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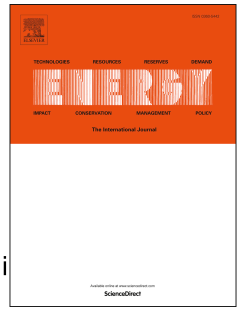

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# Performance improvement of a direct carbon solid oxide fuel cell system by combining with a Stirling cycle

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**Abstract**: An external heat source and a Stirling cycle are proposed for performance improvement of a direct carbon solid oxide fuel cell (DC-SOFC) system. The amount of the heat released in the DC-SOFC is determined based on a previously validated 2D tubular DC-SOFC model, in which the electrochemical reaction, chemical reactions, ion/electronic charge transport, mass transport and momentum transport are fully considered. Numerical calculations show that the overall heat released in the cell may be smaller than, equal to or larger than the heat required by the internal Boudouard reaction, and accordingly, three different operating modes of the system are given. The analytical expressions for the equivalent power output and efficiency for the DC-SOFC, Stirling cycle and the hybrid system are specified under different operating conditions. The results show that the power density and efficiency of the proposed system allow 4000 W $m^{-2}$ and 30% larger than that of the stand-alone DC-SOFC at 30000 A $m^{-2}$, respectively. Parametric studies also show that a higher operating temperature and a smaller distance between carbon layer and anode will increase the overall power density and efficiency of the proposed system.

**Keywords:** Solid oxide fuel cell; Solid carbon; Boudouard reaction; Stirling cycle; heat management

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