Research on the Management of Inter-provincial Transaction Schedules for Promoting Effective Implementation of Medium and Long-Term Transaction Schedules

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Abstract. With the advancement of electricity marketization, the variety of inter-provincial transactions is increasing, and the scale of inter-provincial transactions is expanding, which puts forward higher requirements for the management of inter-provincial transaction schedules. According to the inter-provincial transaction planning business of each trading department of Beijing Power Exchange Center, this paper put forward a cooperative scheme of inter-provincial transaction management, unified the template of inter-provincial transaction schedules, formulated a mechanism for the implementation deviation evaluation of inter-provincial transaction schedules. It is useful to achieve closed-loop management of inter-provincial transaction schedules and ensure effective implementation of inter-provincial transactions.

1. Introduction
During the 12th Five-Year Plan period, China's electric power industry has undergone profound changes from local electricity shortage to the national overall electricity surplus. The electric power industry has entered a new phase, which provides an important opportunity for further deepening the reform of the electric power system. In March 2015, the promulgation of "Some Opinions on Further Deepening the Reform of Electricity System" by the Central Committee of the CPC and the State Council opened the prelude of a new round of electricity market-oriented reform in China. With the advancement of electricity marketization, it is required to establish a preferential power purchase system to ensure the use of electricity by non-negotiating users, and to establish a priority power generation system to ensure clean energy power generation and the priority of regulated power supply of the power grid. Through the market-oriented trading methods such as direct electricity trading, other electricity generation and consumption schedules will be gradually liberalized. In this context, the variety of inter-provincial transactions is gradually increasing, the scale of inter-provincial transactions is gradually expanding, and the trading mode is becoming increasingly complex. In order to achieve the effective implementation of the transactions, it puts forward higher requirements for the management of inter-provincial transaction schedules.

2. Present situation of management
As one of the two national trading institutions, Beijing Power Exchange Center provides services for electricity market transactions in accordance with government-approved regulations and market rules.
It is mainly responsible for the construction and operation of the inter-provincial power market in the operation area of the State Grid Corporation, and it is responsible for implementing the national schedules and local government agreements. It organizes market-based inter-provincial transactions, and gradually promotes market integration across the country, so that the market plays a decisive role in resource allocation. It promotes the construction of the national electricity market system and the optimal allocation of energy resources. In 2017, Beijing Electric Power Trading Center focused on clean energy consumption, large-scale optimization of resources and direct electricity trading. It constantly enriched trading varieties, invigorated the market, and basically formed a market trading pattern with multiple time periods, multiple trading varieties and multi-organizational modes. In the whole year, 409 market transactions were organized, with a trading volume of 873.5 billion kWh, a year-on-year increase of 10.6%, further optimizing energy resource allocation in a larger scale[1]. With the increase of market trading varieties and the increase of organizational frequency, the contents of the monthly inter-provincial transaction schedules are more and more abundant. The main contents are divided into two categories: national schedules (non-market transaction schedules) and market transaction schedules. From the regional perspective, it can be divided into the cross regional transaction schedules and the inter-provincial transaction schedules, covering the entire operation area of the State Grid Corporation.

At present, the trading business of Beijing Power Exchange Center is divided into seven departments. Department One is mainly responsible for cross-regional transaction management. The other departments are mainly responsible for inter-provincial transaction management work in North China, East China, Central China, Northeast China, Northwest China and Southwest China. The above seven departments are also responsible for the management of the inter-provincial transaction schedules. Multiple inter-provincial transaction schedules are issued to the outside, resulting in overlapping of some contents, data consistency is also difficult to be guaranteed, and the degree of refinement of transaction schedules management is insufficient. On the other hand, at present, each trading department focuses on making trading schedules, and the analysis of the completion of the transaction schedules is less involved, which is not conducive to improving the scientific and executability of the transaction schedules.

In the paper[2], a multi-objective model including economy and environmental protection was constructed based on the background of South China Grid, and a method of decomposition of medium and long-term transaction electricity was proposed to compile daily dispatching schedules. For the coordinated dispatching problem of multi-area interconnected system. The paper[3] proposed a decentralized dispatching method considering cross-area tie-line transaction schedules, which solved the problem that tie-line power schedules were only a simple superposition of power transactions and could not fully coordinate the generation resources of multi-area power grid. The papers[4-6] proposed some methods of making the inter-provincial tie line schedules, considering constraints such as contract power, power supply processing, and transmission power limitation in the optimization models. At present, the researches mainly focused on the decomposition of medium and long-term transaction electricity and the compiling daily dispatching schedules. There were few studies on the management of inter-provincial transaction schedules.

3. Collaborative management of inter-provincial transactions schedules

3.1. Business Process
The making and tracking of the inter-provincial transaction schedules requires the participation of the above seven trading departments to work together. According to the current actual business development of each trading department, this paper divides the management of inter-provincial transaction schedules into three main links: planning, signing, and execution. The management of inter-regional transaction schedules is taken as an example, as shown in Figure 1. The business process of inter-provincial transaction schedules management is similar, and will not be described again.
(1) Planning

In the middle of each month, Department One first initiates the monthly inter-provincial transaction planning process. It summarizes key information such as the national mandatory plans, market transaction results, directly dispatched units’ maintenance plans, power grids’ maintenance plans, and available capacities of the channels. Information such as units’ maintenance plans, grids’ maintenance plans, and available channel capacities are provided by the dispatching agency of the grid company. According to the above information, the completion schedule of the annual transactions, the monthly load forecasting level and other information, a preliminary draft of the inter-provincial transaction schedules is made and sent to other departments. Based on this, the other departments put forward suggestions for revision of the schedules to Department One, and make the inter-provincial transaction schedules in the local region. Finally, the revised proposal and the local inter-provincial transaction endorsement will be submitted to the company leader for approval and issuance. Figure 1 presents the business process of inter-regional transaction schedules.
schedules are submitted to Department One. After receiving feedback from the other departments, the first draft of the transaction schedules is revised and improved by Department One. According to the latest maintenance plans of dispatching agency and the security check results of market transactions, the draft will be continuously revised until the final draft of the transaction schedules is formed. During the period of revision, the other departments may also propose new amendments.

(2) Signing

After the completion of the final draft of the transaction schedules, the transaction schedules will be signed. The final draft of the transaction schedules needs to be signed by Power Grid Corp and dispatching agencies before it can be issued externally. It needs to be issued before the last working day of each month.

(3) Execution

The monthly inter-provincial transaction schedules are decomposed to the daily plan by the dispatching agency, and the mode of grids’ operation and units’ startup are reasonably arranged to ensure the implementation of the transaction schedules. Department One is responsible for tracking the implementation of cross-regional transaction schedules. The other departments are responsible for tracking the implementation of cross-regional transaction schedules associated with it and the inter-provincial transaction schedules in the region. Each department can adjust the transaction schedules according to the actual situation of the electricity market. The relevant market participants may submit schedules adjustment requests to Beijing Power Exchange Center before the last week of each month. After the agreements are reached, transaction schedules are adjusted, the transaction schedules adjustment order will be issued as the basis for transaction adjustment and power settlement.

3.2. Template of inter-provincial transaction schedules

In order to avoid the issuance of multiple inter-provincial transaction schedules by various trading departments and to improve the consistency of transaction schedules, the unification of inter-provincial transaction schedules’ templates is imperative. According to the subjects of the transaction schedules, this paper divides the inter-provincial transaction schedules into two categories: the tie line transaction schedules and the directly dispatched units’ transaction schedules. The tie line transaction schedules refer to the transaction schedules arrangement on the main transmission channels of the power grid, focusing on the power seller, the power transmitter, the power purchaser, and the power curve for each time period. The template is shown in Table 1. The directly dispatched units’ transaction schedules refer to the power generation schedules of directly dispatched units, and pay more attention to the transaction components. The template is shown in Table 2.

Table 1. The template of tie line transaction schedules

| Transaction Name | Transaction Mode |
|------------------|------------------|
|                  | Seller | Purchaser |
|                  | Transmitter | Transmission Channel |
| Transacted Quantity | MWH | Transaction Gateway |
| Power Curve 1 | Period 1 | Power | MW |
|                | Period 2 | Power | MW |
| Transaction Date 1 | To |
| Power Curve 2 | Period 1 | Power | MW |
|                | Period 2 | Power | MW |
| Transaction Date 2 | To |
| Remarks |

| Power Curve 2 | Period 1 | Power | MW |
|                | Period 2 | Power | MW |
| Transaction Date 2 | To |
| Remarks |
Table 2. The template of directly dispatched units’ transaction schedules

| Transaction Name | Seller | Purchaser |
|------------------|--------|-----------|
| Generated Quantity | MWH    | On-grid Quantity | MWH |
| Transaction Date | To     |            |      |
| Transaction Component | Quantity /MWH | Power/MW |
| Component 1          |         |            |      |
| Component 2          |         |            |      |
| ......                |         |            |      |
| Remarks               |         |            |      |

4. Implementation deviation evaluation of inter-provincial transaction schedules

After the implementation of the inter-provincial transaction schedules, the analysis of the completion of the previous month will be conducted in the current month. According to the actual settlement of electricity and planned electricity, the completion rate and deviation rate of each transaction schedule are counted. The causes of deviation are obtained from the dispatching agency, and the causes of deviation are classified and counted. It is recommended to hold regular meetings to discuss countermeasures monthly.

Based on the statistics of the inter-provincial transaction schedules for the whole year of 2017, this paper finds that the causes of the deviation of the execution of the transaction schedules are mainly due to the following situations, which are shown in Table 3.

Table 3. The causes of the deviation

| No | Cause                                       | Count | Proportion |
|----|---------------------------------------------|-------|------------|
| 1  | Power generation forecast deviation         | 12    | 19.35%     |
| 2  | Troubleshooting of units or lines           | 10    | 16.13%     |
| 3  | Load forecast deviation                     | 9     | 14.52%     |
| 4  | Incremental transaction within month        | 8     | 12.90%     |

Table 3 lists the top four causes of the deviations, accounting for 63% of all deviations. For the causes 1 and 3, it is necessary to further improve the power generation prediction and load forecasting level, and minimize the deviation. At the same time, trading institutions need to maintain close communication with power generation companies and keep up to date with the latest forecast data. However, due to the uncertainties in the prediction of new energy power generation and load forecasting, the space for improvement is limited. For the cause 2, the power generation enterprise and the power grid company can strengthen the equipment management work, arrange reasonable maintenance plans, find the problem ahead of time and solve them, improve the availability of the equipment, and try to avoid temporary failure of the equipment. For the cause 4, the trading institution should fully exploit the trading demand before the month and carry out inter-provincial transactions, so the transactions could be included in the inter-provincial transaction schedules, which is conducive to the implementation of the transactions. However, because the power supply and demand are in a state of dynamic balance, it is reasonable for the trading institution to organize monthly incremental transactions according to the actual needs of the market participants.
5. Conclusion
With the advancement of power market reforms, the scale of inter-provincial transactions has gradually expanded. In order to effectively implement the transactions and national plans, the management of transaction schedules is crucial. Based on Beijing Power Exchange Center, this paper proposes a cooperative scheme of inter-provincial transaction management, and formulates a mechanism for the implementation deviation evaluation of inter-provincial transaction schedules. They are helpful to improve the management level of the transaction schedules and adapt to the needs of the future power market reforms.

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