Reducing Overall Costs of Day-Ahead Dispatch with Intra-interval Power Balance Modeling

Xiaobing Zhang, Yi Wang, Zhifang Yang\*

ABSTRACT**—**With the accelerating integration of renewable energy sources into power systems, intra-day dispatch adjustment following day-ahead market clearing has become increasingly necessary. While these adjustments effectively mitigate system operation risks, they unavoidably drive up intra-day ex-post adjustment costs. Current day-ahead market clearing paradigms exhibit fundamental limitations by predominantly minimizing ex-ante operational costs while disregarding the cascading impacts of intra-interval power imbalances—a critical oversight that inflates overall costs spanning both market phases. To bridge this methodological gap, this paper proposes a novel day-ahead market clearing framework incorporating intra-interval power balance features through stochastic programming. Firstly, we conduct a systematic investigation into the fundamental origins of ex-post adjustment costs, employing an asymmetric affine policy to formally characterize intra-interval uncertainties in day-ahead dispatch. Secondly, we develop an innovative chance-constrained day-ahead economic dispatch model that explicitly incorporates both intra-interval power balance requirements and the probabilistic nature of uncertainty. Through analytical convexification methods, the proposed model is rigorously transformed into a computationally tractable second-order cone programming formulation. Thirdly, a marginal pricing mechanism matching the proposed market clearing model is derived via duality theory. It is rigorously proven to satisfy the incentive compatibility for market participants. Numerical analysis on IEEE 118-bus demonstrates the efficiency of the proposed method, achieving an average 0.876% reduction in overall costs compared to current methods, with particular effectiveness when the dispatch intra-interval net-load prediction error is 0.25%.

KEYWORDS—Day-ahead market economic dispatch, System overall cost, Ex-post adjustment cost, Prediction error uncertainty, Pricing incentive proof

Appendix A

We assume that the prediction mean value and standard deviation of the net-load with 5-minutes are the percentage of the prediction value. Due to the impact of prediction uncertainty for the net load on the line transmission power and the dispatch intra-interval unit balance power, we recognize that the line transmission power and the dispatch intra-interval unit balance power also exhibits uncertainty.

Considering equations (1) to (7), we express the branch power as in (A1):



Thus,  is also random, and its sensitivity of the uncertainty component can be analytically formulated as in (A2):



Assuming that the mean and the standard deviation of the net-load uncertainty component are known, the operating boundary capacity margin of line transmission can be analytically formulated as in (A3) and (A4):





Therefore, the (21) can be transformed as in (A5):



Similarly, considering (1)-(5), the dispatch intra-interval unit *i* balance power can be rewritten as (A6) and (A7):





Thus,  and  is also random, and its sensitivity of the uncertainty component can be analytically formulated as in (A8) and (A9):





Similarly, the balance power margin of the unit can be analytically formulated as in (A10)-(A12):







The (22)-(23) can be transformed as in (A13):



Where, the value of the standard deviation transfer factor , which is determined by the probability threshold  of chance-constrained over-limit and the distribution of the net-load.

In this paper, we assumed the prediction error uncertainty of the net-load to obey Gaussian distribution, the values of can be decided by (A14) at a give .



Where, the  represent the probability density function of Gaussian distribution.

Appendix B

The list the Lagrangian function corresponding to the proposed dispatch model (1)-(5), (16)-(18), (21)-(23) as shown in (B1):



Appendix C

After the DAM clearing ended and closed, the IEA according to the net load prediction curve with fine-grained clears the power deviation. The IEA model is shown below.













The Lagrangian function of the model (C1)-(C6) shown in (C7).



The optimal condition of  is,





Therefore, substituting (C9) into (C8).



Consequently,



Because  and ,



Because , , are positive values, will always be nonnegative.