Research on the market mechanism of generation grid load storage interaction to promote new energy consumption

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Abstract. With the continuous development of China's clean energy industry, the consumption of high proportion of new energy after being connected to the grid has become the focus of attention of the industry. Flexible resources can effectively restrain the fluctuation of new energy generation and improve the stability of power grid. Therefore, in order to fully mobilize the enthusiasm of flexible resources, give full play to the market advantages, guide the market participants of generation side, power consumption side and energy storage side to participate in the Generation Grid Load Storage interaction, this paper establishes a market-oriented energy storage interaction mechanism to promote new energy consumption and form a win-win market system.

1. Introduction
Taking electricity as the center to promote the large-scale development of clean energy is an important task to optimize the energy and power supply structure and promote the structural reform of energy supply side. Due to the randomness and intermittence of clean energy power generation, the lack of overall planning and coordination between power supply and power grid development, the lag of cross regional transmission channel construction, the lack of peak load regulation capacity, and the imperfect market mechanism, the phenomena of wind and light abandonment still exist, which restrict the sustainable and healthy development of clean energy.

The key to solve this problem is to give full play to the role of grid resource allocation platform, establish a multi-party win-win mechanism, and promote the power market participants to participate in the interactive management of resource allocation. The key point is to strengthen the interactive management of "source grid load storage", establish a market-oriented mechanism of source grid load storage interaction to promote the consumption of new energy, and promote the transformation of power grid from the traditional single power source adapting to the load change mode to "source following load, load following grid" In order to achieve the goal of more secure and green power supply, more economic and efficient power consumption, and more interactive and shared power services, the smart interactive mode of source grid load storage has continuously improved the flexible adjustment ability and elastic recovery ability of power grid.

2. The importance of source grid load storage interaction for new energy integration and consumption

2.1 Change traditional rigid load to flexible load
Because the interaction of generation grid load energy storage can guide users to change their power consumption mode through price and incentive means, so that users can actively adjust the load and
increase their flexibility. On the one hand, the load has the characteristics of flexibility and can be increased or decreased; on the other hand, the load can be transferred with time. Thus, it can effectively adapt to the fluctuation of new energy output, further promote the consumption of new energy, and ensure the stable operation of power grid.

2.2 Improve power system reliability
Generation Grid Load Storage interaction is an active dynamic adjustment to the daily power consumption load of power users, so that the user's electricity consumption behavior tends to the expected power load as far as possible in the determined power balance early warning level, and then the balance range of the whole power system is within a relatively certain controllable range. Therefore, each department of the power system can reasonably adjust the daily power load according to different power balance warning level, so as to improve the operation reliability of the whole power system.

2.3 Improve power system economy
On the basis of improving the operation decision-making level of large-scale industrial and commercial users, the Generation Grid Load Storage interaction can gradually transform the price acceptor implementation mode into a competitive bidding mode, and continuously increase the proportion of large-scale industrial and commercial users participating in demand side bidding, and finally establish the demand side bidding market, which will encourage the generation side to reduce the generation cost and actively explore the utilization and reuse from the perspective of the market. Renewable energy can promote the large-scale integration of renewable energy, and fundamentally achieve the economic goal of power system operation.

2.4 Increase new energy consumption capacity
It is necessary to carry out the interactive incentive work between the load and storage of the source network, and use the economic mechanism such as price and subsidy to encourage users to actively change their electricity consumption behavior according to the new energy generation curve, so as to maximize the utilization rate of new energy power generation, reduce the use of traditional thermal power generation, and realize the general trend of increasing the utilization of renewable energy. Through the implementation of the Generation Grid Load Storage interaction means, the load curve of the grid can be synchronized with the load curve of the whole grid or the peak valley difference can be reduced, so as to improve the absorption capacity of the new energy generation.

3. The market mechanism of Generation Grid Load Storage interaction to promote new energy consumption
The choice of the implementation mode of Generation Grid Load Storage interaction is closely related to the degree of electricity marketization. Under the different degree of marketization, the implementation path of Generation Grid Load Storage interaction can be divided into the primary stage of the market, the transition stage mode and the market improvement stage.
3.1 Primary stage of market

In the initial stage of the market, China's power market has not formed a complete set of market operation rules and price formation mechanism, which can not timely and effectively regulate market supply and demand through economic means to meet the needs of new energy grid connection. Therefore, the implementation mode of Generation Grid Load Storage interaction in this stage should be based on orderly power consumption management, and introduce time of use pricing mechanism.

Orderly power management. Under the current management framework, a hierarchical early warning mechanism of power balance under the condition of new energy grid connection is established. According to different levels of power balance early warning, reasonably arrange the resources of peak shift and peak avoidance, and make clear the implementation means of orderly power utilization management: when the early warning level is low, administrative means such as peak shifting, rest in turn and power transfer are adopted; when the warning level is high, interruptible load and direct load control means are used in turn.

Time of use tariff. In the initial stage of the market, two kinds of tou prices can be implemented alternately, i.e. seasonal time of use price and daily peak valley time of use price, in view of the mid-long term and short-term output fluctuation of new energy.

3.2 Market transition stage

In the market transition stage, the operation rules of China's power market are gradually improved, and the price formation mechanism is initially established. Therefore, we can consider introducing corresponding economic means to improve the response degree of market entities to the fluctuation of new energy output. In this stage, the implementation mode of Generation Grid Load Storage interaction should be improved on the basis of the mode of primary market stage, such as TOU price, direct load control, interruptible load and so on, and key peak load price, real-time price, emergency load response and demand side bidding should be introduced.

Time of use tariff. In the aspect of daily load shaping, the real-time price is more efficient. Therefore, in the market transition stage, the time of use price mechanism is improved. On the one hand, the daily peak valley time of use price is gradually adjusted to the day ahead real-time price, on the other hand, the seasonal time of use price is retained.

Key peak load tariff. Based on the time of use price as the basic load shaping method, the key peak load price is introduced in view of the sudden decrease of new energy output. When the output of new energy is sharply reduced, the power grid operation management organization starts the key peak load price to reduce the power load level.

Spot price. Real time price is an advanced form of TOU price, and its efficiency is higher in load shaping. Therefore, in the market transition stage, the introduction of real-time price mechanism will help to improve the interaction effect between load and storage of source network and mitigate the adverse impact of new energy output fluctuation. According to different classification methods, there
are many kinds of real-time pricing mechanisms, including day ahead, day in day, compulsory and voluntary.

Direct load control and interruptible load. Direct load interruption can be achieved in the new energy load and load control stage.

Emergency load response. Unlike interruptible load, emergency load response load reduction is voluntary and users can ignore load reduction request without penalty. Therefore, the implementation of emergency load response is more flexible, and the response reliability is low. In the market transition stage, on the basis of interruptible load projects, further introducing emergency load response is conducive to expanding the scale of load reduction projects and obtaining more interactive resources of Generation Grid Load Storage.

Demand side bidding. The introduction of demand side bidding can improve the enthusiasm of large-scale industrial and commercial users to participate in the load storage interaction of new energy source network, and then expand the scale of Generation Grid Load Storage interaction project for new energy grid connection. There are two implementation methods of demand side bidding: in the first way, the user submits a combined bid including price and load reduction quantity. If the user wins the bid, he must reduce the corresponding load according to the requirements the next day, otherwise he will have to accept a punishment; in the second way, as the "price receiver", the user does not need to bid, and it is required by the system operation organization Reduce the load and get paid at the market clearing price at that time. In the market transition stage, due to the immature decision-making technology of users, the demand side bidding in the form of "price acceptor" can be considered first.

3.3 Market improvement stage
In the mature stage of the market, China's power market system has been relatively perfect, and various grid operation technologies have been more mature. Therefore, more flexible market means can be considered. Finally, it forms a Generation Grid Load Storage interaction system with capacity market, demand side bidding market and auxiliary service market as the carrier, improved real-time price, peak valley time of use price (and key peak load price as adjustment means, and direct load control as support means).

Price means. We should cancel the daily peak valley time of use price, continue to retain the seasonal time of use price in heating period and non heating period, and further expand the proportion of users of real-time price for new energy grid connection.

Capacity market. Capacity market can be regarded as the combination of interruptible load and emergency load response, and it is a large-scale organized implementation mode of interruptible load and emergency load response. In this kind of project, users promise to carry out a pre-determined or prescribed load reduction in case of sudden reduction of new energy output, and participants can get a fixed income paid on schedule regardless of the reliability event.

Demand side bidding market. Increasing the proportion of large-scale industrial and commercial users participating in demand side bidding, and finally establishing demand side bidding market.

Auxiliary service market. In the auxiliary service market, users directly participate in the auxiliary service market with their load reduction as operation reserve. In the mature stage of the market, with the introduction of advanced real-time measurement technology, the auxiliary service market for medium-sized and above users can be established for new energy grid connection.

Direct load control. Capacity market, demand side bidding market and auxiliary service market are all market-oriented means to guide users to reduce load according to the fluctuation of new energy output. Although the establishment and joint operation of capacity market, demand side bidding market and auxiliary service market can provide relatively stable demand response for new energy grid connection under normal circumstances, market means lack initiative and reliability, and can not respond quickly in extreme cases. Therefore, in the mature stage of market, direct load control method still needs to be retained Increase direct load control resources for new energy grid connection.
4. Conclusion
This paper aims to study the implementation path of source grid load storage interaction, further optimize and improve the relevant transaction mechanism as a means to effectively cultivate the friendly interaction of market participants, stimulate the industry's original development power, promote clean energy consumption, cultivate the rapid growth of regional load, improve the enthusiasm of flexible load to participate in the Generation Grid Load Storage interaction transaction, and reduce the investment and operation costs of power grid enterprises.

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