Daylighting system based on single-axis polar heliostat

INTRODUCTION
The growing need to increase energy sustainability in buildings requires the use of solar radiation as a renewable source of energy. Heliostats consist of a mirror that follows the path of the sun and aims to maintain the reflection of the solar rays into a fixed direction or point [1]. Therefore, they can play an important role in sustainable technological applications in urban environments [2], such as natural illuminators in buildings [3-8]. This paper presents an analysis of the performance of a heliostatic illuminator, based on the single-axis polar heliostat prototype developed by Torres-Roldán et al. [7] (Fig. 1), to improve illumination in a classroom at the Campus of Rabanales of the University of Córdoba (Spain).

METHODOLOGY
Two 1:15 scale models of the chosen classroom have been developed (Fig. 2). A 1:15 scale model of the proposed system of heliostatic illuminators have been developed (Fig. 3) and installed in one of the scale models according to the schemes in Fig. 4 and 5. Additionally, an illuminance monitoring system, with Arduino MEGA 2560 and TSL 2561 illuminance sensors, has been developed and installed in both scale models according to the layout in Fig. 6. With these sensors the increases in the levels of natural lighting thanks to heliostats have been analysed. For that purpose, both scale models have been placed outdoors with the same orientation as the replicated classroom (Fig. 7) and experimental data have been registered.

RESULTS
Fig. 8 shows the image of the interior of each of the scale models, captured by two webcams, at the same instant of time and under the same conditions of solar incidence on the outside.

Table I shows the average illuminance levels registered by the sensors in each scale model, as well as the increment registered in the case with heliostatic illuminators.

Qualitative and quantitative comparative analysis demonstrates that the heliostatic illuminators favours a higher level of light inside the classroom.

CONCLUSIONS
The levels of illuminance are considerably higher in the case of the scale model with heliostatic illuminators, with increases ranging from 70.40% to 242.58% compared to the situation without heliostatic illuminators. Heliostat illuminators can therefore improve daylighting conditions inside buildings, reducing artificial lighting requirements and improving energy efficiency.

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