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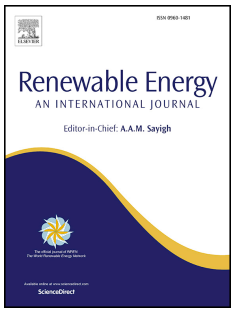

Environmental and cost life cycle analysis of the impact of using solar systems in energy renovation of Southern European single-family buildings

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Environmental and cost life cycle analysis of the impact of using solar systems in energy renovation of Southern European single-family buildings

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Abstract

Nowadays, in the European Union (EU) the construction rate of new buildings is very low and therefore achieving the EU targets regarding the energy efficiency of the building sector is only possible through the reduction of the energy needs of the existing building stock. A building design based on passive measures is a priority to reduce operational energy consumption but it is not enough to achieve the nearly Zero Energy Building (nZEB) level. Consequently, the design must also consider active systems with high efficiency and the use of renewable energy sources to partially/totally replace the use of non-renewable energy. At this level, solar thermal and photovoltaic panels play an important role, mainly in countries with high levels of solar radiation, as in the Southern European countries. Nevertheless, there are still some barriers to overcome for the broader dissemination of the implementation of these systems. One of the most important is that building owners are not fully aware of the life cycle benefits that these systems have at environmental and economic levels. The best way to raise awareness to these benefits is through the analysis of case studies, highlighting the short or mid-term benefits resulting from the integration of these active solutions. Thus, this paper is aimed at analysing the environmental and life cycle costs of different energy renovation scenarios, assessing the contribution of the solar systems to achieve three levels of energy performance. The study is focused on the energy renovation of a detached single-family house considering the climatic conditions of Porto, Portugal. From the results, it is possible to conclude that, on an annual basis, and for the Portuguese climate, it is possible to overcome, many of the energy needs for acclimatization and preparation of domestic hot water with the integration of these systems. The study also shows attractive economic and carbon payback times resulting from their use.

Keywords: Solar systems; Energy renovation strategies; nZEB; ZEB; LCA.

1. Introduction

During the different life cycle stages, a building consumes a great amount of energy. It includes the embodied energy, i.e. the energy required for the production and transport of building products and systems; the operational energy used for Heating, Ventilation and Air Conditioning (HVAC) systems, lighting and production of Domestic Hot Water (DHW); and the energy related with the building demolishing/dismantling and final waste treatment at the end-of-life stage.

Buildings are responsible for 30 to 40% of the primary energy consumption and approximately 33 % of greenhouse (GHG) emissions worldwide [1]. At the European Union,