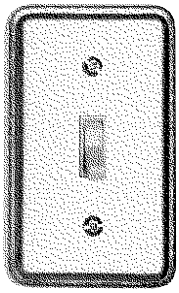
GREEN SEAL'S Green Lease REPORT

FEBRUARY 1997

OCCUPANCY SENSORS

One of the most overlooked energy-saving tools in the work place is the light switch. Lighting accounts for 30 to 50% of a building's energy use, or about 17% of total annual US electricity consumption. Simply turning off unneeded lights can reduce direct lighting energy consumption up to 45%. Reducing lighting electricity usage reduces your energy cost and lessens the environmental impacts associated with electricity generation.



In this report, we discuss one approach to reducing office lighting energy consumption: occupancy sensors. These are inexpensive and effective devices that can quickly and easily be installed on a wall or ceiling. A list of features to look for when you shop for these devices is included. We have gathered information from the major sensor manufacturers and identified a number of devices that satisfy these criteria. We also explore other options for turning off unused lights and other equipment.

Making Sense of Sensors

Occupancy or motion sensors are devices that turn lights and other equipment on or off in response to the presence (or absence) of people in a defined area. Some sensors also control lighting based on the amount of daylight available in their coverage area. Most available sensors are designed to function independently or in parallel with other sensors for large areas.

A complete sensor unit consists of a motion sensor, an electronic control unit, and a controllable switch/relay.

Originally developed for use with security systems, occupancy sensors have been refined and enhanced to control lighting and HVAC in commercial and residential spaces. More sophisticated sensor units now offer users a variety of adjustment capabilities; manufacturers have

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also introduced sensors that can be integrated into a building's automation and control system.

Sensors have become more widely used in the last five years as the devices have become more reliable and as building automation and energy savings have become more prominent. Where there are utility rebates available, sensors can pay for themselves in less than one year, but most pay for themselves in two to three years without rebates.

Units are available in wall-mounted switch configuration for use in offices or other small areas and in ceiling- and wall-mounted configurations for large, open areas. There are also sensors specifically designed for bathrooms, stairwells and hallways.

Although they are commonly referred to as "sensors", a complete sensor unit consists of a motion sensor, an electronic control unit, and a controllable switch/relay. Some units also incorporate an optional daylight (or light level) sensor. The motion detector senses motion and determines the occupancy status of an area. It also has a timer which signals the electronic control unit after a set period of inactivity. The control unit uses the signal from the sensor unit and other inputs, (for example, input from a light level sensor), as the basis on which to activate the switch/relay to turn on or off the lights and/or other equipment.

Where Should Sensors Sense?

Generally, the most effective areas for sensors are areas that are not frequently used, areas with irregular use patterns or areas where lights are inadvertently left on, *e.g.*, conference rooms or reading rooms. Other targets include places where users are not often in control of the lighting/equipment or where the controls are not visible, such as copier rooms, bathrooms or storage areas. In commercial settings, individual offices, hotel and office conference rooms, library stacks, warehouses, store rooms and bathrooms tend to have the most unoccupied periods. The lights in these spaces are also more likely to be left on overnight.

To identify other potential areas for sensors, start where lights are often on, but where there is no continuous or permanent user presence. A rule of thumb is that areas with incandescent lighting usually yield more significant reductions and a faster payback.

Can you really save with sensors?

Here's an example: In Green Seal's building, lights are left on in the bathrooms on every floor for 24 hours a day. If sensors were installed, the on-time would be reduced by at least 12 hours, a 50% savings. At an estimated 500 watts per bathroom and 5 cents per kWh, the annual savings works out to be $219, or enough to buy 7 more sensors. The chart below shows the possible reduction in on-time gathered by MyTech Corp. in a survey of a large corporate headquarters.

Area type	% Reduction
Locker room	65
Large work room	55
Rest room	50
File room	45
Small work room	40
Corridors	25
Small offices	22

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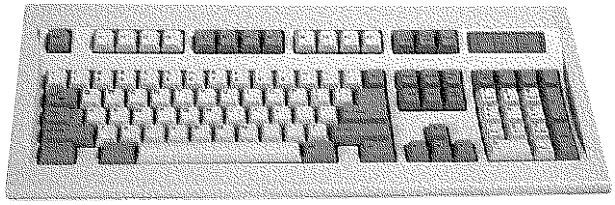
What Kind of Sensors Should You Use?

Device sensitivity/accuracy and capability for multiple adjustments are the two most important characteristics to look for in a sensor. Selection should be a function of the type of activity(ies) in the sensing area. Distinct types of motion that occupancy sensors typically key on are: desktop-type motion such as page turning or mouse and keyboard motion, torso motion such as reaching for objects, and whole body-type motion, such as walking. Depending on type and sensitivity setting, sensors can also respond to false signals (or "false triggering"), such as air movements from HVAC vents, or motion on the desktop due to HVAC flows, or the movement of warm air in front of a sunny window.

Selection should be a function of the type of activities in the sensing area.

Keep in mind that studies have shown that lighting controls work only when they are appropriate and unobtrusive. Occupants have disabled or defeated lighting controls when they interfered with their daily routine, and there are specific areas such as hallways or stairs that should not be controlled by sensors.



Available Types of Sensor Technologies

■ **Infrared or Passive Infrared (PIR)**

These sensors are tuned to detect infrared radiation (heat) from humans. A lens divides its coverage areas into pie-shaped segments and positive detection occurs when the sensor "sees" the motion of infrared radiation from one wedge to the next. IR devices are considered "passive" because they only detect radiation.

Advantages: highly resistant to false triggering, quite inexpensive, do not emit ultrasound or microwaves.

But: they are strictly line-of-sight devices, cannot "see" over partitions; range for small motion is dependent on the lens' focal length. At longer distances, the lens requires larger movements in order to register occupancy.

Recommendations: an excellent choice for areas with little or no obstructions, like library stacks, hallways and smaller offices and conference rooms.

■ **Ultrasonic or Ultra Sound (US)**

These sensors contain both an ultrasound generator and receiver. The ultrasound generator emits sound waves and any motion towards or away from the sensor causes a change in the reflected frequency.

Advantages: sensitive to almost all types of motion, no coverage gaps, and can detect movements that are not in their line-of sight.

But: they tend to be more expensive than PIR sensors, and are more prone to false signals; obstructions can reduce their effectiveness. Care must be taken to avoid overlapping sensors. There have been reports that sensors operating in the 25 to 27 kHz range may interfere with hearing aids.

Recommendations: an excellent choice for larger areas, open offices, hallways, conference rooms, bathrooms and unusually shaped areas.

■ **Microwave**

These sensors contains both a microwave generator and receiver. Sensors emit microwaves and detect movements through changes in the reflected frequency (most automatic door openers are microwave-operated).

Advantages: quite sensitive and usually have good coverage.

But: very little data currently exist on their reliability or operating cost.

Recommendations: specialized applications only.

■ **Audio**

These sensors contain a microphone that "listens" for sounds made by occupants or operating equipment.

Advantages: can be activated by voice, fairly inexpensive, do not emit sound or microwaves; they are not defeated by partitions.

But: they may mistake external sounds such as door closing, people walking, or even phone ringing as signs of occupancy.

Recommendations: a good choice in unusually shaped areas.

Choosing Sensors

For most average-sized offices, wall switch-type PIR or US sensors will perform well. However, care should be taken in cases of unusual shaped rooms where the switch location does not provide the sensor with a good field-of-view (an "L" shaped room, for example); especially where the sensor can be easily obscured. For larger spaces such as an open office area, conference rooms or library stacks, wall or ceiling mounted PIR, ultrasonic or combination sensors should be considered, and more than one sensor unit may be necessary. The sensor/switches combinations generally offer better coverage areas as well as ability to handle larger electrical loads.

Sensors must have an indicator to alert occupants when they are on or about to switch off.

Use the criteria below to select sensors. For use in small individual offices, the coverage area is not as important as the feature requirements.

■ **Compatibility:** Wall switch sensors and control units must be able to switch electronically-ballasted fluorescent lamps. (If you plan to upgrade or install building automation in the near future, look for sensors with outputs that are compatible with building automation systems).

■ **Daylight-Level Equipped Sensors**: Daylight or light level equipped sensors should offer users override capabilities.

■ **Failure Mode**: Sensors must be designed so that the equipment they control remains on in case of sensor failure.

■ **Indicators**: Sensors must be equipped with an audio or visual indicator to alert occupants whenever sensors are on, and provide warning prior to switching off.

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Available Types of Sensor Products

■ **Hybrid or Combination Sensors**

Units combine two or more technologies to minimize false detection, usually PIR and ultrasonic, or PIR and audio.

Advantages: can be very foolproof, allowing wide coverage and applications.

But: they can be more expensive (for small area applications), and may require more adjustments since sensors contain more than one sensing unit.

Recommendations: a good choice for large open areas and areas with unusual occupancy patterns or work requirements.

■ **Integrated Daylight Sensors**

A combination of PIR or ultrasonic sensors with a light-level sensor.

Advantages: can be wired to a dimming circuit to control room lighting based on available light and occupancy.

But: they can be difficult to adjust and require a dimming ballast or special wiring.

Recommendations: good for areas that receive large amounts of daylight.

■ **Wall Switch Sensors**

A PIR, ultrasonic or combination/hybrid sensor and control circuitry packaged into one unit, sized to fit in a standard wall box.

Advantages: small, inexpensive and easy to install.

But: their range can be limited, and depending on the location of the switch, they can easily be obscured.

Recommendations: good for smaller meeting rooms, individual offices and store rooms.

■ **Wall or Ceiling-Mounted Sensors**

PIR, ultrasonic or hybrid sensors designed to be mounted separately from the control unit(s), usually in high locations.

Advantages: can cover wide areas effectively; switching units can control a variety of equipment.

But: they tend to be more expensive and often necessitate rewiring.

Recommendations: a good choice for large areas.

■ **Specialized Sensors**

PIR or ultrasonic sensors designed specifically for bathrooms, hallways and stairwells.

Advantages: specifically designed for these spaces.

But: rewiring may be necessary if certain lights need to stay on.

Recommendations: excellent for these areas.

Recommended Products

Based on manufacturers' provided information, and the criteria listed above, Green Seal selected the following products as "Green buys." These were selected solely on information provided to Green Seal by their manufacturers. Green Seal has not tested or otherwise verified these claims.

COMPANY	MODEL #	TECH	COV. AREA (SQ FT)	WARRANTY (YRS)	LIST PRICE* ($)
SMALL AREA WALL SWITCHES					
MyTech Corp 512-450-1100	LP-2	PIR	900	5	N/A
Novitas, Inc. 310-568-9600	01-200	PIR	300	5	57.00
Sensor Switch 203-265-2842	WSDx	PIR	800	5	47.60
Technology Design Center, Inc. 610-539-4210	LO300WS	US	800	3	55.00
Unenco 510-337-1000	SOM-500	PIR	1000	5	73.00
The WattStopper 408-988-5331	Wx-277	PIR	900	5	65.00
LARGE AREA WALL SWITCHES AND SENSORS					
Leviton MFG 800-323-8920	6775x	PIR	2700	5	92.00
Novitas, Inc. 310-568-9600	01-083	US	2100	5	122.00
MyTech Corp. 512-450-1100	LAS-2200SF	US	2200	5	N/A
Sensor Switch 203-265-2842	WV-PDT	PIR	2000	5	77.00
Unenco 510-337-1000	C-500-2000	US	2000	5	99.00
The WattStopper 408-988-5331	W-2000x	US	2000	5	100.00

* For large area sensors, sensor prices may not include price of switching units.

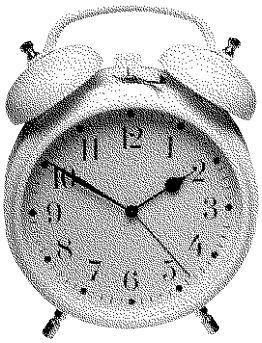
Choosing Sensors continued from page 4

■ **Manual Controls**: Look for wall switches with manual control capabilities.

■ **Minimum Load**: Sensors must be rated for 120, 240 or 277 volts operation, and have a minimum load rating of 600 W @ 120 V, or 1200 W @ 277 V.

■ **Timer Settings**: Look for an adjustable time delay period. At a minimum, the unit should have time delay periods from 30 seconds to 15 minutes.

Look for a sensor with an adjustable time delay period.



Coverage for Large Areas

SENSOR TYPE/CATEGORY	TYPICAL MOUNTING HEIGHT (ft.)	MINIMUM COVERAGE AREA (ft^2)
Wall Switches	3.5	300
Wall Mount	8	900
Ceiling Mount	8 to 10	1500
Hallway	8 to 10	100 linear ft
Combination - Wall Mount	8 to 10	1200
Combination - Ceiling Mount	8 to 10	1800

■ **Warranty**: Look for a repair or replacement warranty covering a minimum period of three years after installation.

■ **Coverage:** For applications other than small, individual offices, bathrooms or store rooms, you should look for the coverage in the chart above.

Other Things to Consider

Your savings will vary depending on the area size, type of lighting and occupancy pattern. Manufacturers claim that in some applications, savings can approach 75%. The California Energy Commission estimates that typical savings range from 35% to 45%.

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SUCCESS STORY

(From Lighting Management & Maintenance, February 1996 — Reprinted with author's permission)

In 1991, the State of Connecticut began an energy-efficiency program for state-owned office buildings in partnership with Northeast Utilities. One of the buildings selected for this program was #55 Elm St. in Hartford. This 188,000 square foot building houses the offices of the State's Attorney General, Treasurer and Comptroller. About 2/3 of the building is open office space and its lights often stayed on for 14 to 16 hours a day, shut off only when the building was totally empty.

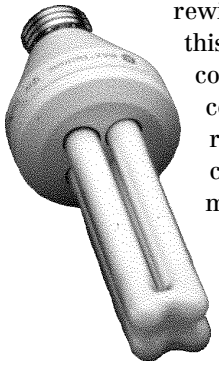
The State used a contractor to outfit the building with hybrid occupancy sensors (dual technology PIR/microphonic). The installation was carried out over a six-week period. All lights not intended for 24 hour use were wired to be controlled by occupancy sensors. Because of the building's open space, sensors were selected over other control methods such as computer-control or timed systems.

With a reported annual savings of $24,000 in direct electricity cost, the project paid for its $51,000 cost in just over two years. Just as important is the fact that the sensors were readily accepted by the building's occupants — high level lawyers and executives — without complaints.

For more information, contact the Connecticut Department of Public Works.

Other Things to Consider continued from page 6

However, savings can be achieved without the use of sensors. If the occupancy pattern in an area is regular and predictable, a more effective choice is a timer system to turn lights and other equipment on and off at predetermined times. Also, the installation of sensors may not provide a payback if extensive rewiring is required. In this case, more effective conservation may come from lighting retrofits or other conservation measures.



Two important issues in the use of sensors with fluorescent lamps are ballast compatibility and the possibility of reduced lamp life. While all switching units are compatible with incandescent loads, some units are not compatible with electronic ballasts — check with manufacturers about the particular model(s) you have selected. Regarding reduced lamp life, the issue is not so clear-cut. Under most applications, the switching actions are long enough (>15 minutes) so that this is not a serious issue. But under certain situations, the useful life of compact fluorescent lamps and certain lamp-ballast combinations can be shortened by frequent on-off cycles.

Other Resources

California Energy Commission
916-654-5200

Lighting Research Center/RPI
518-276-8716

Rocky Mountain Institute/E Source 303-440-8500

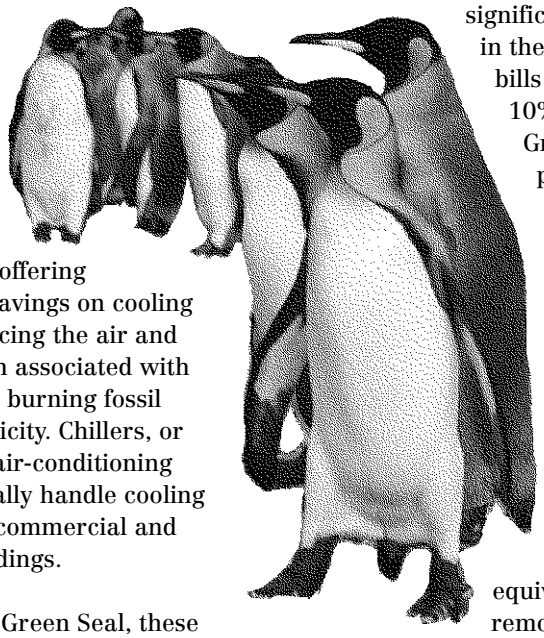
US EPA Green Lights Program
202-775-6650

The development of total building control systems may affect your installation of sensors. These computerized systems use sensors and actuators to monitor entire buildings and regulate their lighting, HVAC and other equipment. Standardized software and control/sensor modules are now being developed for use with these control systems. If your building is scheduled for automation, it may be necessary to use sensors that can be integrated into the proposed system. Additionally, the upcoming revision of ASHRAE standard 90.1, which will include requirements for building lighting and equipment controls, will affect new and retrofit buildings.

ANNOUNCEMENT

Trane Chillers Earn the Green Seal of Approval

Green Seal has certified the Earth•Wise™ CenTraVac® chillers, available in 300–1400 tons capacity, made by The Trane Company. These electric chillers are the first to receive the Green Seal of Approval. They are among the most energy efficient chillers on the market today, offering considerable savings on cooling bills, and reducing the air and water pollution associated with extracting and burning fossil fuels for electricity. Chillers, or chilled-water air-conditioning systems, typically handle cooling tasks in large commercial and industrial buildings.



To earn the Green Seal, these Earth•Wise™ CenTraVac® chillers had to meet Green Seal's rigorous environmental standard for electric chillers. Central to the standard are requirements for high energy efficiency levels and minimal ozone depletor releases. The Earth•Wise™ CenTraVac® chillers, with their low leakage rates and high energy efficiency, offer large commercial and industrial buildings significant savings in their cooling bills — up to 10% annually. Green Seal projects that if the Earth•Wise™ CenTraVac® chillers were used widely, the annual reduction in electricity use would be the equivalent of removing 200,000–300,000 cars from the road every year.

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ANSWERS TO YOUR QUESTIONS

What Is Green Seal Certification?

Green Seal sets environmental standards on a category-by-category basis. A study of the environmental impacts of products within a specific category is conducted, encompassing the manufacturing process, use of the product and its ultimate disposal. Product performance is examined in concert with environmental attributes. After the initial study, proposed standards are circulated for comment among manufacturers, trade associations, environmental and consumer groups, government officials and the public at large. Following a formal review of comments, Green Seal publishes the final standards and allows the use of its certification mark on products found to meet or exceed them.

Green Seal standards are periodically reviewed and updated to incorporate advances in technology and industry practices. Certified products are monitored annually to ensure continued compliance with Green Seal standards.

Who Are Environmental Partners?

Green Seal's Environmental Partners are businesses, government agencies and other organizations that have committed to taking product specific environmental impacts into account when making their purchasing decisions. Green Seal provides detailed, up-to-date discussions of environmentally responsible products and specific sources for buying them. The *Choose Green Reports* show *how* various products you buy may damage the environment, *what* products are better for your health and the environment, and *where* you can obtain them.