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Editorial: Flexibility analysis and regulation technology of clean energy system

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Editorial on the Research Topic
Flexibility analysis and regulation technology of clean energy system

1 Introduction

Today's power system is facing various challenges brought by large-scale renewable energy integration, which puts forward higher requirements for flexibility. Therefore, it is an effective measure to actively build a clean, low-carbon, safe, and efficient energy system with renewable energy such as wind energy and solar energy as the core. The research topic (Flexibility Analysis and Regulation Technology of Clean Energy System) aims to achieve efficient control of clean energy systems in clean energy scenarios in new power systems and provide a communication platform.

2 Published papers

The research topic contains a total of 16 articles. Under the basic premise of energy security, with a strong smart grid as the hub platform, we will establish a clean, low-carbon, controllable, flexible, and efficient new power system based on renewable energy.The articles included in The Research are mainly divided into two directions: 1) Optimization control of distribution networks containing renewable energy generation 2) Power system load forecasting.

For the optimization control of distribution networks, a distribution network scheduling model is established based on the economic indicators, frequency, voltage, and other aspects of the power system.

Wang et al. proposed an evaluation method for quantifying the flexibility of distributed multi energy microgrids in order to effectively utilize their regulatory flexibility. Virtual establishment of flexible bus and assignment of flexible parameters to reflect flexible characteristics. To consider the impact of operational uncertainty on multi energy microgrids, a two-stage adaptive robust optimization model is proposed, which can be solved using the C&CG algorithm.

Yu et al. mainly evaluated and analyzed the economic and technical indicators of distributed power grids, and proposed the advantages and disadvantages, application scope, and objective functions of each indicator. By optimizing location and capacity, voltage quality can be improved, power grid losses can be reduced, and investment costs can be reduced. In addition, the investment cost can be recovered by actively participating in demand response based on the price control mechanism, and the investment cost can be recovered by appropriately increasing the electricity price.

Luo et al. proposed a cloud edge coordination fast adjustment strategy based on intelligent transformer power supply area edge consistency algorithm to address the problem of long-term prediction bias in distribution networks. The edge transformer power supply area cluster performs global initial optimal allocation, and then the cluster performs secondary collaborative optimal allocation for the edge area. A fast power interaction model within a cluster based on consistency algorithm was established, and the micro growth rate of scheduling cost was used as the consistency variable to optimally allocate the cluster adjustment amount to each transformer power supply area, minimizing the total scheduling cost of all transformer power supply areas.

Luo et al. designed an auction method to achieve low-carbon economic scheduling, using blockchain technology to reliably record the entire process data. According to the regional division of market entities, the Owen value method is used to allocate carbon emissions to regions and entities. In order to reduce the expected carbon emissions of the entity, an additional carbon price is added to the original quotation by allocating the results. Based on the typical output characteristics of wind and photovoltaic power generation in bilateral bidding markets, optimization control is conducted hourly.

Lu et al., established a combined wind energy and solar energy hydrogen electrolysis system, and assessed the hydrogen production potential of 31 provincial regions in China in 2050, taking into account the impact of regional wind energy solar load characteristics and transmission costs.

Kun et al., based on the external characteristics of photovoltaic cells, established a mathematical model of the equivalent circuit of distributed photovoltaic power supply and proposed the control mode of the distributed power grid when the distribution network fails.

Lv et al., to realize the efficient and economic operation of building a microgrid, put forward a multi-objective optimization method for planning and operating a microgrid considering virtual energy storage.

Wang et al. established a frequency regulation model of power systems including the primary operation dynamics of the wind turbines and proposed a dynamic integrated inertial control method according to the relationship between load, wind speed, and frequency.

Zhu et al., comprehensively analyzed the working principle of the charging process of electric vehicles, analyzed the relevant factors affecting the failure of power batteries and charging equipment from multiple perspectives, and summarized the relationship between power batteries and charging equipment.

Sun et al. proposed an emergency frequency control method based on deep reinforcement learning to solve the problem of controllable load-shedding response time. The method evaluates the emergency control response capability of the controlled load from three aspects: load response time, controllable load, and controllable load bus.

Su et al., taking the power battery energy storage configuration cost, voltage fluctuation, and load fluctuation as objectives, established a multi-objective optimization model for power battery energy storage configuration and solved it using non dominated sorting genetic algorithm.

Zhu et al. put forward a method for energy storage capacity allocation of wind farm groups. A two-layer model of shared energy storage allocation is established. The upper model optimizes the shared energy storage configuration of each wind farm group to minimize the risk of the out-of-limit output of the wind power base; The lower model calculates the out-of-limit output power of each wind farm group according to the energy storage capacity distribution and transfers the out of limit output power value to the upper model.

Hao et al. put forward a mechanism for evaluating the power balance and power trading potential of the Lancang Mekong countries and South China under long-term operation simulation. The mechanism analyzes the energy supply structure, energy utilization form, cross-border transmission capacity, and multi-regional power trading potential of Lancang Mekong countries and China Southern Power Grid.

For power system load forecasting, the included articles establish a load forecasting model for the power system based on the coupling relationship between loads.

Yang et al. proposed a multi load forecasting method that considers the coupling characteristics of multiple loads and the partitioning of load similar fluctuation sets.

Liu et al. provided a comprehensive review of power information fusion methods for the first time, providing the framework of power information fusion methods and the types of power data.

Li et al. proposed a charging demand prediction model based on real-time data of Baidu Maps. This model can explain the driving strategy and charging strategy of electric vehicle users based on the ability to generate strategy learning against imitative learning.

3 Perspectives

To sum up, 16 papers have been published, including the continuous research results of experts in related fields. These findings will help readers better understand and learn the latest knowledge in relevant fields.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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