

Optimal Sizing of Hybrid Power Plants Considering Multiple Electricity Market Participation

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The short-term uncertainties associated with renewable energy resources lead to imbalances in the power systems, posing major challenges for operators. Energy storage systems, such as batteries, are increasingly considered a promising solution to mitigate these concerns. Thus, co-located wind and battery hybrid power plants (HPPs) operating with a single grid connection are poised to play a vital role in achieving balance in future energy systems. In addition, batteries can potentially improve revenue generation for HPP owners in the electricity markets. However, assessing the profitability of HPPs across different electricity markets such as spot market and balancing market to offset initial investment costs requires a thorough investigation, making optimal HPP sizing crucial. Optimal decisions are also critical for battery operation in various electricity markets, necessitating the modeling of HPP energy management system (EMS) for market participation. Hence, this work proposes a novel EMS that captures spot and balancing markets and performs efficiently within an outer non-linear sizing optimization, aiming to determine the plant's optimal bidding strategy in different electricity markets and optimal plant design for higher returns on investment. Simulations for a wind-dominated region in Northern Europe show significant potential to enhance HPP profitability up to 4 times through strategic multi-market participation and optimal plant sizing.