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Study on Quality Index of Distribution Network Planning

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Abstract: Distribution network planning is to guide the distribution network construction and management of key links, is the global energy Internet construction is an important work. In this paper, the key factors influencing the quality of distribution network are analyzed by using fish bone diagram analysis method, and then the Delphi expert consultation method and fuzzy analytic hierarchy process are used to determine the quality index of distribution network planning. This indicator can not only fully reflect the quality of distribution network planning, but also can carry out longitudinal evaluation and horizontal comparison of the actual situation of distribution network in different regions, find out the weak links of regional distribution network, guide the development of future distribution network direction.

Introduction

Distribution network construction scale is huge, uncertain factors are complex, involving a wide range, is a complex and difficult systematic project. Therefore, only through the scientific and effective distribution network planning program to determine and implement, in order to correctly grasp the future development of the distribution network. The design and construction of the distribution network planning quality index is imminent in the design of the distribution network planning scheme and the detailed data of the distribution network and the evaluation standard. [1,2]

This paper aims to construct a set of distribution network quality index of the global energy Internet by combining the fish bone map, the Delphi expert consultation theory and the fuzzy analytic hierarchy process, through the actual investigation of the current situation of the regional distribution network planning method, The planning level of the power grid planning, the improvement of the overall evaluation of the distribution network planning is not strong, the adaptability is not strong and the evaluation basis is simple, and the efficiency of the distribution network planning work is improved, which brings better management of the distribution network in the area Economic and social benefits. [3,4]

Construction of Distribution Network Quality Index

Construction principles

RFID (Radio Frequency Identification), is a kind of communication technology, mainly composed of an electronic tag, reader, middleware, software system of four parts. [5,6] RFID technology can by radio signal to replace the original mechanical or optical contact method to identify specific targets and to read and write the related data, make the information easier to read and write. [7] Because of the RFID technology is more than a lot of advantage (as shown in table 1), RFID technology is widely used in logistics, transportation, factory management, library management, entrance guard system, food safety traceability, etc.

Distribution network is the basis of the entire power grid, and users are closely linked, with more points, wide, long line characteristics. Distribution network planning quality indicators to establish, we must fully consider the distribution network of the above characteristics, to ensure the practicality and operability of indicators. That is, in the selection of evaluation indicators, should be accurate, standardized, comparable; in the evaluation of indicators of data sources, should be true and reliable; in the evaluation results, should be objective and comprehensive. Specifically, the distribution network planning evaluation index should be established following the following six principles:

(1) The principle of accuracy. The connotation and extension of the evaluation index are definite and the statistical caliber is unambiguous. The data of the repeated calculation should be highly consistent.
(2) Normative principles. The classification, measurement unit, calculation method and survey form of the evaluation index should be unified in order to facilitate the application in practical work.
(3) The principle of comparability. The evaluation index should facilitate the comparison of the planning and construction of the distribution network between different regions and the same area in different time periods, and highlight the guiding effect.
(4) The principle of reliability. Evaluation indicators should have a reliable statistical data channels, with operability, for the time can not be statistics and very necessary indicators can be set, with the company's information system after the improvement and statistics.
(5) The principle of objectivity. Evaluation indicators should be able to truly reflect the statistics of the object, an objective understanding and master the reality of the distribution network.
(6) The principle of comprehensiveness. The structure of the evaluation index should cover all aspects of the operation of the distribution network as much as possible, and determine the scope of the individual indicators and the indicators to be expressed without blind spots.

Construction theory

(1) Fish bone diagram analysis. Also called causal analysis. It is a kind of through the phenomenon of the nature of the analysis method, we through the brainstorming to find these factors, and they together with the characteristic value, according to the interrelated level of structured, well-organized, and marked important factors The figure is called the feature.
(2) Delphi expert advice law. Also known as experts to specify procedural law. The method is mainly prepared by the investigator questionnaire, in accordance with established procedures, in a letter to the members of the expert group to consult, and the members of the panel and anonymous way to submit their views. After several repeated inquiries and feedback, the views of the members of the group gradually tend to focus on the final access to a very high accuracy of the collective judgment results.
(3) Fuzzy analytic hierarchy process. Is a qualitative and quantitative combination of system analysis methods. The basic idea is to evaluate the nature and overall goal of the problem according to the multi-objective, and to decompose the problem itself according to the level, and form a bottom-up ladder hierarchy.

Construction process

This paper first determines the scope of distribution network assessment (110kV power grid), and then through the use of fish bone diagram analysis of the impact of distribution network planning quality of the key factors, the use of Delphi expert advice to seek expert feedback, and fuzzy hierarchy analysis Combined with the final integration of the distribution network planning quality indicators. As shown in question 1:

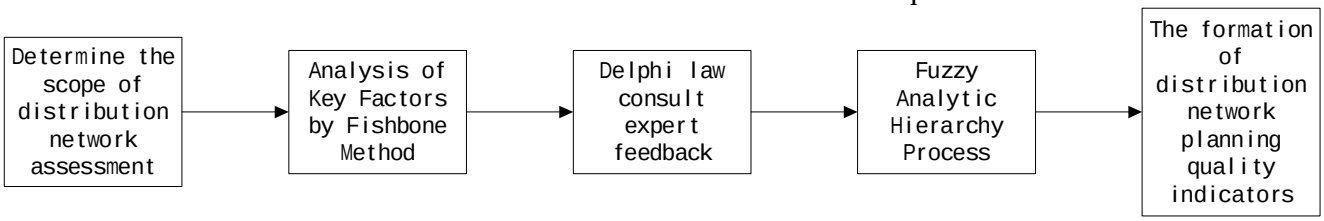

Fig.1 Equipment Distribution network planning quality index compilation process

Selection of Quality Index for Distribution Network Planning

This paper mainly uses the method of Delphi expert consultation and fish bone map to construct the index type. Process, seek 10 expert advice, statistical processing, and feedback the results of the consultation. After repeated rounds of time, the views tend to focus, and then through the analysis of the elements of fish bone analysis of the relationship between the elements to determine the final type of indicators.

In order to fully reflect the quality of distribution network planning, the impact of primary indicators on the quality of distribution network planning can be summarized into five aspects: power supply capacity, power supply quality, power grid structure, equipment level, power grid efficiency. Power supply capacity level is used to evaluate the power supply enterprises can be long-term, stable and safe to the user's maximum load capacity of the level; power supply quality reflects the power supply service quality of the user is good or bad; grid structure is its voltage level combination, the Level power supply range, the capacity of the transformer configuration and network layout; equipment level of technology describes the advanced nature of the power grid equipment and use; power efficiency level of power companies characterize the economic and profit levels.

Power supply capacity

Distribution network power supply capacity, marking the grid company for the user's maximum load capacity, is to achieve the premise of the power supply needs and guarantees, an objective reflection of the distribution network planning level. The index is mainly composed of three sub-indicators, respectively, 110 kV power supply capacity, 35 kV power supply capacity and 10 kV power supply capacity. Of which more than 10 kV power grid, transformer capacity ratio, the proportion of heavy-duty lines and heavy load accounted for the main factors affecting the power supply capacity. While the 10-kilovolt power grid, household with variable capacity, medium-pressure heavy-duty line ratio, medium-pressure heavy-duty distribution ratio for the impact of power supply capacity of the main factors. as shown in picture 2:

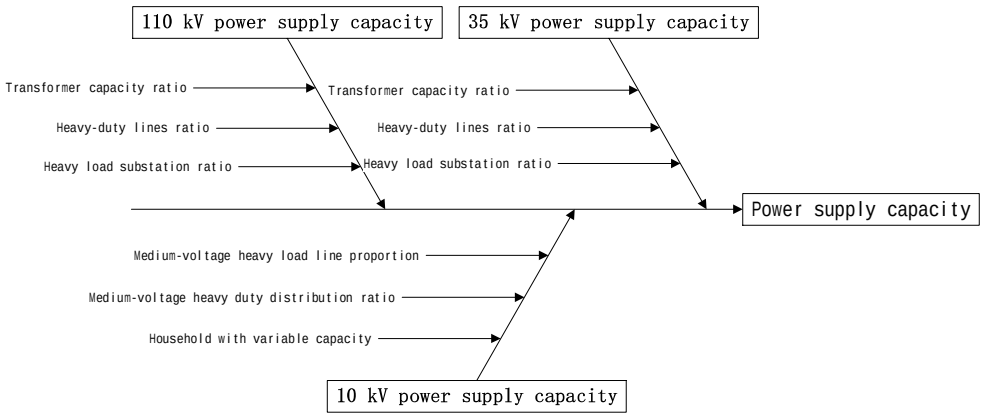

Figure 2 power supply capacity factors

Grid structure

The robustness of the grid structure can be described as the ability of the grid to withstand various disturbances while maintaining the stability of the system. The strength of the grid is a direct factor affecting the planning level of the distribution network in the area. The index is mainly composed of four sub-indicators, respectively, 110 kV grid structure, 35 kV power grid structure, 10 kV power grid structure and 0.4 kV power grid structure. Of which 10 kV or more grid, single-line single variable ratio, N-1 pass rate for the main factors affecting the structure of the grid. 10 kilovolt power grid, the average power supply radius of medium voltage line, medium pressure line connection rate, medium voltage line station between the contact rate and the pressure line N-1 pass rate for the main factors affecting the power grid structure. The average power supply radius of low voltage lines in 0.4 kV grid is the main factor affecting the structure of power grid. As shown in Figure 3:

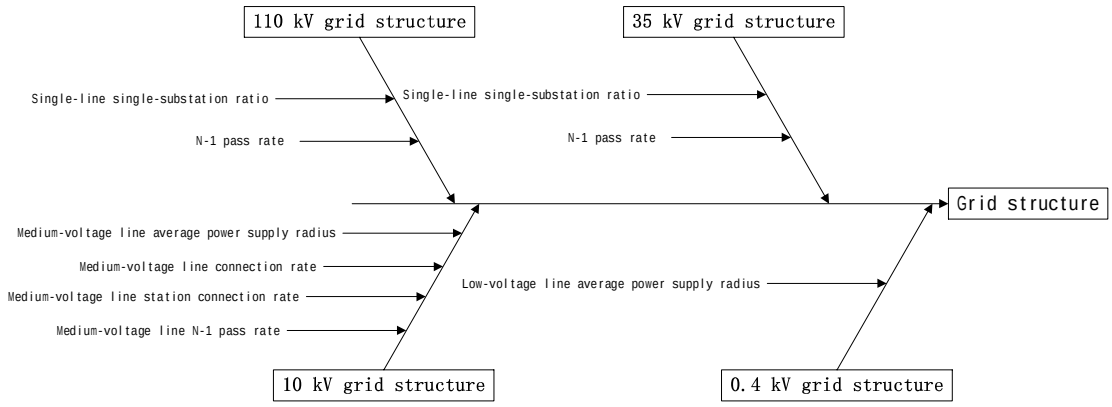

Figure 3 factors affecting the power grid structure

Power supply quality

The quality of the power supply marks the ability and degree of the grid to provide qualified and reliable power. Including voltage quality and power supply reliability in two aspects. The main influencing factors of voltage quality are "low voltage" user occupancy ratio and integrated voltage pass rate. As shown in Figure 4:

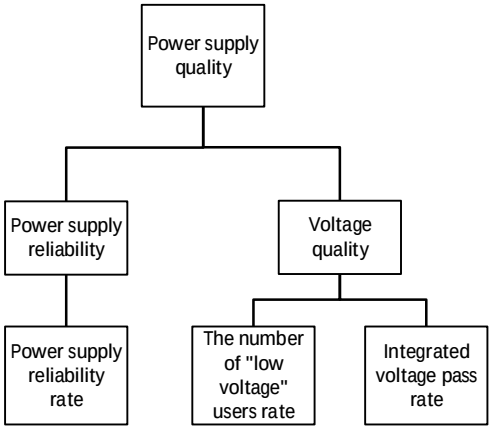

Figure 4 Power supply content contains content

Equipment level

The equipment level of the power grid is the symbol of the advanced nature of the power grid. It is an important index of the quality of the power grid planning. The equipment level of the distribution network is mainly reflected in the equipment of 10 kV, among which the high insulation distribution ratio and the medium voltage overhead line The most important influencing factor. As shown in Figure 5:

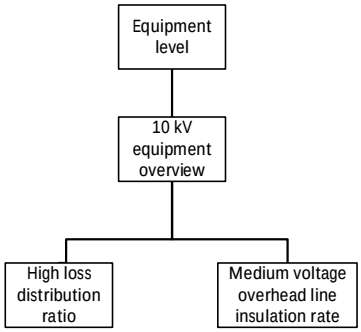

Figure 5 Level of equipment content included

Grid efficiency

Grid efficiency is an important comprehensive technical and economic index of electric power enterprises. The quality of distribution network is mainly reflected in the power loss, that is, the real-time line loss qualification rate of 10 kV distribution network, which directly affects the power enterprises economic benefits.

Distribution network planning quality indicators

According to the previous analysis and summary, and combined with the fuzzy analytic hierarchy process, the final distribution network planning quality indicators as shown in Table 1.

Tab.1 Distribution network planning quality index

Numble	Level 1 indicators	Level 2 indicators	Level 3 indicators
1	Power supply capacity	110 kV power supply capacity	110kV Transformer capacity ratio
2			110kV Heavy-duty lines ratio
3			110kV Heavy load substation ratio
4		35 kV power supply capacity	35kV Transformer capacity ratio
5			35kV Heavy-duty lines ratio
6			35kV Heavy load substation ratio
7		10 kV power supply capacity	10kV Transformer capacity ratio
8			10kV Heavy-duty lines ratio
9			Household with variable capacity
10	Power supply quality	Power supply reliability	Power supply reliability rate
11		Voltage quality	The number of "low voltage" users rate
12			Integrated voltage pass rate
13	Power grid structure	110 kV grid structure	110kV Single-line single-substation ratio
14			110kV N-1 pass rate
15		35 kV grid structure	35kV Single-line single-substation ratio
16			35kV N-1 pass rate
17		10 kV grid structure	Medium-voltage line average power supply radius
18			Medium-voltage line connection rate
19			Medium-voltage line station connection rate
20			Medium-voltage line N-1 pass rate
21		0.4 kV grid structure	Low-voltage line average power supply radius
22	Equipment level	10 kV equipment overview	High loss distribution ratio
23			Medium voltage overhead line insulation rate
24	Grid efficiency	Power loss	10kV Distribution line real-time line loss qualification rate

One of the indicators for the power supply capacity, power supply quality, power supply reliability, grid efficiency, equipment level, power grid structure of the five indicators, the secondary indicators for the 110 kV power supply capacity, voltage quality and other 11 indicators, three indicators for the change Capacitance load ratio, power supply reliability and other 24 indicators. The rationality of the indicators directly affects the evaluation effect. The structure of this paper is a three-tier structure with good integrity and adaptability, compact structure and high degree of aggregation. It can fully reflect the quality of distribution network planning. The indicators of the

meaning of clear, the required value of the calculation by the data collected after the statistics obtained, the data source is simple, easy to calculate.

Conclusion

Because of the simple and unrealistic characteristics of the inherent distribution network, this paper presents the quality index of distribution network planning which is more applicable and practical, and can be used for longitudinal comparison and lateral comparison. It has the following characteristics:

(1) The key factors influencing the quality of distribution network are analyzed by using fish bone diagram analysis method, and then the Delphi expert consultation method and fuzzy analytic hierarchy process are used to determine the construction quality of distribution network planning.

(2) Compared with other evaluation indexes of distribution network, the quality index of distribution network planning is clear, and the planning level of distribution network is mainly evaluated, which covers 110 kV, 35 kV, 10 kV, 0.4 kV power grid, for the future direction of the distribution network to provide an important basis.

Acknowledgments

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