Research of Microgrid Optimization Scheduling Strategy Based on Customer Interaction

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Abstract—With the widespread application of distributed generation and increasingly requirements of power supply quality and reliability, a new type of of power system structure named "Microgrid" was proposed in order to seek a way to ensure environmental sustainability and to meet user demand for energy supply. In the process of development of the smart grid, the distribution network in the form of the transition from a passive to an active network Meanwhile, the microgrid is an important network model of future intelligent power distribution system, the operation control system is key to ensuring microgrid safe, economical and reliable operation. This paper describes the microgrid control system, microgrid optimal scheduling modules, and demand-side response measures. The purpose of microgrid optimizing operation is the coordination and optimization among microgrid, distribution network and users. Three demand response strategies related to time shift, peak shift and load shedding are introduced to the microgrid hourly optimization scheduling.

Keywords- distributed generation; power supply; microgrid;optimal

I. INTRODUCTION

Microgrid is a new network architecture is a set of micro-power system unit, the load, the energy storage system and a control device configured. Microgrid is a realization of self-control, protection and management of autonomous systems, can run with an external power grid, can also be run in isolation. Microgrid is a large grid of relatively traditional concept, refers to the network and its associated multiple distributed power load in accordance with certain topological structures, and through the static switch associated to the conventional grid. Development and extension of the micro-grid to fully promote large-scale distributed power and access to renewable energy, to achieve high reliability of energy supply to the load multiple forms, is an effective way to achieve active distribution network, is the traditional power grid to smart Grid transition.

In the development of low-carbon economy, in order to seek a way to ensure environmental sustainability, and to meet user demand for energy supply, the smart grid concept emerged. In the process of development of the smart grid, the distribution network in the form of the transition from a passive to an active network. Changes in the distribution network enables the power supply side and the user side can participate in the system is running in real time, to achieve power, power and user interaction. The micro grid this new network structure is precisely the kind of proactive distribution grid effective way to promote the transition to the traditional power grid intelligent network. Therefore, as part of the electricity grid distribution and the progressive realization of intelligent micro grid will serve as an integral part of the smart grid to play a greater role [1].

Distributed generation is an important way to improve energy efficiency and changes in energy mix. However, access to distributed generation grid operation, control, protection and other aspects brought a profound influence to solve the access problem of distributed generation, take full advantage of distributed generation, beginners who made this century microgrid operational management. Namely the use of advanced power electronics technology, within a local area directly to the micro-power, load, energy storage devices, control devices and end-users together to form a "single controllable unit", optimize and improve energy efficiency, promote social development to the green, environmentally friendly, energy-saving direction. Microgrid is a realization of self-control, protection and management of autonomous systems, which can run with the big power grid, but also in large grid failure or need to disconnect power grid isolated operation, fully meet the user power quality power supply reliability and security requirements.

To promote the development of micro-grid power systems in countries around the world have done a lot of work in micro-grid tested and demonstration projects. Europe, the United States, Japan and other countries have proposed the concept for their actual micro grid and actively carry out research on the theory and micro-grid applications have achieved fruitful results. Compared with other countries, China's development of micro-grid should have Chinese characteristics; in close connection with the construction of the building and power grid construction to energy micro grid achieve sustainable economic and social development. Domestic research on micro grid relatively late start abroad, many colleges and universities, businesses and research institutions are continuing to focus on this area of research, conducted some exploratory research work and has made a lot of achievements.

By summarizing research results, found in many types of micro-grid power coexist with control objects rich, diverse operating mode and control strategies and complex characteristics, and user demand for supply reliability and

quality of power supply also presents diverse technology[2]. Therefore, the micro-grid operation control system is particularly important, only micro-grid to be able to safe, reliable, economical and efficient operation in the management and operation control system.

II. MICROGRID CONTROL SYSTEM

In view of the operating characteristics of the micro-grid, micro grid control should meet the following requirements[3]: (a) to ensure the quality of the micro-grid power supply, especially for voltage and frequency requirements; (b) micro-power able to "plug and play", and after the access does not affect the quality of power supply; (c) the use of micro-power control of local information instead of global information; (d) micro-grid correctly and solitary flexible grid network, and can be run in both normal operation mode ; (e) the ability to correct the unbalanced voltage sags and systems; and (f) capable of active and reactive power decoupling control.

For a variety of micro-power micro-grid coordination internal control, micro grid control methods currently proposed can be divided into the following three categories:

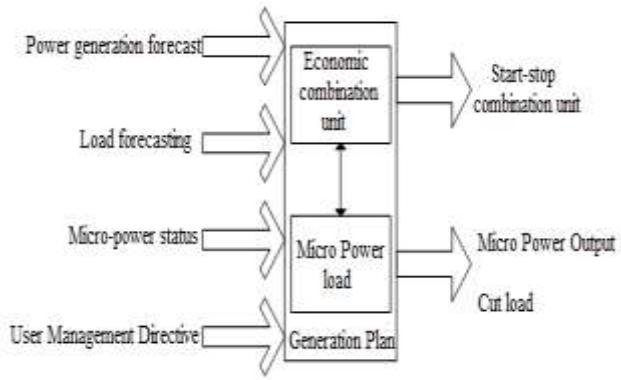
(A) Distributed control. Decentralized control means without communication, each using local information between plug and play and point to point are all controlled decentralized control. When using decentralized control, commonly used method is analogous to the synchronous generator, power electronics interface micro power cord prolapsed according to the control target selection micro grid is controlled by sagging power line system imbalance dynamically allocated to each power to ensure under the lone network power supply and demand balance and the frequency of unity within the micro grid, with a simple, reliable. But the current study is based on decentralized control micro-grid pure power electronic interface, without considering the coordination and control with conventional synchronous generator interface and asynchronous generator interface.

(B) Centralized control. Centralized control will generally be divided into micro-grid element layer, control layer and micro grid distribution network layer control. Distribution network layer for running multiple micro-grid coordination between, let micro grid to participate in the distribution network voltage and frequency regulation, and is responsible for the exchange of information distribution grid and micro-grid controller.

(C) Mixing concentrated decentralized control strategy. Control strategy based on hierarchical multi-agent technology is a typical dispersive mixing centralized control. Capable of using micro power and load changes autonomous micro grid control method based on multi-agent technology, the spontaneous response. A typical three-level control structure and function of multi-agent technology is as follows: at the micro-level power control and load local, decentralized control dynamically adjusts the power balance in order to ensure the reliability of the micro grid operation; central secondary control similar micro grid controllers, micro-grid globally control, reduce the voltage and frequency fluctuations; considering micro grid control coordinated with three large power grids to achieve optimal economic micro grid. Currently multi-agent technology research has just started no mature examples of the application, to enable them to play a greater role in controlling the micro-grid, the need to conduct extensive research.

III. MICROGRID OPTIMAL SCHEDULING MODULES

Micro grid need to develop combinations of micro-power during operation, reasonable arrangements for the opening of the unit, shut down plan. Taking into account economic, environmental, safety and other goals, it makes the operating characteristics of the micro-grid system to achieve optimal article in the course of the study to date on a daily cycle. This will maximize the output of renewable energy technologies, such as the introduction of demand-side management techniques micro grid operation control process in the development of optimal generation scheme within the micro-micro-grid power supply [4].



Figuer 1. Microgrid daily generation scheduling module diagram

Micro grid daily generation scheduling module diagram shown in Fig .1 include: micro power status (will open, you can start and stop, or will stop, micro power of the maximum and minimum output restrictions, etc.), top load measurement information, information on renewable energy power module output forecast information includes: unit commitment combination table, micro-power output and load-shedding.

IV. DEMAND-SIDE RESPONSE MEASURES

In the context of smart grid, demand-side management in real-time vertical control system under the market cannot meet the requirements. Through the introduction of user-side demand side response (Demand Response, referred to as DR), the use of price signals and incentives to guide users to actively participate in micro operation of the grid and rely on market forces to achieve the role of the user side and the supply side of the interaction is to adapt to the inevitable development of smart grid requirements.

Participation in demand response measures under way to transform the process of demand response load, the

load on the user side is divided into periods of translation, the adjustment of electricity load and sort of importance, this paper these three effects are called time shift, peak load shifting and load reductions[5].

(A) Time translation. Time translation feature is a whole load of bulk transfer involved the transfer of part of the load size each time Paul to be the same, the timing is also guaranteed to be the same, so the shape of the curve shift peak electricity consumption before and after the warranty to be the same, such as shown in Fig .2 decision variables to be headed by the load segment load allocation period.

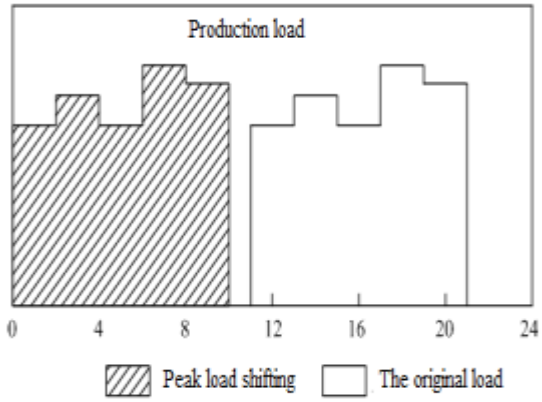


Figure 2. Typical participation time translation production load curve

Micro grid is to solve the island, when an important way to power in remote areas used in this way, the micro-grid production process of industrial load with an adjustable period can participate in pan DR types of measures for industrial users by adjusting device usage time, production shifts, in the low load periods industrial production, so that the micro-grid power curve as smooth as possible [6].

(B) Peak load shifting. Peak load shifting feature is the shift peak electricity around the shape change, by TOU or compensation mechanism to guide the user to shift electricity use to off-peak hours. That power is involved in the implementation of the adjustment in the DR, each time power is undefined, but the total power remains unchanged. Micro grid in shopping malls, office buildings and other commercial users in a large thermal storage type air-conditioning load or regenerative electric boiler, this load with accumulator-based technology can participate in peak load shifting measures DR type accumulator type load by changing the power mode, the load is low hours and accumulator, when the peak load energy release in order to reduce the peak-valley difference micro grid.

(C) Load Shedding. Load Shedding feature is the basis for the use of the load rating of the contract signed by both parties in advance, at the micro-grid power supply is low or when the micro grid to meet optimal operation, uninterrupted power supply load rating lower load reduction can be compensated by taking the power of incentives so that users voluntarily to sell their electricity reliability [7].

Micro grid gas supply class load or energy (mostly heat) users as well as lighting class storage capacity of less demanding on the continuity of electricity load, can act as a low-level load power interruption time with gas, stored energy, etc. peaks were hiding, but get some financial compensation to reduce the supply pressure micro grid [8].

Using the three demand response measures, through reasonable scheduling and guide can effectively achieve various goals micro grid operation, reducing micro-power start-stop, thereby improving the overall effectiveness of the micro-grid operation[9].

V. SIGNIFICANCE OF THE STUDY MICROGRID

Because of the dual pressures of environmental protection and energy depleted, forcing us to develop clean, renewable energy. Efficient Distributed Energy Industries (cogeneration) development potential and benefits of space is huge. Improve the reliability and quality of power supply requirements and bring all kinds of long-distance transmission constraints are driving the establishment of appropriate power near the load center. By microgrid controller can achieve centralized control of the entire grid, distributed on the spot does not need a controller, but only using conventional measuring devices, using fast communication channel between the measuring device and place the controller. Using distributed power and load controller for micro-place grid transient control, microgrid centralized energy management system to achieve steady-state security, economic operation analysis. Microgrid centralized energy management system and place the controller uses the weak communication links.

(A) Expanding the scope of application of micro-grid operation control system to enhance portability

Limitations due to the distribution of resources, hardware, grid conditions and other factors, the application of basic microgrid various regions vary transplant operation control system is difficult to each other. If the extraction of its commonness, operation control system developed structure has some versatility, it can greatly enhance the portability operation control system, expanding the scope of application of micro-grid.

(B) Increasing the utilization of distributed power

IEEE P1547 draft regulations in large power grid fails, distributed power must exit immediately run, which limits the utilization of distributed power would incorporate micro distributed power grid, power grid failure, switch to a solitary microgrid network operation, will not affect the power grid, micro-grid distributed power do not have to quit running, improve its efficiency[10].

(C) Improving the reliability and quality of power supply important load

When the power grid fails, the whole network security considerations, you may cut part of the load. However, if the micro-grid operation control system can be smoothly switched to isolated operation mode. In the case of ample spare, important to ensure continuity and quality of power supply load power, will greatly enhance the reliability of power supply important load, so micro-grid users in terms of becoming a "good energy suppliers."

(D) Increasing the use of distributed power economy and the whole network of environmental protection.

Microgrid operation control system into a micro-grid "single controllable unit" can between multiple micro-grid and micro-grid micro power distribution network optimization and load scheduling, the premise of ensuring stable and reliable operation of the microgrid By maximizing the use of distributed power economy and the whole network of environmental protection.

VI. CONCLUSION

Microgrid is not only involved in power generation unit, in the smart grid need to consider the background while the user-side interaction and volatility due to intermittent renewable energy sources, making the micro-grid energy flow with time variability, uncertainty and asymmetry, etc. Features. Therefore, the need to study the optimal scheduling strategy is suitable for micro-grids to improve their economic, environmental protection, autonomy and so on. Previous microgrid control on optimal scheduling, often through the establishment of economic, environmental protection, reliability, and thus the objective function to optimize the operating point of the system is calculated at each target, but how to evaluate various strategies, and interactive user side to consider in including intermittent achieved within the microgrid power optimization run is also worth further study.

In the context of the smart grid, how the user-side interactive will be introduced into micro grid, and to assess the effectiveness of different optimization objectives of the system are important issues. That needs to be addressed to achieve a smart micro grid. This paper studies daily generation scheduling under support of the power prediction system. And from the user's needs and potential of we design three demand-side response measures of time shift, peak load shifting, and load reductions.

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REFERENCES

[1] Hatziargyriou N and Asano H, “Summary of distributed generation in power systems and applied research,” IEEE Pow.Ene.Mag vol.5,pp.11-16, May 2007

[2] Z.G.Yang, “Impact of Smart Grid on Distribution System Design,” Auto.Ele.Pow.Sys, vol. 33,pp.89-98, May 2009

[3] W.Pei and H.Y.Li.,“Including distributed power distribution network fault recovery strategy,” Auto.Ele.Pow.Sys ,vol.10,pp.12-17, July 2009

[4] Y.W.Liang and Y.P.Chen, “Discussion on power system protection operation and maintenance,” Grid Technology.vol.37,pp.94-98, June 2003

[5] Z.X.Lu and C.X.Wang, “Operation and maintenance of power system protection,” Grid.Tech.Auto.Elec.Pow.Syst, vol.31,pp.12-17, June 2007

[6] M.Wang and M.Ding. “Power distribution systems with distributed power planning,” Grid Technology,vol.33pp.6-11, May 2010

[7] H.J.Zhou and C.X.Guo, “Distributed power grid system access with the construction of technical indicators,” High.Voltage. Eng, vol.36,pp.88-93, May 2010

[8] J.H.Zhang and L.Shu, “A protection scheme for distribution system with distributed generations,” Grid Technology, vol.37,pp.24-28, May 2011

[9] M. Youshim, “Optimal economic power dispatch using genetic algorithms,”3rd ANNPS Japan,1993,pp. 157-162.

[10] K. Iba, “Reactive power optimization by genetic algorithm,” IEEE Trans on Power Systems, vol. 9, pp. 685-692, Apr. 1994.