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Voltage Optimization Method of Distributed Photo-voltaic Power Supply Connected to the Distribution Network

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Abstract: The traditional centralized power generation mode cannot improve the situation of low voltage at the end nodes of rural power lines in practical work, so a voltage optimization method for distributed photo-voltaic power supply connection distribution network is proposed. Firstly, the characteristics of the nodal distribution frame and the load value in each period are used to adjust the photo-voltaic osmosis ratio to ensure that the voltage fluctuation of the distribution network is not affected by other environmental factors. Secondly, the range of line characteristic parameters is expanded according to the ground state model. Finally, the voltage of distribution network is optimized according to the load level at a certain moment. It is proved by experiments that the voltage optimization method of distributed photo-voltaic power supply connected to the distribution network can ensure the voltage fluctuation of the distribution network at a normal level and improve the situation of low voltage at the end nodes of the agricultural network.

Keywords: Photo-voltaic osmosis ratio; Renewable energy; Production mode; Output power

1. Introduction

At present, the problem of environmental degradation is becoming more and more serious. solar and wind energy are the most representative new energy sources. However, problems such as poor distribution and strong regional difference make it unable to imitate the centralized production mode of conventional energy, and thus a reasonable way of utilizing new energy is needed to distribute power supply according to the region. Distributed photo-voltaic power supply refers to the power system connected from the distribution network. Decentralized arrangement in the vicinity of the users of electricity power supply, distributed photo-voltaic power itself has the strong dispersion and environmental protection, and the advantages of power distribution network planning for the future construction plays a key role, therefore, to develop its application potential in the practical work, taking advantage of the characteristics of high value of renewable energy for environment, the construction of the sustainable development of energy is needed[1]. In the future, the planning and construction of the distribution network will select the node near the users to access, directly consume the surrounding load, and reduce the loss of the transmission power of the line, so as to improve the voltage at the terminal node of the line and improve the current situation of low voltage at the terminal node of the agricultural network. Compared with the traditional centralized power generation mode, this circuit transmission mode has greater advantages, which can not only reduce the cost of power infrastructure, but also improve the work efficiency. However, due to the poor operation characteristics of the distribution network, there will be fluctuations when it is connected. In order to adjust the phenomenon of severe voltage fluctuations in the distribution network, a distributed photo-voltaic power supply access to the distribution network voltage optimization method is proposed. By adjusting the photo-voltaic penetration ratio, the range of characteristic parameters of the distribution network line is expanded to achieve the distribution network voltage optimization [2].

2. Voltage Optimization Method of Distributed Photo-voltaic Power Supply Connected to the Distribution Network

2.1. Photo-voltaic penetration ratio adjustment

In the past, when wiring the distribution network, radiation wiring and ring network connection were used. This centralized power generation mode has some disadvantages. Before the actual operation, a certain framework should be set to complete the operation, resulting in excessive energy consumption and great harm to the ecological environment. This, in view of this phenomenon, this paper puts forward a voltage optimization method of distributed photo-voltaic power accessed to distribution network, making use of the characteristic of node distribution network framework, integrated the problem of processing too many nodes in networks, through the coordination of each period of load values, the photo-

voltaic (PV) penetration than adjustment, which is essential to the adjustment of power voltage fluctuation [3].

The distribution network bus will show a lot of wiring situation, which is too complex to operate, and the capacity in the system will also increase with the bus supply load, so that the interference range of the superior system will be reduced, in this case, it is necessary to adjust the photo-voltaic penetration ratio and reset the multiple nodes. For example, in the process of actual voltage control, multiple nodes can be assumed as the source of a voltage, so as to improve the bus layout nodes and ensure the voltage fluctuation of the distribution network at a normal level. When the photo-voltaic power generation system is connected on a large scale, the power flow characteristics and power quality of the distribution network will be greatly affected. The increase of voltage capacity will affect the one-way power flow state from the upper and middle substation bus down to the load side of the distribution network. Once the power flow characteristics are changed, it will directly affect the voltage fluctuation of the distribution network [4].

In order to ensure the voltage fluctuation of the distribution network at a normal level, the PV penetration ratio is adjusted according to the load capacity of the distribution area.

$$x = \frac{\sum P_{PVi}}{\sum S_i} \tag{1}$$

In formula (1), x is the PV penetration ratio of distribution line, P_{PVi} is the installed capacity of the i PV, and S_i is the capacity of the i distribution transformer. When applying this formula, it should be noted that only when certain constraints are met, the load capacity of distribution area can be reset.

2.2. Expand the range of distribution line characteristic parameters

According to the photo-voltaic penetration ratio of distribution network, when the photo-voltaic penetration ratio is different, the corresponding voltage and current-carrying capacity of the distribution network will also be significantly different. In order to ensure the safe operation of the distribution network and achieve good loss reduction effect, the research on the photo-voltaic capacity of the distribution network is conducted. The influence of distribution network characteristic parameters on the photo-voltaic limiting access capacity is analyzed from the perspective of mechanism, and the influence rule of different characteristic parameters on the cable lines under the condition of the different voltage constraint[5]. Within the variation range of characteristic parameters, the distribution network structure is re-calculated according to the distribution network structure, as shown below.

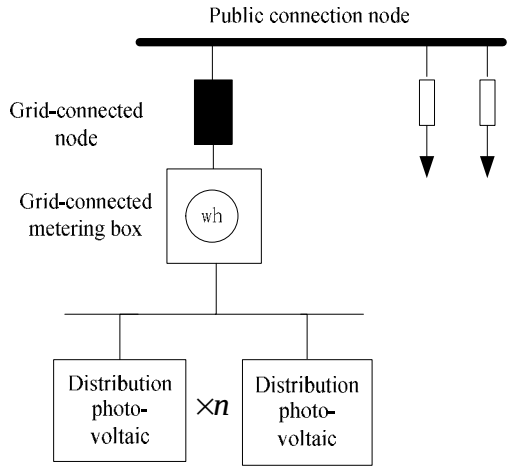

Figure 1. Distribution network structure

Figure 1 is a distribution network structure, to understand the scope of the change of characteristic parameters according to the distribution network structure, from the formula (1), the adjusted photo-voltaic (PV) penetration than the volatility will affect the voltage distribution network, from the angle of the line feature parameters, analysis of voltage and current under the constraints, the circuit characteristic parameter's influence on the photo-voltaic capacity limit access. In order to ensure that the distribution network line current does not exceed load, the characteristic parameters of the distribution network line are expanded, and the mathematical expression formula is shown below.

$$r = \frac{\sum P_{PVi} \bullet \sum S_i}{\sum_{m=1} P_{GM}} \tag{2}$$

In formula (2), r is the network loss rate of the distribution network, and $\sum_{m=1} P_{GM}$ is the total power generation of distribution lines. If P_{PVi} is larger than $\sum_{m=1} P_{GM}$, the influence of line characteristic parameters on the PV limiting access capacity will be smaller. In this way, the range of line characteristic parameters of the distribution network can be expanded according to the structure of the distribution network.

2.3. Realize the voltage optimization of distribution network

The voltage optimization method of distributed photo-voltaic power supply connected to the distribution network is to optimize the load level at a certain moment, and the load data comes from short-term load prediction. When the load of the distribution network is in a state of change, you need to reset the circuit characteristic parameters of the light-stored joint launch system, because the output power of photo-voltaic cells will change with the weather and temperature change, due to the frequent fluctuations of the load, reactive power control equip-

ment will pass the set scope, which will not only affect the use of reactive power control equipment but also affect the volatility of voltage distribution network, at this time, dividing the all-day load data into multiple time period for optimal control, and according to the adjusted photo-voltaic penetration ratio to restrict the action number of reactive power control equipment, then transforming the redicted line characteristic parameters into the economic targets within an operating cycle [6].

The effect of distributed photo-voltaic electricity generation technology application will directly affect the power of photo-voltaic power generation in the actual usage, therefore, in the practical operation, the output power is needed to be controlled within a reasonable scope, when calculating the power curve, the moving average method is used to calculate the actual power to ensure the best effect in the process of actual usage. In addition, in the node layout, it also needs to continuously refine to ensure the distribution network voltage fluctuations within a normal level. In this way, the voltage optimization method of distributed photo-voltaic power supply which is connected to the distribution network is realized [7].

3. The Experimental Result

In order to verify the effectiveness of the voltage optimization method of distributed photo-voltaic power accessed to the distribution network, the moving average method was adopted to compare the volatility of the traditional centralized power generation mode and the voltage optimization method of distributed photo-voltaic power connected to the distribution network. The experimental data are shown below.

Table 1. Circuit parameters

NO.	Length (m)	Ampacity (A)	Unit Resistance (Ω / km)	Unit Current (Ω / km)
1	50	170	0.85	0.417
2	80	170	0.85	0.417
3	100	170	0.85	0.417
4	50	170	0.85	0.417
5	100	170	0.85	0.417
6	80	170	0.85	0.417
7	50	170	0.85	0.417
8	80	170	0.85	0.417
9	50	170	0.85	0.417
10	100	170	0.85	0.417

Table 1 is the parameters of the experimental circuit. In the experiment, the traditional centralized power generation mode and the voltage optimization method of distributed photo-voltaic power supply accessed to the distribution network are compared. The experimental results are shown as follows.

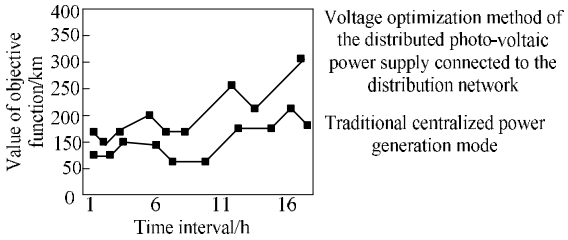

Figure 2. Comparison of experimental results

Figure 2 is a comparison of the experimental results of the traditional centralized power generation mode and the voltage optimization method of the distributed photo-voltaic power supply connected to the distribution network. It can be seen from the figure 2 that the voltage optimization method of distributed photo-voltaic power supply connected to the distribution network is superior to the traditional centralized power generation mode on the node layout, during the running of the scheduling, the voltage optimization method of distributed photo-voltaic power supply connected to the distribution network can guarantee the balance of power, especially on the power balance control, which can control the residual energy of the constrained energy storage device within a limited scope in a balanced way at the beginning and end of the time period. While the traditional centralized power generation mode control of the power energy is poorer, which can be seen from the experimental data, the voltage optimization method of distributed photo-voltaic power supply connected to the distribution network clearly has advantages, at the same time, it can also ensure the distribution network voltage fluctuation within a normal level, thus to improve the low voltage situation of the rural electric wiring terminal node.

4. Conclusion

In the experiment, the voltage optimization method of the distributed photo-voltaic power supply connected to the distribution network was tested. In terms of node layout and fluctuation, it was found that although the voltage optimization method of the distributed photo-voltaic power supply connected to the distribution network has obvious advantages, but in the calculation of the output power control range, there is still a certain lack of accuracy. Further research is needed to improve the accuracy of calculating the output power for the voltage optimization method of the distributed photo-voltaic power supply connected to the distribution network.

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