Study on Photovoltaic Absorption Capacity Evaluation of Distribution Network Based on Improved FPA Computer Algorithm

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Abstract. FPA algorithm is a new metaheuristic swarm intelligent optimization algorithm for solving optimization problems. In order to promote the further development of China's solar power industry, the National Energy Administration has issued a document to promote distributed photovoltaic power generation system, encouraging photovoltaic power generation to be combined with the needs of users, in cities, villages and buildings and public facilities to promote the system. When calculating the maximum surplus ratio of photovoltaic power generation, it is necessary to select a certain power supply area, clarify its power supply mode, power transmission capacity and path, and calculate the value by fitting the photovoltaic power generation and load characteristic curve. In this paper, based on the characteristics of photovoltaic power generation and the typical load, by studying the create a new index of photovoltaic power generation given abilities distribution network, in the process of dynamic change periodically given capacity of photovoltaic research evaluation, set up photovoltaic maximum surplus "than" index, according to the calculation analysis of factors affecting given distributed photovoltaic power generation capacity and its influence on construction of distribution network transformation, and puts forward Suggestions on construction of photovoltaic power generation demonstration area.

Keywords: Absorption Capacity Distribution Network Photovoltaic, FPA Algorithm

1. Study on absorption capacity of distribution network

1.1. FPA algorithm

FPA algorithm is a new meta-heuristic swarm intelligent optimization algorithm for solving optimization problems. The algorithm simulates the biological cross-pollination and abiotic self-pollination processes of flowering plants in nature, and uses probability P to control the transition between cross-pollination and self-pollination. The improved FPA algorithm can be used to calculate the distributed PV absorption capacity of each grid-connected PV node under different power, and the
distributed PV that can be obtained has the maximum absorption capacity and the actual PV installation capacity of each node.

1.2. New index of photovoltaic power consumption capacity
In order to promote the further development of China's solar power industry, the National Energy Administration has issued a document to promote distributed photovoltaic power generation system, encouraging photovoltaic power generation to be combined with the needs of users, in cities, villages and buildings and public facilities to promote the system. With the decline of the price of photovoltaic power generation equipment and the promulgation of relevant national subsidy policies, distributed photovoltaic power generation will usher in a rapid development. The photovoltaic power generation on the user side can compensate the load locally. According to some studies, the improper proportion of distributed photovoltaic power generation in the power grid will have a negative impact on the security and stability of the power grid and the quality of power. In order to evaluate the capacity of distribution network to accept distributed generation reasonably and effectively, permeability index is usually adopted. Under the condition of normal operation of the system, the permeability that the system can bear should be controlled in a certain limit range. The access of photovoltaic power generation is bound to have a certain impact on the operation and monitoring of the distribution network, and the indicators such as power quality and stability will also change. In order to ensure the safety and reliability of the power network, it is necessary to reasonably estimate the absorption capacity of the distribution network by measuring its permeability.

The traditional permeability refers to the ratio between the grid-connected capacity of distributed generation and the grid load, which is a static quantity. Due to its original time-varying characteristics and typical load fluctuations, the absorption capacity of photovoltaic power generation has a dynamic process, and the traditional static permeability index can not fully reflect the absorption capacity of photovoltaic power generation of the distribution network. The grid-connected capacity of distributed generation is calculated according to the installed capacity, which is the peak power for photovoltaic power generation. The grid load is calculated according to the maximum load. PerMEABILITY, to some extent, reflects the quantitative relationship between distributed generation and local load, plays a certain role in guiding the planning of distributed generation, and is a basic index to ensure the safe operation of power grid. However, in the actual operation of the project, the output of distributed power generation such as photovoltaic will change due to the existence of uncontrollable natural conditions (such as illumination and wind intensity), and the load also reflects a certain time-varying periodic rule with different types. In some specific periods, the most unfavorable situation for the power grid will appear. In order to study the absorption capacity of the distribution network to distributed photovoltaic and other power sources in the time-varying period, and to measure the maximum power that the lines, transformers and other equipment may bear, the index of "maximum surplus ratio of photovoltaic" is proposed.

For distribution network planning and construction, the general selection according to the planning phase of the maximum load line, transformer and other equipment to limit transmission power capacity, to implement equipment upgrades and distribution equipment is old and limited capacity margin area of the module, when the distributed generation power, a large number of surplus will produce a large number of return to power, the power grid equipment possible reverse, send a lot of power, and even reverse transmission equipment and wire lines that overload, seriously influenced the stability of the circuit devices. Photovoltaic maximum surplus ", therefore, to send with ratio index reflect the distributed photovoltaic (pv) and the local load dynamic given relationship, indicates that the grid can be run under the most extreme cases, this is the traditional permeability index cannot be reflected, so photovoltaic maximum surplus hair with more practical reference value than indicators, the power distribution network reliability evaluation and guiding significance to the greater of construction and reform.
1.3. Calculation of the maximum surplus ratio of photovoltaic in the building area

When calculating the maximum surplus ratio of photovoltaic power generation, it is necessary to select a certain power supply area, clarify its power supply mode, power transmission capacity and path, and calculate the value by fitting the photovoltaic power generation and load characteristic curve. The ideal daily power generation characteristic curve can be used for photovoltaic power generation, while taking into account the seasonal climate difference. Load characteristic curves can be fitted separately according to different load properties, and can be approximated according to typical load curves of different classes. Considering the differences in peak conditions in winter and summer, actual load curves are preferred. Different regions have different building area and plot ratio, and the photovoltaic installation capacity within the floor area is also different. Calculate the maximum photovoltaic installation capacity in the typical functional area and make a ratio with the total area occupied by the area. For the planned project, to determine the area, building mode, load nature and other factors of the power supply part, the power generation and load can be converted into the density value of unit area, and the value can be calculated by comparing with the time-varying characteristic curve. As is shown in the figure 1.

![Photovoltaic capacity and power supply diagram](image)

**Figure 1.** Relationship between photovoltaic absorption capacity and power supply

2. The form of photovoltaic power generation access to the distribution network

Collect access. The scale of photovoltaic power generation is large when the connection is made, and it is easy to manage when the connection is made. A number of photovoltaic inverters are collected in the low-voltage bus through the AC line, and the booster transformer is used to rise to ten thousand volts, and the special line is used to connect to the public distribution facilities such as the ten thousand volts bus of the substation or the opening and closing stations, and the ring network cabinet. However, it is necessary to build a gathering (booster) station, which has a large investment and great influence on the voltage of distribution network. Therefore, corresponding dispatching and control measures are needed.

Decentralized access. Distributed access generally has a small capacity and is mainly connected to the user's power grid. It can be connected to the network at 380V/220V and can be accessed at multiple points. In decentralized access, there is no need to build collecting (booster) stations, with less investment and less influence on the distribution network voltage. However, the number of access points is large, the measurement is scattered, and the maintenance system is complex and difficult to control. (figure 2)
Building integrated photovoltaic (PV) is the installation of photovoltaic power generation materials on the exterior surface of building structures to provide power. As a new form of photovoltaic power generation, it has attracted more and more attention in urban areas in recent years. Building integrated photovoltaic (PV) can be divided into two types according to the different ways of photovoltaic materials and building combination: one is the combination of embedded installed roof and building; Second, building integration, such as photoelectric tile roof, photoelectric curtain wall, etc.

Of the two, the first is the most commonly used form, as the combination of photovoltaic materials and buildings does not take up additional ground space, which is the best way to install photovoltaic power systems widely used in cities. The integration of photovoltaic materials and buildings is an upgrade of building integrated photovoltaic, which has higher requirements for photovoltaic modules. Photovoltaic modules should not only meet the functional requirements of photovoltaic power generation, but also meet the requirements of basic building functions, so its cost is high.

3. Influencing factors of the maximum surplus ratio index of PV

For areas with specific building forms, there is saturation of photovoltaic installation, which will not reach saturation under the influence of certain factors. At the same time, photovoltaic power generation has a strong regularity. If there are accidental factors, it will only reduce power generation, which is conducive to power generation consumption. The load situation is relatively complex. First of all, the accuracy of power density measurement is not easy to guarantee, and there is often a large space of change in load estimation, simultaneous rate value and other links. In addition, it is difficult to analyze the time-varying characteristics, because it is influenced by economy, society, and emergencies, so there is great uncertainty.

The limit transmitted power is greatly affected by the equipment and the superior power network. With the growth of the service time and the aging of the equipment, it often fails to reach the designed carrying capacity. The overall level of the local distribution network also affects the outgoing power generation. In areas with good grid conditions, the power quality can generally be guaranteed under the limit operation condition, otherwise it will easily lead to the adverse situation of the voltage rise at the transmission end, which will affect the safety of users.

Therefore, the indexes affecting the maximum surplus ratio of photovoltaic include the density of generation power and load power, load characteristics, limit transmission power, and the level of distribution network. Therefore, in photovoltaic maximum surplus more than measurement, various factors should be considered, and the construction of operation for a considerable time power supply area, the measuring value can take conservative to fully expose the risk to the power grid and equipment, for delivery ability is stronger, such as double circuit power supply, such as large capacity margin area, can relax appropriately measure range. When the estimated value obviously exceeds the accepting capacity of the regional power grid, the power grid transformation should be carried out in time.

4. Conclusion

The photovoltaic absorption capacity of the distribution network is affected by the power factor setting of the photovoltaic inverter and the short-circuit capacity of the system, and the voltage fluctuation of
the dot is related to the photovoltaic access volume and the short-circuit capacity of the system. Since both distributed photovoltaic power generation power and local load power vary with time, it is of more practical significance to use the index of "maximum surplus ratio of photovoltaic power generation" to check the reliability of photovoltaic access regional distribution equipment under extreme operation conditions. This index can also be popularized and applied to other distributed power access distribution network planning and design, and calculated according to the actual situation. With the increase of photovoltaic access quantity, the network loss of the system decreases first and then increases, and when the photovoltaic access quantity is equal to the total active power load of the system, the system loss reaches the minimum. At the same time, the system loss is also affected by the power factor of the photovoltaic inverter. The phasing operation of photovoltaic inverters can effectively improve the photovoltaic absorption capacity of the distribution network, but the system loss increases. The power factor of the photovoltaic inverter can be set according to the running state of the power grid.

In the planning and design of distributed photovoltaic demonstration area, the maximum surplus ratio of photovoltaic should be estimated according to the building form and load type. For the area which is too large and difficult to transform, its capacity should be strictly limited in the photovoltaic planning or the corresponding technical means should be adopted to reduce or even eliminate its harm to the distribution network system. In this paper, based on the characteristics of photovoltaic power generation and the typical load, by studying the create a new index of photovoltaic power generation given abilities distribution network, in the process of dynamic change periodically given capacity of photovoltaic research evaluation, set up photovoltaic maximum surplus "than" index, according to the calculation analysis of factors affecting given distributed photovoltaic power generation capacity and its influence on construction of distribution network transformation, and puts forward Suggestions on construction of photovoltaic power generation demonstration area.

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