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

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***Abstract*—****With the accelerating integration of renewable energy sources into power systems, intra-day dispatch adjustments following day-ahead market clearing have 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 methods predominantly focus on minimizing ex-ante market operating costs while neglecting the consequential increase in intra-day ex-post adjustment costs. It ultimately elevates system overall costs spanning both day-ahead and intra-day stages, affecting the economic efficiency of system operation. Therefore, this paper proposes a day-ahead market clearing method with the embedment of intra-interval power balance features to reduce overall costs of day-ahead and intra-day dispatch. Firstly, we formulate the uncertainty of the system net-load with fine-grained and intra-interval power balance features in the day-ahead dispatch interval. Secondly, based on chance-constrained optimal power flow, we establish a day-ahead market economic dispatch model with the embedment of intra-interval power balance features.** **It can be transformed into a second-order cone convex model by analytical method. Thirdly, based on the marginal pricing principle, we derive the price signal of the proposed market clearing model, which is proved to provide incentive signals for market participants to comply with dispatch instructions. Finally, case study demonstrates that the proposed method can reduce the overall costs both day-ahead and intra-day dispatch with the increases of the fine-grained net-load uncertainty.**

***Index Terms*—electrical spot market, day-ahead market economic dispatch, intra-day dispatch adjustments, prediction error uncertainty, system overall cost**

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.