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A hierarchy model to use local resources by DSO and TSO in the balancing market

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Summary

Due to the increasing penetration level of local generating resources at the distribution network, the transmission system operator (TSO) and distribution system operators (DSOs) need to coordinate their operations to use these resources and provide the required energy and regulation for the power system. This work proposes a hierarchy model for scheduling the local flexible resources at the distribution and transmission levels. In the first stage, the optimal bidding strategy of balance service providers (BSPs) and the distribution balancing market-clearing problem are formulated by a bi-level optimization problem, respectively. At this stage, the lower-level sub-problem is replaced by the Karush–Kuhn–Tucker (KKT) conditions, and the bi-level problem is formulated as a mathematical programming with equilibrium constraints (MPEC) problem. Results of the first stage are considered as fixed parameters for the second stage problem, which specifies the feasible bids of local resources that the TSO can dispatch. At the second stage, DSO checks the feasibility of remaining bids, which are not dispatched in the distribution balancing market, and determines the maximum regulation capability of the local resources that the TSO can use. Simulation results indicate that in the IEEE 33-bus distribution test system with the total imbalance energy of 4.672 MWh, 32.36% and 67.64% of the required power are compensated by transmission balancing market and local resources, which results in a reduction of 24.32% in balancing costs.

Highlights

- An optimal strategy for balance service providers at distribution and transmission levels is determined.
- A two-stage model is proposed for using local flexibility resources by balance service providers.
- A hierarchy model is proposed for coordination between DSO and TSO.