Power purchase optimization strategy of State Grid Zhejiang Electric Power Co., LTD.

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Abstract. During the marketization process of electricity purchase and power generation, some users such as urban and rural residents still purchase power from the power utility, which don't need or are not ready to participate in the market. To meet the power demand of these users, grid utility need to purchase power from the units that belong to priority power generation. This part of power purchase of grid utility should ensure reasonable returns under the requirements of the policy. The power purchase optimization strategy of State Grid Zhejiang Electric Power Co., LTD. is proposed in this paper, which is consistent with the current situation and reform background in Zhejiang Province.

1. Introduction
Zhejiang Province has accelerate the marketization process of electricity purchase and power generation [1]. More and more power users will purchase power from the electricity market [2][3]. However, some users such as urban and rural residents still purchase power from the power utility, which don't need to participate in the market or not ready to participate in the market [4].

To meet the power demand of these users, grid utility need to purchase power from the units that belong to priority power generation [5]. In Zhejiang Province, State Grid Zhejiang Electric Power Co., LTD. is the grid utility, which is responsible for selling electricity to the above users. The power purchase optimization strategy of grid utility should ensure reasonable returns under the requirements of the policy. In theory, State Grid Zhejiang Electric Power Co., LTD. can purchase power from non-regulated power plants of dispatch center, wind power, solar photovoltaic power, hydropower power, gas fired power, nuclear power, purchased power from other provinces, and coal fired power. The power purchase optimization strategy of State Grid Zhejiang Electric Power Co., LTD. is proposed in this paper.

2. Analysis of the current situation and reform background
At present, State Grid Zhejiang Electric Power Co., LTD. is facing the main reform situation including the marketization process of electricity purchase and power generation and the reform of transmission and distribution price of grid utility.

2.1. Power supply, external power supply and power consumption in Zhejiang province
As shown in the Table 1, it can be seen that the secondary industry accounts for a relatively high proportion of the total electricity consumption in Zhejiang province, accounting for 269.79 billion
kWh, or about 81.2%. Among the industrial sectors, the manufacturing sector used the most electricity, accounting for 224.47 billion kWh, or about 85.4%.

| Types                                           | Cumulative power consumption (billion kWh) |
|-------------------------------------------------|-------------------------------------------|
| Total electricity consumption of the whole society | 388.43                                    |
| Total power consumption of the whole industry    | 332.43                                    |
| The first industry                               | 1.79                                      |
| The second industry                              | 269.79                                    |
| The third industry                               | 60.86                                     |
| Total domestic electricity consumption of urban and rural residents | 56.00                                    |
| Urban residents                                  | 30.78                                     |
| Rural residents                                  | 25.23                                     |

By the end of October 2019, the accumulative on-grid power (supplied to the power grid) of Zhejiang province was 258.91 billion kilowatt-hours, significantly lower than the accumulative total power consumption of the whole society of Zhejiang province was 388.43 billion kilowatt-hours.

Of this total, 15.80 billion kilowatt-hours were generated by wind power, solar photovoltaic power and biomass power, accounting for 6.1%. Hydropower generated 23.91 billion kWh, accounting for 9.2%. The cumulative net power of thermal power is 178.020 billion kilowatt-hours, accounting for 68.8%. Thermal power is still the main power source, including 12.05 billion kilowatt-hours of gas-fired power generation. The cumulative net power generated by nuclear power was 48.02 billion kWh, accounting for 18.5%. Nuclear power is an important part of power supply in Zhejiang province.

It is estimated that the Zhejiang Electric Power Co., LTD. will purchase 162 billion kilowatt-hours of on-grid power from other province in 2019. Among them, the priority power generation (government catalogue tariffs) part is 92.33 billion kilowatt hours, and the on-grid electricity price is 405.05 yuan per kilowatt hour. The market pricing part is 69.67 billion kilowatt-hours, and the on-grid electricity price was 385.10 yuan per kilowatt-hour.

2.2. Marketization process of electricity purchase and power generation.
In Zhejiang, power users with a voltage level of 10kV and above in the province can participate in the electricity market. Among them, 110kV and above power users are referred to as "wholesale market users", and they can choose to participate in wholesale electricity market or be represented by electricity sales companies in retail electricity market. Wholesale power transactions can be conducted through bilateral negotiations, centralized bidding, and platform listing. Power users between 10kV and above and below 110kV are referred to as "retail users" and participate in electricity market by means of electricity sales companies.

Inter-provincial power market transactions are prioritized, and the results are used as the boundary conditions for power markets in Zhejiang Province. The electricity market in Zhejiang Province includes medium and long-term market and spot market. Medium and long-term market are designed to stabilize market supply and demand and help market entities avoid price risks. The purpose of spot electricity trading is to balance the deviation between long-term transactions and actual loads, and to improve the efficiency of competition in the electricity market.

Zhejiang electric power spot market adopts a centralized market model, which consists of the following rules:
- Market entities include coal-fired, gas, hydropower, nuclear power (non-scenery) of 220kV and above under the provincial dispatch centre, wholesale users of 110kV and above, and electricity sales companies.
- The power generation side declares the price in accordance with the capacity segment. The user side only declares the electricity, not the price. The previous day's quote results are used in the real-time market.
Node prices are used at the generating side, and node-weighted average prices are used at the user side.

- Contract for difference CFD is used for transaction settlement.
- Congestion management is based on node electricity prices.
- Wind power and solar photovoltaic power generation do not participate in the electricity spot market.

2.3. Transmission and distribution price reform
At present, the second round of transmission and distribution price reform in Zhejiang Province has begun. The current round of price verification cycle is from 2020 to 2022. At present, the results of cost supervision and examination and price verification have not been announced, and it is expected that there may be price reductions.

3. Power purchase optimization strategy of Zhejiang Electric Power Co., LTD.
For the market-based electricity part, Zhejiang Electric Power Co., LTD. only charges the transmission and distribution price of the electricity in the market. It does not get income through the difference between the purchase and sale of electricity. In contrast, priority power generation and purchase is non-market electricity. Zhejiang Electric Power Co., LTD. needs to undertake the purchase and sale of electricity by the catalogue tariffs. The priority power purchase consists of residents, agriculture, important utilities and public service industries, which is determined by the government. Then, to optimize the power purchase strategy, it is needed to determine the priority power generation.

According to the relevant national policy requirements and the actual situation in Zhejiang Province, each power supply type (including power from other provinces) is analyzed to determine the priority power generation part. Various types of power sources in Zhejiang mainly include non-regulated power plants of Dispatch Center, wind power, solar photovoltaic power, hydropower power, gas fired power, nuclear power, purchased power from other provinces, and coal fired power (if not otherwise specified, the above refers to the power generation under the Zhejiang Dispatch Center).

3.1. Electricity that is not under the Zhejiang dispatch center
At present, the electricity that is not under the Zhejiang dispatch centre is difficult to be involved in the electricity market. So it can be regarded as priority power generation.

3.2. Wind power and Solar photovoltaic power
Wind power and solar photovoltaic power in Zhejiang Province are fully acquired by grid utility (Zhejiang Electric Power Co., LTD.) by catalogue tariffs, i.e., not participating in the electricity market. Therefore, wind power and solar photovoltaic power are the priority power generation.

3.3. Power from other provinces
Power from other provinces includes priority power generation and market-oriented generation. In terms of price, the price of power from other provinces is relatively low compared with other kinds of power generation in Zhejiang.

3.4. Hydropower
Hydropower is priority power generation. Hydropower prices are higher in Zhejiang Province. The policy of hydropower is for full consumption in Zhejiang Province. Some hydropower stations are expensive. The reason is the high cost of immigration and construction, and the cost of auxiliary services has been considered in the price.

3.5. Gas power
Gas power is not priority power generation, and gas power prices are higher compared with other kinds of power generation in Zhejiang Province.
3.6. Nuclear power
Nuclear power is priority power generation. The nuclear power prices are slightly higher than coal power in Zhejiang Province.

3.7. Coal-fired power generation
Coal-fired power generation is not priority power generation. Its price is relatively lower compared with other kinds of power generation in Zhejiang Province.

3.8. Power purchase optimization strategy
Therefore, this paper proposes the power purchase strategy as follows. All electricity purchased outside the province that has not yet though the market-based transaction remains in priority power generation. Clean energy sources such as wind power, solar photovoltaic, hydropower, and nuclear power are retained in priority power generation. The remaining priority power purchase is coal power. Gas and electricity all entered the power market. According to the above method, it is estimated that in 2020, the on-grid power of the priority power generation will be 143.39 billion kWh. The average on-grid electricity price is 423.69 yuan per kWh.

4. Conclusion
This paper focuses on the power purchase optimization strategy of State Grid Zhejiang Electric Power Co., LTD. The current situation and reform background is analysed, which includes marketization process of electricity purchase and power generation, transmission and distribution price reform. Then, the power purchase optimization strategy of Zhejiang Electric Power Co., LTD. is proposed. All electricity purchased outside the province, clean energy sources such as wind power, solar photovoltaic, hydropower, and nuclear power are retained in priority power generation.

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