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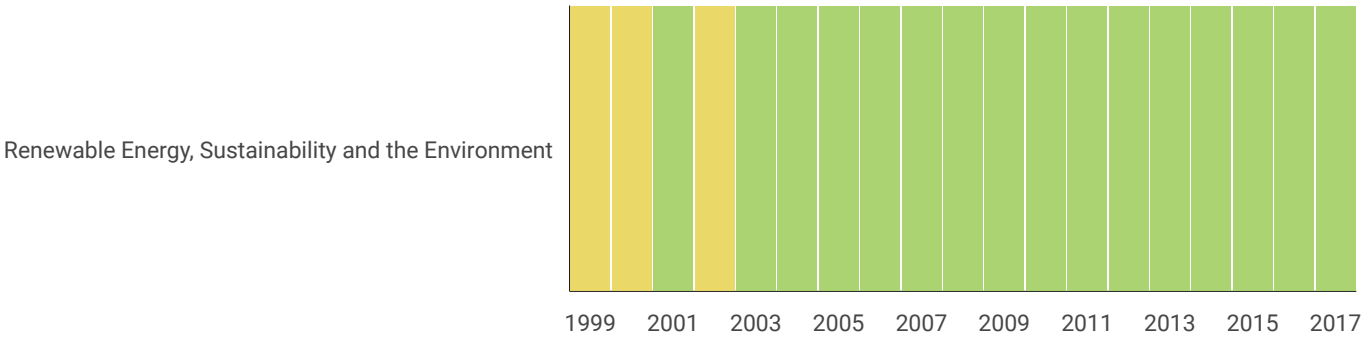

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The stability of the radiative regime does influence the daily performance of solar air heaters

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ABSTRACT

The dependence of the daily photothermal conversion performance on the stability of the radiative regime has been rarely treated in literature and only for systems based on water collectors. The objective here is to estimate whether the daily performance of solar air collectors is dependent on the radiative regime characteristics other than the level of daily solar irradiation. Results are obtained by comparing the performance of two solar air collectors whose design is almost similar but one has a porous absorber and the other has a U-corrugated absorber. First, the daily performance of the collectors are analyzed experimentally during clear sky days in Bucharest (Romania, South Eastern Europe). The instantaneous performance of the collector based on porous absorber is generally higher than that of the collector based on U-corrugated absorber. Second, dynamic models are developed and validated against measurements obtained in Bucharest. Two new performance indicators specific to time dependent operation are defined. It is shown that these indicators equal each other at steady state but in transitory operation they have different values. Simulations are performed for collectors operation under the climate of Timisoara (Romania). Eight days, covering all four seasons and belonging to different relative sunshine classes and different radiative regime stability levels are selected. At daily level, the collector based on porous absorber is more effective than the collector based on U-corrugated absorber. When the instantaneous performance is considered, the U-corrugated absorber may provide better results in the morning. These findings do not depend on the stability of the radiative regime. The dispersion of the instantaneous performance values is higher for less stable radiative regimes during days with medium cloudiness (daily relative sunshine σ_{day} between 0.4 and 0.7) and during days with fully stable radiative regime and overcast sky ($\sigma_{day} = 0.0$). Each collector has a specific behavior when the level of radiative stability and the class of relative sunshine change. During time intervals of transitory operation the traditional coefficient of performance may be used as a substitute of the time averaged value of the instantaneous coefficient of performance. However, the traditional collector efficiency is not a reliable measure of the time averaged value of the instantaneous efficiency.

1. Introduction

The most important radiometric quantity characterizing a geographical location is the level of the incoming global solar irradiation. The output power of the photovoltaic (PV) plants and the efficiency and the useful heat flux provided by photo-thermal converters are directly dependent on the incoming solar global irradiation. This is well documented in excellent reviews [1,2]. Information about recent progress may be found in Refs. [3–5].

However, other features related to the time variability of the solar radiation should be taken into account. Indeed, the same amount of solar energy may be received at ground in different days, despite the time variation of the incident solar global irradiance is

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