Study on the Evolution Stages and Mechanism of China's Unified National Electricity Market

Yan Yang 1, *, Shuo Liu 2, Mengxin Lan 1, Weijie Shen 1, Ming Zeng 1
1 School of Economics and Management, North China Electric Power University, Beijing 102206, China
2 Beijing Electric Power Trading Center, Beijing 100031, China

*Corresponding author e-mail: 1173416446@qq.com

Abstract. This paper mainly studies the stage division and mechanism of the evolution from provincial power market to national unified power market at the present stage. Firstly, this paper analyses the current situation of China's power market construction from both provincial and inter-provincial perspectives, and on the basis of this, it divides the evolution process of China's power market into stages according to the current situation of China's power market construction and future construction needs, and puts forward the market structure and operation modes of each stage, so as to provide reference for China's power market construction.

Keywords. National Unified Electricity Market; Provincial Electricity Market; Market structure; Operation mode; Market mechanism.

1. Introduction
In recent years, the construction of China's electricity market has made important progress in inter-provincial power market construction, power market supervision and power legal system construction, and has initially formed a two-level power market system model. However, China's power market is still facing such problems as incomplete market system, arduous task of energy low-carbon transformation, and challenges of continuously expanding the scale of market-oriented transactions [1-2]. Therefore, in the follow-up market construction, it is still necessary to effectively co-ordinate inter-provincial and intra-provincial transactions and long-term and spot transactions, further enhance the risk prevention and control capabilities of the power market, strengthen the technical support of the power market, and lay a solid foundation for the evolution and development of the provincial market to the national unified power market.

2. Current situation of power market construction in China

2.1. Construction of provincial electricity market

2.1.1. Establishment of provincial trading centers. At present, among the 32 provincial power trading centers established in China, only Guangzhou power trading center and 8 provinces (districts and cities) such as Shanxi, Hubei, Chongqing, Guangdong, Guangxi, Yunnan, Guizhou and Hainan are joint-stock
companies. Other power trading centers are still wholly-owned subsidiaries of power grid enterprises, and have not yet achieved relatively independent and standardized operation of power trading institutions [3].

2.1.2. Electricity Market Construction in Provinces. In 34 provinces, municipalities, autonomous regions and municipalities directly under the Central Government, the construction of power market in each province is different. In 2017, with the gradual liberalization of the power generation plan and the rapid increase of direct trading electricity in all provinces except Tibet, the annual market trading electricity in Anhui, Zhejiang, Shandong, Yunnan, Guangdong and other five provinces exceeded 100 billion kilowatt-hours, while that in Shanxi, Henan, Inner Mongolia, Liaoning and other four provinces exceeded 80 billion kilowatt-hours [4-6]. Most provinces and municipalities have carried out medium and long-term electricity trading smoothly, while spot trading has developed slowly.

2.2. Cross-regional Electricity Market Construction

2.2.1. Establishment of Trading Center. On March 1, 2016, Beijing and Guangzhou Electric Power Exchange Center were set up simultaneously. The two national power trading centers are established in Beijing and Guangzhou, where the headquarters of the State Grid and the South China Grid are located. Their main tasks are to realize cross-regional and cross-provincial power trading within the two power grids.

2.2.2. Transaction organization situation. Under the guidance of Article 9 of the Central Committee, on the one hand, provinces have set up power trading institutions to organize and carry out diversified provincial power trading, breaking the original monopoly pattern of power grid through market-oriented, and initially establishing the market competition mechanism on the selling side; on the other hand, the state has vigorously promoted cross-provincial and cross-regional power trading in order to implement the energy strategy, to promote inter-provincial market construction in order to seek solutions to the uneven distribution of electricity and the imbalance between power resources and market demand, and to promote a wider range of optimal allocation of power resources and energy conservation and emission reduction [7].

By the end of 2017, the cross-provincial and cross-regional electricity transactions reached 1.63 trillion kWh, which effectively guaranteed power balance and safe supply.

3. Research on the "Three Stages" Dividing Mode and Mechanism of the Evolution of National Unified Electricity Market

3.1. Stage 1 - Intra-provincial Market + Inter-provincial Fixed-point Trading

3.1.1. Market structure. (1) Types of transactions in the province.

In the first stage, the types of electricity market transactions in the province mainly include medium and long-term electricity market, spot electricity market, ancillary service market and power generation rights transaction, forming a trading pattern with medium and long-term electricity market as the main market while other markets coordinate and complement each other.

(2) Inter-provincial fixed-point electricity trading

Fixed-point transaction of inter-provincial electricity quantity generally refers to the transmission of electricity from provinces with surplus electricity to large power-using provinces. Fixed-point transmission between provinces is generally based on the transmission of thermal power and clean energy. This kind of power transmission between provinces not only brings certain economic benefits to the sending provinces, but also brings about relatively low price of clean energy. Recipient provinces bring benefits. In the first stage, the inter-provincial fixed points are Ningxia-Zhejiang, Inner Mongolia-Beijing, Qinghai-Jiangsu and Gansu-Hunan.
3.1.2. Operation mode. At this stage, the main trading bodies of China’s electricity market include provincial power trading centers, national power trading centers, power generation enterprises participating in the market, provincial power grid companies, electricity sales companies and power users, etc. The operation modes of each trading body are shown in the table below.

**Table 1. Market operation model**

| market subject                  | Operation mode                                                                                                                                 |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Provincial Power Trading Centers | The first is to deal in the provincial electricity market, and the power generation enterprises, power selling companies and power users (large industries) who participate in the intra-provincial market transactions can buy and sell electricity in the provincial power trading centers; the second is to deal with the inter-provincial fixed-point transactions, and the power generation enterprises who participate in the inter-provincial fixed-point transactions can pass the provincial trading centers and the provincial power saving centers. Network companies carry out fixed-point transmission of electricity between provinces. |
| National Power Trading Center   | Fixed-point electricity trading among provinces needs to be conducted in the national power trading center. The specific situation is that according to their own needs, the transmission and receiving provinces of electricity are unified trading by the provincial power grid companies in the national power trading center. |
| Power generation enterprise     | Power generation enterprises participating in market transactions can not only trade electricity with power selling companies or users through provincial power trading centers, but also conduct inter-provincial transactions through provincial power trading centers, provincial power grid companies and national power trading centers. |
| Provincial Power Grid Corp      | Provincial power grid companies are the "spokespersons" of the provinces, and through the national power trading center for fixed-point transmission of electricity between provinces. |
| Electricity sale company        | Electricity companies trade mainly in the province. Through provincial power trading centers, power generation enterprises and power users participating in the market are engaged in electricity trading. |
| Power users                     | Large industrial users are the main representatives of power users in the first stage, mainly through provincial power trading centers to deal with power generation enterprises or power sales companies. |
3.2. The second stage - the coexistence of inter-provincial and intra-provincial electricity markets

3.2.1. Market structure. (1) Provincial Electricity Market.
In the second stage, the types of electricity market transactions in the province are similar to those in the first stage, mainly including medium and long-term electricity market, spot electricity market, ancillary service market and power generation rights market, but at the same time, they are quite different from the first stage, that is, the option of power users is further liberalized, and commercial users are the same as Dagong. Industry users, like, can participate in the process of market transactions. In addition, the number and scope of power generation enterprises that can participate in market transactions are more and more. In one stage, the power generation enterprises are mainly thermal power, and in the second stage, the clean energy power generation enterprises can gradually participate in the intra-provincial market transactions.

(2) Inter-provincial power market
In the second stage, the inter-provincial fixed-point transaction will gradually expand to form an inter-provincial electricity market based on Provincial units. Provincial power grid companies will no longer conduct inter-provincial electricity transactions, but mainly conduct transmission rights transactions and ancillary services market transactions. Inter-provincial transmission rights transactions can solve the problem of inter-provincial transmission congestion, which is of great significance.
3.2.2. *Operation mode.* In the second stage, the market participants are the same as in the first stage, but the market participation scope of each participant has been expanded, and the relationship between provincial and national trading centers is closer, and cross-provincial transactions are more frequent.

### Table 2. Market operation model

| market subject | Operation mode |
|----------------|----------------|
| Provincial Power Trading Centers | One is to deal in the provincial electricity market. Each main body can buy and sell different types of electricity such as thermal power and clean energy in the provincial power trading center. The other is to deal in the inter-provincial electricity market. Power generation enterprises participating in inter-provincial market transactions can buy and sell inter-provincial electricity through the state-level trading center. |
| National Power Trading Center | Responsible for electricity trading between provinces. |
| Power generation enterprise | Different from one stage, the number of power generation enterprises participating in the market has increased significantly, and the scope is wider. In addition to thermal power, clean energy power generation enterprises have gradually participated in market transactions, and not only with inter-provincial fixed-point transactions, but also began to conduct large-scale transactions in inter-provincial power market. |
| Provincial Power Grid Corp | Instead of trading in electricity, it is trading in transmission rights and ancillary services between provinces. |
| Electricity sale company | Electricity selling companies can not only trade electricity within the province with power generation enterprises and power users participating in the market through provincial power trading centers, but also participate in inter-provincial electricity trading. |
| Power users | Large industrial users and commercial users are the main representatives of power users in the second stage. At this stage, these users can not only trade electricity with power generation enterprises or power selling companies through provincial power trading centers, but also conduct inter-provincial electricity trading through state-level trading centers. |

3.2.3. *The third stage - the national unified power market.* (1) National unified power market.

The national unified power market is mainly based on cross-regional cross-sector energy market (including cross-regional cross-provincial multi-party direct transactions, power generation rights transactions, spot transactions, etc.), supplemented by cross-regional inter-provincial auxiliary service market, cross-regional inter-provincial renewable Energy consumption market, power transmission market, etc., implement national energy strategy, and promote large-scale optimization and allocation.
of energy resources. With the gradual availability of conditions, the trading of electricity futures and power over-the-counter derivatives was carried out.

(2) Provincial electricity market
The provincial electricity market is mainly based on the province's electric energy market (including multi-party direct transactions, power generation rights transactions, spot transactions), supplemented by the province's auxiliary service market and provincial content market, to promote market competition and ensure supply and demand in the province. Balance and absorb clean energy as much as possible. In areas with conditions, the relevant transactions in the provincial power market can be incorporated into the national electricity market; in areas where conditions are not available, the national power market and the provincial power market each have a focused and effective connection.

In the future, with the increase of trans-regional trans-provincial transmission channels and the continuous improvement of market supporting mechanisms, the province's energy trading will gradually shift to the national trading platform. The trading power of the national power trading platform has gradually expanded. It mainly organizes trading types such as contract trading, spot trading and financial transactions, and realizes the optimal allocation of nationwide power resources. The provincial trading platform mainly conducts real-time balancing and auxiliary service transactions to ensure the safe operation of the system. The result is a national unified electricity market consisting of the national electricity market and the provincial balance market.

Figure 5. National unified electricity market framework

4. Conclusion
This paper mainly studies the stage division and mechanism of the provincial power market evolution to the national unified power market. Starting from the analysis of the current situation of China's power market construction, combined with the construction demand of China's future power market, the evolution process of the national unified power market is divided into stages, and the market structure and operation mode of each stage are proposed.

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