Analysis of Distribution Network Protection Based on Distributed Power Sources

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Abstract. After a distributed power supply is connected to a distribution network, the distribution network changes from a single-supply radiant network to a network. When a fault occurs in the distribution network, the size and direction of the short-circuit current will change, giving rise to conventional relay protection. Normal operation brings a series of problems. This paper proposes the configuration principles and requirements for distributed protection relay protection and safety automatic devices with distributed power supply, which can provide reference for the safe and reliable operation of distribution networks with high-permeability distributed power supply.

1. Introduction
The traditional distribution network is generally a single-ended power supply network. To ensure the reliability of power supply, the distribution network also uses a hand-in-hand or dual-end power supply; however, in actual operation, the double-ended power supply system generally adopts open-loop operation. In this mode, one end of the power supply or two ends of the power supply respectively supply power to some of the lines [1]. In the above power supply mode, if the line fails, the system power supply provides a short-circuit current, and the short-circuit current flows from the system power supply side to the fault point. Therefore, the configuration of the relay protection is generally a three-phase current protection and can be determined without direction. For double-ended power ring networks [2], three-stage distance protection is used as primary protection and backup protection, and zero-sequence current protection is used as ground fault protection. The breakdown of the overhead line of the distribution network is mostly transient [3].

2. Distributed power supply overview
The concept of distributed power supply is actually not new. This concept was first proposed in the U.S. promulgated U.S. Public Management Policy Act of the 1970s. It was defined as distributed in a decentralized manner near the user, with a power generation of 5 kW-~50MW small modular and environmentally compatible independent power supply. The International Large-scale Power System Committee (CIGRE) defines distributed power as "non-planned or central dispatch-based power production methods, which are usually connected to distribution networks, and the general power generation scale is between 50 and 100 MW [4].

2.1. Distributed Power Supply's own protection requirements
The DG that connect to the distribution network mainly include wind power, solar power generation, bio-power generation, fuel cells, and small household generators. Invert power supply is generally
equipped with under voltage protection. When the voltage is too low, it will automatically cut off the connection with the power grid, so the fault current will generally not exceed twice the rated value. As a protection for the distributed power supply, it is necessary to take into account the possible faults caused by the generator itself, and to consider the possible impact on the external fault of the distribution network [5]. Therefore, in terms of distributed power supply, it is necessary to additionally consider load asymmetrical protection, under-voltage protection, over-voltage protection, frequency protection, and zero-sequence over-voltage protection due to internal faults in the distribution network.

2.2. Basic requirements for relay protection
In the process of safe operation, the distribution network encounters a variety of faults and abnormal operating conditions. On the one hand, in the event of a fault, the fault current of the system will be very large, which will harm the faulty equipment and non-failure equipment and affect the users. In normal operation, if faults are not discovered in time and fault lines and equipment are removed, the accident will be further expanded, and even lead to serious consequences such as system oscillations and voltage collapse [6]. On the other hand, the system has been damaged in a variety of abnormal conditions, that is, the normal operation of electrical components in the power system, but no faulty operating conditions have occurred, such as system frequency is too high or too low.

3. Effect of distributed power supply on distribution network protection

3.1. Effect of Different Kinds of Distributed Power Supply on Distribution Network Protection
The effect of distributed power generation on distribution networks is that when problems arise in the distribution network, the power supply can guarantee power supply. However, this effect must be designed according to different types of distributed power sources. To protect the stable operation of the distribution network, Must use the type of distributed power that it wants to adapt to. The types of distributed power mainly include converting current machines, running generators, and intelligent induction generators. These three types are based on the input of the distribution network. Arranged, so the switching current machine is suitable for small power plants, while the other two are suitable for medium and large power plants [7].

3.2. It is easy to influence the connection point
When the problem of the distribution network occurs near the starting point of the distributed power supply, the amount of current at this time will increase rapidly, and the currents at the other ends of the three-phase connection will not change much, protecting the problematic line current. When the problem of the distribution network occurs near the end of the distributed power supply, the power supply at this location must be protected and the line must be selected intelligently to provide protection. For the nearby lines, the distributed power supply will also provide direct Corresponding protection, but if it is operated incorrectly, it will lose its effect.

3.3. Smart Devices Affecting the Power Grid
Problems arise in the location of distributed power supply feeders. The problems that arise in the power supply system are often timeliness, that is, they occur in an instant and do not take into consideration the time. Therefore, they need to be controlled through smart devices, and they are automatically powered off and then repaired. However, if the configuration is unreasonable, the smart device cannot operate normally, and the time and area for power interruption will increase. When the feeder in the adjacent position has a problem, the automatic device needs to be automatically opened. If the distributed power source is not configured properly, or consider this link, it will cause the device to start or not start.
3.4. Impact on Current Protection

Usually, the multi-purpose power supply is formed after the DG is connected to the distribution network. If a fault occurs at the end of the bus, both the DG and the main power supply will be short-circuited. And the main power is represented by Is. The fault current is denoted by If. The If increases due to the existence of DG. However, in order to protect the distribution network, the relay protection device will automatically cut off the faulty line. If the If increases sharply, it will exceed the tolerance of the device and cause other devices to cut off. Lines, thereby expanding the scope of faults. If the protection device in the middle of the bus bar fails, although there is no obvious change, but because the DG voltage is much smaller than the main power supply, if the voltage is provided for the fault point for a long time, the line voltage will be greatly reduced, causing partial collapse of the distribution network. Obviously, if the adverse effects of DG are not handled properly, it will directly cause the distribution network to fail to operate normally.

![Fig 1. Distributed power supply current protection](image)

3.5. Impact on Reorganization Devices

The presence of coincidence devices is to avoid the occurrence of transient failures and to ensure that the distribution network returns to normal in a timely manner. After the access to the DG, if the line fails, it will generate a continuous arc, or even damage the insulation layer of the protection device, and convert the fault that should be able to be restored briefly into a permanent failure. If the feeder fails at the same time at both ends to supply power to the main power supply and DG, in order to restore the power supply in a timely manner, it is necessary to handle the situation in the same period of the inspection. However, if the feeder has a large power angle, a large current will occur. The impact phenomenon will not only destroy the distribution network and its components, and even cause fire and other safety accidents. In addition, the access of the DG will also affect the coordination relationship between the closing device and the relay protection device. In the event of a fault, the DG will increase the short-circuit current, which will reduce the power in the recombination location, resulting in an instant fuse. Take action one step ahead, and then affect the normal coordination of closing and protectors.

4. Distributed Power Supply Protection Measures for Distribution Network Protection

4.1. Innovations Existing Methods

First, add parts with protective measures, so that the distributed power supply switch points can be installed near the switch point, and then the problem point can be prevented from affecting the distribution network in the opposite direction. The corresponding parts are installed at the initial end of the distribution network, to improve the overall safety factor; second, to innovate the principle of
distributed power supply, comprehensively consider the problems that arise after the establishment of the smart grid, especially when the problem occurs, the voltage and current range of change, enrich the concept, and then use the distributed power supply flexibly. The form of power supply becomes either a ring network or a two-terminal configuration network. Then, even if a problem occurs in one location during operation, the other links still operate normally. Directional components are installed on both sides of the distributed power supply and circuit breakers are installed on the opposite side of the protection. When the power injection direction at both ends of a line is positive or negative, it can be determined as a fault within the wood zone.

4.2. Reasonably Designed Configurations
When designing the plan, the scope will be expanded, and in order to save resources, we must increase the location or reduce the number of locations to achieve the desired results instead of replacing all of them blindly. This requires strengthening management and regular maintenance of equipment. Train operators to improve their professional capabilities and overall quality, standardize their operations, and maintain them regularly. For equipment that has fallen behind, it should be sent to a recycling station to avoid damage to the environment; based on the existing distribution network, to improve the level of intelligence, especially to achieve automatic supervision, so that when problems occur automatically warning; Second, consider the neural network, through artificial intelligence devices, in the protection of the main distribution network, but also to protect the scattered struts. The network, as a whole, enables the complex cross-cutting networks to be unified and protected. In the event of a failure, the specific location can be known in time. After the system is automatically resolved, the management personnel finds a location for maintenance to prevent the recurrence of problems in the future.

4.3. Carefully Analyze the Current Drawbacks and Improve it
The existing distribution power distribution network using distributed power protection is mainly the above two points, but it is prone to certain problems. For the method of adding or deleting parts only, although the resources are saved, the sensitivity of the grid will be reduced. For the method of changing only the configuration scheme, as the distribution network becomes more and more advanced, the type of the problem will be more diverse, so the organic combination of the above two configurations is the best choice, which not only ensures the conservation of resources, solves simple problems, but also improves the overall advanced degree of the distribution network and can solve the emerging problems.

5. New Distribution Network Protection Scheme

5.1. Distribution Network Wide Area Protection
The wide-area information has the advantages of comprehensive information, synchronization of acquired electrical quantity, etc. The protection criteria and fault location method based on wide area information are proposed. Among them, the IED is installed in each branch of the bus. First, the fault is judged according to the abrupt change amount, and then whether the bus fault is determined by the sum of the currents of each branch on the bus, and then whether the branch fault is determined by the branch current in turn. The fault is located in a relatively small range, and each branch accurately locates the fault and cuts it out; in addition, based on the wide-area information collected online, the power grid operating status and the main protection action status can be comprehensively analyzed and applied to the development of the current fault. Protection criteria.

5.2. Distribution Protection Based on Technology
Application of Technology in Relay Protection. There are two situations in which technology is applied: one situation is that by considering each protection device as an agent, technology is used to enhance information sharing and cooperation among multiple computer protections; another case is to
put a protection device. Considered as being composed of multiple agents, each agent plays its own role and coordinates work to improve the overall performance of the protection device.

The technology is used for the distribution network protection with DG. This is the second case mentioned above. Although the number and the functions of the agents used in these documents are different, they are all based on the role of the agent and perform communication and cooperation to complete the protection function. Among them, a network topology agent, based on the real-time network topology, judges the reliability of the line, and chooses whether the protection principle is current differential protection or adaptive protection. This method is based on the real-time network structure and the requirements of the line to determine the protection principle. It is worth referring. In addition, an adaptive phase-linked protection scheme based on complex wavelet algorithm is also proposed in this paper. The accurate fault current phase is obtained based on the complex wavelet algorithm. The adaptive algorithm is used to judge the operation mode of the power grid with DG, and the protection setting is determined.

![Diagram of distributed power supply access distribution network protection process](Fig 2).

However, the relay protection method of technology in distributed energy access distribution network remains to be further studied.

### 5.3. Distribution Network Protection Based on Neural Networks

The protection method of the neural network is based on discrete wavelet transform technology to analyze the high-frequency transient current components generated by the fault, detect the fault occurrence time and fault type, and use the forward artificial neural network to identify the specific fault, according to the high frequency of the traveling wave. The characteristic can obtain the direction polarity of the traveling wave signal, and realize ultra-high speed protection of the distribution network containing DG based on this information.
5.4. Outlook for distribution network protection configuration with DG
With the access of distributed energy sources, traditional relay protection based on passive distribution networks is no longer adaptable. Although it can be inactivated when the DG provides reverse current, the influence of selectivity and sensitivity on the protection when it provides positive short-circuit current cannot be eliminated. Therefore, considering the DG access, consider DG random. Sexuality can be re-tuned for traditional protection; adaptive current protection considers DG output randomness and other factors, but its on-line setting calculation is complex, and the online computing component requires high intelligence and fault-tolerance capabilities. In the future, adaptive protection In terms of online computing,

6. Conclusion
The new power supply mode will surely be applied in the future power system. The impact of distributed generation on the distribution network is twofold. Resolving adverse effects depends on changing the configuration concept and plan. The state and relevant departments must focus on research. This paper analyzes the impact of distributed power generation, which is an emerging power generation method, on relay protection of distribution networks and proposes corresponding solutions. Distributed generation is the development trend of modern power grids. Resolving the related problems caused by this has very important practical significance. In addition to the content mentioned in the article, the state must continue to improve the program for the development of the electric power industry, increase the level of information, and lay a good foundation for guaranteeing the electricity demand for production and living.

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