The effects observed above are the expected ones, since solar light intensity which is introduced in the scene, and not artificial lighting, is the one increasing significantly the illuminance in it. In that way, it is verified that under the most negative conditions for the visual result of shop windows, which arise during solar incidence, not only does the vertical lighting not have to be increased but, in contrast, it can be drastically reduced while, simultaneously, the visual outcome can be significantly improved.

CONCLUSION

This paper results in a passive design proposal that can offer very positive effects on the visual result of shop windows, improving the quality of their observation, thus fulfilling their commercial visual goals during the day and, in addition, reducing energy consumption. In low latitude countries, the inability of artificial lighting to compete with high solar illuminance makes it vain for any power to increase during daytime, along with the corresponding energy charge this practice entails. Instead, the increase of interior illuminance levels of shop windows by using the very illuminance of the sun may improve the visual outcome and reduce energy consumption for the lighting of the scene.

The positioning of the proposed design of sunlight redirection, with the dual effect of both obstruction of its incidence and the benefit of its intensity to increase illuminance in the interior of the shop window, has very positive effects on its visual presentation, especially in terms of reducing annoying reflections and the possibility of glare. Moreover, these effects are valid even when reducing the installed power for the lighting of the background of the scene, thus making possible, in combination with the use of sensors and resistors, further reduction of energy consumption for the lighting of the display window. This new lighting passive system results in a very simple, effective and low cost solution that can be easily applied in economically emerging countries, with considerable environmental and economic benefits when incorporated in the highly energy-consuming display windows. Therefore, it is deduced that, instead of trying to compete with the sun, it is better for one to ally with it.

ACKNOWLEDGMENTS

The authors would like to thank Axel Jacobs for providing the possibility of luminance maps production using their software online (http://www.jaloxa.eu/webhdr/) and Benoit Beckers for providing the Heliodon2 software. This work has been conducted with the support of the Diputació de Barcelona.

This paper is supported by the Spanish MEC under project BIA2013-45597-R.

NOMENCLATURE

d_M = dimensions of the model

d_R = dimensions of the real window display

DGP = Daylight Glare Probability

REFERENCES

Carillo, C., Diaz-Dorado, E., Cidrás, J., Bouza-Pregal, A., Falcón, P., Fernández, A., & Álvarez-Sánchez, A. 2013. Lighting control system based on digital camera for energy saving in shop windows. Energy and Buildings 59: 143–151

Freyssinier, J. P., Frering, D., Taylor, J., Narendran, N., & Rizzo, P. 2006. Reducing light energy use in retail display windows. Sixth International Conference on Solid State Lighting. San Diego: Proceeding of SPIE.

Institut Catalá d´Energia. 2008. Caracterització del consum energétic en els establiments del sector de pimes de comerç i serveis de Catalunya. Barcelona.

Peoglos, B., Raptis, I., & Christodoulides, C. 2004. Optical Instruments. In B. Peoglos, I. Raptis, & C. Christodoulides, Experimental Physics Techniques. Athens: National Technical University of Athens. 3: 39-82.

Rea, M. 2000. IESNA Lighting Handbook: Reference & application. 9th Edition. New York: Illumination Engineering Society of North America.

Wienold, J. 2009. Dynamic daylight glare evaluation. IBPSA Conference. Glasgow: Building Simulation. pp. 944-951