

# **Flexible robust optimization for Renewable-only VPP bidding on electricity markets with economic risk analysis**

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## **Abstract-**

**This paper investigates the joint participation of Renewable-only Virtual Power Plants (RVPPs) in the energy and reserve markets while considering the imbalance costs in the balancing market. Existing research on robust optimization typically relies on the well-known parameter called the uncertainty budget to define the level of conservatism. However, this parameter is not defined based on economic factors but rather on the nature of each uncertainty. This work introduces a regret-based flexible robust optimization problem to address this gap, accounting for various sources of uncertainty in energy and reserve prices, as well as the production of non-dispatchable renewable energy sources and demand consumption. The concept of average regret is developed and implemented through a set of mixed-integer linear constraints to help the RVPP operator gain relevant economic insights regarding this parameter. Simulation results demonstrate the applicability of the regret-based robust optimization formulation in determining an interpretable level of conservatism against different uncertainties.**

**Index Terms-** Renewable-only Virtual Power Plant; Regret; Flexible robust optimization; Electricity market

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