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Energy-constrained model for scheduling of battery storage systems in joint energy and ancillary service markets based on the energy throughput concept

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Summary

Among different local renewable resources, using battery energy storage (BES) has grown more than other technologies. The main reasons for this growth are flexibility and schedulability of BES. The fast ramp rate of BES systems provides the opportunity for effective participation of these resources in the regulation ancillary service. However, continuous charging and discharging cycles of BES could decrease its lifetime and the expected profit, consequently. Therefore, the lifespan is a crucial parameter that shall be considered in the scheduling of BES. In this paper, an energy-constrained model is proposed for the scheduling of BES in joint energy and ancillary service markets. Moreover, the Energy Throughput (ET) concept is proposed for modeling the lifetime in the short-term scheduling strategy. In the proposed strategy, the uncertainties of energy prices in energy and regulation markets are modeled by the Robust Optimization (RO) methodology. The scheduling problem is linearized and formulated based on the mixed-integer linear programming (MILP) method. The proposed model determines the optimal scheduling of BES based on profit maximization, operational constraints, lifespan, and the defined risk level. Finally, the performance of the model is evaluated via different case studies.

Highlights

- An Energy-constraint model is proposed for scheduling battery energy storage units in energy and balancing markets.
- In the short-term scheduling, the lifetime of batteries is modeled by a new approach, which is the Energy Throughput concept.
- A linear robust model is presented to evaluate the financial risk of uncertain parameters.