

## Analysis and Reflection on Electric Spot Market

Quan Wang<sup>1,\*</sup>

<sup>1</sup>School of Economics and Management, Northeast Electric Power University, Jilin, Jilin, China

\*Corresponding author

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**Abstract:** Based on the power market system of “medium and long term market + spot market + auxiliary service market”, the whole process of power production, transmission and consumption is opened, the medium and long term market is stable, the risk is avoided, the price is found in the spot market, the balance of power system is ensured, the interaction of source-net-charge in time and space is realized, the key role of market in resource allocation is brought into full play, and the reform of power supply side and consumption side is effectively promoted. This paper analyzes the basic situation of power market construction in China, designs the development path and goal of power market at the top level, and compares and analyzes the centralized and decentralized power spot market model, which is the key problem in the process of power market construction and operation.

### 1. Introduction

Focusing on the purpose and key tasks of China's power market construction, under the framework of document No .9 and its supporting documents, this paper summarizes the experience and lessons of international power market practice, analyzes the environmental conditions of the application of electricity spot market theory and combines modern power market theory with China's national conditions. Therefore, the design idea, target mode and realization path of the overall scheme of power market system construction in China are established, that is ,” medium and long term market + spot market + auxiliary service market “power market system.

In the spot market, eight regions, including southern China (starting from Guangdong), Mengxi, Zhejiang, Shanxi, Shandong, Fujian, Sichuan and Gansu, were the first to carry out a trial run of continuous settlement, of which Mengxi and Fujian adopted a decentralized power market model and other regions adopted a centralized power market model.

The present situation of power market construction in China can be summed up into five points: first, the power market trading system is gradually sound; second, the market openness and activity are significantly improved; third, the decisive role of market allocation of resources gradually appears; Fourth, market mechanism to promote clean energy consumption level; fifth, open and transparent market environment healthy development. Overall, the power market construction results are remarkable, market-oriented trading scale gradually expanded, the number of market members gradually increased. At the same time, the spot pilot trial operation, trial settlement of the main problems such as inter-provincial and provincial transaction coordination, planning and market coordination, medium and long term and spot coordination, new energy participation in the market, capacity cost recovery, market information disclosure, technical system is not perfect and so on.

### 2. Power Market Development Path and Objectives

The establishment of the power market should first point out the future target mode and development direction of the market in the top-level design, and then establish a set of core rules system to standardize the most basic market model, transaction timing, trading variety, clearing rules, price mechanism, technical support system construction and so on. On this basis, do a good job of phased implementation of path planning, and finally achieve the unified and efficient

operation of the power market. It is necessary not only to fully tap the potential of unified and optimized market resources allocation throughout the country, but also to adapt to the existing market construction and dispatching management mechanism, starting from the model of “unified market and two-level operation”, and gradually promoting market integration. Finally form the national unified power market [1,2].

At this stage, it is also the initial stage of market development. It adopts the hierarchical operation mode, that is, “unified market, two-level operation” market operation mode, as shown in figure 1. The unified market is embodied in the unified market framework, the unified core rules, the unified operation platform and the unified service scope; the two-level operation refers to the coordinated operation of transactions between provinces and provinces. The inter-provincial transaction realizes the national energy strategy, promotes the clean energy absorption and the large-scale resources optimization allocation, establishes the resource allocation type market, the inter-provincial transaction is carried out on the Beijing, Guangzhou electric power trading platform. The provincial transaction realizes the optimal allocation of resources in the province, ensures the balance of power supply and demand and the safe and stable operation of the power grid, establishes the power balance market, and the provincial transaction is carried out on the provincial power trading platform.

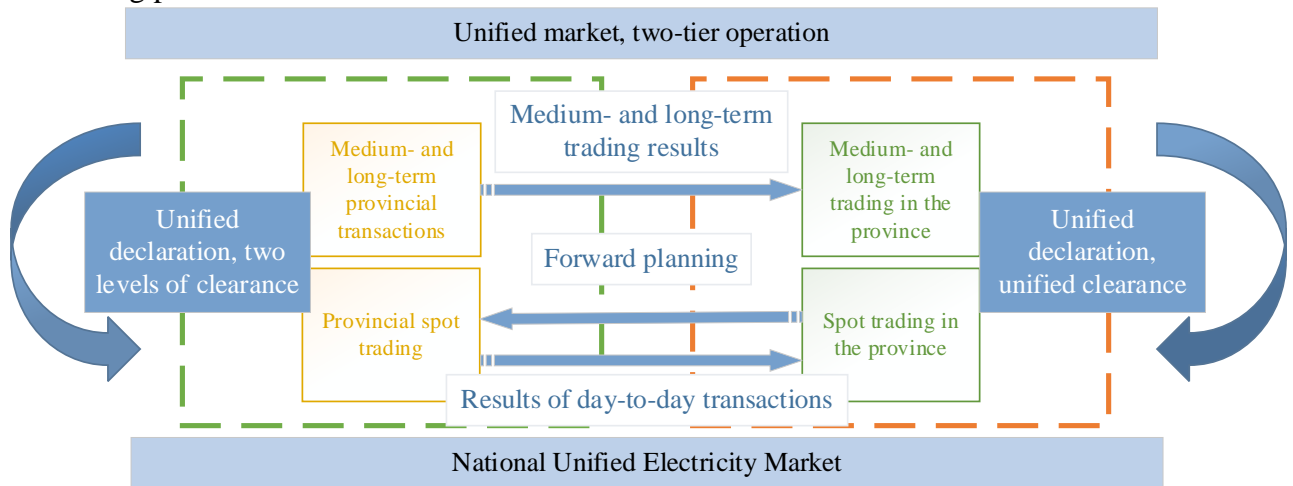


Fig.1 Linkages between Provincial and Provincial Markets

There are two modes of medium-term market transition. The first model is the provincial unified market model, the whole country forms a number of sub-markets, the sub-market internal unified optimization, unified development of medium and long-term, day, day, real-time balance and other transactions; sub-markets between the main medium and long-term bilateral transactions [3]. The main advantage of this model is that it can better adapt to the power grid structure of our country, and its deficiency lies in the higher technical requirements, and the need to adjust the power grid dispatching management system greatly. The second model is the inter-provincial joint market model, which is jointly cleared between the mid-and long-term, day-ahead (intraday) spot markets in all provinces, and the provincial market is still responsible for balancing market organizations in real time [4]. The main advantage of this model is that the calculation of clearing before the day is relatively simple, but to some extent, the blocking of power grid within each provincial level is ignored, and the implementation of market clearing results is difficult.

China's medium-term power market can adopt a mixed mode of two modes, taking into account the power grid structure of our country and the blocking situation in the province, and gradually forming the mode of “unified declaration and two-level clearing” between provinces and provincial markets. With the deepening of integration, the national unified power market is gradually formed.

### 3. Mode Selection

The power market model is mainly divided into decentralized and centralized, as shown in figure 2. Among them, decentralization is mainly based on medium-and long-term physical contracts, and the two parties determine their own daily power generation curve in the day-to-day stage, and the deviation electricity quantity is adjusted by the day-to-day and real-time balanced transactions. Centralized is mainly based on medium-and long-term difference contracts to manage market risks, with spot transactions using the power market model of centralized bidding for total electricity. According to the regional power resources, load characteristics, power grid structure and other factors, combined with the actual economic and social development of the rational choice of power market construction model. Among the influencing factors of mode selection, one of the most critical determinants is grid blocking [5]. If the network blocking is heavy, then the centralized mode should be adopted; if the network blocking is lighter and the market maturity permits, the decentralization can be considered.

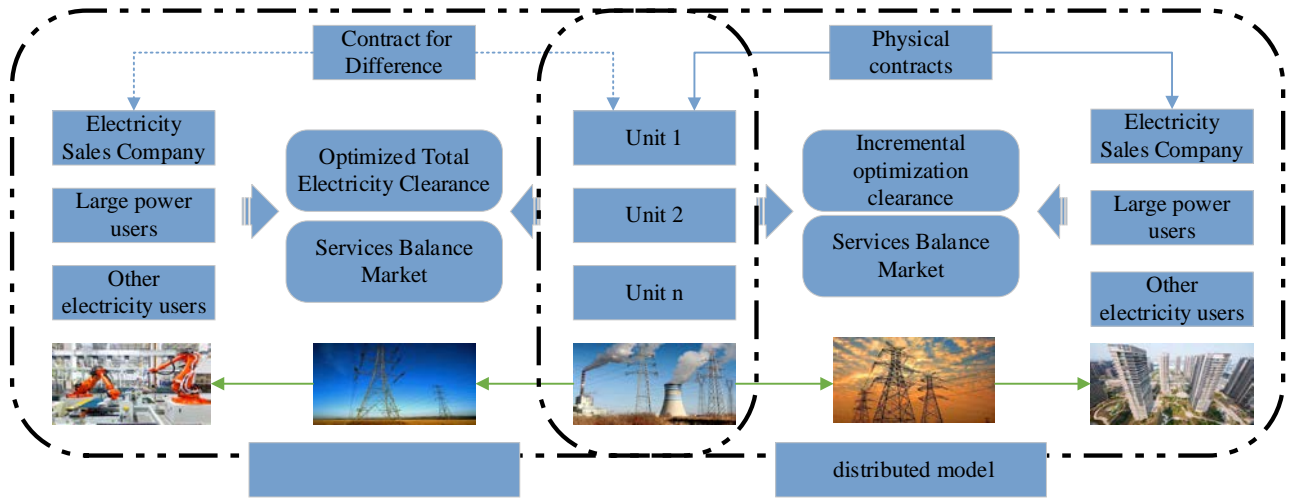


Fig.2 Centralized and Decentralized Electricity Market Models

### 3.1 Centralized Power Spot Market Model Based on Total Power Optimization

The centralized type is characterized by full electricity participation in spot market bidding, medium and long term transactions using bilateral price difference contracts, which are financial standard contracts, and do not need to be submitted to the trading center or power dispatching center for security verification. No physical execution is required, only with settlement function. At present, in the international power market, PJM, New York, Australia and other North American countries and regions of the power market more centralized.

### 3.2 Decentralized Electricity Spot Market Model Based on Incremental Optimization

The decentralized nature is that part of the electricity quantity participates in the spot market bidding, most of the electricity quantity is solved through the medium and long term transaction contract, which is the same as the current contract, which is a physical contract. Must be submitted to the trading center and power dispatch center for security check, by the grid arrangement. At present, in the international power market, Nordic, British and other European countries and regions of the power market mostly use decentralized.

## 4. Mechanism Design

### 4.1 Clearance Mechanisms

The clearing result of spot transaction is directly related to the scheduling operation. Before the day, the market clearing directly generates the pre-adjustment plan, and the real-time market clearing determines the real-time scheduling arrangement, so the clearing model should consider the quotation factor and the system physical model at the same time. In the case of only considering the

quotation factors, the trading institutions superposition the total power generation and total electricity price curves according to the quotation curves provided by the main body of the market. The focus of these two total electricity price curves is the market inventory. All transactions on the left side of the clearing point are closed. In order to coordinate the relationship between transaction clearing and grid dispatching operation, the clearing model of spot market should consider system balance, unit capacity and network constraints in addition to the quotation of market main body.

In the market before the day, the area that chooses the decentralized market generally has the characteristics of good system peak-shaving resources, light blocking, sufficient power resources supply and so on. The selection of centralized market areas generally has the characteristics of weak peak-shaving resources, serious congestion and tight supply of power resources. The most precise physical model should be considered when clearing. The specific approach is through the safety constraint unit combination (SCUC) and the safety constraint economic dispatch (SCED), to ensure that the clearance results can meet the requirements of safe and stable operation of the system. In order to fully reflect the real operation state of all kinds of equipment, the generator should report its actual physical parameters, such as the climbing rate of the unit running, the maximum and minimum output force, the continuous opening and stopping time constraint and so on [6,7].

In the real-time market, the clearing results are directly used in the balance scheduling and blocking management of the system. Therefore, both decentralized and centralized markets are constrained by the most accurate system physical model and cleared according to the principle of lowest price. The operation mechanism of real-time clearing is basically the same as that of the day before the physical model constraint is considered, but because the unit combination has been determined before the day, the real-time market only needs to run SCED, no SCUC required.

## **4.2 Price Formation Mechanisms**

The electricity spot market transaction cycle is short, the network constraint also has the certain influence to the transaction result, therefore the price mechanism is relatively complex, one is to reflect the electricity price fluctuates with the demand in different time period, realizes the market discovery price goal; Second, to reflect the change of electricity price with space under network conditions.

There are three kinds of power spot market price mechanism: unified marginal price, node marginal price and zonal marginal price. In spot trading, the main body of the market quotes for different periods, and the clearing price of different periods can reflect the change of electricity price with time and demand [8]. Because these three price mechanisms adopt the way of marginal electricity price transaction rather than quotation transaction, power generation enterprises will tend to quote according to their respective marginal cost to ensure the success of the transaction. Therefore, to a certain extent, power generation enterprises can prevent speculation in driving up electricity prices.

The scope of application of the three price mechanisms is different, each has its own advantages and disadvantages. In the construction process of spot market, price mechanism should be selected according to local conditions. According to the specific blocking situation, the regional marginal electricity price or node marginal electricity price mechanism should be established as soon as possible, and the node marginal electricity price calculation function should be integrated in the SCUC and SCED program. For areas where there is no blocking at present, we can adopt the method from simple to complex, first adopt the unified clearing electricity price mechanism, then transition to the partition marginal electricity price and node marginal electricity price when necessary, or adopt the one-step method. The node marginal electricity price mechanism is established first and then simplified to partition marginal electricity price or node marginal electricity price according to network characteristics [9,10]. Because the node marginal electricity price mechanism is very different from the current electricity price mechanism, its complex algorithm also needs to have the mature technical support system support, therefore the concrete implementation should adopt the pilot first way.

## 5. Summary

In a word, through the analysis of the construction situation of the electric power spot market, it is not difficult to find that the electric power spot market, as one of the important components of the electric power market, has a direct impact on further improving the social and economic benefits of the electric power industry. At the same time, considering the complexity of market construction and the uncertainty of power system operation, it is necessary to further study the construction of market mechanism and technological development, combine with the demand of China's power market, and carry out innovative spot market management mechanism. And in order to promote the sustainable development of the power market.

## References

- [1] Maziar Karimi, Morteza Kheradmandi, Abolfazl Pirayesh. MW-mile recovery method in merchant transmission investment by generation companies. 2019, 175
- [2] Chenyang Huang,Zheng Yan,Sijie Chen,Libing Yang,Xiaogang Li. Two-stage market clearing approach to mitigate generator collusion in Eastern China electricity market via system dynamics method[J]. IET Generation, Transmission & Distribution,2019,13(15).
- [3] Jieting Yin,Qingyou Yan,Kaijie Lei,Tomas Baležentis,Dalia Streimikiene. Economic and Efficiency Analysis of China Electricity Market Reform Using Computable General Equilibrium Model[J]. Sustainability,2019,11(2).
- [4] Chuntian Cheng, Fu Chen, Gang Li, et al. Reform and renewables in China: The architecture of Yunnan's hydropower dominated electricity market. 2018, 94:682-693.
- [5] Rui Gao, Hongxia Guo, Ruihong Zhang, et al. A Two-Stage Dispatch Mechanism for Virtual Power Plant Utilizing the CVaR Theory in the Electricity Spot Market. 2019, 12(17)
- [6] Yang Yafei, Lu Xiaoyu, Wu Lei. Integrated data-driven framework for fast SCUC calculation. 2020, 14(24):5728-5738.
- [7] Yantao Wang, Quan Wang, Daxiang Suo, et al. Intelligent traffic monitoring and traffic diagnosis analysis based on neural network algorithm. 2020, :1-11.
- [8] Shuai Fan, Jiang Liu, Qing Wu, et al. Optimal coordination of virtual power plant with photovoltaics and electric vehicles: A temporally coupled distributed online algorithm. 2020, 277
- [9] Zheng Yanchong, Yu Hang, Shao Ziyun, et al. Day-ahead bidding strategy for electric vehicle aggregator enabling multiple agent modes in uncertain electricity markets. 2020, 280
- [10] David P. Brown, Andrew Eckert. Imperfect Competition in Electricity Markets with Renewable Generation: The Role of Renewable Compensation Policies. 2020, 41(4)