Analysis on Main Problems and Solutions of System Peak Shaving After Large-Scale Wind Power Integration

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1. Introduction

Since 13th Five-Year, the power supply structure has been optimized in China, and renewable energy installed capacity has accounted for more than 35%. At the end of 2017, the installed capacity in China is 1780GW, 164GW grid-connected wind power installed capacity, accounting for 9.2% of the total installed capacity; in 2017, the full-aperture power generation capacity of 6.4×106GW·h grid-connected wind power generation capacity of 3×105GW·h, an increase of 26.3% in China. According to the Guiding Opinion on the Implementation of the 13th Five-Year Plan for Renewable Energy Development, the new construction scale of wind power in 2017-2020 will be 110GW. By 2020, the installed capacity of wind power in China will reach 210GW.

Under the situation that the power grid must ensure that the renewable energy generation is fully connected to the grid, with the continuous expansion of the scale of wind turbines, the rapid development of offshore wind power, coupled with the random, intermittent and anti-peak-shaving characteristics of wind power generation, the contradiction between wind power Grid-connected Generation and peak-shaving of power system is becoming increasingly prominent. The low reliability of wind power affects the development of wind power. Therefore, measures must be taken to solve it.

2. Review of System Peak Shaving

2.1. The necessity of peak shaving

With the continuous expansion of wind turbine assembly capacity, the increasing proportion of power generation, conventional power supply is constantly replaced, the power grid frequency modulation ability is seriously constrained and the stability of the power grid is threatened; with the increase of the proportion of new energy at the receiving end and the feeding end, the dynamic reactive power reserve of the system decreases sharply and the reactive power support capacity is insufficient; with the increase of the proportion of wind turbines, the problem of regional wide-band oscillation may occur due to the
combined influence of various power regulation equipment; when large-scale wind power grid operating, once the grid impact occurs, large areas of wind power will be disconnected due to the unique protection design of wind turbines, resulting in greater impact on the grid. Based on the above several cases, it is necessary to arrange enough reserve capacity of conventional power supply, and use peak shaving measures to solve the problem, so as to indirectly enhance the stability and capacity credibility of wind power generation.

2.2. Peak load regulation mode
In the current generation system in China, according to the different peak-valley value changing modes of the equivalent load of the power grid, the peak-shaving effect of wind power can be divided into three peak-shaving modes: inverse peak-shaving, positive peak-shaving and over-shaving. The different modes of peak shaving are determined by the trend of wind power sunrise and load curve. Figure 1-3 shows a typical daily curve corresponding to the three modes intercepted in the timing load curve of Gansu power grid and the simulated wind power output curve. The daily curves of different peak shaving modes are shown in Figure 1-3.

![Figure 1. Schematic diagram of wind power reverse peak shaving](image1)

![Figure 2. Schematic diagram of positive peak shaving for wind power connection](image2)
2.3. Main problems encountered in peak shaving

2.3.1. Restriction of heating to peak load regulation. At present, although the grid is trying to increase the capacity of wind power absorption, there are still some wind abandonment. The wind abandonment rate in 2017 was 12%, down for 5% compared with that in 2016. In the northern region, especially in the "three north" region, the proportion of urban heat and power cogeneration units occupies a relatively large proportion. In winter nights, the wind resources are abundant and the load of power grid is at a low ebb stage. The operation mode of heating units "heat to power" restricts their power generation capacity. With the increasing proportion of heating units and the increasing demand for heating, the peak-shaving capacity of the system is severely constrained during the heating period, the amount of wind power on the grid is limited, and the contradiction between peak-shaving of the power system and the proportion of cogeneration units is deepening. The situation of abandoned wind in China in the past 2011-2017 years is shown in Figure 4.
2.3.2. **Insufficient peak load capacity.** In order to absorb new energy sources, relevant policies and methods are being promulgated all over the country. Taking Shandong Province as an example, Shandong Province promulgated the "Shandong Province Renewable Energy Peak-shaving Unit Priority Generation Trial Method" in 2016. In 2017, eight renewable Peak-shaving Units were identified, with an increase of 350MW of the total network depth peak shaving capacity. However, in the late half of the year, the negative reserve shortage of the grid occurred many times during the nighttime wind power generation period, and it was very difficult to absorb new energy because wind power and photovoltaic power exceeded 1000MW in many midday periods in winter. Renewable energy peak-shaving units participate in peak-shaving based on forecasting new energy generation capacity. It is a kind of extensive control mode with low flexibility and frequent start-up and shutdown of renewable energy peak-shaving units to participate in peak-shaving during difficult periods of absorption. In order to cope with long-term low load or load fluctuation, the equipment of units is damaged. It is more difficult to adjust the peak load of power system in case of emergency maintenance.

3. **Measures to Solve Peak Shaving Problems in Chinese Wind Power Generation System**

3.1. **Building UHV channels to increase wind power outgoing capacity**

At present, the problem that affects the full amount of wind power is the absorption of wind power, which can be solved by establishing a nationwide interconnected power grid. Wind farms are generally built in the "three north" areas where there is plenty of wind energy. These areas have strong wind power and are suitable for wind power generation. However, the economy is relatively backward. At the same time, in order to ensure winter heating, the amount of electricity generated by heating monsoon wind power is severely restricted by cogeneration units, so the local power grid cannot accept too much wind power. It is transported to more economically developed areas through UHV channels.

3.2. **Development of multi energy complementary intelligent micro grid power generation system**

For the unstable wind power and the low flexibility of peak-shaving units, it can be solved by developing a multi-energy complementary intelligent micro-grid power generation system. For example, in areas with low central heating coverage, new or existing wind turbines are bundled to build heating thermal power units, and wind-fire complementary micro-grid power generation systems are constructed. On the basis of plant-level power planning under grid dispatch, the plant-level power is allocated for the purpose of completely absorbing wind power, and the thermal power units are allocated according to wind power output. Real time compensation. In southern China, there are abundant hydropower resources. Wind turbines and hydropower can complement each other to generate electricity. When the wind is strong, the water energy will be accumulated. The power grid uses the electricity produced by wind power completely. When the wind is weak, the water power will make up for the shortage of wind power and realize peak shaving. The development of multi-energy complementary intelligent micro-grid power generation system can greatly shorten the peak shaving dynamic response time, improve flexibility, and reduce the impact on the grid after large-scale wind power disconnection, conducive to the construction of large-scale wind farms.

3.3. **Improve the peak shaving incentive mechanism, encourage flexibility transformation**

When the wind power is sufficient, according to the law of supply and demand, the electricity price on the market will be reduced, the profit of the thermal power plant will be reduced, when the cost price or below, the thermal power plant will not have any profit, or even loss. Therefore, it is necessary to improve the peak shaving incentive mechanism and encourage the cogeneration units to carry out flexible transformation, which can be matched with the construction of electric boilers, isoelectric-thermal conversion equipment, heat storage tanks and other heat storage equipment, as well as steam turbine low-pressure cylinder zero-output transformation. During the period of large wind power generation, the thermal power plant is encouraged to reduce its output, and the restriction on the peak
shaving ability of the system is broken by the operation mode of “determining electricity by heat” of the thermal power unit.

3.4 Building energy storage facilities to reduce wind energy wastage
Wind energy is unstable and is likely to generate large amounts of electricity when electricity demand is low. Energy storage equipment is needed to store excess electricity. Pumped storage power stations like hydropower stations can be used for peak shaving and wind abandonment when electricity demand is high. Waste.

3.5 Improve the accuracy of wind power forecasting
As a kind of weather phenomenon, the variation characteristics of wind are irregular. Peak shaving is the basis of adjusting the output of peak shaving units according to the prediction of wind load curve, which is the basis of safe and stable operation of power system. At present, most wind power forecasting is based on wind power forecasting system and weather conditions provided by local meteorological bureau, but the accuracy is still low, it is necessary to improve the accuracy of wind power forecasting, in order to accurately calculate the peak-shaving capacity of power grid, to avoid inadequate peak-shaving allowance of the system in the period of wind power generation.

4. Conclusion
As a kind of clean energy, wind power will be widely used in China in the future, so it is necessary to solve the peak shaving problem in the current wind power generation process. This paper introduces the relevant information about peak shaving and how to strengthen the system peak shaving capacity after wind power access, we hope to bring some inspiration to relevant practitioners and promote the progress of power industry in China.

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