Summary of Research on Microgrid Technology

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Abstract

Distributed generation has the advantages of flexible and non-polluting power generation, which has attracted more and more attention worldwide. The micro grid can coordinate the distributed power supply in a more flexible way so as to give full play to the advantages of distributed power generation. This paper firstly introduces the background and the concept of micro grid micro power grid is put forward, and gives the composition and characteristics of the micro grid, discusses the core technology of micro power grid, and then summarizes the research status at home and abroad in recent years, micro power grid, finally combining the future smart grid construction planning, the future for the development of micro grid technology is prospected as well.

Keywords

Distributed generation, micro grid, distribution network, safety stability, power quality.

1. Introduction

With the development of global economy, energy demand keeps increasing and energy supply continues to be in short supply. In order to alleviate energy crisis and improve environmental pollution, the rational development and utilization of green and clean energy has become an important research topic in the field of energy. Distributed generation refers to the power generation (energy supply) mode in which relatively small wind and solar power generation devices are distributed and installed on the site or near the user (load) to meet the user's load. As an effective complement to centralized grid power generation, distributed power generation provides users with "green power", which has many advantages such as less pollution, high reliability, high energy utilization efficiency and flexible installation locations, and is conducive to realizing the long-term goal of "energy conservation and emission reduction".

Although the advantages of distributed generation are outstanding, it is an uncontrollable power source compared with the large external power grid. When it is connected to the external power grid, it will adversely affect the safe and stable operation of the grid. For example, voltage fluctuation and voltage flicker are easily caused after the distributed power supply is connected to the network. To achieve power balance of the distribution network, it is difficult to guarantee power supply reliability and power quality.

For harmonizing the contradiction between the external power grid and the distributed power, distributed generation was fully for the value and benefits brought by the power grid and users, at the beginning of the 21st century, electric force work and related experts and scholars put forward a new concept - Micro grid (Micro - grids), by Micro grid ACTS as a medium between the distribution network with distributed power distribution network is no longer directly in the face of distributed power, but by Micro power grid to realize the management of the distributed power supply, control dissolve the intermittent and volatility of distributed power supply, set up a fully new efficient use of distributed energy system.

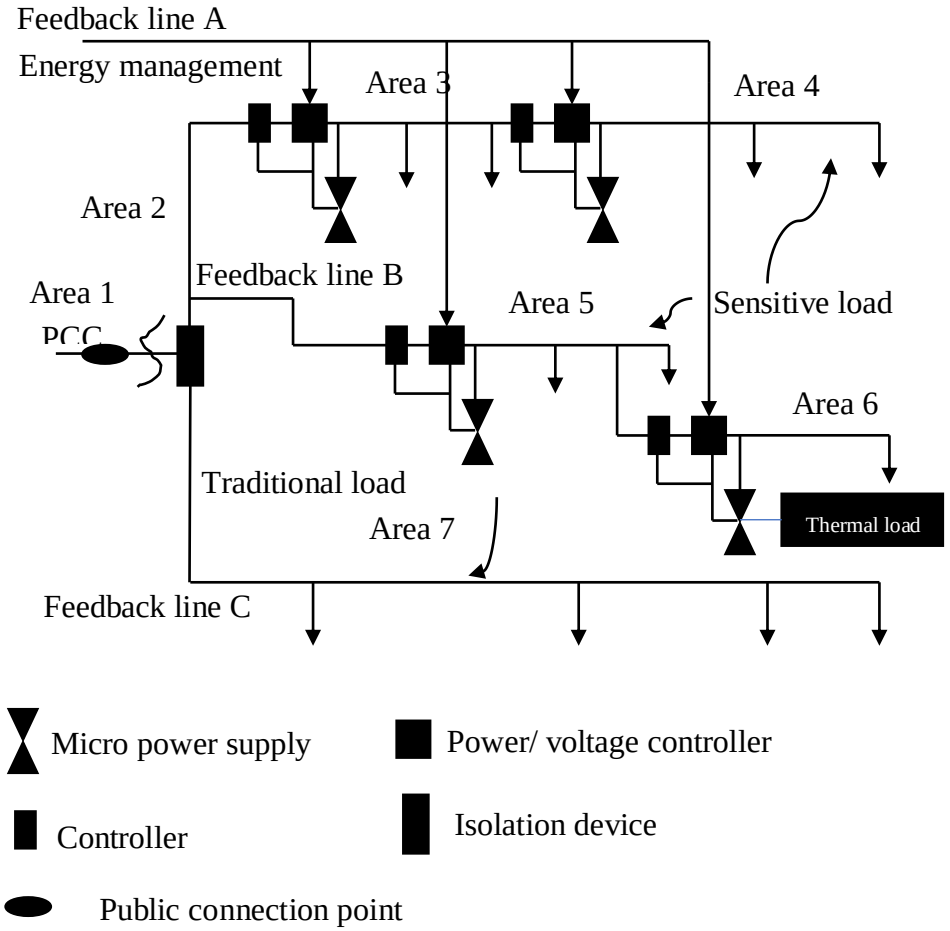

Figure 1. CERTS microgrid architecture

2. The Concept of Microgrid

The concept of micro grid was first proposed by the United States, aiming to coordinate the contradiction between large power grid and distributed power generation and to maximize the advantages of distributed power generation in economy, energy and environment. It is primarily through will power generation capacity is less than 500 kw of power electronic devices distributed power and energy storage device groups together, provide electricity to the user, to the nearest by distributed generation, load, energy storage device and control device of power system, is the ability to realize self-control, protection and management of autonomous system, as well as with large power grid parallel operation, can also be isolated operation. Flexible and intelligent power electronic device is the key of micro grid, and it is through this technology to realize the control idea of "plug and play"

The definition of micro grid in China is that micro grid is a small power distribution system which is made up of distributed power supply, energy storage device, control system and related load. It can supply cooling, heating and electricity for loads in the region. It is an autonomous system that can achieve self-control, protection and management. It is an important part of smart grid, and a third-level grid after transmission and distribution. As a new network structure, micro grid is an effective way to realize active smart power distribution network. Intelligent micro grid is a new organizational form of active smart power distribution network in the future.

3. The Characteristics of Microgrid

It can be seen from the structure and definition of the micro grid that the micro grid technology is an organic combination of new power electronics technology and distributed generation, renewable energy generation technology and energy storage technology.It has the following main features:

(1)Intelligence.Microgrid includes intelligent technologies and equipment, provides an effective way to integrate DG applications, and inherits the advantages of all individual DG systems.

(2)Independence. As an independent power supply system, micro grid has unique and complex dynamic characteristics. As a small energy network, it can be connected to large power grid and run autonomously as an independent power grid. It can always achieve self-balance of power in micro grid.There is no adverse impact on the large power grid and there is no need to modify the operation strategy of the large power grid.

(3)High quality. The micro grid of multiple DG networks increases the system capacity and has corresponding energy storage system, which increases the system inertia, weakens the voltage fluctuation and voltage flicker phenomenon, and greatly improves the power quality.

(4)Reliability Based on real-time communication, rapid control and energy storage units, micro grid can achieve power balance and voltage/frequency stability in steady and transient processes, ensuring power supply reliability and power quality. The operating mode of the isolated network can continue to guarantee the power supply when the large power network fails, and improve the reliability of power supply. Accurate micro grid control technology can well manage harmonic and reactive power, effectively improve power quality, improve the power grid's ability to resist disaster and strike, and ensure the security of power supply in the network.

(5)Cleanability. The micro-grid is dominated by distributed clean energy, which allows access to multiple clean power generation modes and energy storage units. The integrated operation of internal power sources and loads can meet the full integration of clean energy and power consumption, improve the efficiency of clean energy utilization, and contribute to the long-term development of distributed power generation.

4. Research Overview at Home and Abroad

4.1 Research Status of Micro Grid in China

With the deepening of the research on micro grid technology in our country, the increasing maturity of the technology, the central and local governments at all levels pay more attention to promote the application and development of micro power grid, the energy policy document mentioned micro power grid construction problem for many times, however, renewable energy capacity is small, power is not stable as well as to the electric network fluctuation, influenced the stability of the system, such as faults will hinder its development.Therefore, the development of distributed energy generation technology, energy storage technology and power electronic control technology is further required.China's research in this area has also made progress.However, the research on micro grid is still in the preliminary review stage. The concept of continuous power substation reflects the idea of micro grid.According to different types of distributed power source, different control methods are adopted, and the design method of corresponding controller is given.For U/f control unit, multi-loop feedback control based on droop characteristics is adopted, and for PQ control unit, PQ decoupled current control is adopted, which ensures the reliable operation of micro grid in two working modes.A deeper research on the optimal operation of micro grid has not been carried out.

4.2 Research Status of Micro Grid in Foreign Countries

At present, the United States, Europe, Japan and other countries have carried out microgrid research.Based on the practical problems of the power system and the national sustainable development energy goals, the concept and development goals of microgrid are proposed.

The micro grid proposed by the United States is mainly composed of small micro power supply and load which is based on power electronic technology and the capacity is not greater than 500kw, and the control method based on power electronic technology is introduced.Several other countries in the americas have conducted a series of studies on microgrids.Set up a linear state space model of the micro grid system, the model is used to investigate the dynamic characteristics of micro power grid, the selection of the distributed power control parameters, and the micro power is the choice of control strategy, also discussed the system dynamic relative control parameters and operating point changes,

the sensitivity of the optimized micro power grid operation features for with electric products and technology.

European countries proposed the smart grid plan in 2005, and subsequently developed a technology implementation plan for the plan.As Europe's 2020 and subsequent electricity development goals, the plan points out that future European power grids will need to be flexible, accessible, reliable and economical.The corresponding control strategies of the output inverter of micro power supply are put forward: PQ control and VSI(voltage source inverter) control strategies.On the basis of these two strategies, two corresponding micro power control strategies are proposed: single VSI control operation, and multiple VSI control operation.

It can be clearly seen from the research and application of micro grid technology in various countries that the emergence of micro grid will fundamentally change the traditional way of coping with load growth and has great potential in reducing energy consumption and improving the reliability and flexibility of power system.Micro grid technology is an effective way for the sustainable development of power industry and in line with the current energy utilization direction of intensive society. It will be a powerful supplement to the large power grid in the future.

5. Key Technologies of Micro Grid

(1) New energy and renewable energy power generation technologies. Now only a few countries have mastered the new energy and renewable energy power generation technology, the cost of which is not obvious compared with the traditional energy power generation. Therefore, how to reduce the cost of these new generation technologies and make them marketable is also a key issue.

(2) power electronic control device.The flexible operation mode of micro grid is based on the advanced power electronic interface. It is precisely because of this advanced power electronic interface control, micro grid can not only be flexibly connected to the main network, but also enable each micro power source to realize "plug and play".

(3) Energy storage technology.Energy storage device is also an indispensable part of micro grid. It can play the role of peak load cutting and valley filling in the grid and greatly improve the efficiency of intermittent energy utilization.At present, people have made a breakthrough in energy storage technology.

(4) Coordinated relay protection and reactive compensation technology.Due to the multi-power characteristics of the micro grid, the radiation structure of the traditional distribution network is changed, which makes the protection method of the micro grid significantly different from the traditional protection.In addition, the protection becomes more complicated due to the fluctuation of the voltage and frequency of the intermittent power supply.For the problem of reactive power compensation, the concentrated compensation of the low-voltage side of the traditional distribution network is no longer suitable.

(5)Monitoring technology.The structure of micro grid has changed the power supply mode of traditional distribution network, and the number of monitoring points has increased dramatically. Advanced monitoring technology has provided the foundation for the effective management of micro grid.

To sum up, the progress of micro grid is closely related to new energy generation technology, power electronics technology, energy storage technology and communication technology. Therefore, it is necessary to strengthen the research and development of related technologies so as to lay a foundation for the development of micro grid.

6. The Development Prospect of Micro Grid

Compared with the traditional centralized energy system, distributed power supply is given priority to with new energy to the load power supply, do not need to build large grid for long-distance transmission, can greatly reduce the line loss, save electric power transmission and distribution construction investment, but also with big power grid centralized power supply complement each

other, is the comprehensive use of existing resources and equipment, to provide users with reliable and high quality electricity ideal way.

With multiple service functions such as power generation, heat supply and refrigeration, micro grid can effectively realize energy ladder utilization, achieve higher energy comprehensive utilization efficiency and improve the safety of power grid.Micro grid technology complies with the requirement of promoting the sustainable development of renewable energy power generation in China.

From the perspective of current development, micro grid is still in the stage of experiment and demonstration, and its technology has a long way to go to the large-scale promotion and application, but its market size has begun to appear. From the current environmental situation and the impact of energy crisis, micro grid has a good technical prospect.

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