Research on operation monitoring system of spot electricity market

Ming Xu¹, Wenqin Song¹, Jianjun Tuo¹, Dunnan Liu² and Tengjian Li²*

¹ State Grid Gansu Electric Power Company Economic and Technological Research Institute, Lanzhou, 730050, China
² North China Electric Power University, Beijing, Beijing, 102206, China
*Corresponding author’s e-mail: mingguangliu@ncepu.edu.cn

Abstract. At present, the power system reform has entered a critical period, and the construction of electric power spot market is the core link of deepening the reform of electric power system. In this paper, based on the spot market, combined with the theory of power market operation analysis and monitoring, on the one hand, it analyzes the establishment of power market operation evaluation index system frame, on the other hand, it puts forward the basic principle of power market operation monitoring. Market power monitoring in the electricity market is a key direction that the power regulatory agencies in the market-oriented environment pay close attention to and urgently need to study. We should actively study and explore the market operation monitoring system to adapt to the characteristics of China’s power industry and power market reform.

1. Introduction

On July 31, 2019, the national development and Reform Commission and the State Energy Administration jointly issued the opinions on deepening the pilot work of power spot market construction, which provided timely guidance and policy requirements for the key and common problems existing in the pilot work of power spot markets. The main contents of "spot work opinions" can be summarized as follows: reasonable design scheme, overall planning of market connection, establishment of operation mechanism, improvement of operation ability, standardization of operation platform and improvement of supporting mechanism.

The purpose of power market operation analysis is to study the law of electricity market, analyze the market potential, predict the future trend and formulate planning strategies. Power market operation analysis is carried out from multiple angles and levels, using the principle of data mining, including: business environment analysis, market index analysis, market prosperity analysis, etc. Business environment analysis has always been an important part of industrial operators to maintain strong market competitiveness. In the analysis of market indicators, through the analysis of the changes in the composition of all sectors of electricity consumption in the whole society, the key factors leading to the changes of power consumption in the whole industry are identified, the main objectives of marketing services are defined, and targeted decisions are made. Market prosperity analysis reflects the changes of the future market. It is the direction light of the electricity sales market and a part of the power enterprises pay close attention to.

To implement effective market monitoring, we should first define specific issues, such as what constitutes market power and what constitutes market manipulation, so that we can carry out
monitoring work. The monitoring process is generally divided into three steps: information collection, analysis and control.

2. Analysis and monitoring theory of power market operation

Power market operation analysis mainly realizes the establishment of business index analysis system, data integration and conversion, data hierarchical storage and integrated analysis and decision-making.

2.1 Establish business index system

Sort out the business indicators of the company's main departments, standardize the professional index name, index definition, index centralized department, calculation formula, data source, index frequency and other attributes closely related to business indicators, so as to form an enterprise level decision-making auxiliary analysis index library.

2.2 Building object oriented data warehouse

After the integration and transformation of business objects from different systems and codes, a unified business data is formed in the data warehouse system of the data center to avoid the confusion of meaning and multiple definitions of an indicator by decision analysts. According to the different granularity of data, the data warehouse is divided into summary data storage and detailed data storage. The summary data is directly object-oriented data for analysis, and the detailed data provides the traceability analysis of indicators.

The construction of power market comprehensive evaluation index system is a system engineering. The index can reflect the market operation effect produced by the guidance and restriction of market operation rules. The evaluation of the index can judge the advantages and disadvantages of the power market design. The evaluation system should include indicators related to power system operation and power market operation. In addition, the design of China's electricity market rules should follow the main principles of safe and economic operation, "three public" and sustainable development, so as to build a safe and efficient market structure and market system.

The basic framework of power market operation evaluation index system can be constructed from four aspects: security, economy, fairness and environmental protection.

Fairness: adhere to the principle of "openness, fairness and justice", ensure fair competition without discrimination, and provide fair and perfect trading services for all kinds of market participants.

Security: it is necessary to ensure the safe and high-quality operation of the power system and promote the stable and healthy development of the power market.

Economy: we should realize the optimal operation of the system and the optimal allocation of resources through market means.

Environmental protection: it should be able to promote the stable, orderly and coordinated development of the power market, realize energy conservation and environmental protection, and promote the harmonious development of economy.

3. Framework of power market operation evaluation index system

Market equity mainly comes from three aspects to consider: market non discrimination, market supervision ability and market concentration. Market non discrimination indicators include non discrimination of trading institutions, non discrimination of dispatching agencies and non discriminatory opening of transmission and distribution networks; market supervision capability indicators include regulatory capacity and executive ability of regulatory agencies; market concentration indicators include top-m share, HHI index, necessary operation rate of power plants, residual supply rate and local market power. Among them, the market non discrimination index requires trading institutions, dispatching agencies, transmission and distribution networks to treat all power market users fairly, which is obtained through market subject investigation and expert evaluation.
Market security is mainly considered from three aspects: power system security, market transaction security and market operation security. Among them, power system security mainly considers generation capacity adequacy, transmission capacity adequacy and power supply reliability; market transaction security mainly analyzes market power situation and market competition degree from the perspective of market declaration parameters, and then evaluates market transaction security; market operation security mainly evaluates whether the market operation is safe and stable from the perspective of market supply and demand, market behavior and price fluctuation.

The economy of power market operation is usually reflected in the existence of competitive elements in the market, the efficiency of market operation and the effectiveness of resource allocation by market price mechanism. Therefore, the economy of electricity market rules is evaluated from five aspects: market opening degree, market price, market main body benefit, social economic benefit and power grid benefit.

Environmental indicators are mainly considered from three aspects: clean energy trading evaluation, fuel diversity, environmental protection. Environmental indicators reflect the impact of power market on energy saving, environmental protection and economic development.

Generally speaking, the market evaluation should lag behind the market construction, that is, there is the market first, then the market evaluation. However, the current situation in China is that the real power market has not yet been established. Some of the regional power markets under construction are still in simulated operation, and some have been in trial operation for a period of time. There are two ways to solve this problem: one is to establish two different evaluation systems, which correspond to two different stages of market reform and market maturity respectively; the other is to refer to the data of foreign power markets which are relatively successful in operation. For example, PJM power market in the United States and national electricity market in Australia are used to verify the applicability of the evaluation indexes and methods, which can also be used as a reference for the construction of China’s power market.

Figure 1. Power market operation evaluation index system

4. Basic principles of power market operation monitoring

4.1 Monitoring process under real-time monitoring

Market monitoring is inseparable from the necessary data support. Data issues are particularly important when implementing "real-time" analysis. If the speed of data collection is not guaranteed, the analysis can not be realized at all. If there is a problem with the quality of the data, the accuracy of the analysis is difficult to improve. Therefore, data collection is an important constraint factor to be considered when designing the organization and process of market monitoring. In order to carry out
"real-time" analysis, the following types of data are essential: quotation information of market members, including power purchasers and sellers; network topology information and measurement data; Association of market members; other possible data not provided by the trading center.

"Real time" market monitoring is mainly realized by the program embedded in the power market technical support system or by manual means. Generally, it only needs to test and judge the quotation information to complete the analysis. The implementation methods of "real-time" analysis mainly include the following two categories:

Behavioral testing. Generally, the quotation is compared with the known threshold value or reference results to find out the quotation behavior beyond the limit.

Impact testing. A simple analysis of the quoted price can determine whether it will have a positive or negative impact on the market efficiency, or obviously does not meet the requirements of a competitive market.

4.2 Monitoring process under post monitoring

"Offline" analysis needs a lot of data, and the data it faces is also huge. Most of them come from the dispatching center and trading center, such as quotation, maintenance and outage planning, forward market planning, scheduling and other information. Because the power market is affected by many factors, it is necessary to pay attention to such data as the electricity market information, fuel prices, weather data, hydrological data and so on in other areas.

Private data of market members may be involved in market monitoring, such as bilateral contracts and cost information of power producers, which are difficult to be used for market monitoring. At the same time, for some information related to trade secrets, in order not to infringe on their competitiveness, some information needs to be kept strictly confidential during the analysis, calculation and disclosure.

In order to get valuable data, we can consider using database, data mining and other advanced processing technology to establish a special analysis software.

Market and power system conditions. Calculate and analyze the power market transactions and the overall operation of the power system, enhance the understanding of the market and system conditions and development trends of all parties, including market members, and find out the possible improper points in the market design, structure and member behavior, and help to improve.

Market structure index and analysis. This paper analyzes the structure and technical composition of market members in each sub market, including power buyers. Its function is to find out the actual or possible problems in the market structure, so as to take measures or find out the objects that need further analysis.

Member behavior indicators and analysis. The members here include both buyers and sellers, and market operators. The purpose is to find out the members' illegal or unreasonable behaviors, quote prices and other behaviors that affect the transaction efficiency and system security, so as to make adjustments.

Market efficiency index and analysis. Through the application of indicators and calculation model, the efficiency, liquidity and competitiveness of the market are analyzed, and the factors affecting the improvement of market efficiency are predicted or discovered afterwards. Market efficiency analysis can also focus on the important aspects and contents concerned by regulators, government departments or other market members, such as the efficiency of a demand side management measure.

Market design control can be preventive or feedback. Through simulation or analysis and calculation, the problems existing in market design can be found in advance to a certain extent, so as to eliminate the problems. After the problems are found, adjusting the market design in time is the key to avoid more losses.

5. Conclusion

This paper studies the operation monitoring system of spot market of electric power from the perspective of theory, index system and monitoring process. The research of power market operation
monitoring system is helpful to balance the fairness and competitiveness of the market, and can also help us to effectively distinguish the price fluctuation caused by normal supply-demand relationship and the price rise caused by market power. Market regulators should put forward a monitoring system suitable for local electricity spot market according to the target of market design and the characteristics of power industry.

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