Management Practice on Speedily Developed Power Distribution Network

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Abstract

*During the Tenth Five-year Plan, a rapid growth raising new challenges for Shanghai Shinan Power Supply Company in its distribution network and in distribution management as well as in services. To solve such new problems and adapt to the new situation, they have improved the distribution management including load forecasting management, distribution network structure dynamic analysis, and network reliability dynamic analysis etc. based on the geographical information system. Such practices and analysis enhances overall managerial level of power distribution network and witnesses substantial improvement in power supply service*s.

Introduction.

Shinan Power Supply Company of SMEPC in Shanghai supplies power for an area of 2713.78 km^2, covering 43% acreage of the municipality. By the end of October, 2006, the number of powers users has registered to 2.13 million in which 1.89 million are household users.

During the 2006, the peak load climbing to 6.23 GW (excluding capacity for avoiding peak time). The power supply growth rate reached 13.9% in average annually. The persistent fast growth brings to distribution network management and power supply service a new challenges: 1, load forecasting has failed to adapt to the acceleration of power supply growth, leaving load forecasting management in passive state; 2 rapid growths of load demands urge infrastructure construction and technological upgrading projects handled perfunctorily, thus affecting the reasonable adjustment of network structure; 3 affecting the forward-looking strategy on the structural development of distribution network; 4 affecting the adaptability to meet the requirement of high quality power supply services. From the year 2002, we set up a special team and set off to cope with these challenges by a unified designing and step-by-step implementation based on distribution network GIS.

1、Overall Designing

It turns out to be an arduous task to enhance distribution grid in a comprehensive manner. Therefore we should put the program into effect step by step by considering the actual development of distribution network as follows:

1.1 Principle of Designing

1), Practicality: The outsets of program were determined to follow a practical way to implement the project. We focus on practical use and push forward step by step in selecting software for development and database, such as selecting graphical platform, analyzing load and positioning of network assessment function.

2). Modularization: The entire system is to be completed under unified graphical platform and database. Each functional module is independent from the others and can independently carry out medium or low voltage reliability statistical analysis and assessment, functional load analysis as well as distribution network structure assessment.

3). Data sharing: The system covers a wide range of data of different types, including customer information in CIS system, telemetry data in SCADA integrated system, topological data information in medium voltage network structure, urgent repair information of low voltage network, etc. All these data are well shared and not left redundant so as to decrease the workload of data maintenance by implementing the program.

1.2 Infrastructure platform construction

We have selected the M.O graphical platform which is practical and ease of use and for to store equipment property data and data in real-time operation using Oracle database. M.O graphical platform helps us automatically extract the topological relationship between lines, distribution transformer stations and substations, automatically calculate the statistics for network related information in functional modules, assess network structure based on topological relationships, conduct load forecasting analysis and load-capacity ratio statistics for functional modules by virtue of the automatic collecting function.

1.3 Determination of development items:

Considering actual progress of IT information program, we are determined to carry out three “popularizations” and two “developments”: ①, popularization of medium or low voltage power supply reliability dynamic statistical assessment, ②popularization of TCRS ③ development of load forecasting and management system, ④development of distribution network structure analysis and assessment, ⑤, development of online business system.

1.3.1 Popularization of medium or low voltage power supply reliability dynamic statistical assessment.

The healthy performance of 10 KV equipments has improved substantially, thus increases the proportion of low voltage equipment failures. The establishment of 10KV distribution network information platform and marketing management information system becomes possible to make statistical assessment reliability of power supply for low voltage users.

The system provides functions such as query, statistics, collection and analysis according to equipment reliability; period of prearranged outage, period of outage due to faults, times of repeated outage, multiply choice statistics according to days, months, seasons, years and voltage levels and district characteristics; and the comparing (with

the same month, season value of past year) between reliability performance and planning index. A relative regulation was issued so that the duties and relationships between departments are defined and data can be processed with all kinds of queries, statistics, collections and analyses.

Since the system is concerned with a wide range of data of different types including medium voltage grid data and user information, we have drawn up detailed data census and entry planning. Inputted statistical data will be checked every month and "Rules for implementation of data operation and maintenance in medium and low voltage power supply reliability statistical assessment system" has been laid down to enhance the data accuracy of users' power consumption. At present, the best accuracy rate has touched 97% to assure a normal functioning of system.

Now we have completed the network data census of our company. There are 6509 km of 1038 10kV overhead and underground cable feeders and 21362 10kV distribution transformers in our company. We sorted the relationship between 906514 customers（including 901496 low voltage customers）and the network structure. The data association between CIS and the transformers and distribution stations based on GIS has been realized. We succeeded in realizing medium and low voltage power supply reliability dynamic analysis and statistical assessment as well as the completion of distribution network graphical data. We sorted all the customers' information. We explored load analysis of functional modules to meet the preliminary condition for distribution network dynamic assessment.

1.3.2 Popularization of TCRS system

The TCRS had popularized in all our sub-companies for to enhance the power distribution services to suit the demands of customers, The system includes not only the functions of voice record, consultant navigation, rush to repair event record, rush to repair back acknowledgement, but also the enhanced functions of query, statistics, analysis and its tables. It can be easy to query the rush to repair information by fault code, fault address, fault description, fault report and rush to repair result and its back acknowledgement. It can also execute the analysis and the statistics including the rush to repair time, back acknowledgement information, and average time of rush to repair based on different time range, fault address, fault type, repair department, address sort and so on. And finally we can get the analysis and statistics tables we needed. Now we can not only shorten the rush to repair time but also we can have a good response with the customers to satisfy their requirements.

1.3.3 Load forecasting and load management system.

The establishment of GIS based network information system and establishment of marketing information management system has paved the way for efficient load forecasting and load management. It provides scientific evidence for load distribution forecasting of each district, power deployment of distribution network, adaptation of network to new development and enhancement of power supply capacity.

The load forecasting analyzing system categories all 10 KV grid structures under Shinan Company into 141 functional modules and then extract 10KV lines module information based on M.O graphical platform. We also introduce SCADA main transformers, feedback load data and VIP load control system information and add new users information to query module in marketing system so that query information statistics can be automatically calculated, that is to say, once the reply solution is given, newly added capacity of the main transformer and other information will be recorded in the functional modules. We are able to extract both the load data and power supply capacity for each functional module automatically and users' information combining marketing management information system. The system offers real-time automatic statistics for following items: capacity to load ratio, load density, query, electric quantity, module load curve, analytic figure for module load and temperature, analysis of basic load, intermediate load, height load and peak load, duration and distributions, durations of all main transformers with maximum load above 70% of total capacity, average maximum load rate for main transformers (the average load of 25 highest loads in 25 working days), variation of load as the initial sensitivity point varies 1℃, variation figure of load temperature, analyzing structural changes in initial sensitivity point, initial sensitivity zone, strong sensitivity point, strong sensitivity zone, typical users questionnaires, analyzing typical VIP load indicators.

Now we can forecast load peaks for summer and winter based on functional modules plus natural growth trend and expansion of power demands. Through functional zones of different properties and accumulation of data from users of different properties, we can constantly refresh the empirical value of natural load growth and load growth due to new users' entry so that regional variation of load can be provided timely and accuracy of load forecasting based on modules can be improved.

As there is a serious gap between power demand and supply in recent two years, load forecasting system enables us to avoid peak time more effectively. We set out forecasting the coming summer peak after the winter peak every year and forecasting the winter peak after the summer peak every year. We figure out the forecasted summer or winter load rate of main feedback line and transformers for main districts. Then we list the capacity demand for districts and transformers needed to avoid peak time" according to the principle of 90% control of main transformers load capacity and 100% control of lines during peak load. After business department calculates detailed demand and makes decision on the final solution, we can assure a secure functioning of equipments in busy districts meanwhile our company can meet the prescribed requirement of avoiding peak time.

1.3.4 Application and practice of network structure analysis and assessment

Entry of massive infrastructure construction, alteration and extensions the customers affects the adjustment of

distribution network structure directly. More formidable challenges have been posed for us on how to analyze distribution network power supply capacity dynamically, how to propose guidelines on project planning, how to improve grid structure and decrease redundant investment through infrastructure construction, alteration and extension and other engineering projects.

The developed distribution network assessment system adopts Windows 2000 OS and Oracle database, extracts network topological relationships between lines, transformer stations and power distribution stations, main transformer information (specifications or capacity) in a transformer substation or in a distribution station based on MO graphical platform and accesses distribution grid load data from DSCADA system. The distribution network assessment system can dynamically analyze main transformer N-1, transformer station N-1, line capacity of different sections, line connection, line N-1, line users of different sections, line power supply radius, line power transformation capability and line transformation solution and so on.

So we are now able to detect problems timely by observing changes in grid structure and to make preliminary improvement on grid structure in alignment with regulations and guidelines on grid infrastructure construction. We have formulated a tentative target for the Eleventh Five year Plan according to the grid assessment statistics.

As we set the tentative target for Eleventh Five year Plan, planning adjustment can be better guided by the Five Year Plan combining infrastructure construction and fundamental requirement for grid structure functioning, restructuring blueprint can be more effectively implemented coordinated with the Eleven five years Plan and grid structure can be better consolidated in development according to dynamic modification to extension project.

1.3.5 Development of online business system.

To adapt to deepening market economy, the Power Grid Cooperation of China has put forward the goal “High quality service” towards society and “intensifying restructuring reform, standardizing power market” within power supply companies, an online business system had developed.

The household customers can fill out application form online. Relevant office in designated area shall process the application form within prescribed period and customers can complete their application in nearby service station of our company upon reminder on the website... And for the other customers, they can download application form on the website and we shall notify them the application procedures and materials needed.

As for the revocation or alteration, the customer can fill out the relative form online. Designated office in this area will process the application form within prescribed period. Customers can go to nearby station to complete their applications upon reminder on the website.

For to assure normal functioning of the website and bring transparency, immediacy, interactivity and convenience of the website into better play, we lay down the operation regulations to define duties of relevant departments or data maintenance duties.

2. Conclusion:

The construction of these systems based on our fundamental businesses, creates a solid technological foundation for network planning, construction and reliable operation and in turn, enhances our distribution network managerial level. And we have to improve these systems following the development of the network and the new requirements in customer’s services.