

With electricity costs ranging from about \$1.00 to more than \$6.00 per square foot per year, energy is a major operating expense for commercial building owners. (See our other business fact sheets for more details). Optimizing energy consumption can considerably reduce operating costs without compromising the quality of lighting, comfort or refrigeration of goods. Costs can be reduced by retrofitting lighting equipment, reducing losses in air-handling systems and properly sizing air conditioning equipment. But energy consumption can also be optimized by carefully monitoring and controlling the operation of a building's energy-using equipment.

This fact sheet provides guidance on energy management and control strategies for small- to mid-sized commercial buildings which can result in considerable energy cost savings as well as a number of other benefits. Energy management and control technologies include a wide range of devices and systems from a simple timer that turns off a lamp or a bathroom fan, to centralized, computer-based systems that monitor, control and optimize building systems. Technologies that are most applicable to the small business sector include:

- Programmable time controls
- Automatic lighting controls
- HVAC control systems and programmable/smart thermostats
- Energy management or building automation systems

The features and benefits of each of these technology categories are discussed below.

## Programmable Time Controls

Energy is wasted in commercial buildings by powering equipment when it isn't needed. Programmable time controls are among the simplest, least expensive, and most effective energy management devices available. There are a wide range of time control devices, ranging from plug-in timers to multi-channel electronic time controls. HVAC systems, lighting circuits, hot water heaters, office equipment, battery re-chargers and other types of equipment can be effectively managed with time controls. Electronic programmable time controls offer many additional features and advantages over the mechanical time clocks that most people are familiar with including their ability to account for calendar changes, range of programming options, and the elimination of pins and knobs which often get lost. Features and benefits of common devices are briefly discussed below.

**Simple time switches** – Simple time switches include the familiar twist-dial timers and plug-in timers that are available through most hardware stores. New generation timers include wall mounted electronic time switches that automatically turn lights, fans or other hard-wired devices off after a pre-set time. These devices are good choices for areas that are not appropriate for occupancy sensor controls and are far more functional and convenient than conventional twist-dial timers.

**One- to four-channel time controls** – Most people are familiar with conventional mechanical timeclocks with their dials, pins and knobs that are used to schedule equipment operation. Programmable digital time controls provide the same basic function as mechanical timeclocks as well as a range of expanded features and functions. They have back-up battery power in case of a power outage, the ability to set multiple on/off operations, and include automatic adjustment for



Wall-mount Digital Time Switch



Single-channel Digital Timeclock



Multi-channel Digital Timeclock

calendar changes such as daylight saving time, leap year, etc. Some include the ability to have different schedules for each day of the week and programming is simple.

**Multi-channel time controls** – Multi-channel time controls provide the ability to control from four to 16 or more different loads. They typically include an expanded range of features found in one- to four-channel timeclocks, as well as additional features such as duty cycling, run-time data logging, self-diagnostics, and remote communications.

**Special-purpose time controls** – Special purpose timers include cycle timers for repetitive short-duration cycling of equipment, time-of-day water heater controls, and outdoor lighting time controls that combine time clock and photocontrol technologies.

## Occupancy Sensing Controls



Wall-mounted  
Occupancy Sensor

Occupancy sensing controls include a family of devices that can be used to control lighting, room HVAC units and office equipment although their primary use to date has been in lighting. Occupancy sensors operate by sensing the presence of people in their control area and turning equipment on and off accordingly. Occupancy sensors have become quite sophisticated and include multiple sensing technologies such as heat (infrared) and sound sensing to avoid false switching when occupants are working quietly. They also include time delay and sensitivity settings in order to adjust their operation to the occupancy patterns in the space.



Power Strip  
Occupancy Sensor

Occupancy sensors are available in a range of styles including wall- and ceiling-mounted devices. They are particularly effective controls in low-use rooms or areas with erratic occupancy hours. The table below presents an estimate of the annual energy cost savings that could be achieved by installing occupancy sensors on lighting systems in various areas.

### Lighting Energy Savings Potential with Occupancy Sensors

Application	Potential Energy Cost Savings
Offices (private)	25-50%
Offices (open areas)	20-25%
Restrooms	30-75%
Corridors	30-40%
Storage areas	45-65%
Meeting rooms	45-65%
Conference rooms	45-65%
Warehouses	50-75%

*Source: U.S. Department of Energy*

## Photocell and Day lighting Controls

Photo sensors operate by sensing the quantity of light in an area and switching or adjusting the output of light fixtures accordingly. The most familiar application of this technology is the simple photo control that turns outdoor lighting on and off in response to the amount of sunlight. These are simple and cost-effective control devices. More sophisticated applications include day lighting controls that adjust indoor light fixture output levels in perimeter areas next to windows or under skylights in response to natural outdoor light entering the building. Day lighting controls are available in simple on/off, stepped light output reduction and continuous dimming models. Lighting energy cost savings can be substantial with day lighting controls as shown in the table below. They have the additional distinct advantages of reducing loads on air conditioning equipment at times



Photo Control

when that load is at its highest, and of reducing peak demand on the APS system when it is at its highest. The latter benefit helps APS avoid the need for building expensive new power plants, and helps our customers reduce load when the cost of electricity can be at its highest. Since direct sunlight can cause glare and also increase cooling loads, photosensors can also be used to control automated blinds that limit those negative effects.

### Potential Annual Lighting Energy Cost Savings with Day Lighting Controls

Day lighting Strategy	Control Type	Potential Annual Energy Savings
Window sidelighting	On/off	32%
	Stepped	44%
	Continuous dimming	56%
Skylighting	On/off	52%
	Stepped	57%
	Continuous dimming	62%

Source: Lawrence Berkeley Laboratory

### Programmable Thermostats

Thermostats have come a long way in recent years. Modern programmable thermostats provide the basic function of maintaining comfortable indoor temperatures, but they include other valuable features as well. First, they can be programmed to automatically raise or lower the temperature of your facility according to schedules that you define. Manufacturers claim that you can save three to four percent for each degree you lower your thermostat in the winter and raise it in the summer. Most programmable thermostats allow you to input weekday and weekend schedules. The most sophisticated thermostats will control humidity, outdoor air ventilation, and inform you when the air conditioning filters need to be changed. Some modern thermostats can also include a communications link and demand management features that can be used to reduce air conditioning system energy use during periods of peak electrical demand or high electricity costs. Programmable thermostats can also be combined with HVAC zone control systems to provide optimal comfort and efficiency throughout the facility. When combined with programmable thermostats, manufacturers claim that zoning systems can save up to 30 percent on heating and cooling costs while providing superior comfort.



Programmable Electronic Thermostat

### Centralized Energy Management and Building Automation Systems

Energy Management Systems (EMS) or Building Automation Systems (BAS) refer to centralized, computer-based systems that monitor and control building systems and energy use. These systems vary in capability and functionality, but are all designed to give some level of centralized oversight and remote control of HVAC systems, lighting and other building systems. EMS systems can also interface with other building automation systems that control building functions such as fire and life safety, security systems, elevators and manufacturing processes in industrial facilities. Some centralized systems also provide the capability to monitor and integrate the functions of multiple buildings from a central location. The ability to conduct multi-site monitoring and control over the Internet is a rapidly emerging function and will significantly improve the management of geographically diverse operations. Some EMS also monitor and analyze energy use and costs and can help building operators manage energy costs across their entire enterprise. The table below summarizes typical functions of an EMS. EMS vendors estimate that an EMS can reduce energy bills by 10 to 20 percent while providing other valuable building management functions.

## Energy Management System Functionality

Function	Description
Scheduled start/stop	Turning equipment on and off according to a set schedule.
Optimal start/stop	Restart equipment at the latest possible time prior to building occupancy while still maintaining setpoint conditions.
Temperature setback/setup, reset	Change indoor or system temperature setpoints according to building occupancy patterns or other variables such as outdoor air temperature.
Economizer control	Use “free cooling” from outdoors whenever conditions are suitable.
Equipment optimization	Optimize operation of sophisticated HVAC equipment such as central chillers in order to balance operation against loads.
Demand limiting	Shed loads according to a load shedding regime when building peak electrical demand approaches a pre-set limit.
Duty cycling	Cycle equipment on and off according to an established schedule to reduce energy use or for demand shedding.
Status monitoring and alarm	Monitoring of equipment operating parameters such as on/off status, temperatures, and pressures, and alarm notification of equipment failures or out-of-bounds operating conditions.
Energy use and demand monitoring	Monitoring and reporting of energy use and peak demand by time interval. A potentially important attribute of multi-site energy management.
Maintenance history reporting	Logging and reporting of equipment failure, downtime and maintenance histories
Trend logging and reporting	Trend logging of a variety of parameters such as energy use and demand, equipment run time, and temperature.

### For More Information on Energy Management Systems and Controls

Contact the Web sites of the U.S. Department of Energy’s Energy Efficiency and Renewable Energy Network, and the U.S. Environmental Protection Agency’s Energy Star Buildings Program.

For general information regarding electric service for your business, call the APS Business Center at 602-371-6767 or 1-800-253-9407. For an on line analysis of your business energy use visit the APS Web site and take the Energy Survey at [http://www.aps.com/aps\\_services/energysurvey/Default\\_BUSRES.html?type=b](http://www.aps.com/aps_services/energysurvey/Default_BUSRES.html?type=b)