

## **Voltage Stability Analysis of Micro-grid Based on double Data Center**

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**ABSTRACT :** *The double data center is introduced into the micro-grid to adjust the whole system, and the double data center placement method is analyzed, and the optimal distribution strategy is designed in the whole micro-grid system. Using the load adjustable features of the data center to keep the micro-grid maintenance. First, due to the new energy and the residents load is a key problem leading to micro-grid imbalance, in the new energy access and residential load nodes around the placement of data centers to achieve demand response. Then, analyzing the influence of new energy fluctuation and residential electricity load on micro-grid, the load adjustment strategy of data center is established. Because the distribution of new energy and resident load is located at different positions of micro-grid, double data center is used to carry out maintain the micro-grid in a balanced state. Finally, the establishment of double data center interactive compensation strategy to achieve demand response and the maintenance of micro-grid stability.*

**Keywords** -Micro-grid; Data Center; Regulation Strategy; Demand Response

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### **I. INTRODUCTION**

With the rapid development of the world economy, the demand of energy has increased dramatically. Conventional energy reserves are limited and fossil fuels are facing depletion. Optimizing the energy structure, developing new energy sources and expanding using of renewable energy is an inevitable choice to solve the energy problem. Micro-grid as a new form of energy organization, distributed power can be effectively included. Due to the fluctuation and unpredictability of the distributed power generation output power and the diversity of the load in the micro-grid, the voltage and frequency fluctuation in the micro-grid is still very serious during the operation of the micro-grid. Therefore, the stability of the micro-grid voltage and frequency is a micro-grid facing a major challenge.

As the new energy intermittent, the current general additional battery to balance the power supply, composed of energy storage system. The battery charge and discharge is efficient, and it can adapt to the dynamic characteristics of load, but it often will greatly increase the cost of the entire micro-grid system, battery capacity configuration has important significance in the study of energy storage micro-grid system. According to the micro-grid system operation mode and the storage function of the energy storage equipment, the optimization of the micro-grid storage capacity in recent years mainly focused on keeping the system stability, cutting peak and filling the valley, keeping the power of the contact line constant and seamlessly changing the network.

Through the battery to improve the energy fluctuations caused by power grid instability, to achieve demand response. But the capacity of the battery and the actual controlling take into account, the problem still exists energy that can not fully absorb and response time is too long. In order to better absorb new energy, to achieve demand response, take the data center into the micro-grid.

As the requirements of telecommunications, finance, petrochemical, energy, education and other industries on the data processing are getting higher and higher, data center is a mass data bearing and transmission media has gradually become the hub of the information center. At the same time the data center power consumption also showed explosive growth momentum, while the data center on the outside of the information and loading is set by the operator, so the work of the data center determines the load adjustable features. Although the new energy growth index continues to rise, while the data center energy consumption growth is also rapid, through the data center load adjustment can be effective to absorb new energy.

Based on the above background, this paper discusses the use of double data center in the micro-grid regulation, analysis of micro-grid stability caused by the factors, and double data center between the control method to design, in order to achieve stable regulation of the micro-grid.

## **II. THE STABILITY OF MICRO-GRID**

Demand response is the latest development of electricity demand side management in the electricity market. According to the US Department of Energy's research report, according to the needs of market participation, demand response projects can be divided into real-time electricity prices, peak and valley price, etc. based on the price and according to system requirements or power shortage to reduce the demand for electricity to obtain direct compensation or other periods of preferential tariff based on the two types of incentives. At present, the research on demand response mainly aims to encourage users to participate in the power grid peaking and guide the user science, rational use of electricity for the purpose. The demand response is achieved by adjusting between the energy side and the client side. The traditional demand response does not affect the normal use of ordinary users, and the agreement will control the number of responses, in frequency the total time to be limited. So controlling in the minute / hour level peaking play a role, while the second frequency control is powerless. With the advent of large-scale energy storage controllable load such as electric vehicles, the restrictions on the number, frequency, total time and so on of such load participation will become loose and will meet the needs of participation in response frequency control. Thus, it is proposed that the definition of the demand response be extended to the user's participation in the frequency control according to the system requirements or the intermittent power supply impact in order to obtain a direct compensation or other period of preferential tariff. Thus, peak-to-peak and FM control are included in the requirements response.

In the micro-grid, the proportion of distributed energy increased, intermittent fluctuations on the whole system caused a considerable impact, in order to suppress fluctuations, we can use the adjustable load characteristics of the data center to adjust the micro-grid to achieve the corresponding needs of maintenance Power grid stability. But taking into account the factors that affect the stability of micro-grid is not just new energy, while the system of household electricity load changes will lead to micro-grid imbalance, a single data center can not maintain the entire system, adjusting the use of two data centers load and reset the node to achieve the stability of the micro-grid voltage.

## **III. ANALYSIS OF UNBALANCED FACTORS IN MICRO-GRID**

When the intermittent power supply energy access to the micro-grid from the power structure of the current use of some energy storage methods such as wind storage to solve the problem of intermittent fluctuations in micro-grid, but the domestic small-scale intermittent power supplement and grid operation after the grid voltage impact the control strategy achieved by the demand response therefore needs to be further explored. Wind energy and solar energy as a representative of the distribution energy is a pollution-free, renewable energy, but it due to weather and climate effects of power supply output with randomness and uncertainty will cause a greater impact on the power grid to the safety of the grid, Stable operation is difficult. Therefore, the micro-grid system is a complex system with mixed dynamic characteristics that also makes the energy management of micro-grids more complex. At present, some of the existing domestic research and research is only from the assessment requirements to do some passive correction of regional control bias to encourage wind power access micro-grid rather than from the grid voltage to take the initiative to adjust the study. We can learn from foreign experience for us to provide the study of ideas and foundations. In the micro-grid, voltage control will be intermittent power supply as a load access and ultra short-term prediction of the idea of power grid voltage control to provide predictable and measurable load disturbance signal research basis. The micro-grid environment should be an environment that can provide new energy access and micro-grid research should include the full access to new energy sources which should have a special grid for new energy in the intermittent energy consumption of the study. Intermittent energy with randomness and uncertainty such as wind power, photovoltaic power generation characteristics of their intermittent type is not as adjustable as thermal power, and hydropower will affect the voltage of micro-electric network This is the current limit of large-scale intermittent Energy access bottlenecks. Therefore, in order to ensure the micro-grid economic scheduling and optimization of micro-grid technology to achieve a wide range of applications and the promotion of urgent black to a good energy scheduling and management strategies.

In this paper, the maintenance of the data center is used to maintain the micro-grid, the impact of the intermittent fluctuation of the new energy on the micro-grid is reduced, and the control of the data center is based on the prediction of the energy output. The study of the ultra short-term load forecasting with intermittent power supply has brought into research hotspot in the modern smart grid and the prediction accuracy is the guarantee for the control quality in the voltage control. Reasonable prediction algorithm becomes the main content of the research intermittent power supply, The ultra short term prediction uses the grid of new energy for the ultra short term prediction and the intermittent power supply of the ultra short term load forecast synthesis.

To the residents of the load characteristics, changes in electricity consumption time, household electricity, building electricity-based living electricity, smart meters as the representative of the small power load and plug-in electric vehicles, such as new electrical equipment. These different types of loads are not only different in electrical characteristics but also different in demand for power quality. Again, micro-grids contain a

variety of different dynamic characteristics of power equipment such as controllable energy is a continuously variable power equipment new energy, energy storage equipment is a continuous but not adjustable control of the power equipment, battery charging and discharge process is a dynamic variable and discrete variables containing the process. Second, the micro-grid will provide a demand for a variety of user loads with different power characteristics. In addition to the actual situation in the control of micro-grid energy management operations often need to consider the control of the economy, security constraints such as by the cooling, heat load micro-steam turbine can provide controllable and continuous power supply The demand for time constraints, resulting in the load on the stability of the micro-grid impact. Therefore, the energy management for micro-grids not only takes into account the real-time satisfaction of user load requirements but also the economics of power supply costs. The control of the data center is based on the prediction of the use load of the residents. The main content is the ultra short-term load forecast for short-term forecasting of intermittent power supplies.

#### **IV. MICRO-GRIDDDOUBLE DATA CENTER CONTROL MODE**

Due to the new energy and the residents load in the micro-grid affect the system stability, at the same time in the micro-grid energy side and the residents load side distance, through the data center to control the two ends, but between the two through the data center to control The stability of the micro-grid is difficult to achieve the global scope, the scope of the impact does not coincide, so the use of double data centers in controlling of energy and load, complement each other to achieve global stability. However, due to the impact of energy and load, data center prediction control is also different.

Data center in the energy side of the control mode is based on time differential multi-step predictive control.

$$y(k-a)' = \frac{y(k-a) - y(k-a-1)}{T} \dots \dots \dots (a=1,2,3\dots)$$

$$y(k)' = \frac{y(k-1)' + y(k-2)' + y(k-3)'}{3}$$

$$y(k) = y(k-1) + \frac{y(k-1)' + y(k-2)' + y(k-3)'}{3} \times T$$

Through the differential multi-step processing, the analysis of multiple data, the current use of three-step control, in order to ensure accuracy can be used more steps, or change the sampling cycle can also improve the predictive control effect.

As the output curve of new energy is variable, irregular, and intermittent fluctuations with special circumstances will occur frequently, so the use of conventional forecasting model, that is based on the weather forecast cycle span of one day forecast may not be able to match the new energy. In addition, if only based on the current state of the average calculation will cause the output effect and the actual deviation of the situation. Through the use of differential multi-step to ensure the accuracy of the curve prediction, and then collect real-time data to do the forecast calculation.

The closer the new energy output curve is to the predicted curve, the smaller the effect of the intermittent fluctuation, and the stability of the micro-grid is achieved by the constant correction of the prediction curve.

As the residential electricity load has a time-varying characteristics, and with people's way of life, in the evening, electricity consumption increased sharply, in the late night power consumption, in order to achieve the coordination of electricity load. The change in load depends mainly on the regularity of people's daily production and life, while being affected by some relevant factors such as weather, temperature, wind speed, humidity and so on. Therefore, the load changes include both regularity and randomness. Residential electricity is only a change in the load, there are a variety of situations variable load (including production, production environment, supply and demand characteristics, industry trends and so on all aspects of the impact of the load changes include the law The same, the use of data center control is not the same way.

User load curve is different from the phenomenon of the new energy output, the phenomenon of irregular load enhance, so the forecast curve is based on the previous load curve, through the load curve to control the data center, in order to achieve user side stability.

At present, there are sufficient controllable loads to participate in the operation controlling of the power grid, and the controllable load is run on the micro-grid island. The controllable load is mainly based on the user controllable load, and the general condition of the large power grid is taken as the background. FM controlling was analyzed, controllable load can effectively maintain the micro-grid voltage, frequency stability. But did not consider the impact of micro-grid distributed power supply fluctuations on the user's response to demand.

Distributed power supplementis intermittent and unpredictable, users frequently participate in the regulation of the grid in the unpredictable situation, which will seriously affect the stability of the micro-grid, based on the simulation of Fig1.

In the double data center control, the load control mode is a key, located in two different locations of the data center for the system of two different units to control, to achieve demand response, so that the micro-grid voltage stability. Through the voltage fluctuation to determine the double data center in the actual micro-grid regulation effect, select two different capacity data center to facilitate the installation in Figure 1 in different locations to design, which first consider the optimal location, the two 5MW data center Through the software simulation, observe the voltage fluctuation of the node, we can find that the average data fluctuation of the double data center is set at 1 node and 34 nodes respectively, as shown in Fig2; adjust the input of the data center, It is found by simulation that the 1MW data center is set at 1 node and the 9MW data center is located at 34 nodes to achieve the optimal regulation, as shown in Fig3. The interdisciplinary synergy between data centers is based on the concept of load compensation, dominating in a unit-dominated, energy or load that dominates the data center control on the load side, and the other side of the data center is maintained, the data center Between the two sides of the regulation, in order to achieve micro-grid stability.

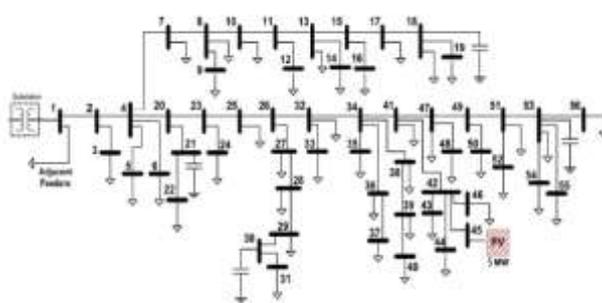


Fig 1: Micro-grid

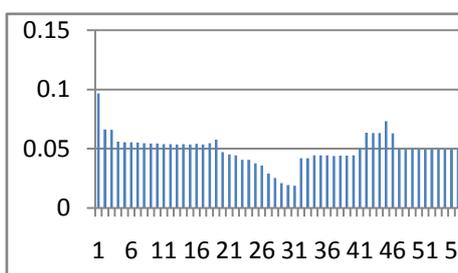


Fig2 Data center:5MW in 1 node, 5MW in 34 node

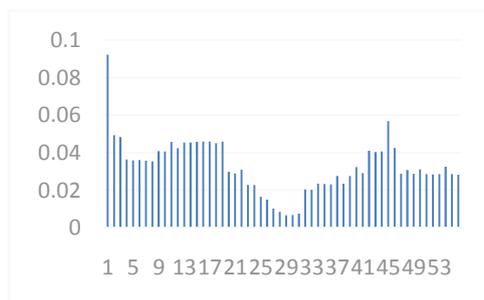


Fig3 Data center:1MW in 1 node, 9MW in 34 node

## V. CONCLUSION

Double data center in the energy side and load side has a stable role, the use of adjustable load to achieve demand response, in the future micro-grid to introduce a large number of new energy, the data center can also play a control. The data center is controlled for the different working states of different units in the micro-grid.

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