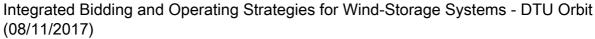
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Integrated Bidding and Operating Strategies for Wind-Storage Systems

Due to their flexible charging and discharging capabilities, energy storage systems (ESS) are considered a promising complement to wind farms (WFs) participating in electricity markets. This paper presents integrated day-ahead bidding and real-time operation strategies for a wind-storage system to perform arbitrage and to alleviate wind power deviations from day-ahead contracts. The strategy is developed with two-price balancing markets in mind. A mixed integer nonlinear optimization formulation is built to determine optimal offers by taking into account expected wind power forecasting errors and the power balancing capability of the ESS. A modified gradient descent algorithm is designed to solve this nonlinear problem. A number of case studies validate the computational efficiency and optimality of the algorithm. Compared to the existing strategies, the proposed strategies yield increased economic profit, regardless of the temporal dependence of wind power forecasting errors.

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