

# **Flexible robust optimal bidding of renewable virtual power plants in sequential markets under asymmetric uncertainties**

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## **Abstract-**

**In this paper, a novel approach to define the optimal bidding of Renewable-only Virtual Power Plants (RVPPs) in the day-ahead, secondary reserve, and intra-day markets is proposed. To this aim, a robust optimization algorithm is developed to account for the asymmetric nature of the uncertainties that characterize the market prices, as well as the energy production of the RVPP stochastic sources and flexible demand consumption. Simulation results show increased RVPP benefits compared to other existing solutions and demonstrate the potential of renewable sources to further increase their economic competitiveness. The simplicity of the implementation, the computational efficiency, and the flexible robustness are also verified.**

**Index Terms-** Energy markets; renewable-only virtual power plant; reserve markets; robust optimization; stochastic sources

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