

Power system flexibility quantitative evaluation: A case study of Zhangjiakou



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Background

Proposing a quantitative evaluation method for power system flexibility analysis is crucial for renewable energy development, as flexibility is one of the fundamental factors to affect renewable power curtailment. Zhangjiakou is currently the only national renewable energy demonstration zone in China. However, as it faced severe curtailment issue during the 13th Five-Year Plan period, it is necessary to come up with technical and economic available solutions to improve local power system flexibility. The ERI of NDRC and NCEPU jointly develop a quantitative evaluation model – H3E - which could analyze this issue for Zhangjiakou. The results is published as a research paper on [Energy](#).

About the model

The existing quantitative methods to evaluate power system flexibility have some limitations such as not comprehensively describing the physical features of flexibility, not fully considering the uncertainties in the power system, and not possessing high computational efficiency. These will bring challenges to evaluate large-scale power system flexibility and study mid- to long-term flexibility improvement path. Therefore, combined with the definition of power system flexibility, a sequential and efficient quantitative method is proposed and built as a model called H3E. It is an uncertainty model that considers the uncertainties of key components on power generation, transmission, load and storage sides. In combination of the established models, H3E introduces the improved universal generating function, a more efficient uncertainty analysis tool, to carry out power system sequential production simulation, as well as flexibility evaluation.

The H3E model proposes a flexibility metric system which comprehensively considers flexible regulation ability, power supply reliability and economy of the power system. The effectiveness of the method has been verified in IEEE test system and the method has been applied to several practical cases such as Beijing-Hebei-Tianjin region. Comparing with other flexibility evaluation methods, H3E could provide stronger theoretical support for large-scale power system flexibility evaluation and study of regional flexibility improvement path.

Case study of Zhangjiakou

The model adopts four major flexibility solutions covering power generation, transmission, load and storage in Zhangjiakou, Hebei province. The case study shows that coal-fired unit flexibility retrofit would be the prior choice for Zhangjiakou; this is followed by improving interconnectors in power transmission system, introducing demand side response service, and installing energy storage facilities. By combining the short-mid-and long term renewable energy development plans of Zhangjiakou, the paper proposes specific flexibility solutions for different time phases.

Figure: Short-mid- and long-term power system flexibility improvement paths for Zhangjiakou

