with good part-load efficiency. Be careful not to oversize your HVAC system if not all spaces in the building are used, or if there is an imbalance in the amount of use spaces get. If your existing system is old enough, it may be cost-effective to replace it with a new one immediately. A qualified energy auditor, preferably one who is familiar with congregational buildings, can determine which measures are most cost-effective for your building.

Zoned HVAC. In HVAC, a zone consists of a number of rooms that have a similar function and experience similar heating and cooling needs. Consider a separate HVAC system for more frequently used zones in the building that have a similar function and need, such as staff offices.

Demand-controlled ventilation. For spaces that have large swings in occupancy, congregations can save energy by decreasing the amount of outdoor ventilation air supplied by the HVAC system during low-occupancy hours. A demand-controlled ventilation (DCV) system senses the level of carbon dioxide in the return air stream; using that as an indicator of occupancy, the system decreases the amount of outdoor air supplied to the space when carbon dioxide levels are low. DCV systems are particularly applicable to variable-occupancy spaces like worship spaces, meeting rooms, and cafeterias.

Air-to-air heat exchangers. Consider air-to-air energy recovery heat exchangers for your building's ventilation system. These heat exchangers are cost-effective in spaces that are occupied every day, such as staff offices; they reduce the energy needed to cool and heat ventilation makeup air. They are best used in tightly constructed buildings, where they can have a payback period ranging from less than one year up to three years.

Building Construction

Insulation, secondary glazings, and weather-stripping. Consider insulation , secondary glazings, and weather-stripping after the quick fixes of turning things down and off and tuning your HVAC equipment. Older congregational buildings are notoriously energy inefficient because they leak. Insulation, secondary glazings, and weather-stripping hold heat, and they are more cost-effective for older buildings that are continually occupied (and must continually hold heat). If your congregation's buildings leak but are used intermittently, such as a small church used only for Sunday services, these measures may not be cost-effective. A qualified energy auditor, preferably one familiar with congregational buildings, can determine which of these measures are cost-effective for your building.

Entries. During times of high occupancy, entryways allow heating and cooling to escape your building. To reduce losses, construct an interior divider, separating the entryway from the worship area of the building.

Windows. Replacing windows is expensive. In cold climates, your congregation may find it cost-effective to replace old, single-pane windows with more energy-efficient (low-emissivity) windows. If not, an alternative is window film, which typically costs between $1.35 and $3.00/ft2 to install. Window film generally has a lifetime of 7 to 12 years, but it must be installed properly to avoid bubbles, cracks, or damage to your windows. Window film is not appropriate for stained-glass windows because they are uneven. For stained-glass windows, protective glazing such as laminated glass or polycarbonate will decrease drafts, but without proper ventilation and proper glazing may cause damage to the stained glass. On plain-glass windows, use window treatments like drapes and shades and, on walls of south-facing windows, awnings or window film to block solar heat gain in the summer and reduce air conditioning.

Cool roofs. These are not suitable for all congregations, but if your roof needs recoating or painting, consider a cool roof — one that is white or some other highly reflective color—to minimize the amount of heat the building absorbs. This change can often reduce peak cooling demand by 15 to 20 percent.

Landscaping. Deciduous trees, planted on the west- and south-facing sides of your building, will shade windows, reducing solar gain and therefore air conditioning needs during the summer months.

Appliances and Equipment

Purchases. When replacing appliances such as freezers, refrigerators, dishwashers, room air conditioners, water heaters, furnaces, boilers, and even ice makers and washing machines, select energy-efficient models. Also select energy-efficient computers and office equipment. Look for the blue-and-white Energy Star label on many appliances and compare their energy usage to other models. The Energy Star web site has a listing of appliances and products that have earned the Energy Star label. For computers, also look for the 80 PLUS label, which indicates that the computer has an energy-efficient power supply. Visit the 80 PLUS web site for a list of suppliers.

Maintenance. Disconnect unused equipment like refrigerators, freezers, and water heaters, and keep the appliances you do use in good condition. A refrigerator, for example, operates more efficiently when door seals are tight, condenser coils are clean, frost is removed, and airflow for exhaust heat is allowed sufficient clearance.

Water Use and Water Heating

In addition to insulating hot water pipes and fixing leaks, consider installing sink and shower controllers that automatically shut off after a certain length of time. Low-flow faucets and showerheads can also help conserve energy used to heat hot water.

Explore New Ways to Heat and Cool

If you are planning a comprehensive renovation of your heating and cooling system, consider some energy-efficient alternatives:

Geothermal heat pumps. Also known as ground-source heat pumps, these systems rely on the thermal stability of the ground to heat and cool a building. Because the ground temperature below the frost line remains relatively constant throughout the year, it can be used as a heat source in the winter and a heat sink in the summer. The first costs of a geothermal heat pump can be slightly higher than those of other systems, but the life-cycle costs are often lower. The energy consumption of geothermal heat pumps can be 25 to 50 percent less than that of traditional heating and cooling systems.

Evaporative cooling. An evaporative cooling system uses the natural cooling of evaporation—a tactic that is especially effective in warm, dry climates. It typically uses less than 25 percent of the energy of a vapor-compression air-conditioning system. First costs

may be higher than for a vapor-compression system, but paybacks can be rapid: six months to five years, depending on climate.
