Operating Elements of UK Electricity Contract Market and Its Enlightenment to China

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Abstract. The United Kingdom is the birthplace of the world industrial revolution. Its marketization of the power industry has been going on for more than 20 years. It is a developed country with a relatively mature power market system. The UK electricity market reform has experienced the Power P00L model, the New Electricity Trading Arrangements model, and the British Electricity Trading and Transmission Arrangements model. Since the NETA model, the UK has formed a power production-transaction-regulatory system centered on bilateral transactions. China is undergoing market-oriented reform of the power system. In order to break the monopoly, the main contents include changes in the development concept of the traditional power industry, the establishment of a new mechanism for direct trading between power generation enterprises and users, the establishment of an independent and reasonable transmission and distribution mechanism, and the opening of private capital into the electricity market, and so on. This paper introduces the reform process of the UK electricity contract market, summarizes the substantive elements and mechanism elements, lists the operation elements of the current UK electricity contract market, and analyses the structure of the UK electricity market and the bilateral electricity trading mechanism deeply. On this basis, some suggestions are put forward to further improve the construction of China's electricity market.

1. Introduction
Since the 1980s, Britain has implemented a series of electric power system reform, and has become one of the earliest countries in the world to promote the reform of electric power system. Strengthening government supervision and stimulating the vitality brought by market competition have become the most obvious characteristics of the reform of the British power industry. Building an open, transparent and fully meet the multi-level demand market system has been the track and goal of the reform of the British power market. Britain's perfect contract market system and trading mechanism are worth learning from China.

2. Evolution of UK Electricity Contract Market

2.1 The first stage (1989-2000) power contract market under POOL mode
Its symbol is based on the State Grid Corporation of Britain, which was established on March 31, 1990. It adopts the compulsory power pool (POOL) model. In the market, the two sides of the transaction evade the price risk of power pool by signing price difference contracts or power forward agreements. Almost all the electricity transactions are carried out in the power pool.
2.2 The second stage (2000-2005) Power contract market under NETA mode

The market model of the second reform came into operation in 2000, marked by the introduction of a new market trading model, NETA (New Electricity Trading Arrangements). NETA model is mainly based on bilateral transactions, and generators dispatch their units by themselves instead of centralized dispatching by the State Grid Corporation. The new power market consists of three main links: contract market, balance mechanism and unbalanced settlement [1]. Under this mechanism, the State Grid Corporation is only responsible for balancing the market. This reform introduced futures contract trading.

2.3 The third stage (2005-present) electricity contract market under BETTA mode

This stage will implement the NETA model throughout the UK and implement the British Electricity Trading and Transmission Agreement (BETTA). Under this model, a large number of electricity transactions are conducted through the contract market, including forward contracts, futures contracts, short-term contracts and so on. Market participants can sign sales contracts with other participants anywhere in the country and trade freely.

The market operation mode at this stage can still be regarded as NETA mode.

2.4 The fourth stage (2011) New Electric Power Reform

In July 2011, the British government released the White Paper "Planning Our Electricity Future: Developing Safe, Proper Price and Low Carbon Electricity", which opened the prelude of a new round of electricity market reform. In 2014, the UK tried out the power reform plan, which included fixing the fixed grid price based on the differential contract, establishing the carbon price support mechanism and establishing the carbon emission standard [2], and introducing the capacity market mechanism to ensure the safety of power supply.

Since the market operation mode at this stage is still BETTA mode, it can still be regarded as NETA mode.

3. The Operating Elements of the Current UK Electricity Contract Market

The current UK power contract market operation elements are divided into physical elements and mechanism elements.

3.1 Substantive elements

3.1.1 Transactors. The main trading bodies in the UK electricity contract market include power suppliers, sellers, intermediaries and large power users. Trading in the UK electricity contract market is mainly between generators and sellers. One is power generation. There are more than 400 generators in the UK, and the six largest generators have a total market share of more than 70%. The other is the sale of electricity. The UK has more than 20 e-commerce vendors and the top six companies have a total market share of more than 85%. British power producers and sellers are characterized by a vertical integration, and sellers are also power producers.

3.1.2 Subject matter of transaction. Electricity (MW) is generally the trading target in the UK electricity contract market. In Britain, 90% of OTC forward contracts are traded on charges, while the rest are peak loads and non-peak loads. The trading targets of UK futures contracts are the charge, peak load and so on.

3.1.3 Organizational structure. 80% of the contract transactions in the UK electricity market are completed by over-the-counter forward contracts, while the rest are mainly completed by short-term spot transactions through the power trading center N2EX, APX (merged with the European Continental EPEX SPOT Exchange in 2015) and ICE. The balance mechanism is the responsibility of the State Grid Corporation of the United Kingdom. In the UK, ELEXON has a special agency responsible for
unbalanced settlement of contracts. The overall operation mode of the UK electricity contract market is shown in Figure 1. Details can be found in the mechanism elements section.

Figure 1. Overall operational model of the UK electricity contract market.

3.2 Elements of mechanism

3.2.1 Transaction mechanism. The sequence flow of the UK electricity contract market is shown in Figure 2. Long-term and medium-term contracts are mainly completed through bilateral over-the-counter transactions, while short-term spot transactions are mainly completed through power trading centers. The volume of the contract market accounts for 95% to 98% of the total volume, and the balance mechanism is responsible for the remaining part. Balancing mechanism starts one hour before the real-time operation. The dispatching agency accepts the quotation of increasing or decreasing the output of the balancing mechanism unit according to the principle of minimum cost, and calls auxiliary services to complete the real-time balancing of the power grid. This stage is not a real market, because only dispatching is the only buyer and one with operational capability. The main purpose of unbalanced settlement after the event is to encourage market members to generate electricity as far as possible according to the signed contract, and to minimize the unbalanced amount.

Figure 2. Sequence flow of UK electricity contract market transactions. Forward contract transaction: Forward contract transaction is a long-term transaction contract (one
year or several years purchase contract) signed by power producers and sellers, rather than a refinement to 0.5 hours of electricity, and the volume of transactions is very large. In addition to stipulating the rights and obligations of both parties, the contents of the contract generally include the main parameters, such as power supply time, power supply capacity, price and penalty amount in case of breach of contract [3].

Futures contract transaction: After the forward contract transaction is signed, near the time of real-time power generation (e.g. one month before real-time power generation), power traders can constantly revise the electricity quantity of the original contract transaction according to the latest start-up plan and load forecasting, in order to meet the latest generation plan and load forecasting curve by the transaction of goods. Futures contract transaction plays a guiding role in determining forward contract price.

Short-term spot contract transaction: When the forward contract transaction is signed, near the time of real-time power generation (e.g. one month, one week or one day before the real-time power generation), the power trader can constantly revise the electricity quantity of the original contract transaction according to the latest start-up plan and load forecasting situation, so as to meet the latest generation plan and load forecasting curve by short-term transaction turnover and sale.

3.2.2 Balance mechanism. Balance mechanism is the system used by the State Grid Corporation to ensure the balance of power supply and demand per hour [4]. This mechanism is a rolling process of full-time operation. As the system operator, State Grid Corporation purchases long-term options and capacity balancing services under long-term contracts through bidding to ensure the real-time balance of the system. Generators and sellers can submit increasing or decreasing bids.

3.2.3 Settlement mechanism. In the contract market, for forward contracts signed by over-the-counter transactions, both parties need to authorize a notification agent to register in BSC (Balance and Settlement Rules System). The notification agent notifies the contract power to the contract power acquisition system in BSC. The notification agent is the third party power contract notification agency that meets the requirements of BSC. (Energy Contract Volume Notification Agent). For example, the trading center APX can provide the agency service; the power trading center directly informs the futures trading and the contract electricity volume of the day-ahead trading. The contract power acquisition system integrates all contract power data for every 0.5h operation period and transmits them to the settlement management system. For the balance mechanism, after the end of the operation period, all upgrades or downgrades accepted, together with the corresponding offer or bid price data, are transmitted to the settlement management system. The settlement management system uses the information and data received to calculate the cost of unbalanced electricity purchased by the system operators, and transmits the resulting cost to the fund management system for information notification and settlement [5]. The settlement process is shown in Figure 3.

3.2.4 Price mechanism. The price mechanism of the UK electricity contract market is based on ancillary services and transmission and distribution prices. The contract price is formulated through consultation between the two parties involved in the transaction with reference to the standard price of electricity for generators and sellers [6].

3.2.5 Risk prevention mechanism. The margin system in electric power futures is an important part of futures trading. After paying the basic margin, the power trader must pay additional margin when the market situation changes unfavorably, which greatly prevents the risk of non-contract between the two sides of the transaction; through the credit guarantee of trading institutions and the balanced mechanism and unbalanced settlement adopted by the British electricity market, the risk can be prevented.
Market members (Generator, retailer)

Contract Market

APX, N2EX, ICE

Short-term spot contract

Future contract

System dispatching organization (NGET)

Electricity metering system

0.5h electricity consumption per unit

0.5h is the unit's power consumption

Power generation metering system

0.5h is the unit contract power

Settlement system

Cash Management System

Bill Payments

Unbalanced settlement (ELEXON)

FPN (Electricity plan)

Balance mechanism

Unbalanced electricity settlement

The offer/bid price corresponding to the amount of up/down

Figure 3. Power contract settlement management flow chart.

4. The Enlightenment of Operation Elements of UK Electricity Contract Market to China

4.1 Optimizing the transaction management mechanism of power market to promote the healthy development of power market

Britain's power trading centers and dispatching agencies are functionally independent of each other. Power grid dispatching agencies are mainly responsible for balancing services and do not participate in normal market transactions, effectively avoiding possible unfair practices caused by State Grid monopoly. By learning from the experience of the British electricity market, China's electricity market should consider the interests of all parties, improve relevant laws and regulations, and build a fair and reasonable trading platform for participants.

4.2 Perfecting the time structure model of power market and establishing a complete power market trading system

From the perspective of the time structure of the UK electricity contract market reform, all kinds of transaction types in different time ranges need to coexist in the market. Only when a variety of trading products cooperate organically can the system be balanced and safe. Britain achieves the balance of total electricity in the market through forward contract trading, futures trading, spot trading, dispatching temporary trading and other trading modes. Through the unbalanced electricity settlement mechanism, Britain encourages the behavior that is beneficial to the system's electricity balance and punishes the behavior that is unfavorable to the system's electricity balance. Electric power futures are the product of the highly developed electricity market, which can not only promote the balance of electricity, but also expand the financial attributes of electric power commodities. Therefore, the establishment of a complete power market trading system is the necessary process of China's power system reform.
4.3 Establishing a reasonable and efficient settlement mechanism to ensure the effective operation of the electricity market

In the UK electricity contract market settlement mechanism, we can draw lessons from the establishment of unbalanced settlement mechanism for participants in balanced transactions. With the continuous development of China's electricity market, the diversification of trading entities, the more flexible and changeable types and cycles of transactions, these have put forward higher requirements for transaction settlement in the power market. At present, there is a lack of effective market tools to deal with these problems in China. China urgently needs a scientific and reasonable settlement mechanism to ensure the fairness of the interests of market participants and promote the smooth development of the market.

4.4 Establishing risk prevention mechanism of power market and playing the role of trading center as a platform

After bilateral electricity transactions, there are often greater credit risks. There are two power exchanges in the UK that carry out physical electricity transactions. Market members must provide mortgage guarantees on the exchanges in the form of cash or letters of credit. In the construction of power contract market in our country, we should give full play to the platform supervision role of power trading center in bilateral transaction, management, settlement and so on, and do a good job in credit management, so as to prevent the risk of power market and safeguard the interests of each transaction subject. In addition, China's electricity market should gradually introduce electricity futures, options trading, through financial instruments to further avoid market trading risks.

5. Conclusion

As a pioneer country in the reform of power system in the world, Britain has undergone four major reforms of power market successively, which has provided valuable experience for all countries in the world in exploring the market-oriented road. At present, China's electricity contract market is in its infancy, and the market model and market rules need to be improved. By reviewing the process of power system reform in the UK and introducing the operating elements of the power contract market in the UK, some suggestions are put forward in order to bring some enlightenment to China's power system reform.

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