

Research on the Methods of Low-voltage Distribution Network Planning

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Abstract. Low-voltage distribution network is at the end of the electricity network, directly connected to the user. With the rapid economic development, a substantial increase in power consumption, and low voltage distribution power grid construction and transformation rate is far less than the growth rate of the load. As a low-voltage grid development "leading", low voltage distribution network planning plays a vital role. In this paper, a low-voltage distribution network planning research, the low voltage distribution network planning ideas and processes, and a numerical example.

Introduction

Low-voltage distribution network is a low-voltage distribution lines consisting of electrical equipment and its subsidiaries provide electricity to low-voltage distribution network, its function is to pressure (or hypertension) distribution network receives power, low-voltage direct distribution to each user. Low-voltage distribution network directly to end-users, is an important part of the distribution network. According to the voltage level can be divided into high voltage distribution network (35~110kV), medium voltage distribution network (6~10,20kV) and low-voltage distribution network (220~380V); supply areas by function can be divided into urban distribution network, rural distribution network and plant distribution network. The overall situation of low-voltage distribution network is: complex structure, branch lines are more complex nature of the load, and incomplete historical data, the city has a low load density distribution network, centralized power consumption, and high reliability of power supply requirements, some of the old urban distribution network is relatively weak, the poor capacity for load transfer and other issues.

Rural low voltage distribution grid main characteristics are: (1) electricity load strong seasonal rural power grid, power distribution equipment and lines effective utilization is low; (2) power supply and more complex structure; (3)lack of more complete records and data run ; (4)three-phase load imbalance is more prominent; (5)grid structure is weak, power supply radius large and small cable cross sections, low power quality, naturally low power factor; (6)obsolete equipment, low health, poor security, and reliability; (7) lack of comprehensive management awareness, poor management, line loss rate; (8) inadequate understanding of rural power grids, lack of funds; (9)low level of rural electrification.

The ideas of Low-voltage Distribution Network Planning

Both common characteristics require background planning analysis, the main issues to be addressed in a targeted plan to work every time. This chapter presents the idea of low-voltage distribution network planning.

Data Collection.

Since the low voltage distribution grid involves difficult statistical data, it becomes necessary to station units to complete a comprehensive survey of basic data, including the table variable and high and low voltage equipment; low-voltage poles cascade model, elevation; low 380V and 220V line length (average span 50m estimate) and wire model; checks several users to use the most electricity appliances, to prepare for the transformation of the stage area.

The Analysis of Current Situation Grid.

Before the low voltage distribution network planning, network first analyzes the status quo. According to the data collected an overview of the status of the power grid. Specifically, first understand the distribution transformer and profiles and operating conditions and low voltage lines, and then analyzes the status quo network problems such as distribution transformer capacity and low line models do not match the distribution transformer and line weight overload, low-voltage line length rather long and voltage quality low and so on. Distribution transformer capacity and low line models are matched with specific reference to Table 4.9; weight distribution transformers and circuit overload its load factor is a combination of determination; if voltage is low quality mainly through the actual measurement voltage to determine, if not found, then by calculated to strike; if the length of the low-pressure line powered qualified to decide whether to meet the requirements according to the terminal voltage. Overloaded qualified power line length is short, on the contrary, light-load power line length longer qualified. But for the terminal voltage cannot be measured, to be calculated using the method of determining the length of the line power supply is rather long. Belong to the scope of upgrading, not great withdraw big change, but take targeted measures.

Load Forecast.

Basic network planning is forecasting, for public forecasting, based on the stage area as a unit, regression to predict major growth curve and natural law. We forecast the low-pressure line load depending on the type of area and the average electricity consumption method of forecasting under different area.

Power Balance.

It is to analyze the power balance in the finish after load forecasting. According to the plan of the year is generally recommended load forecasting and distribution transformer capacity-load ratio, you can get the power balance year after year, a clear need new distribution transformer station number and the capacity to lay the foundations for network planning.

Target Network Planning.

The target grid planning is from three aspects. (1) Distribution. As a low-voltage power distribution network, before carrying low voltage distribution network planning must first be changed with the planning. It is in the power balance on the basis of the distribution transformer station number, capacity and distribution optimization, combined with varying problems of grid planning divisional annual construction plan, and the new distribution transformers were layout planning, taking into account site premise next, it must meet the "load center, miniaturization, dense point and short radius" principles. (2) Network. Determined according to regions in the form of low voltage distribution grid connection, there are radial, trunk and hybrid wiring. (3) Diameter. According to the distribution transformer capacity and load forecasting and planning low voltage wires back a few sections of the wire to be checked choice, combined with the problems and the low line load development plan for low voltage distribution lines. Faced with the development and planning of electric power load forecasting results of the market, the reality of the current situation, according to preliminary determine the planning objectives, technical principles, objectives initially proposed in the grid and the grid are listed in order of priority programs each year.

Investment Estimation.

According to local real price of equipment and construction quotations, according to the distribution network planning project schedule, the construction scale and Investment Unit investment estimates. If the investment is out of range, then adjustments until invest in the planning manageable.

Scheme of Assessment.

In the structure of the grid on the basis of the planning of the distribution transformer and the presence of low voltage line problem solving situations, low line voltage line loss rate and the loss rate (by improved loss coefficient method), distribution transformers and low voltage distribution network theory Line loss rate with a variable capacitance load ratio to be evaluated. If the assessment result is not up to adjust the project until the planning assessment index basically meet the requirements.

Low-voltage Distribution Network Planning Study

A practical grid County, for example, according to the low voltage distribution network proposed ideas and processes for low-voltage distribution network A county plan. Before carrying out planning, we must first understand the situation A county population, area, national economic and social development, geographical location and the like.

Current Situation Grid.

Various models of distribution transformer, S9-type distribution transformers larger loss following high total number of share distribution transformer station, and nine distribution transformer operation more than 15 years. Situation A county 380V line 590km, which insulated wires 78km, 13.2% of the total line length; 220V line 627km. There are currently 1992 low-voltage pole height is less than 9m. For capacity 400kVA distribution transformer, the prevalence of low-voltage lines trunk section is 70mm², 50mm² even 35mm² wires. Distribution transformer capacity is too small, less frequently larger cross-section of low-voltage lines, but there are also present.

Distribution Transformer Planning.

A county is a typical plateau between mountain basin, flat, while the county and rural rates were 0.87 and 0.75, respectively k_1 can be calculated as 1.15 and 1.33; the status quo distribution transformer reactive power compensation compared to only 3.3%, reactive power equipment unit less reactive planning the new equipment will improve power factor, estimated Planning k_2 respectively 0.89 and 0.85; T_{max} 3300 and 2900 respectively, thus k_3 0.676 and 0.767, respectively; and then according to the status of the county county and natural load growth in rural areas, is expected to Planning Natural load growth rates were 10.16 percent and 8.16 percent, to calculate the load development reserve coefficients were 1.05 and 1.03. In the case of high load distribution transformer and line load low, according to the load of development and status of the case load rate, at the appropriate time to carry out the distribution transformer capacity transformation, as well as high-loss distribution transformers, there are security risks and operating years compared with Long distribution transformer needs to transform appropriate.

Distribution Transformer distribution required in accordance with the principle of "load center, miniaturization, dense point and short radius", combined with the terrain factors, often to avoid lightning, floods, contamination and explosive places; low-voltage distribution transformer out of consideration line set up safety and convenience; consider the principle of the recent increase in electricity load and so on.

Low Line Plan.

Low Line planning is also divided into new lines and upgrading railway line. The situation with respect to the line load becomes high and low loads, at the same time, the new feature also in need of change the route planning. Therefore, the new line consists of two parts: First, the new distribution transformer outlet planning; second is to solve the status of the line load is high or poor reliability. In addition to the transformation of the line to be solved the problem of the status quo line load is high, the need to solve the line they are aging and security risks and other issues. ① Situation load rate is too high, the new line load transfer, the new line may have come from the same distribution transformer, distribution transformer can also be from different. ② Status line load ratio is too high, increasing the wire cross section.

Planning Assessment.

(1) Low line voltage line loss rate and the loss rate was assessed using an improved loss coefficient method on the line length is long, heavy loads and low voltage lines planned line loss rate and voltage loss rate assessment, line loss and voltage loss rate control In the corresponding level (such as class D, E and F class line loss rate of 2.5%, 5% and 9%, the voltage loss rate of 10% or less). (2) Distribution transformer capacity-load ratio assessment 2016 A county seat distribution transformer capacity of 27.11MVA, County public load 12.56MW, therefore 10kV distribution transformer county capacity-load ratio of 2.16; rural distribution transformer capacity of 45.48MVA, rural utility load 20.37MW, therefore the rural 10kV distribution transformer capacity-load ratio of 2.23. (3) Line loss

rate to assess the status of A county distribution transformer line loss rate was 5.07%, low voltage distribution network line loss rate was 7.97%; After the plan in 2016 with a change of theoretical line loss rate was 3.54%, low voltage distribution network line loss theory rate of 3.87%. Thus, in 2016 the planning grid to meet the requirements of the distribution transformer and low voltage distribution network theoretical line loss rate regulations.

Summary

This paper presents a low-voltage distribution network planning ideas and processes, and numerical examples. Example, the first analysis of the status quo power grids, to find out their problems; then to the local situation analysis, distribution transformer capacity-load ratio, and then to the distribution transformer capacity planning; and planning for low-voltage overhead lines, thereby planning low voltage distribution Power wiring, finally estimating and planning investment planning program evaluation, numerical example shows the applicability of the proposed method and operability.

Reference

- [1] H.L.Willis. Power distribution planning reference book [M]. Marcel Dekker Inc, 1997.
- [2] R. L. Grimsdale, P. H. Sinclair. The Design of the Housing-estate Distribution System using a Digital Computer [J]. Proceeding of the IEE. 1960, 107(33): 295-305.
- [3] Y. Backlund, J. A. Bubenko. Distribution System Design using Computer Graphics Technique[C]. Power Industry Computer Application Conference. 1979: 382-388.
- [4] E. Díaz-Dorado, E. Míguez, and J. Cidrás. Design of large rural low-voltage networks using dynamic programming optimization [J]. IEEE Transactions on Power Systems. 2001, 16(4): 898-903.
- [5] H.Shateri. Cost and Loadability Based Design Technique for LV Distribution Networks [C]. Power & Energy Society General Meeting. 2009: 1-6.
- [6] Eloy Diaz-Dorado, Edelmiro Miguez Garcia. Planning of Large Rural Low-Voltage Networks Using Evolution Strategies [J]. IEEE Transactions of Power Systems. 2003,18(4): 1594~1600.