Research on the Condition Evaluation Index of Distribution Network Equipment and Its Application

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Abstract. The current researches on investment decision of projects of power grid construction are feasibility studies or post-evaluation of single power grid construction projects. This paper mainly considers two types of index: abnormal state technical indexes and environmental indexes. During studying the investment demand of distribution network, firstly the operation state evaluation model of distribution network is formed to evaluate the equipment state, and then the investment demand is analyzed based on the results of the equipment state evaluation.

1. Introduction

Power grid enterprises are infrastructure enterprises and important public utilities enterprises in the national economy. Power grid investment and construction activities are extremely important for national economic and social development. However, power grid construction and renovation projects often require a huge amount of funds, and the power grid corporations need invest in many types of projects. Therefore, power grid companies must consider how to make reasonable arrangements for the allocation of limited funds in different power grid construction projects. It is very important to study the scientific theory and method of power grid enterprise investment decision for the purpose of standardizing the investment decision and management behavior of power grid enterprise, to reduce the risk of investment decision, improve the level of investment decision, improve the efficiency of power grid investment, and enhance the sustainable development ability of power grid enterprise. In recent years, the pace of distribution network construction has been accelerating, and the investment in distribution network has been increasing year by year, which accounts for a large proportion in the current investment in power network construction. Therefore, how to establish a set of operational project selection scheme, optimize the investment decision of distribution network construction, and guide the development of distribution network construction has become an important research topic for power grid enterprises.

The existing researches on investment decision of power grid construction projects are all feasibility studies or post-evaluation of single power grid construction projects. Generally speaking, it includes two aspects: one is technical evaluation, mainly examines the necessity, urgency, technical feasibility and rationality of technical standard of project construction; second is the economic evaluation, mainly examining the project after the production of economic benefits, utilization rate. In the current study, in the actual power grid enterprise project investment decisions, it is often difficult to put the costs and benefits of most projects accurately, such as projects that are related to centralized replacement and technical renovation of old equipment, where the project investment cannot
correspond accurately to the economic benefits of power grid enterprises. Therefore, the economic evaluation is not feasible in such cases. Meanwhile, the technical evaluation of the project lacks some important operational evaluation indexes of power grid equipment. Most of the methods adopted are traditional methods, such as analytic hierarchy process (AHP) and fuzzy comprehensive evaluation.

The smallest area of the distribution network is called the station area. Specifically, the station area refers to the power supply area or area of a transformer. The internal monitoring system of the power grid company also takes the Taiwan area as the main body, forming the monitoring level of users, Taiwan area and lines. This study combined with the actual needs of distribution network area reconstruction, selected area for the analysis and description of the main body, build a distribution network area abnormal running state evaluation model, based on the equipment operation data and environmental data, using the clustering method, in courts, classifying the priority of the investment in equipment, and the classification of the objective results are obtained.

According to the actual business requirements, as well as the results of interviews with distribution network experts. In the actual selection and decision-making of distribution network investment projects, the status assessment of the equipment in the distribution network area should be fully considered, and the environmental indicators that affect the equipment should also be considered. Therefore, this paper mainly considers two kinds of indexes: abnormal state technical indexes and environmental indexes. When studying the investment demand of distribution network, firstly, the operation state evaluation model of distribution network is formed to evaluate the equipment state, and then the investment demand is analyzed based on the results of the equipment state evaluation.

2. Technical Index of Abnormal Status

The technical index of abnormal state refers to the technical parameter that describes the abnormal operation state of distribution network equipment. According to the monitoring data of the power grid operation monitoring system of one transportation supervision center, the technical indexes of abnormal state adopted in this paper mainly include abnormal load, abnormal voltage, power failure and three-phase unbalance.

Load anomalies include heavy loads and overloads, which are the operating conditions when the carrying capacity of an equipment exceeds or is close to exceeding its maximum load. In the power grid equipment, heavy overload will cause rapid increase in the temperature of the equipment, while light overload will cause accelerated aging of the equipment, and serious equipment burning loss and other faults. Heavy overload operation of the equipment is one of the main causes of failure power failure, seriously affecting the safety and reliability of users.

Voltage is an important power index for direct contact with users, and users are sensitive to abnormal voltage. Therefore, abnormal voltage will directly affect users' evaluation of services provided by power grid companies. Abnormal voltage is divided into over voltage and low voltage. Low voltage will affect the normal and effective work of ordinary appliances and cause production interruption for some factories, and a long time high voltage will cause higher equipment line loss, or even worse, lead to equipment heating and failure.

Power outage: to stop or interrupt the transmission of power so that electrical appliances have no access to external power. The power failure is the direct factor affecting the power supply reliability of distribution network. Once the power failure happens, it will affect the normal operation of power distribution system. Sudden power failure may destroy electrical appliances, and directly affect the normal production and life.

Three-phase unbalance means that the amplitude of the three-phase current (or voltage) in a power system is inconsistent and the amplitude difference exceeds the specified range. Three-phase unbalance will lead to neutral point potential deviation, output reduction, output capacity can not reach the rated value, increase the transformer power loss.

Therefore, the technical indicators are further determined as the quantitative results of blackout, heavy load, overload, low voltage, over-voltage and three-phase unbalance.
3. Environmental Index

Environmental indicators refer to the possible impact of the environment on the equipment after it is put into operation. As most of the power grid equipment is located outdoors, it is greatly affected by weather or climate factors. While other conditions are the same, different weather conditions and climate conditions will have an important impact on the operation state of the equipment. In this study, the study region suffers from seasonal fog and condensation, thunderstorm and gale and other weather all year round. Therefore, climate and environment are an important factor in dealing with the equipment investment in this region. The environmental indicators in this study mainly include average air temperature, average wind speed, average precipitation, ozone concentration and air quality (PM2.5 concentration, etc.). The data were captured from the website of the environmental monitoring department.

Based on the research of distribution network area operational condition assessment, the data monitoring system according to the area of geographical information grid will come from luck monitor center operation monitoring system for big data analysis results of abnormal load, abnormal voltage (over voltage, low voltage), three-phase imbalance, power cuts, etc. various index after dealing with the dimension reduction in the form of heat map shown on the map.

The more important and characteristic part of this system is to show the situation of each platform area based on geographic information, and intuitively judge the severity of the platform area from the macro perspective according to the color distinction of the thermal diagram, as shown in Figure 1. Additionally, clicking the color point on the diagram will display the information of the platform, as shown in Figure 2.

![Figure 1. Overvoltage thermal diagram](image1.png)

![Figure 2. Display of overvoltage information in the area](image2.png)
After dimension reduction, each single index is regarded as the attribute of the platform, and the importance of each index to the status of the platform is utilized to obtain the comprehensive score of the operation status of the platform, as shown in Figure 2. Meanwhile, k-means clustering is used to classify and evaluate the comprehensive operation state of the Taiwan area. The evaluation results will be used as the basis for the investment demand analysis of distribution network station reconstruction.

4. References

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