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Demand Reduction and Energy Savings Using Occupancy Sensors

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Demand Reduction and Energy Savings using Occupancy Sensors

Lighting is one of the single largest users of electrical energy in a typical commercial building. While occupancy sensors have become a mainstream solution for eliminating wasted lighting energy in these applications, there continues to be a need for research documenting both the magnitude of the savings by application and the impact these controls have on demand. A study by the Environmental Protection Agency and the Lighting Research Center of Rensselaer Polytechnic Institute presented at the IESNA Annual Conference in Washington, DC (August 2000) provides unique and valuable data about occupancy sensor demand reduction and energy savings potential.

Study Highlights

Sixty organizations, which were active participants in the EPA's Green Lights Program, provided a total of 158 rooms falling into 5 occupancy types: 42 restrooms, 37 private offices, 35 classrooms, 33 conference rooms and 11 break rooms. Each room was monitored for occupancy and lighting status over a 14-day period using Watt Stopper's Intellitimer Pro light logger. The light logger data were converted to one-minute intervals, which made it possible to evaluate occupancy patterns, calculate energy savings and estimate the demand reduction potential using simulated occupancy sensor time delays. Occupancy sensor time delays of 5-, 10-, 15-, and 20-minutes simulated in the study, although data for the minimum (5-minute) and maximum (20-minute) time delay simulations are presented here.

Energy Savings

The percentage of energy waste that actually occurred for the 14-day period and the calculated energy savings for the 5- and 20-minute time delay simulations are summarized in Table 1. Not all of the wasted lighting energy is captured when occupancy sensors are used because lights remain on for the duration of the time delay setting. Similarly, the energy savings decreases as the timeout setting increases because lights remain on in the unoccupied room for a longer time period. Shorter time delays also increase the switching frequency of the lamps and ballasts, which may reduce lamp life.

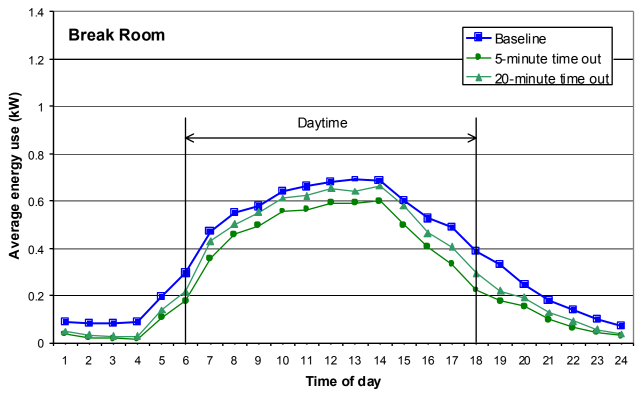
Table 1. Energy waste for the 14-day period and energy savings for the 5- and 20-minute time delay simulations.

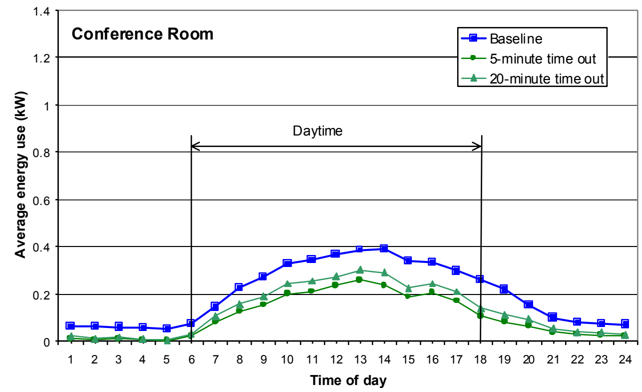
Application	Energy waste[1]	Energy savings using the 5-min time delay[2]	Energy savings using the 20-min time delay[2]
Break Room	39%	29%	17%
Classroom	63%	58%	52%
Conference Room	57%	50%	39%
Private Office	45%	38%	28%
Restroom	68%	60%	47%

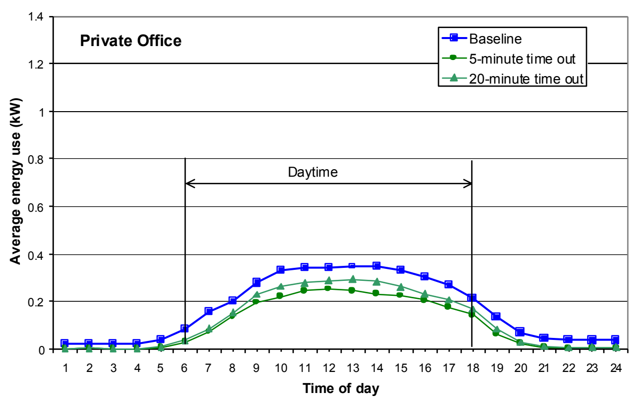
1. Maniccia and Tweed, 2000
2. Von Neida et. al., 2000

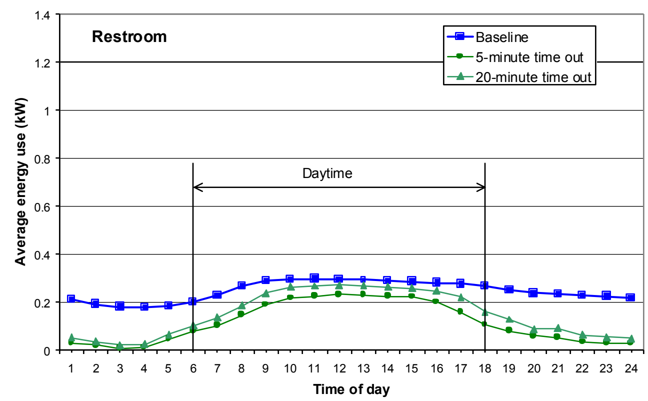
Demand Reduction

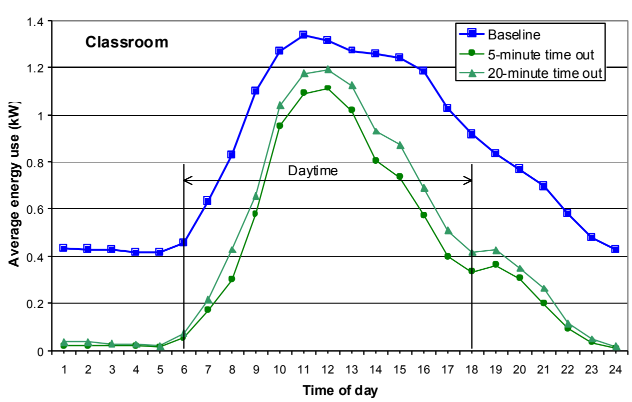
Demand reduction potential was analyzed by separating the analysis into a "daytime" analysis which analyzed the data from 6:00 AM to 6:00 PM, and a "nighttime" analysis which analyzed the data from 6:00 PM to 6:00 AM. Load profiles for each space type were also developed. The weekday load profiles for each space are illustrated below. These graphs show the hourly time-of-day load profiles for the actual energy use ("baseline"), and the load profiles resulting from the 5- and 20-minute time delay simulations. In all cases, the load profile is reduced when occupancy sensors are used.











The classroom data set includes both K-12 and higher education facilities data. The load profile for each of these segments for would likely be different than the combined average shown here.

The average daytime energy demand reductions for the minimum and maximum time delay settings are listed in Table 2. These values represent the average reduction that occurs between the hours of 6:00 AM and 6:00 PM, and do not represent reductions at any specific time-of-day. An estimate of the magnitude of the reduction at a specific time of day can be garnered by comparing the baseline value from the graph to the value from the 5- or 20-minute timeout setting simulation.

Table 2. Weekday daytime average demand savings for the minimum and maximum time delay simulations[1].

Application	Time delay	Daytime average energy demand savings[2]
Break Room	5-min	18%
	20-min	8%
Classroom	5-min	40%
	20-min	31%
Conference Room	5-min	41%
	20-min	28%
Private Office	5-min	31%
	20-min	20%
Restroom	5-min	33%
	20-min	17%

1. Von Neida et al., 2000
2. Daytime demand savings are the average savings between 6:00 AM to 6:00 PM, and do not represent hourly demand reduction.

Unlike changing out lamps and ballast to reduce the lighting watts per square foot, demand reduction with occupancy sensing reflects the fact that a portion of the individual spaces on a floor will be unoccupied at any point in time. The load profiles shown here illustrate that occupancy sensors will reduce lighting energy use and demand throughout the day. The magnitude of the savings will depend upon the time delay setting and when the peak demand occurs, which may vary among building types. When looking at a large building with numerous individual spaces being controlled, the natural diversity factor will lead to a reduction in overall demand.

More space types need to be added to the test database, but it is clear from the results to date that occupancy sensors impact both total energy use and demand in individual enclosed spaces.

References

Maniccia, Dorene and Allan Tweed. 2000. Occupancy sensor simulations and energy analysis for commercial buildings. Troy, NY: Lighting Research Center, Rensselaer Polytechnic Institute.

Von Neida, Bill, Dorene Maniccia and Allan Tweed. 2000. An analysis of the energy and cost savings potential of occupancy sensors for commercial lighting systems. Illuminating Engineering Society of North America 2000 Annual Conference: Proceedings. New York: IESNA.