Research of Trading Mechanism on New Energy to Replace the Captive Power Plant

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Under the background of energy saving and low-carbon economy in our country, it is the inevitable choice to develop new forms of renewable energy generation with great efforts and adjust the power structure for the power industry to respond positively to the national policy and fulfill their social responsibilities. So we need to study how to improve the phenomenon of wind power curtailment and solar power curtailment and to enhance the level of new energy consumption. This paper introduced the captive power plant into power generation transactions. And let the new energy companies buy generation right from enterprise-owned power plant to improve the phenomenon of wind power curtailment and solar power curtailment. On this basis, we design clearing processes and alternative processes of new energy to replace owned power plant and measure corresponding interests of all parties.

Keywords: New Energy Consumption; The Captive Power Plan; Power Generation Right Transaction

1. Introduction

Traditional energy sources cannot meet the growing demand for energy gradually as the result of the increasing of energy demand, depletion of fossil fuels with the rapid development of the world economy. At the same time, vigorously development of renewable energy is an effective way to response to the climate change and achieve energy reduction targets, which has far-reaching significance for sustainable development of our economy.

To solve the new energy consumptive problem, scholars launched a lot of research. Literature [1] introduced new energy consumption problem into power system planning process and established a network planning method. Some scholars pointed out that the factors limiting new energy connected into the grid include power flow and the node voltage [2-3]. Literature [4] and [5] established...
algebraic models to solve power limit of wind power connected into the grid in consideration of power system static security constraints. Literature [6] modified the maximum capacity of the wind farm after testing the security and stability of system by the system simulation, and then successive calculated wind farm grid capacity limits Literature [7] pointed out that partition configuration of the wind farms and PV fields would produce better results than configuration in the same area.

Based on previous studies including substitute trading patterns of generate electricity right of thermal power plants[8-12], we introduce the enterprise-owned power plant into new energy consumptive mode for the first time, based on which we design alternative processes and settlement processes of new energy instead of the enterprise-owned power plant to participate in the generation rights trade. And then we conduct a feasibility study for introducing the enterprise-owned power plant into new energy consumption problem.

2. Alternative Process

It is large-capacity, environmentally friendly desulfurization units that replace power generation enterprises in the conventional substitute transaction mode of public thermal power plants. We learn from this transaction model and take new energy plants to replace enterprise-owned power plant to achieve a reduction of new wind energy plants abandoned (light) electricity targets, while we face the risk of abandoning wind power (solar power) in the new energy plant after public thermal power units have been reduced to minimum operating mode, which means meeting the need of residents heating operation mode or minimally satisfying the operation of the grid.

Enterprise-owned power plant thermal power units reduce the output for the new energy plant in the case of new energy plant facing abandoning output. Transfers working is in accordance with centralized auction trading patterns. In the implementation process, power grid enterprises pay to the new energy companies who win the bid according to an alternative electricity price of enterprises owned power plant. These new energy companies pay the tariff price difference (transaction compensation benefits) to the captive power plant. The captive power plant pay to the grid enterprise according to the increasing purchase of electricity with the corresponding flat section price.

Therefore, transactions subjects in this paper that replacing the captive power plant with new energy plant to participate in trading the generation rights (we use wind power plant to replace the new energy plant in this paper), include:
Be replaced: a company which has owned thermal power plant in a region. Replacing: wind power enterprises; Transmission side: a provincial power grid companies. Alternative flow shown in Figure 1.

3. Clearing Process

It is easy to get accurate calculation of the offline power of the captive power plant owned enterprise, namely metering point data can be achieved by calculating with current technology. However, the corresponding abandoned wind power result from adjusting the captive thermal power output is hard to be calculated. During the transaction, we use the reduction output of captive power plant to represent alternative abandoned wind power, and to define with the following principles:

Firstly, we define the adjustment period of alternative power. When the grid thermal power run with the minimum operating mode, if there is wind farms abandoned wind power, the dispatcher will inform the captive power plant to increase the offline load and record information about four nodes, namely offline magnitude of the adjustment (P2), beginning time (T1), the actual load at the beginning (P1) and the cut-off time (T2).

Secondly, we define offline measurement and adjustment of electricity at the time. First, we use electricity to extract the power data with acquisition system, and then do the integrated calculation according to the relevant information. Such as using the extracted data (the bottom code value at the...
gateway, the difference and the ratio etc.) to calculate the measurement of electricity ($W_1$) and the difference between the two power ($W_2$). The specific formula is as follows:

$$W_1 = (T_2 - T_1) \times \text{ratio}$$  \hspace{1cm} (1)

$$W_2 = W_1 - (T_2 - T_1) \times P_1$$  \hspace{1cm} (2)

$$w_{1x} = \frac{w_0}{W_{all}} \times W_{all}$$  \hspace{1cm} (3)

Where, $w_{1x}$ means alternative electricity of new energy plant of number $x$; $w_0$ means electricity access to the grid of new energy plant of number $x$; $W_{all}$ means electricity access to the grid of all new energy plants; $W_{all}$ means alternative electricity of all new energy plants. Specific pricing process shown in Figure 2:

4. Feasibility Analysis

In this paper, the interest calculation is based on price of the Xinjiang region. At present, Xinjiang thermal power desulphurization coal-fired unit electricity price is 0.25 yuan / kWh, wind power electricity price is 0.58 yuan / kWh. Therefore, grid enterprise needs to pay 0.25 yuan each degree to the wind power company, government subsidies to wind power 0.33 yuan each degree. And we assume that the wind power plant separates 0.2 yuan/kWh from its...
income, namely 0.58 yuan/kWh. Economic analysis of the results of trading interests of various stakeholders are as follows:

4.1. **Wind power business interests: A**

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\[ A = (P_1 - P^*) \times Q \]  

(4)

Where, \( P_1 \) is the highest price that a wind power plant can withstand, \( P^* \) is the actual transaction, \( Q \) is the volume. Since the marginal cost of wind power is 0, we can obtain the final income each degree of the wind power plant:

\[ 0.25 \text{ yuan/kWh} + 0.33 \text{ yuan/kWh} - 0.2 \text{ yuan/kWh} = 0.38 \text{ yuan/kWh} \]

4.2. **The captive power plant interests: B**

\[ B = (P^* - P_2) \times Q \]  

(5)

Where, \( P_2 \) is the lowest withstand price of the captive power plant

The benefits of the captive power plant in the transaction include: 0.2 yuan / kWh compensation costs paid by the wind power plant, reduced power generation has brought the average cost of electricity savings of about 0.278 yuan / kWh (including direct coal consumption costs, direct labor costs, management fees, etc.) and save backup capacity costs 0.038 yuan / kWh, total:

\[ 0.2 \text{ yuan/kWh} + 0.278 \text{ yuan/kWh} + 0.038 \text{ yuan/kWh} = 0.516 \text{ yuan/kWh} \]

At the same time, this transaction has brought to the captive power plant generating capacity loss, namely 0.337 yuan / kWh. Due to 0.337 yuan / kWh < 0.516 yuan / kWh, so the captive power plant in this transaction is also beneficial, trading 1 kWh of electricity that could benefit 0.516 yuan - 0.037 yuan = 0.179 yuan. As can be seen, wind farm generating capacity increases significantly and generating revenue grow with it. And the captive power plants obtain substantial benefits from the wind farm for peak shaving. Both parties improve their economic profit, which means they have a active participation in this transaction.

In summary, it is possible for using new energy power plant to replace the captive power plant to participate in trading the generation rights.

5. **Conclusion**

- With reference to conventional thermal power plants public trading mode, we introduce the captive power plant into new energy consumptive
mechanism for the first time. New energy company purchase the generation rights from the captive power plant to reduce wind abandoned, light abandoned phenomenon. And this paper confirm the feasibility of the scheme from the economic aspect.

- we select a sample of the Xinjiang region and describes the method of measuring the interests of wind power business and the captive power plant.
- we design the alternative process and clearing process of introducing the captive power plant into new energy consumptive mechanism after taking the interests of multi-stakeholder into consideration.

References


