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Research on Optimization Method of Substation Location

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ABSTRACT. *The selection and determination of substation sites must be based on in-depth and meticulous investigation and research, and comprehensive consideration should be given to the requirements of load requirements, exit corridors, environmental protection, geology, transportation, etc., so as to select the most reasonable solution. .*

KEYWORDS: *site selection; basic requirements; intelligence; algorithm*

1. Introduction

Substation address selection is a scientific, comprehensive and policy-oriented project, and is a major component of electric power infrastructure construction. Whether the site selection is correct or not plays an important and even decisive role in infrastructure investment, construction speed, economics and safety of operation. Practice has confirmed that where ever the prior work is valued and the site selection is good, the investment will be saved, the construction will be fast, and the economic benefits will be high. On the contrary, it will cause loss and waste to the power construction and even affect the safe power supply.

2. Basic requirements for site selection

2.1. Near the load center

When selecting the site plan, it is necessary to find out the power supply load object, load distribution, power supply requirements of the substation, the status and role of the substation current and prospects in the system, and should be related to local town planning, industrial zone planning, and nature protection. The district planning and tourism area planning are coordinated, as close as possible to the main users, close to the load center, which can reduce grid investment and network loss, and reduce the probability of accidents.

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2.2. Saving land

Saving land for engineering is our national policy. We need to follow the principle of technical and economic rationality, rationally arrange, and improve the utilization rate of land as much as possible. Any land that can be used by wasteland must not occupy cultivated land. . In particular, it is necessary to avoid occupying land with high economic benefits such as vegetable fields. The land should be compact and adapted to local conditions. The use of inferior land as a site selection scheme is one of the main conditions for determining the quality of a design. With the rapid development of Beijing's economic construction and the increase of electricity consumption in urban areas, it is very difficult and uneconomical to use a piece of land for substation construction. Therefore, we should properly develop underground substations, all of which are located in high-rise buildings. Basement to meet the requirements of urban construction. For example, the North Taipingzhuang 110kV underground substation designed by the Beijing Electric Power Design Institute and the Ganjiakou 110kV underground substation, these substations have a small footprint, but the cost is high, and the focus is to solve the problem of ventilation and fire prevention. This will be the extraordinary development of the city's central power.

2.3. Requirements for geological conditions

The site should have suitable geological and topographical conditions, and should avoid unfavorable geological structures such as landslides, mudslides, bright and dark river ponds, subsidence areas and earthquake-fracture zones. Avoid karst caves, goafs, shore scouring areas, and areas prone to rolling stones. Attention should also be paid to avoiding or reducing the damage to forests and the natural landscape of the environment.

2.4. line corridor

The selection of substation site should facilitate the introduction and extraction of voltage lines at all levels. When the substation's in and out lines are around the substation, they often need to be erected together. The range of the substation and the path of the path are called line corridors. For large and medium-sized substations with voltages of 110kV and above, there should be a certain width of open space around the substation to facilitate the introduction and extraction of the line. Therefore, the entrance and exit corridor should be determined at the same time as the site selection. Coordination with town planning should also be considered when determining the exit corridor.

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2.5. Transportation

When selecting the site, consideration should be given to the transportation of equipment and materials such as transformers during construction, as well as transportation during operation and maintenance. In general, the site should be selected as far as possible in the vicinity of existing or planned railways, highways, etc., and the roads should be short, so as to reduce investment.

2.6. Try to avoid dirty areas

The location of the site should be avoided as far as possible from the dirty area. The pollution of the substation electrical equipment is seriously affected by the various pollutants in the contaminated area. The degree of damage to electrical equipment is closely related to the conductivity, water absorption, adhesion, meteorological conditions, the amount of pollutants, specific gravity and the distance from the pollution source.

2.7. Environmental Protection

The choice of site must carefully consider the requirements of environmental protection, reduce and prevent pollution. As much as possible, use the corners of the station to carry out greening to increase the greening rate. A clean and beautiful ecological environment is a worldwide topic. Therefore, in the final stage of the new site selection, it is necessary to discuss the impact of the site on the environment and win the consent of the environmental protection department. At the same time, it should also consider whether the surrounding environment has adverse effects on electrical equipment in the substation and achieve good environmental benefits.

3. Application of intelligent optimization algorithm

The intelligent optimization algorithm has good robustness and fast convergence speed, and is widely used in solving the substation location and volume model.

3.1. Application of Genetic Algorithm

The genetic algorithm GA has powerful ability to solve complex combinatorial optimization problems. The search results of the algorithm can give a batch of excellent solutions while giving the optimal solution. The use of genetic algorithm for substation planning needs to give a candidate site or candidate site capacity, and there are problems such as long calculation time and low quality of solution. The use of GA generally requires the site to be selected and the given station capacity, and the GA convergence speed is slow and the local optimization ability is poor. Based on the above problems, a hybrid genetic algorithm (GA-LA) is proposed, which does not require a given location. It also combines GA's hybrid genetic algorithm

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(GA-LA). The LA operator operation makes the substation coordinates close to the load center, thus improving the optimization ability of the hybrid algorithm. And the LA operator improves the calculation speed of GA.

3.2. Application of Particle Swarm Optimization (PSO)

Particle swarm optimization (PSO) is a computational method for simulating the behavior of flocks foraging behavior of birds. The essence is to use the current position and global extremum and individual extremum to guide the next iteration of the particle. The advantages are easy to implement, fast convergence, and good robustness, but it is easy to prematurely converge on complex search problems, and the local optimization ability is poor. An improved multi-organization particle swarm optimization algorithm (RMPSO) is proposed to solve the problem of location and capacity of substation in distribution network. Enter the site, plan the plot, lake, building and other data to determine whether the substation site is in the planned plot; distribute the load to each substation according to the principle of proximity. The capacity of the substation is then determined by the magnitude of the load. Find the optimal location of the substation site by factors such as capacity, location and geographic information of the substation (ground area, land use, traffic conditions, construction conditions, geological topography, etc.). The single-source location and multi-source location are performed by basic PSO and improved PSO respectively. The example shows that the improved PSO algorithm reduces the optimization complexity and makes the location result scientific and reasonable.

3.3. Application of Differential Evolution Algorithm (DE)

The differential evolution algorithm (DE) was first proposed by Rainer Storn and Kenneth Price in 1995 and is a new type of heuristic evolutionary algorithm. Compared with the genetic algorithm, it has the characteristics of fast evolution and convenient use; however, there are difficulties in binary coding, and there is no uniform selection method for parameter setting. The random initialization site (individual in DE) can be given first, and then the feasibility of the site is standardized according to the geographic information. Finally, the fitness function is constructed by the outer point method, and the state variable constraint is included in the objective function with a penalty function. Determine the site and capacity by mutating and crossing. Compared with the PSO algorithm, the DE algorithm can avoid premature aging, and when the problem size is large, the global optimization ability is better. If the differential evolution improvement algorithm of the inertia weighting coefficient strategy is applied, the calculation speed is faster than the traditional DE algorithm, but the inertia weighting coefficient needs to be adjusted according to the actual function each time, and the process is cumbersome.

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3.4 Intelligent algorithm combined with the application of Voronoi

The Voronoi diagram, also known as the Tyson polygon, was first proposed by the Russian mathematician G. Voronoi in 1908. It has unique advantages in the geometric analysis of geographic information. The single Volnoy diagram method has some sensitivity to the initial value. The computational geometry Voronoi diagram can be used to solve the substation planning problem, but the method is proposed on the premise that the load is evenly distributed and the capacity and number of new substations are fixed. The rationality of the power supply range and the substation load rate is not considered. A sub-problem of substation optimization planning. Some literatures make full use of the characteristics of the V map and combine the selection principle of the substation site to guide the selection of new sites. The V map is applied to both the load uniform distribution and the non-uniform distribution. Based on the existing substation, the new site is selected. An example simulation of the alternate iterative method for new site selection under non-uniform load distribution is carried out. However, this document does not limit the substation capacity range, and the optimized substation capacity may exceed the alternative capacity, resulting in unreasonable planning results. There is also a weighted Voronoi diagram (WVD) substation planning method based on particle swarm optimization. Using the optimization technique of integer programming to obtain the capacity combination of the new station, combined with the improved weighted Voronoi diagram (adaptive adjustment weight) and the alternate positioning allocation algorithm, determine the site and power supply range of the new substation; Substation site, cost function as an adaptive function, optimize the substation site through particle swarm optimization; compare WVD and PSO-WVD investment costs and program planning results, indicating the superiority of PSO-WVD over a single algorithm.

4. Conclusion

This paper starts with the introduction of basic requirements for substation site selection, and discusses the application of intelligent optimization algorithm in substation optimization planning from the shallower to the deeper. In practical engineering, the most suitable method should be selected according to the specific conditions of the project and the advantages and disadvantages of several algorithms. Save resources and improve resource utilization.

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