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A novel hybrid CSP-PV power plant based on brayton supercritical CO2 thermal machines

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Abstract-

A novel hybrid CSP-PV power plant is presented. Instead of the integration used in current hybrid power plants, where part of the PV production is charged into the thermal energy storage system through electrical resistors, the proposed system integrates both PV and thermal solar fields using a high-temperature heat pump. Both the heat pump and the heat engine are based on Brayton supercritical CO2 thermodynamic cycles. Such integration allows for charging the molten salt storage as if a central tower receiver field supplied the thermal energy, whereas parabolic trough collectors are employed. Unlike conventional hybrid plants, where the storage of PV production leads to a decrease in power injected into the grid throughout the day, the power injected by the proposed system remains constant. The heat engine efficiency is 44.4%, and the COP is 2.32. The LCOE for a 50 MWe plant with up to 12 h of storage capacity is USD 171/MWh, which is lower than that of existing CSP power plants with comparable performance. Although the cost is higher compared with a PV plant with batteries, this hybrid system offers two significant advantages: it eliminates the consumption of critical raw materials in batteries, and all the electricity produced comes from a synchronous machine.

Index Terms- Brayton supercritical CO2 power cycle; high-temperature heat pump; thermal energy storage; Carnot battery; CSP-PV hybrid power plant

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