Distribution network integrated operation optimization management based on Network Reconfiguration Technology

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Absrtact: A distribution network planning simulation platform is designed, which integrates the functions of distribution network simulation, planning evaluation and Web publishing and displaying. Firstly, each component model of distribution network is designed to simulate the operation state of distribution network, and the planning scheme is verified by simulation. Secondly, the reliability and economy of the planning scheme of regional power network are evaluated by using data from data center. Finally, on the basis of traditional distribution network planning and evaluation methods, the location and scale of new energy access, such as photovoltaic and wind power, are analyzed to assess the impact of various schemes on the new energy absorption capacity and the intermittent high permeability of new energy on the security and stability of distribution network. The evaluation results of distribution network are displayed by Web. The practice results show that the simulation software of distribution network planning research improves the information level and work efficiency of distribution network planning of Institute of Economics and Research, and has good generalization.

1. Introduction

With the gradual development of computer technology and urban power network planning theory, many researchers have made tentative research and development on urban power network planning assistant decision-making system, and achieved a lot of good results [6-11]. However, the database technology used lacks the evaluation function for distribution network planning indicators, especially for the distribution network planning indicators. Topology-related analysis functions such as wiring mode analysis and transfer rate calculation can not be directly applied to the evaluation and analysis of distribution network planning. At the same time, due to the lack of systematic and scientific power grid analysis and evaluation software, the existing and forthcoming problems can not be quantitatively given the severity of the problem and the specific location of the problem, which will directly affect the smooth progress of distribution network planning and transformation.

In view of the problems existing in the distribution network evaluation under the traditional conditions, this paper analyses the evaluation of distribution network planning and the related requirements of the system, and develops the corresponding distribution network statistics and evaluation system. Realize the value and topology check of the data inputted into the database, ensure the correctness of the original statistical information as far as possible, realize the network structure topology analysis and connection pattern recognition based on the database, complete the calculation of the relevant indicators in the current network evaluation, and generate standardized analysis report forms to facilitate the use of distribution network planners.

2. System Design Principles

The overall principle of design and development of integrated system for distribution network planning and evaluation simulation is guided by marketing business needs. It must follow the principle of "unified planning, unified design and unified construction", pay attention to practical application, and strive to make the scheme feasible.
    (1) Principle of Unity

On the basis of abiding by relevant international standards, national standards, industry standards and company standards, the software database, function, performance, interface and security protection are unified designed to ensure the standardization and scalability of software design.

(2) Principle of practicality

Software design must focus on the integration with actual business to ensure that it meets the needs of Distribution Network Data Acquisition and Intelligent Application System.

(3) Reliability Principle

Software design must pay attention to the principle of reliability to ensure that the stability of the system is not affected by the long running time of the system, the growth of access users, the growth of system data and the change of system functions.

(4) Prospective principles

On the basis of satisfying practical and reliable requirements, we must fully consider the need for the construction of a unified and strong smart grid, and provide necessary technical support for the construction of a unified and strong smart grid.

(5) Standard Principles

The power grid model is designed according to the international standard CIM 610970 61968.

(6) Openness Principle

In the future, the system will interact with many systems, and the data structure of resource center must adopt open structure.

(7) Extensibility Principle

The types of electric power equipment in our province are increasing. Resource centers must support the expandable requirements of electric power equipment to facilitate model expansion when new types of equipment are available.

(8) Principle of Efficiency in Data Retrieval

After the successful construction of resource center, there will be many frequent data interaction. When Resource Center interacts with other systems, it must ensure the principle of high efficiency, and specific technical indicators need to be determined.

(9) Principle of Convenience in Expanding Development

As a unified data storage center, resource center will interact with many systems in the future, so it must have the characteristics of expanding and developing conveniently.

(10) Massive data storage

Because of the huge scale of data in all aspects of distribution network, the resource center will store many aspects of data, so the storage capacity of the Resource Center for data must be huge.

3. Distribution wiring pattern recognition algorithms

Distribution network wiring pattern recognition based on computer algorithm has always been a technical problem faced by distribution network statistical evaluation software. Especially for switching station type or two independent single-loop network type double-loop network wiring pattern recognition, the existing distribution network statistical evaluation software has not been able to identify correctly. Because of the huge process of distribution network connection pattern recognition, the main process of identification of overhead lines is described here, and the flow chart of cable connection pattern recognition is given in the form of appendix.

1) Trunk wiring judgment: take the outlet of the feeder as the starting point, search the tie switch or the branch with the thickest average diameter as the trunk of the feeder.

2) Type judgment of grid structure: the number of overhead lines and cable lines in the main line is counted separately, and the type of lines with more segments is regarded as the type of grid structure; if the number of the two segments is the same, they are classified as atypical wiring.

3) Number calculation of power supply: counting the number of connection switches connected to the main line, together with the power supply of the circuit itself, the number of power supply connected to the circuit can be obtained.

4) Discrimination of single radiation wiring: If the number of power supply is 1, the feedback line is determined to be single radiation wiring.

5) Discrimination of N-segment n-connection connection: Statistical analysis of the number of connection switches N and N in the backbone. If N < 6 and N < 3, the connection mode of the circuit is N-segment n-connection; if the above conditions are not met, it is atypical connection.

6) Effective sectional switches: When counting the number of sectional switches on trunk lines, only the grid segments on both sides of the switch are counted to be loaded. Statistical number n of sectional switches is the number of effective sectional switches plus the number of sectional switches at bus outlet of substation.

4. Distribution Network Simulation

(1) Power flow simulation

Based on the planned state model, the power flow calculation is carried out according to the known bus model and the injected power of each bus, or using the predicted data and historical data. This scheme has the following advantages in theory and algorithm: good robustness of the algorithm, when the algorithm diverges, the system automatically transfers to the optimal multiplier method or DC power flow, and gives a reasonable power flow distribution; an improved AC/DC power flow calculation method is proposed to overcome the traditional algorithm under some control modes. In the case of irreversibility of DC side coefficient matrix, sparse matrix technology is used comprehensively to improve the calculation speed.

(2) Fault simulation

Typical fault application pool is designed. Typical distribution network faults are arranged in the fault pool. According to the set fault sequence table, virtual measurement (telemetering and telesignaling) information is sent to the master station system through protocol parser. There are five types of schemes that can be set: fault, switch, RTU, telemetry, telecommunication and so on.

(3) Simulation of Imperfect Abnormal Information

The scenarios include missing and false alarm of communication message, telemetry mutation, telecommunication error, switch rejection and so on.

(4) Simulation of typical load curve

In order to truly simulate the operation of distribution network, it has the customization function of typical load curve, conveys load value to distribution transformer (load) according to the predetermined curve, and carries out automatic interpolation. The maximum running time accuracy of load curve can be set to 1 second.

5. Planning Research

(1) Data collection and status analysis

Collect the planning scope and duration, planning basis, power supply area division and power grid information within the region, and analyze the social development of the region, as well as the status of power grid and power generation resources.

(2) Demand analysis

To forecast the demand of power grid development, the system design covers multiple demands, such as load growth demand, power supply demand, grid modification and strengthening demand, networking demand and so on.

(3) Load Forecasting and Power Planning

By analyzing the current situation of power grid and power supply in the region, various methods are used to predict the future power consumption and power supply planning in the region, and market space and power balance are analyzed according to the results of power consumption prediction and power supply planning.

(4) Propose a plan

According to the results of load forecasting and other data, the preliminary design of power grid planning scheme is carried out to determine when and where to build (expand) and what type of power transformation and transmission projects, so as to achieve the required power transmission and transformation capacity in the planning cycle. The main contents of the system planning

scheme include transmission mode, voltage level, network structure, substation layout, construction scale, location and scale of new energy planning and construction, etc.

(5) Technical feasibility comparison

The power flow calculation, stability calculation and short-circuit current calculation of the planning scheme are carried out, and the technical feasibility of the scheme is investigated from the aspects of grid structure, equipment technology level, load supply capacity and new energy absorption capacity.

The grid structure reflects the continuous power supply capability and fault resistance capability of distribution network. It evaluates the scale of distribution network, the proportion of unqualified lines in length, the proportion of qualified lines in line segments, the proportion of overhead lines in connection with each other, and the rate of looping network. It also introduces the power factor of feeder, the load rate of feeder, the maximum static safety rate and the user loss. Loss rate, load loss rate, short-circuit capacity, feeder supply radius, closed-loop current and other indicators are evaluated.

The equipment technology level mainly studies the distribution network public line situation, the public distribution transformer capacity situation, the high loss distribution transformer situation, the equipment commissioning life, the reactive power compensation level and so on.

Load supply capacity is evaluated from six indicators: the proportion of heavy-duty medium-voltage lines, the proportion of convertible lines, the proportion of lines with installed and connected transformer capacity greater than 12MVA, the proportion of heavy-duty and overloaded transformers, the average load rate of medium-voltage lines and the proportion of lines with voltage exceeding the limit.

In terms of the intermittentity of high permeability new energy, the system considers the output of new energy according to probability distribution, describes the output of wind farm with Weibull distribution, describes the output of discrete photovoltaic power station with Markov chain, and evaluates the intermittentity of existing or proposed new energy for the security and stability of power grid in different seasons and different operation modes of power grid. The impact of fixed operation.

(6) Economic comparison

Analyses and compares the annual cost, price competitiveness, investment recovery rate and other indicators of the various schemes, and investigates the new energy absorption capacity of the schemes: under the constraints of meeting the break-even utilization hours of new energy and system peak shaving, frequency modulation, line power flow and voltage stability, evaluates the investment and operation of the schemes to improve the new energy absorption capacity.   Line cost.

6. Conclusion

In summary, through the establishment of distribution network planning and evaluation simulation integrated system, based on various real-time and historical databases such as GIS, the various components of the power grid model is established to provide simulation verification. Integrating the business units of distribution network planning and evaluation by the Institute provides an effective way and strong guarantee for the planning and design work of the Institute.

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