

Integration of concentrated solar power plants in renewable-only VPP with electrical and thermal demands: A two-stage robust bidding approach

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Abstract-

This paper proposes the integration of Concentrated Solar Power Plant (CSP) in the Renewable-only Virtual Power Plant (RVPP) for bidding in the electricity day-ahead and secondary reserve markets, as well as trading thermal energy through a heat purchase agreement. A reformulated two-stage robust optimization approach is introduced to account for multiple uncertainties, including electricity prices, non-dispatchable renewable energy sources’; electrical production, CSP thermal production, and uncertainties in electrical and thermal demand consumption. The provision of energy and reserve by the thermal storage of CSP is modeled using an adjustable approach, which allocates a share of energy for up and down reserves based on the profitability of the RVPP. Simulations are conducted for several case studies to demonstrate the effectiveness and computational efficiency of the proposed approach under different RVPP operator decisions against uncertain parameters and various trading strategies for electricity and thermal energy. The simulation results show that integrating CSP into RVPP enhances RVPP flexibility for both electrical and thermal trading. Furthermore, the results indicate that the profitability of the RVPP increases when all trading options are considered, across different levels of conservatism adopted by the RVPP operator in response to uncertain parameters.

Index Terms- Concentrated solar power plant; Virtual Power Plant; Thermal storage; Electricity markets; Heat purchase agreement; Robust optimization

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