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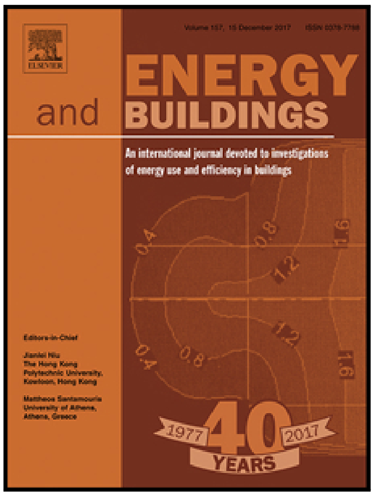

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Smart windows for carbon neutral buildings. A Life Cycle approach

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Abstract

This study assesses the influence of photovoltachromic windows (PVCCs) on the Life Cycle Impact and Life Cycle Total Energy of office buildings. To this aim, two commercial buildings, having the same size and typology, only differing on glazing's technologies - PVCCs and commercial solar control glass panes integrated with photovoltaic (PV) panels - were compared. A full analysis was performed in three locations representative of as many climatic conditions (Aswan, Brindisi and London). The results obtained showed that the overall impact due to the production of a PVCC cell is considerably lower than the one of traditional technologies offering the same performances. Reductions of impacts spanning between 41% and 44% were obtained. Moreover, all impact categories benefited from smart windows' building integration in the operational phase, especially in the Mediterranean climate. If in Aswan the reduction of impact is mainly ascribable to energy demand for cooling, in cold climates savings in lighting energy dominate.

Keywords: *Building-integrated photovoltaics; Photovoltachromics; Energy savings; Life Cycle Analysis.*

1. Introduction

In the current European context of energy performance directives for buildings [1], in order to achieve the nearly Zero Energy Building (n-ZEB) standard, more demanding requirements for building envelope and building services sub-systems have to be applied. With this aim, adaptive technologies [2], acting as highly responsive filters on the multiple energy flows impinging on building surfaces, have demonstrated to achieve substantial energy savings [3] in comparison with high-performance static technologies. The sustainability of buildings is a pivotal challenge, considering the large number of actors and variables involved in the eco-balance of buildings, throughout their lifecycle.

In this framework, a relevant aspect is represented by the analysis of the environmental burden related to project choices, directly influencing the consumption of resources and energy, waste and emissions generation during the construction, use and disposal stages of buildings. In the absence of this wide vision, the adopted solutions, characterized by low impacts during the production and assembly phase, could show environmentally unfavourable behaviour in the subsequent years, due to reduced durability and onerous maintenance needs and/or poor recycling and reuse potential, at the end of life [4, 5].

Designers, therefore, should have the chance to analyse and focus all the competing variables to the overall impact of a material/component or a given technological solution, envisaging all the foreseeable flows of the building process.

In this context, the market offers, of course, many operational possibilities thanks to a wide range of innovative technologies able to balance multiple performance targets. Many of these solutions, however, still need to be deepened from the environmental point of view, in order to understand their real potential in the reduction of building overall impacts. Conversely, it might be useful to observe that sustainability assessments applied to buildings (especially