Computer Analysis and Smart Calculation of New Energy Operation Information by Big Data

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Abstract. In order to promote the consumption of new energy and rationally arrange the preparation of dispatching plans, a new energy operation analysis and application system based on big data is proposed. Taking wind power consumption as the research content, the application of big data technology in wind power information statistics and analysis is analyzed. The calculation method of wind power obstruction based on big data is proposed, and the performance evaluation process is proposed in combination with the consumption demand of new energy. Finally, simulation experiments are used to illustrate the effectiveness of the method proposed in this paper.

Key words: Big data, new energy, blocked wind power, system analysis.

1. Introduction

Wind power generation is highly dependent on natural weather conditions, and its power generation capacity fluctuates greatly. At the same time, due to the constraints of the grid structure, the current scale of new energy construction is increasing, and the possibility of restriction in some areas is gradually increasing. In order to effectively carry out wind power dispatch, it is necessary to predict the wind power in advance. The obstruction of power generation provides strong data support for the priority consumption of new energy and the safe and stable operation of the power grid.

In the fields of wind curtailment, The institutional barriers for wind curtailment in China [1] are analyzed. Decomposing driving factors for wind curtailment under economic new normal in China are discussed [2]. Market segmentation and wind curtailment are analyzed [3]. The role of state-owned enterprises in wind power investment versus wind curtailment is put forward [4]. Wind curtailment in China and lessons from the United States are discussed [5]. In [6], scheduling electric vehicle charging to minimize carbon emissions and wind curtailment is proposed. In [7], energy management of CHP-based microgrid with thermal storage for reducing wind curtailment is proposed. In [8], analysis of energy storage systems to exploit wind energy curtailment in Crete is carried out.
2. Analysis of wind power characteristics and obstruction reasons

2.1. Wind power characteristics
The analysis of new energy power output characteristics is the basis for the study of new energy power grid connection and control, and its purpose is to make the new energy power generation output electric power more stable. Affected by the natural environment and weather, new energy power represented by wind energy and solar energy shows obvious volatility and intermittency, which leads to the risk of frequency fluctuations and system instability in power networks containing new energy generation.

The 250-hour power output characteristic curve of a wind farm is shown in . It is easy to know that wind power generation exhibits obvious power output fluctuation and intermittency, and there is no obvious fluctuation and intermittency.

![Fig. 1 Typical wind output](image)

2.2. Wind power obstruction reasons
The power of wind power generation is affected by weather factors such as wind speed, and has great randomness and volatility. Due to the randomness and volatility of wind power, it is difficult to meet the power demand of the load, and conventional power supplies are required for peak shaving. However, the installed capacity of wind power in China has increased by 115 times in the past 10 years, far exceeding the development speed of system load, resulting in a reduction in the proportion of conventional power supply peak-shaving capacity and a serious shortage of power system peak-shaving capacity. Insufficient peak shaving capacity has become the main factor hindering wind power consumption.

In the case of large-scale wind power grid connection, the conventional power output adjustment speed is slow, and the generation unit is restricted by the minimum technical output, resulting in limited space for down-regulation on the power supply side of the grid. At the same time, the characteristics of wind power reverse peak regulation will cause the source and load power imbalance at night. To ensure the normal operation of the system, wind abandonment is usually required to maintain the power balance on the source and load side, as shown in Figure 2.
Insufficient peak shaving capacity of conventional power sources makes the system unable to absorb surplus wind power, reducing the available time of wind power. Therefore, improving the ability of down-peak regulation to absorb blocked wind power is an urgent problem to be solved.

3. Obstructed wind power calculation based on big data

3.1. Wind power big data characteristics

Wind power equipment monitoring devices not only need to collect more than 30 state parameters such as power generation, vibration, and energy conversion of the wind turbine, but also need to monitor external wind speed, temperature, humidity and other data, thereby forming a massive data flow to the data platform. On the basis of storing these data efficiently and reliably, the data platform also provides fast data query and access methods. The big data of wind power presents the following three characteristics, which pose certain challenges to the calculation of the blocked power of wind power:

(1) The data volume is huge. At present, intelligent monitoring devices installed in large-scale wind farms can collect data at a frequency of 10 min, 5 min, 1 min or even higher, and the amount of data generated has increased exponentially, and the scale of data has grown from TB to PB, which brings the problem of "data disaster". The power industry needs to develop more reliable storage technologies to cope with the ever-increasing massive data resources.

(2) The data has temporal and spatial characteristics and relevance. On the one hand, wind power monitoring data collection process generally identifies the collection location and collection time. On the other hand, wind power related application research needs to conduct association mining and analysis on various data from the spatial and temporal dimensions. Due to the large number of data types involved in association analysis, the demand for multi-source data association query is increasing. How to optimize the storage and optimization of wind power generation obstructed data and provide efficient associated query methods in a big data environment is an urgent problem to be solved.

(3) High data processing rate requirements. Wind power related application research requires calculation and analysis of massive data, which requires data storage and query technology to be able to deal with the challenges of subsequent high-rate data processing.

3.2. Obstructed wind power calculation method

The theoretical power and blocked electricity calculation methods of wind farms mainly include model machine method, wind tower extrapolation method and nacelle wind speed method.

The state of the wind turbine is classified into categories; among them, the state of the wind turbine includes the normal power generation state, the off-site blocked state, and the on-site blocked state; among them, the off-site blocked state includes dispatching power limit derating, dispatching outage standby, and off-site tired outage. The obstructed state of the site includes planned outages, unplanned outages, and on-site tired outages. Dispatched outage standby refers to the outage of wind turbines
caused by the maintenance of power grid equipment in accordance with the power grid dispatching and maintenance instructions during the operation of the power grid. Off-site affected shutdown refers to the outage of wind turbines due to equipment operation failures on the grid side during the operation of the power grid. Planned outage refers to the outage of wind turbines caused by the overhaul of power equipment in the wind farm in accordance with dispatching instructions. Unplanned outages refer to the outages of wind turbines in the wind farm due to the malfunctioning of the wind turbines. On-site exhausted stand-by refers to the outages of wind turbines caused by equipment failures other than the wind turbines; The impact of thermal power, hydropower and other power supplies on the grid side requires a reduction in the supply of wind power.

Among them, the calculation method of the blocked electricity inside and outside the wind farm is as follows:

\[ E_{i,j} = \Delta t \cdot \sum_{j=1}^{n} \left( P_{j,i} - P'_{j,i} \right) \]

\[ E_{O,j} = \Delta t \cdot \sum_{j=1}^{n} \left( P'_{j,i} - T_{j,i} \right) \]

Among them, \( E_{I,j} \) is the blocked electricity in the wind farm, \( E_{O,j} \) is the off-site blocked electricity of wind farm \( j \); \( P_{j,i} \) is the theoretical power generation of wind farm \( j \) at time \( i \); \( P'_{j,i} \) is the available power generation of wind farm \( j \) at time \( i \); \( T_{j,i} \) is the actual power generation of wind farm \( j \) Power generation; \( n \) is the number of samples in the statistical period; \( \Delta t \) is the time resolution.

The theoretical power generation of the entire grid is obtained by summing the theoretical power generation of all grid-connected wind farms in the grid:

\[ P = \sum_{j=1}^{N} P_{j} \]

Among them, \( P \) is the theoretical power generation of the whole network; \( P_{j} \) is the theoretical power generation of wind farm \( j \); \( N \) is the number of all wind turbines in the whole network.

The blocked power in the whole grid is obtained by summing the blocked power in all grid-connected wind farms in the grid:

\[ \Delta P_{I} = \sum_{j=1}^{N} \left( P_{j} - P'_{j} \right) \]

The blocked power in the whole network is obtained through the blocked power points in the whole network:

\[ E_{I} = \sum_{j=1}^{N} E_{I,j} = \Delta t \cdot \sum_{j=1}^{n} \Delta P_{I,j} \]

Among them, \( \Delta P_{I} \) is the blocked power in the whole network; \( E_{I} \) is the blocked energy in the whole network; \( E_{I,j} \) is the blocked energy in the wind farm \( j \).

The blocked power of the whole grid is obtained by subtracting the available generating power of all wind farms from the available generating power of the whole grid:
The blocked power of the whole network section is obtained through the integral of the blocked power of the whole network section:

$$\Delta P_G = \sum_{j=1}^{N} P_j' - P'$$

Among them, $\Delta P_G$ is the blocked power across the entire network; $E_G$ is the blocked energy across the entire network.

4. New energy operation and consumption capacity analysis process
Calculating the optimal power generated by the generating units in a high-proportion new energy system that is compatible with the system should take into account the economics, safety, and inherent characteristics of the system. In terms of economy, it includes the power consumption cost of various units and the corresponding electricity price level. In terms of safety, it is necessary to consider the maximum power allowed to be sent and passed by the unit, line, and equipment to ensure that the power does not exceed the limit and the voltage fluctuation is within the allowable range. In terms of inherent characteristics, there is need to take into account the specific structure, connection mode, line impedance and load level of the regional grid.

The first part is to establish an optimization model for wind power obstruction analysis. For the system to be studied, select the specific research time scale, collect, analyze, and consider the information and data of the system to be evaluated in a typical day, and study the grid to be evaluated from the three aspects of economy, safety and inherent characteristics, including: ① Various types of grids The cost of power generation consumption of power plants, stations, and equipment (including traditional energy and renewable energy); ② Regional electricity price level; ③ Power upper limit of various power generation equipment in the grid; ④ Power flow constraints satisfied by the system; ⑤ Voltage fluctuation range; ⑥ Regional load level; ⑦ Grid structure parameters. Based on the above data, a mathematical model for calculating the optimal power dissipation of the system to be evaluated is obtained.

The second part is to calculate the blocked electricity of wind power. Combining the span range of the time scale to calculate the electric quantity, the index result of evaluating the integration capacity is obtained.

The third part is to systematically evaluate the integration ability, current status and improvement measures of the research object.

5. Application and analysis
Taking a wind farm in 2017 as an example, the method proposed in this article is used to calculate the blocked power of wind power under various conditions, as shown in the following table:
It can be seen from the above table that in 2017, the wind farm’s annual obstructed total electricity accounted for 35.95%. Among them, the wind abandonment rate due to on-site obstruction is 15.62%, and the abandonment rate due to off-site obstruction is 20.32%. The statistics in the above table show that the abandonment of wind power caused by the failure (unplanned outage) is the largest abandonment power of the blocked wind power in the site, and the cross-section constrained abandonment power is the maximum abandonment power of the blocked power off-site. The failure of the unit is characterized by the performance defect of the unit. Therefore, the performance defects of the unit and the wind curtailment caused by the cross-section constraint are the main factors affecting the wind power consumption of the wind farm, and the others are secondary factors. Therefore, the wind curtailment caused by the cross-section constraint and the wind curtailment caused by the unit performance defects is the most urgent need to be solved problem.

6. Conclusion
This paper analyzes the reasons for the obstruction of wind power, and mainly explains the calculation methods based on big data analysis for the total cross-section of wind farms across the grid, and the peak shaving of the entire grid wind farms. The analysis process can provide data support for the priority consumption of new energy power generation.

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