Discussion on Short-Term Dynamic Economic Dispatch of Renewable Energy High Penetration Power Grid

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Abstract. Before the widespread use of alternative energy sources, economic dispatch only included traditional thermal power units, which needed to consume a large amount of non-renewable energy and produce polluting emissions such as carbon, sulfur and nitrogen. In the current situation of increasingly serious energy crisis, wind energy has become an important representative of new energy. However, wind energy is difficult to predict, so that the output power of wind turbines cannot be dispatched and distributed as expected, and the intermittent and random nature of wind energy will also bring security and stability threats to the entire grid after large-capacity wind power is connected to the grid. Therefore, it is necessary to study a reasonable short-term economic dispatching energy saving plan including wind farms. Therefore, in-depth analysis of the coordination and interaction mechanism between high-penetration distributed power sources and other dispatching resources, and discussion of reasonable optimal dispatching methods are of great significance for promoting the consumption of high-penetration distributed renewable energy and improving the safe and economic operation of the power grid.

Keywords: Economic dispatch, renewable energy, load forecast.

1. Introduction
With the gradual advancement of my country’s energy structure reform, distributed power systems represented by photovoltaics and wind power have been widely used in power grids due to their flexible access, clean and low-carbon advantages. High-penetration distributed power sources are connected to the active distribution network, which can supply power to users nearby, reduce the large-scale and long-distance transmission of electric energy, and make up for the lack of centralized power generation. However, due to the decentralization of its access location and the inherent characteristics of randomness, volatility, and intermittency of output, distributed renewable power has brought huge challenges to the traditional power grid dispatching operation mode, so this article focuses on the high penetration rate of distributed, the status and problems of short-term optimal dispatch of power grids are discussed in depth.
2. Current status of economic dispatch research

2.1. Economic dispatch with renewable energy
Economic dispatch mainly includes long-term economic dispatch and short-term economic dispatch. This article mainly discusses the short-term economic dispatch of power systems containing wind farms, that is, using a 24-hour a day as a cycle to study the optimal unit combination arrangement of wind turbines. For short-term dispatch models with wind farms, relevant research has been done at home and abroad. Literature [1] studies the economic dispatch model of virtual power plants that takes into account electricity consumption behavior under the carbon trading mechanism. Literature [2] studies the dynamic economic dispatch of renewable energy power generation. Literature [3] studied the economic optimization dispatching model of the combined cooling and power system with multiple renewable energy sources and cold energy storage devices. Literature [4] carried out research on the economic dispatch of microgrid in Southwest China based on two-stage robust optimization. Literature [5] studies the day-ahead economic dispatch of the power system considering the randomness of renewable energy and demand response. Literature [6] studied the optimal dispatching model and optimization method of power system considering demand response.

2.2. Short-term economic dispatch
At present, domestic and international economic dispatch optimization technologies are booming. Whether from the long-term power market perspective or the algorithm development of the solution, both domestic and foreign universities and scholars have achieved remarkable results: Literature [7] studies considering N-1 Robust optimization of safety-constrained transmission grid structure with renewable energy. Literature [8] studied the economic dispatch of regional integrated energy system based on improved two-stage robust optimization. Literature [9] studied the short-term optimal economic dispatch of linearized unit commitment. Literature [10] studied the two-layer optimization method for economic operation of microgrid containing renewable energy. Literature [11] studied the short-term load forecasting of the power grid and the nonlinear economic dispatch of the water-heat hybrid system. Literature [12] studied the optimization method of short-term water and fire combined economic dispatch of cascade power stations.

2.3. Research on economic dispatching algorithm
In terms of economic scheduling algorithm, this part of the content involves the optimal solution, the length of the solution, plus the non-linearity, multi-dimensionality, and non-convexity of the economic scheduling problem, and the multi-objective also involves Pareto optimization. Multi-party participation also involves multi-party game solving. No algorithm is fully applicable to all economic dispatch models. According to different objective functions, constraint conditions, etc., it is necessary to adjust the algorithm and choose the most suitable algorithm for the solution of a specific economic dispatch model.

Common algorithms are nothing more than two categories, traditional planning methods and intelligent optimization algorithms (typically heuristic algorithms). Mainly include genetic algorithm, particle swarm algorithm, interior point method, pattern search algorithm, differential evolution algorithm, teaching and learning optimization algorithm, tabu search algorithm and other algorithms.

3. Analysis of the impact of renewable energy on the power system

3.1. Impact on economy
The impact of renewable energy access on economy includes two parts: cost and benefit, thereby changing the result of traditional power planning with economy as the goal.

In terms of cost, renewable energy access itself includes investment in renewable energy generator sets, construction costs of renewable energy power plants, and fixed and variable costs incurred in the process of operation and management. Limited by the development of technology, the price of
renewable energy generators is high, but in recent years there has been a significant decrease. In order to realize the access of renewable energy, it is also necessary to add power generation and grid-connected projects on the grid side to support, which will bring certain equipment investment costs and grid-connected engineering construction investment costs to the grid companies. In addition, in order to deal with the uncertainty of renewable energy output, it is necessary to increase the reserve capacity of the system at this stage, which increases the cost of consumption. Especially in order to adapt to the fluctuation of output, the operating point of the thermal power unit deviates from the optimal coal consumption point or the unit has to be started and stopped frequently, which increases the power generation cost of the conventional unit.

In terms of benefits, renewable energy power generation is a green, pollution-free and renewable power generation method that can not only obtain energy, but also reduce the emission of atmospheric pollutants such as carbon dioxide and sulfur dioxide, with obvious environmental benefits. Of course, renewable energy power generation will also cause some negative impacts on the environment, which are mainly reflected in noise impact, visual impact, impact on birds, electromagnetic radiation, etc., but compared with conventional power generation methods, these effects are almost negligible.

It should also be noted that the access of renewable energy may cause some equipment in the power grid to be lightly loaded or even idle, thereby affecting the economic operation of the equipment. In addition, the integration of renewable energy into the grid will affect the distribution of the power flow of the power grid, and the distribution of the power flow is the main factor that determines the power grid loss. The increase of power grid loss will inevitably lead to the decline of power grid efficiency.

3.2. Impact on reliability
The failure and recovery process of renewable energy power generation components, the influence of climatic conditions, and planned maintenance are different from conventional generator sets, which will inevitably affect the overall reliability of the power system, thereby changing the results of traditional power planning with reliability as a constraint.

Taking wind power as an example, there have been a large number of studies to analyze and calculate the reliability of the power system after wind power is connected. The reliability analysis methods of power systems including wind farms can be divided into two types: analytical method and simulation method. The literature results show that the reliability of wind turbines is far lower than that of traditional ones. The capacity of wind power integrated into the system and the location of the access point will all have different effects on the reliability of the system. However, it should be noted that the access of renewable energy will also have a beneficial side to the safe and reliable operation of the power grid, such as increasing the power transmission and distribution margin of the power system; if certain devices are installed, voltage regulation can also be effectively performed. To reduce the risk of voltage sag.

3.3. Impact on load forecasting
Traditional power planning is based on the predicted annual maximum load as the balance point of supply and demand. The difference between supply and demand caused by load fluctuations can be adjusted by automatic power generation control. However, renewable energy power generation is uncertain and uncontrollable, especially with strong seasonality, and power generation output fluctuates widely. Relevant studies have shown that there is almost no correlation between system load forecasting and renewable energy output forecast, and there is no mature technology to accurately predict the system net load after a high proportion of renewable energy is connected. The uncertainty of renewable energy and the uncertainty of the trend brought about by it makes it difficult for planners to accurately predict the overall load growth.
4. Solutions
Analyze the current power system operation stability and reserve, as well as grid load forecasting with distributed power and renewable energy. Establish a unified economic dispatch model to explain the rolling dispatch, dispatch time window, change time solution and input constraints. The two-tier operation model, three-tier operation model and model solution of short-term dispatch in the power system dispatch process are briefly analyzed. Explain the role of random unified economic dispatch in modern power system dispatch. It analyzes different operating scenarios and reserve requirements, mainly explaining the role of load and wind power forecasting in unified economic dispatch, focusing on analyzing load forecast errors and reserve requirements, and generating different scenarios. Establish a dynamic economic dispatch model with a solution interval of 5 minutes, which can reduce the dimensionality of the model variable complexity. Finally, the simulation is explained smoothly, and the effectiveness of the proposed algorithm and the practicality of the proposed method are analyzed.

5. Summary
By summarizing the existing literature, it can be found that the penetration rate of renewable energy has an important impact on the economic dispatch model. In the current economic dispatch of power grids, it is of far-reaching significance to study the impact of renewable energy on the economic dispatch of power and the solution of ultra-short-term economic dispatch models and algorithms. It is also meaningful to further improve the reliability of power supply, reduce environmental pollution, and comprehensively improve the economics of the power grid. Provide effective reference.

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