Wasserstein-metric-based distributionally robust optimization method for unit commitment considering wind turbine uncertainty

gengrui chen[1], Donglian Qi[1], yulin chen[2], yaxin wang[3], and jingcheng mei[3]

[1]Zhejiang University
[2] Hainan Institute of Zhejiang University
[3]zhe jiang da xue

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Abstract

Abstract The penetration of wind turbines in the power grid is increasing rapidly. Still, the wind turbine output power has uncertainty, leading to poor grid reliability, affecting the grid's dispatching plan, and increasing the total cost. Thus, a distributionally robust optimization (DRO) method for thermal power unit commitment considering the uncertainty of wind power is proposed. For this method, energy storage and interruptible load are added to simulate increasingly complex electricity consumption scenarios. Furthermore, the amount of load cutting reflects the satisfaction level of electricity consumption on the user side. Based on Wasserstein metric, an ambiguity set is established to reflect the probabilistic distribution information of the wind power uncertainty. An ambiguity set preprocessing method is proposed to depict the probability distribution of ambiguity set more clearly, to minimize the operation cost under the condition that the uncertainty of wind turbine output power obeys the extreme probabilistic distribution of the ambiguity set. The test case in a modified version of the IEEE 6-bus system shows that the proposed method can flexibly adjust the robustness and economy of optimization decisions by controlling the sample size and the confidence of Wasserstein ambiguity set radius. In addition, the proposed ambiguity set preprocessing method can obtain more economical dispatching decisions with a smaller sample size.

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