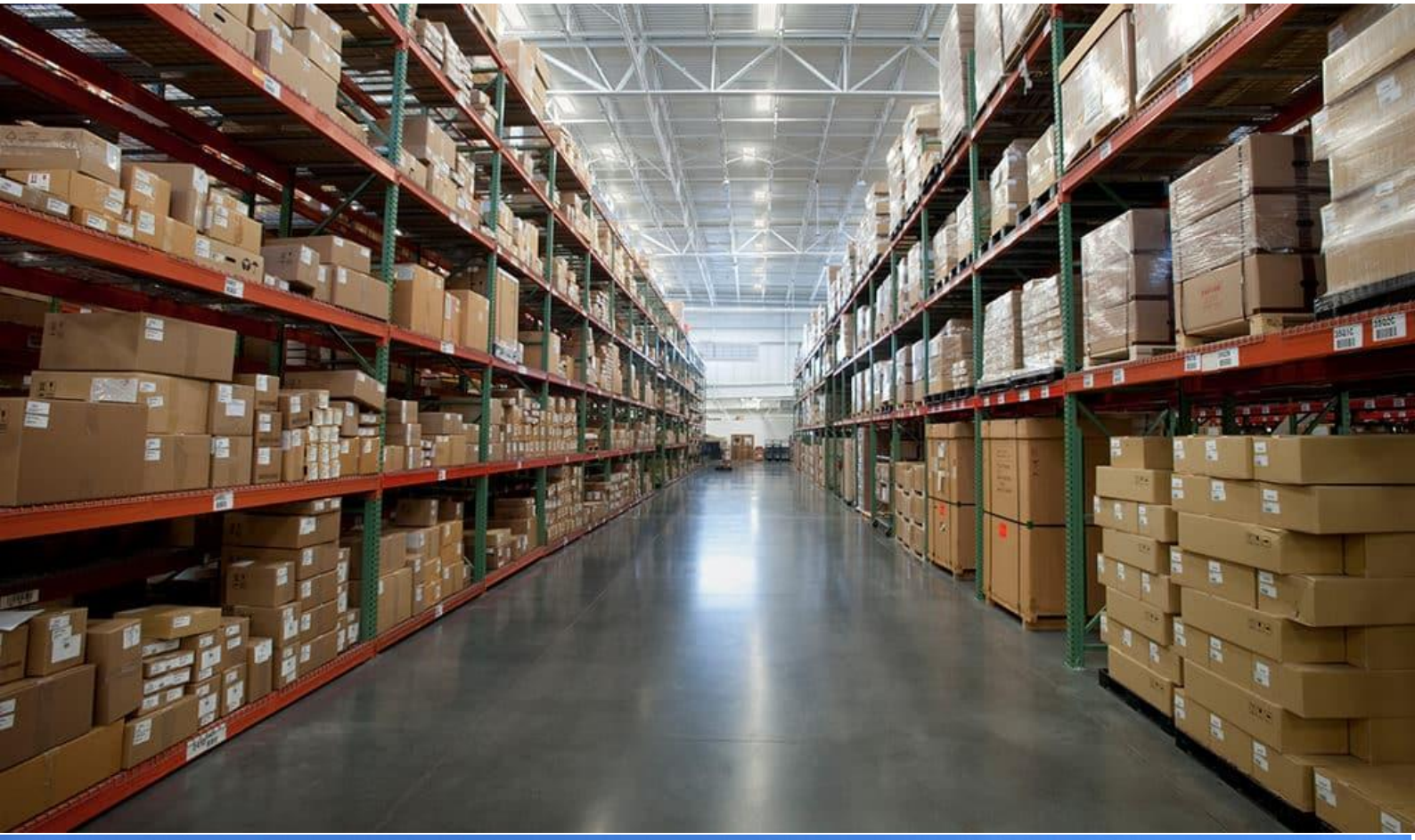

ENERGY SAVING POTENTIAL OF MOTION SENSORS

In Warehouses – A Case Study

Ocelli Systems, Bangalore, INDIA – Oct 2019

Motion sensor based lighting control has good potential to save energy used for lighting. Various studies have different figures for percentage of energy saved using these devices. A trial was conducted by Ocelli system in a real functional warehouse in Chennai, INDIA. The trial shows that motion sensors can potentially save more than 97% of the energy used for artificial lighting.

Introduction

U.S Energy Information Administration reports commercial sector consumes about 50% of the total electricity. Of the 50%, about 39% is used for lighting alone. So there is a good potential to conserve energy by conserving electricity used for artificial lighting alone.

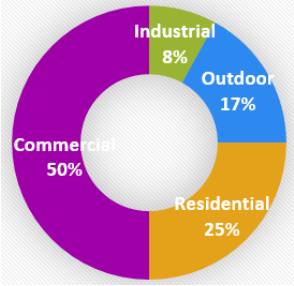

Fig 1 Sectorwise energy utilization

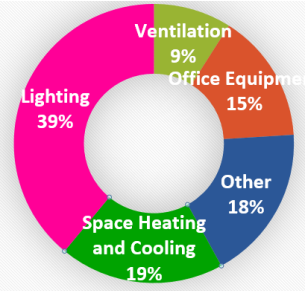

Fig 2 Commercial sector energy usage break-up

Among others, motion sensor based lighting control plays a primary role in achieving this goal. Motion sensors have the potential to significantly reduce energy use by switching off electrical loads when an occupied space is no longer occupied. While motion sensors can be used to control a variety of load types, their most popular use has been to control lighting in commercial buildings. Passive infrared (PIR) sensing has been the mainstay technology used in these products.

PIR Operation

PIR (Passive Infrared Receiver) is an infrared-based sensor; as the name "Passive" implies, the device does not emit any infrared radiation. PIR only responds to infrared radiation emitted by other objects within its detection sphere. The detector at the heart of the sensor is specially designed to respond to optical energy (light) in the infrared spectrum (Human bodies emit infrared energy wavelength at about 9.5µm). A compound lens in each fixture divides the coverage area into triangular zones. When the infrared temperature in a zone changes (such as that produced by a human body movement) this is interpreted as movement and the lighting system in kept on. If no motion is sensed over a given time delay (typically adjustable from 30 seconds to 30 minutes) the lighting system is turned off. A sensor operation is illustrated in Figure 1.

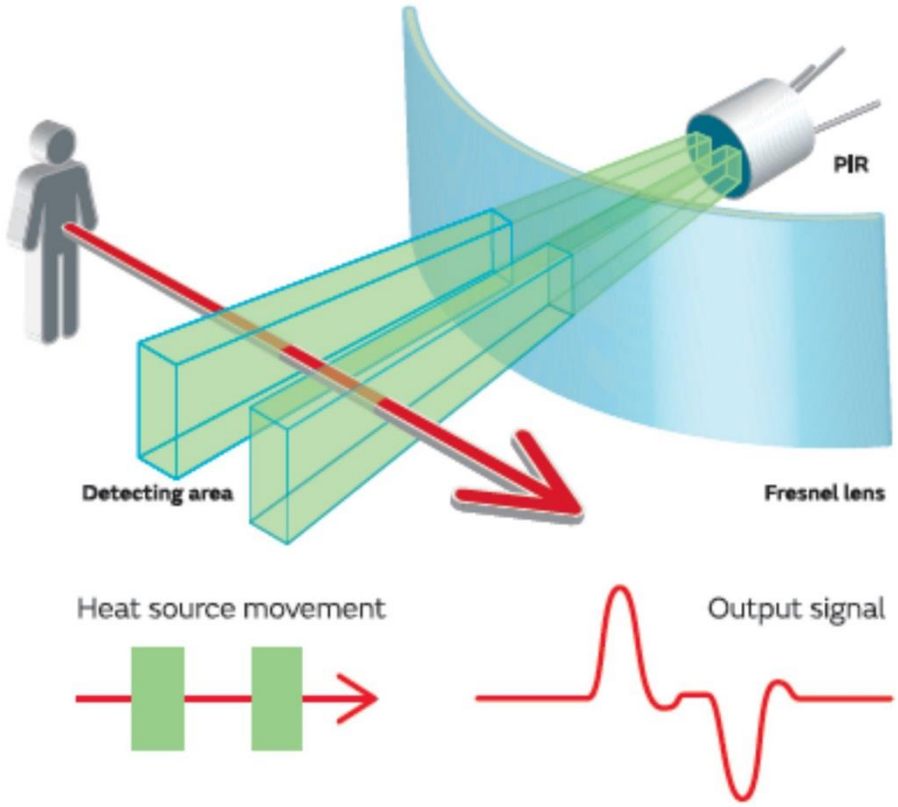

Figure 3 PIR Sensor Operation

Various reports claim savings from 15% to 85%, although there is little published research to support the magnitude or timing of reductions. Energy savings and performance are directly related to the total wattage of the load being controlled, effectiveness of the previous control method, occupancy patterns within the space, operating hours per day and proper sensor commissioning (like time delay). Some of these in turn depends on the kind of movements (major movements or minor movements) expected in the given space.

Study

This case study documents the trial conducted by Ocelli systems in a real functional warehouse in Chennai, INDIA that stocks products for multiple known brands. Customer selected the location for the trial. Ocelli systems was unaware of the occupancy pattern of the chosen location but some inference can be made as discussed in the conclusion. The trial conducted for a period of 6 days from 05-Oct-2019 2PM to 12-Oct-2019 2PM (6th October being Sunday, the warehouse was closed). The location had 12 luminaries of 28 watt capacity each. So the controlled lighting load is 336 (=12x28) watts. As per the information collected, it is general practise to keep the lights ON in a fixed schedule from 8AM to 8PM (12 hours/day). So the expected energy consumption per day is 4.032KWh. For six days, **expected energy consumption is 24.192KWh**. Since the expected energy consumption is known for "before" scenario due to known load and fixed schedule. Trial was conducted only for "after" scenario

with motion sensor controlled lighting. Time delay used for the trial is 30secs. Separate non-utility grade, Class I energy meter was used to monitor the energy consumption during the trial. Energy consumption for "after" scenario is 0.55KWh.

Installation Images

Figure 4 Energy meter reading with sensor controlled lighting

Figure 5 Sensor Installation with Energy meter (Red circled area)

Figure 6 Sensor Installation with Energy meter (Close-up view)

Figure 7 Sensor Installation with a view of coverage area

Results and Analysis

Based on the collected data, energy savings achieved is 97.72%. This is very good savings for the motion sensor controlled lighting in a warehouse. U.S General Services Administration (GSA,) study 2014 estimate for warehouse savings is about 75%. A higher percentage savings achieved during this trial can be attributed to very low occupancy rate in this location. Furthermore, in a warehouse environment, most of the movement is of major in nature except while picking an item and this activity lasts only for short duration. So there is very little chance for a motion sensor not to detect a movement (false negative) that is occurring in its detection sphere. This in turn means, that it is possible to use shorter time delay without the risk of failing to detect a movement. Since in a motion sensor, the time delay is a trade-off between failed detection (shorter time delay) and wasted energy (longer time delay), it is possible to lower the time delay and save more energy without losing motion detection.