Analysis on the operation mechanism of spot mode adapting to the initial stage of China's electricity spot market

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Abstract: In the new round of power system reform, the construction of power market is the top priority. It is particularly important to design a reasonable power market construction path for the smooth transition from planned mode to market mode and finally achieve the target market mode. This paper makes a comparative analysis of the decentralized market and the centralized market, and further analyses its applicability and the necessity of medium and long-term contracts according to its characteristics. It proposes to coordinate the generation resources, grid structure and load resources within the jurisdiction of the power grid, and implement the decentralized power market mode for the parts that have the ability to achieve self-balance, that is, the physical execution of medium and long-term contracts; For some units with large deviation and without physical execution or for some period of time, the centralized power market mode is implemented. The specific mode division adopts the principle of adjusting measures to local conditions, and strives to realize the smooth transition of market construction.

1. Introduction

On March 15, 2015, China issued several opinions on further deepening the power system reform, marking the start of a new round of power system reform. One of the key tasks of the new round of power system reform is to promote the reform of power trading system and improve the market-oriented trading mechanism. On December 29, 2016, the national development and Reform Commission and the National Energy Administration issued the basic rules for medium & long term Electricity Trading (Interim), which provides guidance for promoting direct electricity trading, inter provincial and inter regional electricity trading, contract electricity transfer trading and other organizations, as well as regulating medium and long term electricity trading. Under the guidance of the basic rules for medium & long term Electricity Trading (Interim), the implementation rules for medium and long term electricity trading have been issued in accordance with local conditions. According to the statistics released by the national energy administration, in 2018, the market-oriented electricity trading volume was about 2.1 trillion kwh, accounting for nearly 40% of the electricity sales volume. The number of trading entities was increasing, the access threshold was decreasing, and the market electricity volume was expanding. The medium and long-term electricity trading system has been initially established nationwide[1][2].

On the basis of medium and long-term electricity trading, in order to further speed up the construction of an effective competitive market structure and market system, release the reform dividend, it is urgent to explore the spot trading mechanism of electricity, change the planning and
dispatching mode, find the price of electricity commodity, form a market-oriented electricity balance mechanism, and gradually build a power market system combining medium and long-term trading with spot trading, so as to play an important role in power resource allocation. So, how to do a good job in the long-term and spot market convergence mechanism, first of all, we need to analyse the characteristics and applicability of the spot operation mode.

2. Definition of decentralized electricity market and centralized electricity market

On April 17, 2018, the comprehensive Department of the National Energy Administration issued the "letter on Soliciting Opinions on relevant functional specifications of the electricity spot market", which defines the centralized electricity market and the decentralized electricity market.

- Decentralized electricity market: One of the two modes of China's electricity market is the mode of electricity market, which is mainly based on medium and long-term physical contracts, in which both the generator and the user determine the daily electricity generation and consumption curve by themselves in the day ahead stage, and the deviation of electricity quantity is regulated by day ahead and real-time balanced transactions.

- Centralized power market: One of the two modes of China's electricity market is spot trading, which adopts the centralized bidding of all electricity, mainly hedging the spot market risk with medium and long-term price difference contract.

3. Characteristics of decentralized power market and centralized power market

Table 1: comparative analysis of power market modes

| Organization            | Price mechanism          | Market clearing                | Power structure                          | Economic base             | Power grid situation     |
|-------------------------|--------------------------|--------------------------------|------------------------------------------|---------------------------|--------------------------|
| PJM (centralized spot market model) | Nodal price            | Safety constrained unit commitment and economic dispatch | The distribution of resource load is uniform, and the proportion of thermal power and gas power is high | There is little difference in the level of electricity price | The regional power grid is relatively independent |
| Nordic (decentralized spot market model) | Zonal price            | Intersection point of supply and demand curve (only considering the restriction of interval tie line) | The distribution of energy is complementary, with a high proportion of renewable energy such as wind and solar energy | The electricity price level is similar | Frequent interaction between regions |
| China                   | Energy price             | Intersection of supply and demand curves                     | The distribution of energy resources is complementary, with thermal power as the main and coal power as the regional integration | There are great differences in economic and electricity price levels, and the tidal current flows from low electricity price areas to high electricity price areas | Frequent interaction among provinces |
3.1. Decentralized market model features

In this pattern, part of the electricity participates in the spot market bidding, and most of the electricity is solved through medium and long-term trading contracts. The medium and long-term trading contracts, like the existing contracts, are physical contracts [3], which must be submitted to the transaction operator for implementation by the power grid. Good liquidity, simple rules, can reduce the risk of large price fluctuations, but the power structure of the power grid and the maturity of market players are very high, and need to do a good job in the connection of dispatching and trading institutions. It is mainly used in UK[4-6] and European power market[7].

3.2. Centralized market model features:

In this mode, all the participants participate in spot market bidding, and the medium and long-term trading adopts bilateral price difference contract. The price difference contract is a financial contract, which does not need to be submitted to the transaction operator and physical execution. The efficiency of resource allocation is high, which can reflect the time and space value of electric energy. However, the market rules are complex, the monitoring of market power is difficult, and the risk of price fluctuation exists. The dispatching and trading institutions are often the same subject. It is mainly used in the electricity markets of the United States[8][9], Australia and New Zealand[10].

The market model of the combination of decentralized power market and centralized power market is in line with the development needs of China's current power market. The combination of large-scale centralized multi-party transaction and decentralized bilateral market transaction is a relatively mature market transaction mode in the world. This mode gives power generation, power sales and users the right to choose the trading partner, power quantity and price independently. Users can choose the appropriate trading subject according to their own power consumption, power quality demand and other factors to further enlarge the market share the decisive role of resource allocation is the market model which is in line with the characteristics of China's electricity market. Among them, decentralized electricity market is feasible in the short term, while bilateral physical transaction and real-time equilibrium market are the basic modes of decentralized spot electricity market.

4. Applicability of centralized power market and decentralized power market

The latest edition of "top level design scheme of national unified power market" puts forward that China's provinces can adopt different market modes according to local conditions according to the differences of sending and receiving end market, power supply structure, power consumption structure and market maturity. There are three basic models of spot market.

(1) One is the mode of "medium & long term contract for difference + centralized bidding of total electricity" (centralized model), which is suitable for provinces with low proportion of flexible regulated power supply, more grid congestion and high proportion of new energy.

(2) The second is the "medium & long term physical contract + balance mechanism" mode (decentralized model), which is suitable for provinces with high proportion of flexible regulated power supply, less grid congestion and mature power generation and consumption market.

(3) Third, the medium and long-term contract can adopt the mixed mode of price difference and physical contract.

There are three main ways for market entities to declare: one is "quoted quantity on the generation side and accepted price of non-quoted quantity on the user side"; the other is "quoted quantity on the generation side and accepted price of quoted quantity on the user side"; the third is "quoted quantity on both the generation side and the user side".

In order to coordinate the generation resources, grid structure and load resources within the jurisdiction of the power grid, the decentralized power market mode should be implemented for the part that has the ability to achieve self-balancing, that is, the physical execution of medium and long-term contracts; and the centralized power market mode should be implemented for the part of the units that have large deviation and do not have physical execution or the units in part of the period. The specific mode division should be adapted to local conditions.
Establish a balance mechanism to ensure the medium and long-term physical execution. Establish a "medium & long term physical contract + balance mechanism" model. Among them, the balance mechanism mainly includes the short-term trading within a week of continuous opening in advance, the balance mechanism of up and down listing in advance and the contract transfer mechanism after the event.

1) Composite bidding mode: the monthly electricity trading adopts the composite bidding mode of centralized bidding and rolling match trading. The centralized competitive trading adopts the trading mechanism of centralized declaration and matching in the call bidding stage, which is completed before the rolling match bidding. The trading declaration that has not been completed in the call bidding stage automatically enters the rolling match trading stage.

2) Short term trading within a week of continuous market opening in advance: after the monthly trading with curve in different time periods, the rolling matching trading of continuous market opening is carried out. In the rolling matching trading stage, the trading mechanism of continuous declaration and continuous matching is adopted. The same market entity can purchase or sell electric energy according to its own power production or consumption needs. In order to reduce the risk of market manipulation, the electricity sold by a power generation enterprise in a single electricity transaction shall not exceed its remaining maximum generating capacity, and the electricity purchased shall not exceed the net value of the electricity sold (refers to the net electricity sold after multiple sales and purchases offset each other). In a single electricity transaction, the sales of electricity by power users and power selling companies shall not exceed the net value of their purchased electricity (the net purchased electricity after multiple purchases and sales offset each other). The short-term trading within a week of continuous market opening in advance is oriented to the prediction deviation of the medium and long-term contracts adjusted by the generator and user, which can effectively guarantee the physical execution.

3) Up and down pre listing mechanism: after the end of the monthly transaction, the power generation enterprises shall apply for the price increase (the selling price per unit of additional electricity) and the price decrease (the purchasing price per unit of reduced electricity), which shall be subject to the declared price on the deadline. Jiangxi electric power trading center forms up (down) dispatching unit call sequencing table according to up (down) dispatching quotation from low (high) to high (low), and submits it to power dispatching organization for execution. According to the electricity balance prediction, when the decomposition and implementation of various types of contract electricity cannot meet the balance of supply and demand in the province, the power dispatching organization refers to the up-down call unit sequencing, and on the premise of meeting the security constraints, arranges the units to provide up-down electricity in advance to achieve the balance of supply and demand. The pre listing mechanism of up and down regulation on the generation side adopts the mode of "quoted price, no quoted quantity". All units with regulation capacity shall participate in the up and down regulation of quoted price, and the units not included in the start-up combination in the next month shall not participate. The pre listing mechanism is used to price the adjustment part of the day ahead plan in advance, aiming at coordinating the difference between the decomposition of medium and long-term contracts and the actual physical execution of the scheduling.

4) Post contract transfer mechanism: the post deviation assessment of the power side, the electricity transfer transaction is carried out monthly, and the power side participates in the transaction. The electric power transaction operator publishes the trading announcement of the electricity transfer after the deviation assessment on the power side on the trading platform, including but not limited to the trading scale, trading mode, trading time arrangement and other information. If deviation assessment occurs after pre settlement, the market entity on the power side shall participate in demand declaration through the power trading platform within the time specified in the trading announcement, otherwise it can’t participate in the subsequent contract transfer transaction. Other power users who have no deviation assessment after pre settlement do not need to declare, and can participate in post transfer transaction as needed. The subject matter and price of the transaction. The subject matter is the electricity quantity declared by the market subject of the electricity side with deviation assessment.
after the pre settlement; the transaction price is the electricity quantity with deviation assessment, and the transfer transaction price is the direct transfer price, and both parties can obtain or pay the transfer fee through the transfer transaction. The power trading platform is ranked by the price of the transferor from low to high, the price of the transferee from high to low, and the power packages of the same price are ranked by the time of hanging out. After the event contract transfer mechanism, also known as the after-event deviation assessment electricity transfer transaction, is located in the users with large deviation after the budget and settlement. The transaction to reduce the financial risk of deviation assessment can effectively reduce the economic risk brought by the blocking and security constraints of medium and long-term contracts to the market entities.

5) Criteria for judging after the event: the latest version of basic rules for medium & long term Electricity Trading (Interim) can effectively guarantee the physical execution of medium and long term contracts. However, it can’t be ruled out that there is a big deviation in the physical execution of medium and long-term contracts due to individual factors. Therefore, it is necessary to further distinguish the areas where the decentralized power market mode is implemented according to the difference between the user side and the generation side.

- When there is a large difference between the cost of deviation electricity on the power user side and the cost of up and down adjustment and deviation electricity on the power generation side, the power generation and consumption in this region can’t achieve self-balancing, so it is suggested to change the decentralized market mode into the centralized market mode.
- When the difference between the decentralized power generation cost and the original power consumption cost is kept unchanged, the difference between the decentralized power generation cost and the original power consumption cost is kept unchanged.

(4) Considering the different physical characteristics of power grid and the different distribution of renewable energy in different regions, the hybrid power market model of different regions can be adopted.

1) For the areas with strong power grid structure construction, the network constraints are small and the possibility of congestion is low. Therefore, it is more suitable for the decentralized power market model.

2) For the weak areas of power grid construction, the network constraints are large and the possibility of congestion is high. Therefore, it is more suitable for centralized power market mode.

3) In order to reduce the possibility of little overall congestion, it is necessary to monitor and control the market power and limit the market power of some special generators.

4) For the areas with abundant and intensive renewable energy power generation resources, the decentralized power market mode is adopted. For the renewable energy market, centralized power generation mode is less used.

5. Conclusions
In the decentralized and centralized markets, the status of medium and long-term trading is different. In the decentralized market, medium and long-term trading is absolute, signing physical contracts, which can actually lock in the price of most of the electricity and reduce the transaction risk; but in the centralized market, medium and long-term trading is relative, signing price difference contracts (financial contracts), which can only lock in the price of part of the future electricity consumption. In the decentralized market, the medium and long-term and spot trading are separated and decoupled, while in the centralized market, the two are integrated and inseparable. This is also the difference between the subject referred to by "decentralization" and "concentration". Generally speaking, the problems faced by the construction of China's power market are complex. All localities need to coordinate the power generation resources, power grid structure and load resources within the jurisdiction of the power grid. Based on the principle of adjusting measures to local conditions, the decentralized power market model is implemented for the part that has the ability to achieve self-balancing, that is, the physical execution of medium and long-term contracts; for the part that has large
deviation and does not have physical execution in order to realize the smooth transition of market construction, the centralized power market mode should be implemented.

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