Analysis of influence of large-scale External power on East China Power Grid

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Abstract. The reliability of external power is of great significance to the protection of regional power, with the continuous development of grid structure, the ability of accept external power has been greatly improved. However, the continuous increase of the external power has posed new challenges to the power consumption and the peak regulation and the safe and stable operation of the power grid. According to the present situation and development planning of East China Power Grid, the influence of large-scale external power on East China Power Grid is analysed. The results show that the external power sent to East China Power Grid in the future should not be too large, and East China Power Grid should speed up the construction of pumped storage power stations, and give full play to the role of platform, and comprehensively configure and utilize external power sources in the area, which can promote the safe and stable operation of the power grid.

1. Introduction
The East China Power Grid is one of the largest inter-provincial and municipal power grids in China[1], covering four provinces and one city in Shanghai, Jiangsu, Zhejiang, Anhui and Fujian. East China is poor in energy resources, and the regional resources are difficult to meet the needs of its own development. For a long time, it has been necessary to purchase a large amount of electricity from other provinces to meet its own electricity needs. The absorption of external power by East China Power Grid is not only in line with the strategic decision of the large-scale development of the western region and the transmission of electricity from west to east[2] [3], but also can solve the contradiction between power supply and demand of East China Power Grid, reduce the pressure of environmental protection in the transportation of coal from north to south[4] and East China, and realize the sustainable development of the national economy [5] [6].

The East China Power Grid is the first power grid to realize cross-regional power supply, and now it undertakes the largest cross-region power receiving task in China. By the end of 2019, a total of 12 external power were sent to East China Power Grid, including 11 inter-district DC and 1 cross-region AC, with a total scale of 73100MW (accounting for 16.3% of the total installed capacity of East China), of which the total transmission capacity of hydropower and thermal power outside were 31800MW and 41300MW, respectively. Among the external power sent to East China Power Grid, the cross-region AC is Yangcheng communication. In the cross-district DC, GE Nan, Yihua, Lin Feng and Fufeng DC are connected to Shanghai Power Grid, Longzheng, Jinsu DC, Xitai DC, Yanhuai DC, Shanxi Yangcheng
DC are connected to Jiangsu Power Grid, Binjin DC and Lingshao DC are connected to Zhejiang Power Grid. Jiquan DC is connected to Anhui Power Grid.

The continuous increase of the scale of external power has posed new challenges to the power consumption and the peak regulation and the safe and stable operation of the power grid. In order to actively respond to the new trend of power development in East China Power Grid, promote the optimal allocation of power resources inside and outside, plan the power supply and power grid construction as a whole, and strengthen the safe and stable operation level of the power grid while meeting the requirements for the consumption of external power, in this paper, The influence of external power on the power market space, peak regulation and safe and stable operation of East China Power Grid is studied by analyzing the operation characteristics of external power from different regions, which provides a reference for the future power supply and power grid planning of East China Power Grid.

2. Operation characteristics of external power

At present, the power transmission plans of most external hydropower DC lines are arranged according to the operation requirements of the power supply or the power surplus of the power grid at the sending end, and the power generation is concentrated in the flood season, which accounts for a large proportion of the annual power generation, which basically does not regulate peak with the load. There are few cases of power transmission considering the load demand of the receiving end, so non-peak regulation transmission often occurs. It brings new challenges to the low-valley power consumption and peak regulation of East China Power Grid. The power generation of external thermal power is relatively uniform, but because most of the external thermal power is bundled with local wind power, photovoltaic power and other new energy, so its own operation flexibility is limited.

In addition, the distribution of external power in many provincial and municipal power grids in East China basically distributes power in each period of time according to the proportion of electricity stipulated in the framework agreement, which has little effect on alleviating the peak regulation pressure of the receiving end of the power grid. Sometimes, some provincial power grids have to passively absorb a large amount of valley power, which brings greater challenges to the load regulation of provincial power grids.

3. Analysis of Electric Power balance and Peak regulating balance

When analyzing the electric power balance of East China Power Grid, conventional hydropower, thermal power, gas power, nuclear power, pumped storage power stations and external power participate in the balance according to existing, under construction and approved projects, and renewable energy such as wind power and photovoltaic power generation participate in the balance according to the planned scale. the decommissioning plan of the unit is considered in the balance.

The results of electric power balance show that the power market space of East China Power Grid is 116240MW in 2030, and East China Power Grid still has a certain power market space in 2030. The power gap of East China Power Grid in 2030 is 337.8 billion kWh. The annual utilization hours is 2906h, indicating that East China Power Grid should increase the use of less hours of power in 2030. Based on the analysis of the load growth of each province and city of East China Power Grid, considering the load increment of each province and city, East China Power Grid should give full play to its platform role after external power from outside the area are sent in, according to the actual consumption situation of each province and city, dispatch the reasonable proportion of the scale of external power among the provinces and cities.
storage power station is more obvious. that compared with the peak regulation of external power, the peak regulation effect of the pumped influence on the peak regulation. Through the sensitivity analysis of pumped storage scale, it is found load rate of power grid and the peak regulation amplitude of thermal power in the area also have great power increases during the low flood period, and it is necessary to shut down the pressure load operation of thermal power units and nuclear power units, and the thermal power units and external power should properly participate in the peak regulation, or appropriately reduce the capacity sending into the East China Power Grid during the low flood period, it is known that the peak regulation pressure of thermal power in East China Power Grid in 2030 is 48.0%. Through the analysis of the peak regulation of the East Power Grid, if the proper peak regulation of thermal power and nuclear power units is considered, it is

| Project                        | East China | Shanghai | Jiangsu | Zhejiang | Anhui | Fujian |
|--------------------------------|------------|----------|---------|----------|-------|--------|
| Maximum load                   | 466000     | 40000    | 170000  | 126000   | 88000 | 64500  |
| Standby rate                   | 12%        | 12%      | 12%     | 12%      | 12%   | 12%    |
| Effective capacity             | 521920     | 44800    | 190400  | 141120   | 98560 | 72240  |
| Actual effective capacity      | 405680     | 42711    | 142852  | 105083   | 51575 | 63459  |
| Effective capacity inside      | 346890     | 32883    | 117116  | 85718    | 47714 | 63459  |
| 1.1 Conventional hydropower    | 12438      | 358      | 382     | 3594     | 939   | 7165   |
| 1.2 Pumped storage             | 27190      | 2566     | 4944    | 10130    | 4550  | 5000   |
| 1.3 Thermal power              | 274162     | 29020    | 101780  | 62860    | 41944 | 38558  |
| 1.4 Nuclear power              | 27800      | 689      | 7210    | 7734     | 55    | 12112  |
| 1.5 Wind power                 | 2700       | 125      | 1400    | 450      | 225   | 500    |
| 1.6 photovoltaic power         | 2600       | 125      | 1400    | 950      | 0     | 125    |
| 2 External effective capacity  | 58791      | 9828     | 25737   | 19365    | 3861  | 0      |
| 2.1 external hydropower        | 38228      | 9828     | 13638   | 13888    | 874   | 0      |
| 2.2 external thermal power     | 20563      | 0        | 12099   | 5477     | 2987  | 0      |
| Electricity market space       | -116240    | -2089    | -47548  | -36037   | -46985| -8781  |
The above analysis results show that the peak-valley difference of East China Power Grid system is increasing day by day in the future. With the continuous increase of external power and new energy scale, the peak regulation range and pressure of thermal power in East China Power Grid in the future is higher. It is difficult to meet the requirements of safe, stable and economic operation of the power grid, so there is an urgent need to build a peak-regulating power supply.

4. The optimal allocation of power source
Based on the composition of the power supply participating in peak regulation balance in East China Power Grid in 2030, adjust the scale of thermal power, gas power and pumped storage power stations, maintain the principle that other power sources are installed, and optimize the power supply structure of East China Power Grid. From the calculation results, it can be seen that the present value of the total cost of the system is the smallest in the scheme of pumped storage power station, and when the scale of pumped storage power station is 43500MW, the present value of power system cost is at a low ebb, and the flexibility and economy of power system operation are better.

The influence of different peak regulation amplitude of thermal power on the scale of pumped storage power station is analyzed on the basis of power system power structure optimization simulation. At the same time, the scale of pumped storage power station is analyzed when the peak regulation amplitude of coal power is 38% with different peak regulating amplitude of other power. Considering the economy of the system, the peak regulation capacity and possibility of all kinds of power sources, it is recommended that the reasonable scale of pumped storage power station in East China Power Grid in 2030 is 43500MW, accounting for about 8.1% of the total installed capacity of the system.

5. Conclusion
According to the analysis of power demand forecast and power planning, if the scale of external power into East China Power Grid is too large, it will squeeze the power generation space of units in the grid, and the problem of insufficient peak regulation capacity of the power grid will become increasingly prominent. In order to ensure the safe and stable operation of East China Power Grid and the basic interests of local power sources, the scale of external power sent into East China Power Grid in the future should not be too large. The East China Power Grid should speed up the construction of pumped storage power stations, improve the grid frame, give full play to the role of the platform, and co-ordinate the allocation and utilization of external power, so as to promote the safe, stable and economic operation of East China Power Grid.

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