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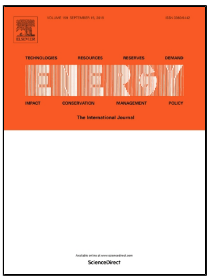

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A novel optimal design method for concentration spectrum splitting photovoltaic–thermoelectric hybrid system

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Abstract

In this paper, a novel optimal design method for the concentration spectrum splitting photovoltaic-thermoelectric hybrid system is proposed. The newly provided optimal design method tries to optimize the solar energy distribution of the concentration spectrum splitting photovoltaic-thermoelectric hybrid system while maintaining the optimal operating states of the subsystems, which has never been mentioned before. For the optimal design, the optimum operating temperature of the hybrid system is firstly determined. Then, a series of cutoff wavelengths of the spectral splitter is given, and the efficiencies of the coupling systems with all different cutoff wavelengths are calculated. The highest efficiency and the optimal cutoff wavelength will be obtained by comparing the performances of the concentration spectrum splitting photovoltaic-thermoelectric hybrid systems with different cutoff wavelengths. The optimal thermoelectric thermal resistance and structure factor related to the optimum operating temperature of the thermoelectric subsystems are finally acquired. The effects of the thermoelectric figure of merit and the convective heat transfer coefficient of the cooling system on the optimal design are also discussed. The results show that the optimal temperature distribution of the thermoelectric subsystem can be obtained by regulating the thermoelectric structure factor. Although the solar energy transferred to the thermoelectric subsystem decreases, as the cutoff wavelength increases, the thermoelectric efficiency can be increased through optimization. The optimal cutoff wavelength of the spectral splitter decreases with the increase of the thermoelectric figure of merit, and a thermoelectric module with smaller thermal resistance should be used to maintain its optimum operating temperature.

Keywords: Spectrum splitting; Photovoltaic-thermoelectric hybrid system; Optimal design method; Solar energy;

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