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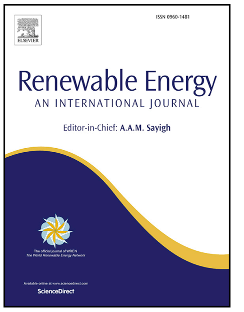

Outdoor performance of a trapeze solar thermal collector for facades integration

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Outdoor performance of a trapeze solar thermal collector for facades integration

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Abstract: Increasing the share of solar energy convertors installed on buildings asks for using all the suitably positioned places, including facades. However, facades integration asks for collectors with various colours and/or shapes to increase the architectural acceptance. Following these constraints, a new solar thermal flat plate collector was designed and developed, having a rather small area (0.67 m^2) and trapeze shape; this shape allows a much higher coverage degree of the buildings' facades, in lego-type arrays; additionally, variously coloured absorber plates (red, green) support the architectural acceptance. A trapeze demonstrator collector was developed and proved an optical efficiency of 62.38% during indoor testing using a solar simulator. Further on, this demonstrator was outdoor installed on the vertical façade of a laboratory building, in the R&D Institute of the Transilvania University of Brasov, Romania (mountain temperate climate, 45.65°N, 25.59°E, at 600 m above the sea level). The paper presents the results obtained during two years of monitoring for the outdoor installed trapeze collector, in terms of thermal power output and efficiency. Data are compared with those obtained using a commercial flat plate collector (with 2.1 m^2 active area and optical efficiency of 85.1%) vertically installed on the same façade as the trapeze collector. These data are extensively discussed in the paper, considering the monthly cumulative output, the efficiency and the peak values (highest and lowest), in direct correlation with the irradiance values and outdoor temperature. It is found that the thermal energy output of vertically installed solar thermal collectors is larger during the autumn months as compared to the summer thus protecting the solar thermal system against overheating. The results show that during predominant cloudy days the infield conversion efficiency is recommended to be reported not based on instantaneous values but over longer time frames (e.g. of hours) due to an inherent time delay between the higher irradiance values and the collectors' response.

Keywords: trapeze solar thermal collector; outdoor testing; outdoor conversion efficiency; vertically mounted collectors

Introduction

The last century developments led to significant steps forward in insuring a better quality of life but also to the accelerated depletion of key natural resources. This is why the concept of sustainable development was in the past decade seriously considered; a key issue is related to the changing pattern from a predominant rural area, inhabited by the world population, to an increasingly larger urban residential area. This asks for a novel and sustainable built environment, developed to meet the quality and the environment protection standards. This is why the implementation of clean, renewable energy sources was extended in the built environment and the share of renewable energy used to cover the electrical and thermal energy demand in the urban built environment significantly increased in the past decades. For the first time, the Renewable Energy Report 2017 [1] outlines that during the past 12 months a large increase in the renewable energy production was observed (161 GW newly installed), especially on electrical energy, leading countries in EU being Germany and Denmark.

Increasing the renewable energy share to meet the energy demand in the built environment has to be done considering the conversion efficiency but also additional acceptance pre-requisites. This