Research on case management technology of power market simulation

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Abstract. The construction of electric power spot market in China is gradually advancing. Since the operation of electric power spot market is affected by various factors such as grid structure, supply and demand situation and external environment, and is closely related to grid operation, it is difficult to predict through theoretical analysis and estimate the operational effect of the market, so before the formal operation of the power spot market, it is necessary to verify and analyze the operational process and operational effects of the market. In order to facilitate the recording of market operation process and result data under various simulation scenarios and to carry out data comparison and to analyze the causes and influencing factors of market operation effects, this paper proposes case management and case data comparison of the electricity market operation simulation. The case management is used to manage the process and result data of the market operation simulation, and support the data comparison and analysis of different simulation scenarios, it provides technical support to the verification analysis of the operation effect of the power market and the effective factors.

1. Introduction
The spot market is an important part of the power market system. It plays a fundamental supporting role in the open, competitive and ordered power market, and it is also the key to coordinate the market transactions and grid operation [1]. At present, Guangdong and Zhejiang have successfully started the construction of the power spot market, and other pilot areas are gradually advancing. The operation of power spot market is a long-term dynamic evolution process, it is affected by various factors such as power grid structure, supply and demand situation and external environment, so it is difficult to predict the operation effect of the market only through theoretical analysis.
Power market simulation is an important research method in the field of power market. At present, there are many research institutes in foreign countries that research and develop power market simulation platform to simulate the power market operation processes of various transaction types [2-4]. In order to realize the verification and analysis of the operation effect of the power spot market, it is necessary to simulate the operation process of the power spot market before its practical application. Based on the simulation results of the market operation, we can verify whether the electricity price is reasonable, analysis and verification the trend of market price changes, the security of grid operations and bidding strategies in trends, which is helpful to ensure safely and stably operation of the power spot market [5].
Case management of power market experimental simulation is one of the key technologies to realize simulation data management and market operation effect evaluation and analysis. However, the simulating data’s storage and management are rarely mentioned [6-8], and in many information system, case management techniques often identify cases in data during operation, and multiple case
data are simultaneously stored in the database at runtime, so that as the number of cases increases, the operating efficiency of the system will gradually decrease. In view of this drawback, this paper proposes an post case management technology for market operation simulation with which the simulation data is stored and managed after the market operation simulation is completed, and design the case data configuration display tool to realize the configuration display and comparison of the case data, all of that provides technical support for the verification and analysis of power market operation effects and effective factors.

2. Case data management

2.1. Case definition

The case in this paper is used to record the data information involved in the market operation simulation process, including the case information itself and the simulation data corresponding to the case. The case information includes the case ID, name, associated market operation simulation round, creation time, etc. The case simulation data is a data set that can characterize a power market operation simulation process, including physical model, economic model, section data, and bidding data, clearing parameters, clearing results, etc., wherein the physical and economic models refer to the basic model data used for transaction clearing and security constraints, and the cross-sectional data refers to pre-data such as load forecasting, maintenance planning, and tie line planning corresponding to the trading period. The bidding data refers to members’ bid of both the power generation and sales side, and the clearing parameters refer to the control parameters of transaction clearing and safety check. The clearing result data refers to the node electricity price, the unit’s winning output, the load winning standard power and the corresponding statistical analysis.

According to the business needs of the electricity market operation simulation, the cases can be divided into different types by various uses such as market simulation clearing result records, market operation law analysis, and operation simulation process inversion, the data details corresponding to each type of case may be different.

2.2. Case configuration

The power market operation simulation involves a lot of data. Therefore, in order to improve the adaptability of the case data management to the case data content, before the case data management, the data that needs to be stored and managed in the case should be configured first, and the configuration information includes the storage tables, storage fields, etc. for each type of data. The case data table configuration is shown in figure 1.

![Figure 1. Case configuration diagram.](image)

In fact, due to the difference in the use of the case, the configuration files corresponding to each case are different. Therefore, the system often configures the corresponding data requirements for each type
of case to form multiple case data configuration files. When managing, choose one as the case template.

2.3. Case saving
When the market operation simulation is completed, the simulation system's case service can store the data involved in this simulation in the form of a case. According to the definition of the case, the case saving includes two steps, the preservation of the case information data and the preservation of the case data content. When the case information data is saved, the global unique case ID is determined for the case. When the case data content is saved, the data related to the simulation is sequentially retrieved based on the case data configuration file, and wrote into the case database with the case ID as its identifier.

The preservation of case data records the process and result data of market operation simulation for various market scenarios, and provides a data foundation for market operation law analysis and effect verification. Different from the way in which the case data is stored in the running database, the case data management technology in this paper stores the case data in an independent case database, that is, the market operation simulation function runs in the running database, and the increase of case data in the case database does not increase the amount of data in the running workspace, so it does not affect the efficiency of the simulation function.

2.4. Case loading
The market operation simulation case realizes the management of simulation data. The market operation simulation application often needs to analyze and compare the simulation data, for example, inverting the previously saved cases, or adjusting the parameters based on the previous simulation data and simulating once more. Therefore, it is necessary to provide the case loading function on the basis of the case data storage, load the existing case data into the current running workspace, refresh the current system to the state when the case is saved, which is facilitate to observe the case data, and adjust the pre-data to recalculate and compared the case data to seek market operating rules.

From the perspective of data flow, case loading and case saving are the opposite operations. Case loading is to copy case data from the running workspace to the case database, while case saving is to copy the case data from the case database to the running workspace. Therefore, the case loading process also needs to use the previous case data configuration.

2.5. Case import and export
In order to carry out the effect analysis and verification of specific market scenarios, simulation systems often need to access market scenarios or market operations simulation case data from other market simulation systems, and because different simulation systems are often in different network environments, they are difficult to directly interact with each other. Therefore, this paper designs a case-based offline interaction to achieve data interaction between simulation systems. That is, the market operation simulation data is first exported from the source system in the form of a case data file, and then the exported case data file is imported into the destination simulation system.

The import and export of the case is also based on the case data configuration file. When the case is exported, the data configured in the case data configuration file is used as a list, and the data is retrieved from the case database according to the selected case number and written to the case data file. Then, the data in the case data file is read and written into the system’s case database.

In summary, the main functions and processes of case data management can be summarized as shown in figure 2.
3. Case data comparison analysis

3.1. Case data configuration tool design

In the electricity market operation simulation system, multiple simulation cases can be formed by adjusting the scene data and simulating multiple times. The case comparison refers to selecting several of the saved cases for data difference comparison and development trend analysis. The case comparison process involves statistical processing of large amounts of data and data comparison and data variety trend display. Therefore, in order to adapt to different angles of data comparison analysis, this paper designs the case comparison function into a configuration tool, which can be used to configure the Alignment analysis screen needed.

The content of the case comparison analysis mainly focuses on the analysis and display of the transaction operation simulation process data or result data. Combined with the display requirements of the comparative analysis of the electricity market operation simulation data, the case data configuration tool of this paper designs the following primitives.

- Various input primitives, including text boxes, time selection boxes, drop-down boxes, etc., which are used to define and change the data retrieval conditions.
- Dynamic data, used to display the value of a data field in the data table, supporting the definition of the search condition.
- Pie chart, which can associate the value of a data field of a data table on different pie slices, supporting the definition of search conditions.
- Bar graph / polyline, can display easy data corresponding to different time periods or different body components, display type can flexibly switch bar graph or polyline type.
- The dashboard, can display the value of a data field in the data table and can set different alarm ranges with different colours.
- Data table, support single-table data query function, the table can configure the column name to be retrieved and displayed, supporting to configure the search condition and the data can be sorted.

Through the various types of primitives provided by the case data configuration tool and the associated response between the primitives, the case data can be displayed and the data comparison and trend analysis between the cases can be realized.

3.2. Case data statistics

In effect analysis and case comparison of electricity market operation simulation, it is often necessary to perform statistical comparison based on the original data in the case to form some evaluation indicators before comparison. For this reason, we further design data statistics tool which realizes the customiztion of the evaluation index calculation by setting the components, the calculation logic, and
the multiple configurations of the calculation results. The definition interface of statistics tool is shown in figure 3.

![Figure 3. Definition interface of statistics tool](image)

In this way, if we configure the case data display analysis interface with the evaluation index result data, when the case data analysis comparison is performed in the browsing configuration screen, the system performs the calculation component retrieval and the statistical calculation and the result data saving according to the statistical configuration defined by the result data, and according to the retrieval logic configured by the configuration screen, the result data is displayed on the screen.

### 3.3. Comparison item setting

In the case of multi-case comparison analysis design, in order to ensure the comparability between cases, two or more cases corresponding to the same time period are usually selected for comparison. The indicators for comparison analysis between multiple cases are set as follows.

- **Computational condition comparison:** refers to the input data of the transaction operation simulation case, including the model data of the unit, load, section, and tie line participating in the market, equipment maintenance plan arrangement, clearing calculation parameter setting, load forecasting, and tie line plan. Data, etc.

- **Electricity price index comparison:** refers to comparing the electricity price data in the simulation result of the transaction operation simulation case and the corresponding statistical analysis indicators, including the electricity price data of each unit and each node, the average price of each region, and the average price of each group, the highest daily price of the whole system, the daily minimum price, and the trend of the above price data, etc.

- **Cost-benefit comparison:** refers to comparing the cost-benefit data of various entities in the simulation results of the transaction operation simulation case, including the single-day purchase and sale cost, revenue, and cost of the main types of units such as units, power plants, power sales companies, and power generation groups. The trend of income, the total power generation cost of the system, the total cost of electricity purchase, the power generation cost of various types of power generation resources, the blocking cost of various statistical calibers, etc.

- **Grid operation comparison:** refers to the comparison of the operation status of each node in the simulation result simulation data of the transaction operation, including the operation status and output of each unit in each period of the selected comparison time period, and the load of each load node, the transmission power of each section.
4. Conclusion
This paper studies the case management technology of the electricity market operation simulation process, and proposes the design implementation method of case data storage, loading, import and export and case comparison analysis. The case management process is realized through the data configuration of the simulation case which can improve the adaptability of case management to deal with data content and data format changes. The case data comparison is realized through the design of the case data analysis configuration tool and the statistical analysis index calculation tool which support the customization of case data display and comparison analysis. Research results of this paper can provide effective technical support to electricity market operation simulation and market operation effect analysis.

5. References
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