Research on market trading risk assessment of multi-species electricity trading

J B Wang¹, D W Song¹, M Yang¹ and Q He²,*

¹State Grid Henan Electric Power Company Economic and Technological Research Institute, Zhengzhou 450052, China
²North China Electric Power University, Changping District, Beijing 102206, China
*heqian031506@163.com

Abstract. The power system reform is a key step in the development of energy Internet. With the gradual advancement of the reform of power system, the forms of electricity market trading under the energy Internet are increasing. This paper studies the market transaction risk assessment and prevention of multi-species electricity trading in the context of energy internet. Firstly, the basic laws of market transactions are analyzed. On this basis, a multi-species market trading risk assessment index system is established. Finally, measures for multi-species transactions are proposed. The purpose is to improve the ability to identify and prevent transaction risks in the power market, form a fair and equitable market trading system, and promote the steady construction of the electricity market.

1. Introduction

In July 2015, the Guiding Opinions of the State Council on Actively Promoting the “Internet Plus” Initiative was released, and “Internet + Smart Energy” was listed as one of the key areas of action. Energy Internet is the product of the deep integration of energy and information, an important fulcrum to promote the energy revolution, and also the focus of China’s energy field work in the future.

The core of the energy Internet is electricity, which is based on the unique nature of electricity and the current state of development of energy systems. Power has efficient transmission efficiency and convenient terminal usability, providing the basis and guarantee for the efficient use of renewable energy. Therefore, different energy sources can be converted into electricity and then participate in electricity market trading.

Under the energy Internet, the electricity market will present a variety of trading products: energy, ancillary services, derivatives, and green certificates. Due to the diversity of trading products in the power market, the trading model of the power market will present diversity and high risk. The identification, evaluation, and prevention of market risks are of great significance to the successful construction of the power market and smooth and fair trading of power products. Therefore, it is imperative to study the market risk assessment of multi-species power trading.

2. Classification of power transaction types

Electricity market transaction types can be classified in terms of time, quantity, and form of implementation. According to the number of transactions, the electricity market can be divided into electricity wholesale market, electricity retail market and external market. Under the power wholesale
market, there are mainly power wholesale transactions, contract power transfer transactions, cross-provincial cross-regional transactions, auxiliary service transactions, user-side energy storage systems, and distributed generation marketization transactions. The power retail market includes electricity retail transactions. And under the external market are carbon emissions transactions, green certificate transactions. The classification of power transaction types is shown in figure 1.

![Figure 1. The classification of power transaction types](image)

### 3. Analysis of market trading behavior of multi-species electricity trading

In all types of power trading markets, there are acts of suppliers violating market rules, and there are also some acts that are not violating market rules, but are directly or potentially harmful, such as profit-seeking pricing, speculation, alliances, etc. These harmful market behaviors have damaged the competitiveness and effectiveness of the market and affected the optimal allocation of limited resources, thereby undermining the efficiency of the electricity market.

#### 3.1. Basic law of electricity market trading

The Basic rules of market trading can be shown in figure 2.

![Figure 2. Basic rules of market trading](image)

The figure 2 shows the basic relationship between the electricity market transaction results and the various factors. The meaning of each module is as follows:
• Objective factors
These are the fundamental characteristics of the market itself. They are not shifted by the will of market participants. They mainly include market supply and demand and market structure. The market structure is determined by the number and size of bidding power plants in the market. Without new power plants joining the market, the market structure is relatively stable. The market supply and demand balance is affected by the increase in installed capacity, social power growth, and seasonal factors. On a specific trading day, the market supply and demand conditions can be predicted in advance. Market structure and market supply and demand are also two basic characteristics of any commodity market.

• Subjective factors
These refer to the market behaviors determined by the subjective will of market participants, and the specific performance is the quotation of the market participants. Market participants can formulate quoting strategies based on their respective market forecasts, subjective risks, and income preferences. Market behavior is a comprehensive manifestation of willingness of subjective quotations of market participants.

• Subjective factors
Transaction result: The market transaction result includes the transaction power/electricity and electricity price. It is the result of optimization calculation based on market participants' quotes and various constraints, which can be reflected by market efficiency and benefit.

• Market rules
The information disclosure rules in Figure 2 are responsible for the disclosure of market basic information before trading and information on the outcome of transactions to market participants. The market trading model is responsible for converting the quotation into the result of the transaction.

The above types of factors have the following internal relationships:
First, the market rules determine the basic relationship among market factors. The rules module in the chart connects objective factors and subjective factors with the results of the deal, the market trading model will not change once it is determined, the disclosure module before and after the transaction serves as information filtering. The change of disclosure rules will have an important impact on the bidding behavior of market participants.
Second, under certain market rules:
• Objective factors determine subjective factors
Market supply and demand and market structure determine the bidding status of market participants, thus affecting their bidding behavior;
• Subjective factors are the direct factors that determine market transactions
The result of the deal is based on the quoted price of the market participants, taking into account settlement rules and various constraints, and carrying out optimization calculations.

In the long run, with the increase in the number of transactions, market participants will gradually adjust bidding strategies according to information disclosure and information feedback before and after the transaction, so as to adapt to the characteristics of market supply and demand and market structure.

In the electricity market, the quoted behavior of market participants directly determines the market's result. As shown in figure 2, market bidding behavior is a subjective factor in the market and is at the core of the market transaction process. Figure 2 shows the relationships among various indicators: market objective factors, subjective factors, and transaction results are the comprehensive representation of market participants' bidding status, bidding strategies, and bidding risk returns. Analyzing and evaluating bidding behaviors of participants in the electricity market is also a core task of market operations and market analysis.

3.2. Analysis of electricity market transaction violations
Market irregularities can be discriminated, punished and regulated according to market rules, and harmful market actions cannot be identified and controlled according to market rules. Therefore, an effective method must be established to identify, monitor and control them. The common harmful market behavior and main features are shown in table 1.

Table 1. The common harmful market behavior and main features

| Type                  | Behavior          | Behavior Characteristics                      |
|-----------------------|-------------------|----------------------------------------------|
| Excessive competition | Competing for price| Quotes are below the cost for a long time.   |
| Insufficient competition | Speculation   | Quotes are much higher than the average price in certain periods. |
|                       | Windfall pricing | Some suppliers report prices much higher than other competitors. |
|                       | Alliance         | All members of the coalition report high prices collectively. |

Market suppliers refer to various types of power generators such as power plants, generating units, group companies, or out-of-area power sellers who participate in the bidding of power market sellers.

4. Market trading risk assessment index for multi-species electricity trading

4.1. Market supply and demand indicators
Under the premise of relatively stable structure, market supply and demand are the key factors for market competitiveness. The tighter the market supply is, the more important the status of each supplier is; the greater the elasticity of demand, the more intense the competition. In the real power market, it is generally necessary to ensure that the total market declared capacity exceeds the total load demand by a certain amount in order to ensure market competitiveness. The market supply and demand indicators study the market supply and demand balance and changes, and the market supply and demand situation will directly affect the power supply company's purchase price.

4.2. Market structure indicators
Market structure is the most fundamental attribute of the market. The more the number of power generators, the smaller the market share, the closer the share of different power generators, the more favorable the market structure is for competition, on the contrary, it is easy to cause monopoly. At present, the analysis and assessment of the market structure of the power generation side are commonly used HHI index, Top-m index and RSI index, the market concentration is high, indicating that the market structure is irrational. Some power generation companies have the ability to manipulate market prices, and the power supply companies will face the risk of rising electricity prices.

4.3. Market trading indicators
The market transaction status is the basis for analyzing the relationship between supply and demand and market volume and price. It can be analyzed from the market transaction power price and transaction power. Through the comparison analysis of the volume and price before and after the implementation of the electricity market, it reflects the orderliness of market competition and market efficiency, illustrates the impact of market transactions on the entire market, and reflects the risks posed to electricity purchasers from the side.
4.4. Market behavior analysis and evaluation indicators
The relevant indicators of market behavior mainly reflect the bidding strategies and behaviors of market participants, so as to judge whether there is any use of market power or manipulation of market price in the process of market bidding.

4.5. Market safety indicators
The premise of the electricity market is the safe operation of the electricity market, which is also one of the necessary conditions for the trading organization to survive, especially in China's current high-speed economic growth, rapid increase in load power consumption, rapid increase in power investment, and relatively backward power grid development, the construction of the electricity market must ensure the safe operation of the power system. Therefore, when conducting risk assessments for market trading organizations, it is necessary and meaningful to evaluate the safety of power systems in the power market environment.

4.6. Analysis and assessment indicators of primary energy impacts
The situation of primary energy supply and price will directly affect the power supply capacity and indirectly affect the price of electricity. Therefore, the primary energy situation will be analyzed and evaluated from the following three aspects, including the assessment of supply reliability, supply price, energy structure and coal price linkage.

4.7. Market price fluctuation indicators
The price fluctuations of purchased electricity indicate the risk of price fluctuations in purchased electricity. The large fluctuations in the purchase price of electricity indicate that the power supply companies face greater market trading risks. On the contrary, the stable purchase prices indicate that the market is operating stably and the power company's trading risks are low.

5. Prevention of market trading risks in multi-species electricity trading
• Accelerate the development of medium and long-term plus spot market
  The medium and long-term markets circumvent price fluctuations in the spot market through financial derivatives such as physical contracts, differential contracts, and futures, providing a means for both parties to share price risk. The spot market considers the actual safety constraints of the power grid, reflects the physical conditions of the power system operation, and organically realizes the real-time balance between the optimal allocation of resources and the power system.
  • Establish differentiated access and strict exit mechanism
    In order to actively nurture power sales entities, differentiated access mechanisms can be established for different types of power sales companies. The power sales companies that serve large industrial and commercial users require their financial status and financial strength to have a relatively high level and have the technical capabilities needed to serve such users; for the power sales companies that only serve small and medium-sized industrial and commercial users and ordinary residents, the access standards can be appropriately reduced. In order to promote fair competition in the market, a strict market exit mechanism need to be established, and the main sellers of electricity that violated the law and violated regulations should be ordered to withdraw from the market.
  • Build a huge information collection network
    Policy risks can only be reduced, cannot be completely eliminated, and cannot be transferred. Establishing a huge information collection network to obtain information in advance and make timely and effective adjustments to market strategies in response to new policies can reduce policy risks to a certain extent, and can even make a difference in time before the market becomes acquainted.
  • Establish information disclosure system
    Formulate information disclosure management methods, specify the information disclosure of various types of power sales companies and power grid companies, require the sale of basic information, electricity sales price, additional services and other contents of various selling enterprises
to be disclosed to the market subject through the transaction information platform, providing users with a comparison of prices and services. The grid company is required to disclose information on grid investment and construction, system operation, and user power consumption to all power sales companies, so as to prevent information asymmetry and reduce the competitiveness of power grid asset-free power selling companies.

6. Conclusion
This paper starts from the basic laws of electricity market trading, analyzes the trading behavior of the electricity market, establishes a market trading risk assessment index system for multi-species trading, and gives application methods. For one thing, establishing a market trading risk assessment index system for multi-species power trading is conducive to the immediate identification and prevention of market transaction risks, making the power trading fair and equitable. For another, through the risk assessment of power market trading, it is conducive to establishing a sound electricity market trading system and promoting the construction of the electricity market on the basis of ensuring safety.

References
[1] Tang Tianqi. Study on the risks and countermeasures of power market transactions after the sale side is released[D]. North China Electric Power University (Beijing), 2017.
[2] Zhang Juan, Wu Ze, Chen Changman. Analysis of Electricity Market Transactions in the Background of Power Market Deregulation [J]. Modern Industrial Economy and Informatization, 2017, 7(11):14-15.
[3] Li Xiao. Research on evaluation index and method of China's power market[D]. North China Electric Power University (Beijing), 2017.
[4] Ma Li, Huang Liming, Xue Song, Fan Menghua, Zhang Xiaoxuan. Key issues for the orderly operation of China's new pilot reform of the electricity market[J]. China Electric Power, 2017, 50(04): 17-22.
[5] Bao Jie, Xie Qin, Wang Zhongrong, Li Yan. Power Market Transaction Management Based on Risk Management Theory[J]. Electric Age, 2017(11):20-21.