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Analysis of Key Technologies and Related Problems of Microgrid

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Abstract: Microgrid construction is an important part of the current intelligent development of electric power in China. In the current intelligent development of electric power, people have higher and higher requirements for the construction of microgrid, and the corresponding research on the construction of microgrid will pay more and more attention. For the construction of micro grid, scientific control of micro grid construction technology is very crucial. Only by improving the implementation of micro grid control technology can we improve the level of intelligent construction of power grid. In view of this, this paper studies the key technologies of microgrid and their related problems, trying to find out the key technologies suitable for the construction of microgrid and improve the implementation of relevant technologies in this study and analysis, so as to provide help for the construction of smart grid.

1. Introduction

As an important part of the development and operation of electric power system, the micro grid plays an important role in the construction and development of existing electric power enterprises [1]. Through the analysis of the technical application in the construction of microgrid, the technical application requirements in the construction of existing power grid are clarified, and the construction mode of power grid is easily and timely refined, so as to provide help for the key control of power grid construction [2]. The significance of this paper is to optimize the control strategy of key technologies of microgrid based on the technical application requirements of current power grid construction, so as to improve the application level of intelligent technology of microgrid.

2. The operation mode of microgrid

2.1. The microgrid control under grid-connected operation

As an important control mode in the operation of microgrid, the control of microgrid under grid-connected operation has an important influence on the construction of microgrid. In the implementation of microgrid control technology under grid-connected operation, PCC point connection is used to carry out power exchange disposal based on external network power switching, so as to ensure that the external power exchange disposal can better help the operation of microgrid. When distributed power supply appears in microgrid operation, it is necessary to control energy conversion in grid construction in order to reduce line operating load [3]. In this process, the PCC connection can realize the external power control, so as to reduce the power load control purpose. It should be noted that the grid-connected operation control is carried out by the power balance regulation of the large power grid. Through the operation control of the large power grid, the frequency in the operation of the whole power grid is converted, so as to realize the control of the operating voltage inside the power grid. In addition, the local voltage is controlled according to the requirements of the power control of the grid, so as to ensure that in the control of the local voltage, reduce the voltage deviation and oscillation in the operation of distributed power supply and improve the current flow effect.

2.2. The microgrid control under solitary network operation

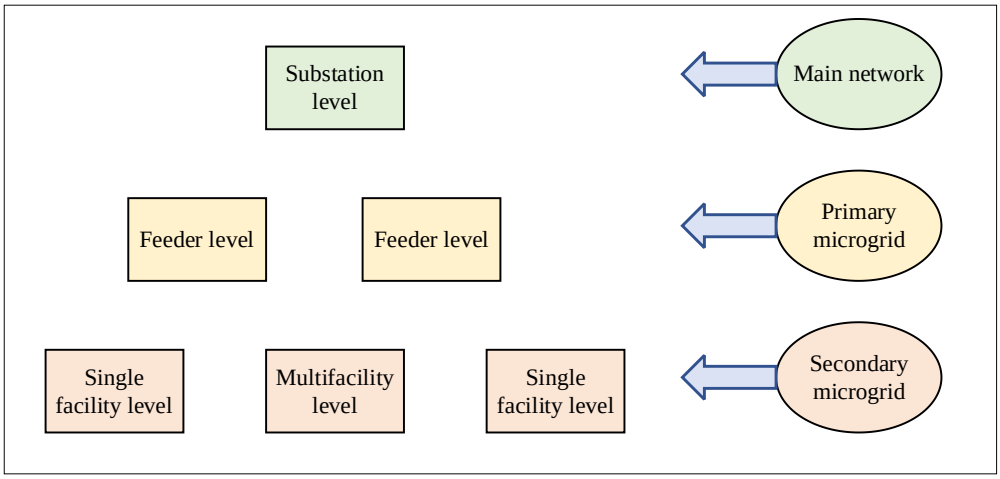

Figure 1: The microgrid capacity and voltage level classification.

In microgrid control under isolated network operation, it is necessary to isolate microgrid and large grid operation control, and analyze power grid operation fault according to the requirements of power grid operation control, so as to ensure better help for power grid operation fault analysis and disposal. In many cases, the operation of isolated network is the control mode of the power grid after the sudden failure of the power grid, and it is a relatively key control element in the whole power grid control. In the operation control of isolated network, the operation control should be mainly undertaken by DG [4]. The environmental protection and economy of power grid operation can be scientifically controlled by DG control. It should be noted that in the isolated network operation control of microgrid, with the control and adjustment of the power grid operation frequency, the corresponding system operation power and system operation rotation mode will change. In this process, due to the different components of electronic conversion devices in power grid operation, the corresponding frequency change will be different. Therefore, in this context, the

response time of power grid operation equipment will change. Scientific control of power grid operation mode can provide help for system operation control, and has important guarantee significance for reducing power grid operation load. Meanwhile, in the construction of microgrid, power enterprises need to select the type of microgrid according to the power load, as shown in Figure 1.

3. The control method of micro power supply

3.1. PQ control

PQ control is an important control mode in microgrid control. In this control mode, the control system of microgrid is adjusted mainly through PQ control, and the control mode of distributed power supply in power grid operation control is optimized, so as to ensure that the control mode of microgrid operation can be better helped in the adjustment of power grid control. In the process of PQ control, due to the different control purposes and methods, there are differences between the control methods of useful power and useless power in the whole control system, which affects the control effect of the power grid. Generally speaking, in the process of PQ control, the useful power control output form of distributed power supply can be changed by adjusting the frequency sag curve, and the useless power can be reduced, so as to provide help for voltage regulation of power system control. It is assumed that the outlet voltage of the distributed power supply is at a constant value and the system frequency is maintained at about 50Hz. In this case, the operation of the distributed power supply is adjusted around the rated power. In the process of power adjustment, the lower vertical line of the power is controlled to provide help for power adjustment. It should be noted that PQ control is mainly applied in grid-connected operation control, because in this state of power grid operation, load changes and voltage and power changes are different, through the system control adjustment can realize the system power control frequency adjustment, to meet the useful power conversion adjustment for voltage system control.

3.2. Sagging control

Sagging control refers to the control of power grid operation voltage by means of frequency regulation of traditional engine system in microgrid control [5]. In this process, the conversion regulation of useful power and useless power will change, and the corresponding frequency regulation mode of voltage system will be different. With the help and implementation of distributed power supply, the transformation of voltage and power supply control power output form is realized. It is assumed that in microgrid control, the useful power output form of distributed power supply is increased, the sag control mode of distributed power supply is adjusted, so that the control form of distributed voltage is changed, and the voltage control difference appears. However, it should be noted that in the sagging control process, there is no need to fix the communication mode between distributed power sources, but a non-communication control mode is adopted. However, there will be control differences in the control process, which will affect the power adjustment. Under normal circumstances, in micro grid control, sagging control needs to be based on detecting the voltage and frequency of distributed power supply, combined with the detection and analysis of corresponding power, to adjust the line resistance value under voltage level, so as to achieve the purpose of controlling voltage transmission.

3.3. Constant voltage and constant frequency control

Constant voltage and constant frequency control is mainly carried out by u/f control mode, which

regulates the voltage and frequency in the operation control of isolated network. When the load transfer occurs in the operation of isolated network, in order to better control the load change, it is necessary to analyze the frequency parameters in the load change control, so as to ensure that the voltage and power regulation mode can be changed in the analysis and control of frequency parameters. The output voltage and output power can be monitored in real time, and the voltage and frequency stability can be controlled with the help of PI regulator. However, it should be noted that in the process of constant voltage and constant frequency control, u/f only collects information on the voltage control of the output port of the inverter, and then performs voltage regulation disposal based on the regulation of the inverter control. Due to the droop characteristic of voltage waste power, the system voltage and frequency will change when the microgrid operation is under load. At this time, the power output of distributed power supply can be adjusted to control the frequency of the power grid and reduce the fluctuation of the power grid operation, so as to improve the power transmission control effect of the isolated network. At the same time, in the constant voltage and constant frequency control, in order to improve the voltage control effect, it is necessary to control the internal voltage value of the constant network, so as to meet the purpose of the lower vertical line migration conversion of voltage.

3.4. Micro-power supply classification and control strategy

For the control of microgrid, the control of micro-power supply is relatively critical. If the control of micro-power supply is not well controlled, the operation control effect of power grid will be affected. In the operation of the micro power grid, the control mode of the micro power supply is different due to the different control mode of the control power supply and the intermittent power supply in the operation of the power grid. At this time, the control mode of the battery internal power supply and the formation mode of voltage are different, which affects the control of the micro power supply. For example, in the process of photovoltaic power generation, there is no fuel consumption and no pollution, so the whole process of power generation presents high power output. PQ control will improve the control level of this kind of power supply. For wind power generation control, due to the influence of the characteristics of its power supply, sag control should be taken as the main control mode in the whole power control, so as to improve the control level of microgrid. In the control process of micro gas turbine, the power supply characteristics are controllable micro power supply. In this kind of power control, the power control should be based on u/f priority control, so as to improve the quality of power control. It should be noted that in the control of the micro power supply, the control form of the micro power supply is different due to the different control modes of the power supply, thus affecting the control mode of the micro power supply.

4. The control mode of microgrid system

4.1. The master-slave control mode

The master-slave control mode refers to that in the control process of microgrid, the isolated network operation power supply is mainly controlled, the control voltage and frequency of one of the DG is constant controlled, and the voltage and frequency reference control is carried out to other DG in the microgrid [6]. However, in the operation of the whole control mode, due to the different control modes of DG, there are differences in the voltage control mode of the whole control system. In order to better target the voltage control, it is necessary to adjust the energy storage device in the voltage control, so as to achieve the adjustment purpose of the main controller. For the adjustment of the application mode of master and slave controllers in the implementation of PQ control mode,

ensure that the power network control mode can be changed during the operation adjustment of master and slave controllers. In the implementation of the power grid operation control strategy based on u/f control, the wind-solar energy storage system model is established through the adjustment of reliable operation mode, and the main control unit is adjusted based on the control of the energy storage device, so as to achieve the purpose of stable system operation. Due to the differences in the frequency and voltage of the control system of the main controller, there are differences in the units, requirements and controllable output capacity of the whole system control. When the isolated network operation mode appears in the microgrid operation, the corresponding control mode of the control unit will change, and at this time, it needs to use the DG to adjust, so as to achieve the purpose of power control.

4.2. The peer control mode

The peer-to-peer control mode refers to the differences in power and voltage regulation forms in microgrid control due to different power control modes. In order to better control the microgrid, it is necessary to change the operation control form of the grid units in its control, and control the access mode of distributed power without changing the Settings of each power supply in the microgrid. In this process, the system can automatically adjust the energy balance according to the control relationship. In the implementation of peer-to-peer control mode, the control strategy adopted is mainly based on microgrid power supply control, and based on the operation of distributed control system, the local control mode of distributed power supply is implemented. For the implementation of peer-to-peer control mode, control voltage and frequency are relatively key, and the voltage and power control is carried out on the basis of increasing useful power control. The frequency of voltage system control can be reduced through useful power control adjustment, so as to improve the power grid operation control level. In the implementation of the peer-to-peer control mode, the regulation form of power network frequency and voltage changes due to the state of isolated network operation, and in the power network control, due to the influence of sagging control mode, the control form of load power change is deviated. In this process, it is necessary to adjust the peer-to-peer control strategy based on PQ control.

4.3. The hierarchical control mode

The hierarchical control mode is also an important control mode in microgrid control. In the implementation process of hierarchical control mode, master-slave control is mainly used, and system operation adjustment is carried out through the master-slave control, so as to ensure that the system control levels can be changed in the system control operation adjustment. In the operation of the power system, due to the different hierarchical control methods, the management system, organization and grid structure of the system control have changed. In this process, it is necessary to conduct useful power control and regulation analysis based on the power dispatching to ensure that the purpose of controlling and improving the system management can be achieved in the control and regulation process of useful power. In the implementation of the layered control mode, the central controller is used to transform the DG control information in the microgrid and predict the power generation control at the same time, so as to ensure that the power generation load can be stabilized in the control and adjustment of the power generation. For the operation and implementation of hierarchical control mode, the changes of voltage, frequency and power are important factors affecting voltage control. The implementation of hierarchical control mode and the transformation of microgrid operation control form are helpful to improve the control level of power grid, as shown in Figure 2.

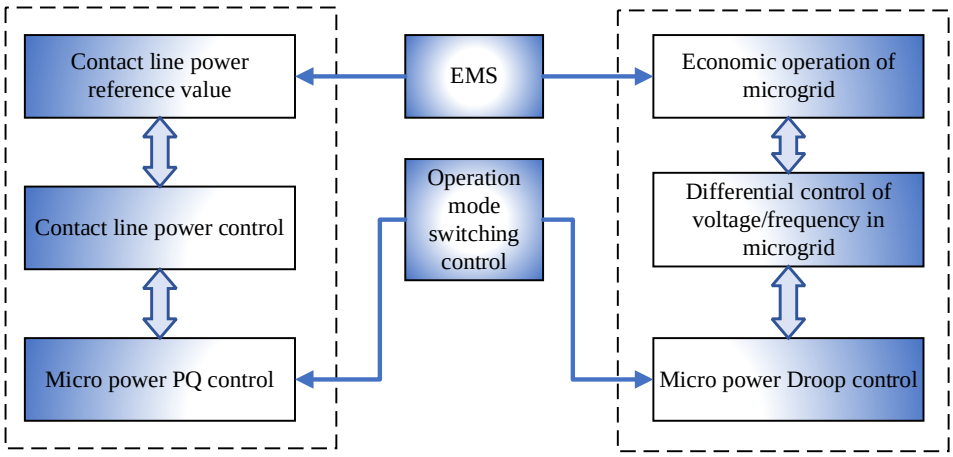

Figure 2: The hierarchical control mode.

5. The key technologies and difficulties of microgrid

5.1. The control and protection technology

In microgrid control, the main goal is to improve the voltage control frequency and transform the relevant control system based on the stable regulation of voltage. However, because the operation of microgrid is divided into two different modes: grid-connected control operation and isolated network control operation, different control forms need to be adjusted, so as to achieve effective control of microgrid. For microgrid control, there are three problems as follows:

First of all, in the operation process of connecting to the grid, the grid current will be changed, thus affecting the relay protection function of the grid. Secondly, due to the influence of load operation during the operation of microgrid, internal faults occur in the system operation, which affects the normal operation of the power grid and has a certain impact on the transmission of the power grid. Finally, when the power grid fails, the operation of the microgrid needs to be based on the de-sequenced operation, so as to realize the switch of the power grid operation control mode. Therefore, in order to improve the operation control effect of microgrid, it is necessary to pay attention to the implementation mode control of microgrid control and protection technology, that is, to clarify the operation fault characteristics of microgrid, improve the fault handling mechanism of traditional equipment and intelligent control equipment, and improve the power grid fault handling ability.

5.2. The power electronics technology

As an important part of the construction of smart power grid, the construction of microgrid should improve the operating load and quality of the power grid with the help of power electronics technology. Through the application of power electronics technology, the transformation of intelligent technology control form in the construction of micro grid is realized, and the control level of micro grid is improved to the maximum extent. At the same time, in the control process of microgrid, the frequency and active work of power grid control are also realized, and the internal voltage stability control of microgrid control is satisfied. Due to the difference of voltage control form and voltage control system in the process of microgrid control, the control effect of microgrid is different. Therefore, in order to better control the operation of the microgrid, it is necessary to implement the unbalanced load control and regulation in the operation of the power grid to ensure that the power grid voltage can be stabilized in the process of stabilizing the unbalanced load, so as

to scientifically control the frequency of the microgrid.

5.3. The operation and energy management technology

The operation control of microgrid is mainly grid-connected operation control, and the other is mainly isolated network control. In the implementation of the two different control modes, it is necessary to scientifically adjust the energy control in the power grid operation, so as to ensure the control of energy management in the disposal and implementation of the power grid operation control mode. For microgrid operation control management, energy management is mainly aimed at the internal power supply adjustment of distributed power supply, energy storage system and load system, so as to achieve the purpose of scientific control of power supply adjustment. And in the process of power control adjustment, the objective optimization control is integrated, so as to optimize and control the power grid energy management. In general, in the implementation of power grid energy management technology, it is mainly through genetic algorithm and linear programming control analysis to adjust energy management methods, so as to achieve the purpose of improving and controlling energy management.

6. Conclusions

To sum up, the key technologies in microgrid operation are mainly reflected in control and protection technology, power electronics technology and operation and energy management technology. In order to improve the application level of intelligent technology in the construction of micro grid, it is necessary to pay attention to the analysis of key technologies in the construction of micro grid. At the same time, in the construction of micro grid, scientific exploration should also be carried out on the operation mode and control strategy of micro grid, to ensure that in the disposal of operation mode and control strategy, the construction quality of micro grid should be improved.

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References

[1] Zhao, J. Q., Li, R. (2022) Research progress of microgrid technology. Shanxi Electric Power, 5, 10-13.
[2] Liu, G. C., Xiong, H. T. (2022) Case analysis of microgrid technology application. Electronic Technology, 51(9), 180-181.
[3] Zhang, S. J. (2021) Application analysis of microgrid technology in active distribution network. Modern Industrial Economy and Information Technology, 11(10), 146-148.
[4] Yu, H., Luan, W. P., Xiong, X. (2020) Current situation and prospect of International standardization of microgrid technology. Journal of Hebei University of Water Resources and Electric Power, 30(2), 1-5.
[5] Zhang, Z. B., Ye F. Y., Zhao, S. Y. (2020) Application of distributed generation and microgrid technology in power grid. Science and Technology Innovation Review, 17(3), 33-34.
[6] Liu, X. S., Xu, K., Wang, P. (2017) Application of microgrid technology in industrial and commercial parks. Power Demand Side Management, 19, 13-15.