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Harvesting daylight in a classroom, the case study of Leontios School

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Abstract

The energy consumption for artificial lighting in school buildings is one of the main consumers of electricity during the year. In Greece where daylight is adequate during the year there is a missing opportunity for energy savings. Scope of this paper is to examine the lost opportunities for optimizing the lighting system combining with daylight harvesting techniques using photosensors. A case study of a classroom that utilizes photosensors is compared with an identical classroom that uses only artificial lighting. The energy savings in the lighting system are more than 56%.Considering near zero energy buildings the use of daylight controls should be obligatory in school buildings while their operation schedule in Greece is during daytime only.

Keywords: Classroom, daylight harvesting, lighting, School building

The case study

A case study was implemented in two classrooms of Leontios School (Lycée Léonin) [1, 2], a private high school located in Nea Smirni (Athens, Greece), in order to examine the impact of daylight harvesting in a classroom. Two identical classrooms A and B were selected side by side facing north at the second floor of the main school building (Figure 1).

Figure 1. The main building of Leontios School (Lycée Léonin), where the two classrooms A and B were located at 2nd floor facing north [1]

In each classroom 4 luminaires with 2 T8 36W tubular fluorescent lamps were already installed targeting for a uniformly lighting level of 300lx on the working plane (0,8m). Four photosensors were installed on each luminaire in classroom A (Figure 2, right). The standalone photosensors were integral-reset and thus only a nighttime commissioning was needed (Figure 2, left). The target illuminance due to the integral-reset algorithm of was set at 350lx in order to have optical discomfort although the appropriate lighting levels for classrooms is 300lx [3]. Having as a target illuminance the value of 300lx lower light levels might occur while there is daylight harvesting for more than 20% of the monthly hours of the school's operation schedule [4, 5]. Classroom B remained with exact the same artificial lighting system as classroom A without the daylight exploitation, meaning that the installed power of each classroom was the same. Both classrooms are used with a common operation schedule from 7:30 to 14:30. The artificial system is deactivated manually after the operation by a school guardian.

Figure 2. Left**:** Classroom A with the installed photosensors during the nighttime commissioning [4, 5]. Right:The installed standalone photosensor using integral-reset algorithm

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Results

Two power meters were installed outside the classrooms in common view for the students in order the benefit of daylight harvesting to be observed and logged by them The results from the energy consumption of each classroom is presented in figure 3. The value of 596kWh corresponds to classroom B and the value of 260kWh to classroom A using photosensors for daylight harvesting. The total number of 336kWh corresponds to 56% energy savings in electricity for the artificial lighting system. The recorded energy savings could be more if the school guardians didn't were mistaken by the low levels (10% of the dimming level) of the artificial lighting system during the deactivation time (14:30) in contrast with daylight and thus missing to switch off the lights of classroom A. For this reason, many times the lighting system of the classroom A remained in function during the day until the night when someone could easily notice that the lights were forgotten to be switched off at 14:30. Thus a time switcher could be adapted in the future.

Figure 3. The metering equipment and the corresponding results from the first year of implementation. Left: Energy consumption of classroom B (Electricity kWh). Right: Energy consumption of classroom A using photosensors for daylight harvesting (Electricity kWh).

Conclusions

Almost at the total number of schools in Greece there is a waste of 56% energy savings in electricity consumption for artificial lighting due to daylight as presented from this case study. Considering as a cost of each photosensor a value of 20 € the extra cost for daylight harvesting per classroom could be more or less 100 € including the installation but excluding any discounts for a classroom with 4 luminaires. With an average value of electricity tariff in Greece 0,18€/kWh, the benefit of saving 336kWh per classroom per year accounts for 60€, namely the return of investment is less than one and a half year. Then each classroom could save 60€ per year for this case study. Considering the main volume of the public schools with classrooms that overpowered with 9 or 12 luminaires each, the benefit could be larger.

We plan to upgrade the current case study scenario by replacing the artificial lighting system with LED luminaires and powering it with renewable energy source.

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References

1. Lycée Léonin Nea Smyrni Private high school (http://www.neasmyrni.leonteios.edu.gr)
2. "Laboratoire virtuel pour éduquer à l'énergie durable (Programme Lifelong Learning)", Programme Pour L'éducation Et La Formation Tout Au Long De La Vie (LLP) Energ@tic 2007-2013, Intelligent Energy – Europe
3. European Norm 12464-1: Light and lighting—lighting of work places Part 1: Indoor work places, 2011.
4. L. Doulos, A. Tsangrassoulis and F. Topalis, "Multi-criteria decision analysis to select the optimum position and proper field of view of a photosensor", Energy Conversion and Management, 86 (2014) 1069–1077
5. L. Doulos, A. Tsangrassoulis and F. Topalis, "Quantifying energy savings in daylight responsive systems: The role of dimming electronic ballasts", Energy and Buildings, 40 (2008) 36–50