Concentrated solar power plants: Review and design methodology

H.L. Zhang, J. Baeyens, J. Degrève, G. Caçeres

Abstract

Concentrated solar power plants (CSPs) are gaining increasing interest, mostly as parabolic trough collectors (PTC) or solar tower collectors (STC). Notwithstanding CSP benefits, the daily and monthly variation of the solar irradiation flux is a main drawback. Despite the approximate match between hours of the day where solar radiation and energy demand peak, CSPs experience short term variations on cloudy days and cannot provide energy during night hours unless incorporating thermal energy storage (TES) and/or backup systems (BS) to operate continuously. To determine the optimum design and operation of the CSP throughout the year, whilst defining the required TES and/or BS, an accurate estimation of the daily solar irradiation is needed. Local solar irradiation data are mostly only available as monthly averages, and a predictive conversion into hourly data and direct irradiation is needed to provide a more accurate input into the CSP design. The paper: (i) briefly reviews CSP technologies and STC advantages; (ii) presents a methodology to predict hourly beam (direct) irradiation from available monthly averages, based upon combined previous literature findings and available meteorological data; (iii) illustrates predictions for different selected STC locations; and finally (iv) describes the use of the predictions in simulating the required plant configuration of an optimum STC.

The methodology and results demonstrate the potential of CSPs in general, whilst also defining the design background of STC plants.

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