Research on regional renewable energy interconnection characteristics analysis and coordination optimization technology

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Research on regional renewable energy interconnection characteristics analysis and coordination optimization technology

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Abstract. As one of the important means to accelerate the transformation of the world to sustainable energy, regional energy internet accepts as much renewable energy as possible without significantly increasing system costs. This paper analyses the operation characteristics of renewable energy, studies the regional renewable energy coordination and optimization technology, and the regional energy complementarity characteristics and different energy coordination and optimization control technology, and realizes the complementary absorption of regional energy to accept new energy better.

1. Introduction
Energy Internet is a centralized and distributed multi-energy structure with renewable energy as the priority, electricity as the basis and other energy as the supplement. At the same time, by using Internet technology as the management and operation platform, the supply and demand of multi-energy systems can be interacted and orderly allocated, thus promoting low-carbon, intelligent and social economy. Efficient and balanced development of new eco energy system. Energy Internet is still in its infancy, and the interests of energy suppliers, operators, agents and users will run in and collide violently. This is a necessary and inevitable process for the emergence of energy Internet.

2. Analysis of renewable energy power generation characteristics
Renewable energy has the advantages of renewable, low-carbon and environmental protection. Besides, its power generation output is changeable and relatively unpredictable, and it is difficult to change the power generation output in real-time according to grid dispatching instructions. According to the characteristics of renewable energy, power generation fluctuates at seconds, minutes, hours and seasons. In addition, wind power generation, photovoltaic power generation and other new energy generation currently also has a small proportion of the total power generation, high grid price non-technical characteristics. In order to absorb high-permeability renewable energy generation, including distributed energy generation, and make it the main power source of power system, the energy Internet needs to solve the intermittent and random problems to ensure the real-time power balance.

2.1. Characteristic analysis of wind power generation
Wind power generation system is an energy conversion system that converts wind energy into electrical energy. As a kind of renewable energy, wind energy is widely distributed and easy to develop and utilize,
so it has received great attention. There are many classifications of wind power generation system, such as classifying according to the type of generator, classifying according to the driving mode of generator, and classifying according to the frequency and speed of fan.

From the point of view of primary energy, because sometimes the wind is sometimes absent, the time is large and the time is small. As a result, the output of the wind power system is intermittent and fluctuating. On the other hand, the output characteristic of wind power system is closely related to its control mode. The common control methods are maximum power control, power limit control, phase angle control and balance control. According to the speed division, wind power generation system can be divided into constant speed wind power generation system and variable speed wind power generation system. In a constant speed wind power generation system, the generator is directly connected to the grid. When the wind speed changes, stall control is used to maintain the generator at a constant speed. In the variable speed wind power generation system, the speed of the generator can be adjusted according to the wind speed condition to optimize the operating efficiency of the fan, and then the generator output frequency to the grid can be maintained by power electronic frequency converter, including permanent magnet synchronous direct drive wind power generation system and doubly fed wind power generation system.

2.2. Characteristic analysis of photovoltaic generation
Photovoltaic power generation system is a kind of power generation device which utilizes photovoltaic effect to convert solar energy directly into electric energy. It can be operated independently or connected to the grid. It is not limited by region and environment. It has the advantages of simple structure, flexible scale, safety and reliability. Photovoltaic cells are the most basic components of photovoltaic power generation system, but because of their low output voltage and current, it is necessary to make photovoltaic power generation module by parallel or series connection of several cells; photovoltaic power generation module through parallel and series combination of photovoltaic arrays to form a direct current power supply. Usually, photovoltaic arrays need to be connected to the grid by converting direct current into alternating current through power electronic devices.

From the analysis of the natural characteristics of photovoltaic power generation system, its output characteristics are mainly determined by temperature and illumination. Experiments show that the higher the temperature is, the smaller the maximum power is. On the other hand, the higher the illumination is, the greater the short-circuit current, the open-circuit voltage and the maximum power are. The variation of the maximum power point voltage is relatively small, which can be considered to be approximately unchanged. Usually, because the illumination is affected by various meteorological conditions, the output of photovoltaic power generation system has a certain fluctuation, belonging to intermittent energy. In terms of control characteristics, photovoltaic power generation systems usually operate in the way of maximum power point tracking to maximize the use of renewable energy, so photovoltaic systems are usually unreliable scheduling distributed energy. In the traditional distribution network environment, small-scale photovoltaic power stations need not have the ability to regulate the active power, and try to maintain the power factor to 1, do not absorb or emit reactive power from the grid. Under the framework of active distribution network, the photovoltaic system can withdraw from the maximum power point operation according to the actual demand, thus playing a supporting role in the operation of the grid.

2.3. Characteristic analysis of small hydropower station
The characteristics of small hydropower can be divided into long period characteristics and short period characteristics. In terms of long term, small hydropower has obvious seasonal characteristics. In order to make full use of small hydropower resources in flood season, small hydropower should generate electricity as much as possible on the premise of ensuring reliability. For the adjustable hydropower station, the reservoir should be allowed to operate at high water level as far as possible under the premise of meeting the load requirements of the power system; in the dry season, the operation mode can only meet the reliability requirements of the micro-grid. In short-term, small hydropower generation has
small short-term fluctuation, and can be regarded as constant in the short term, and start-stop flexible, short-term regulation effect is better, can well balance the power fluctuation generated by intermittent power supply, to overcome the impact of intermittent power supply running alone on the system. Small hydropower stations are mostly runoff type or small reservoir capacity, and their regulating ability is weak. The output of small hydropower is obviously affected by precipitation.

2.4. Characteristics analysis of energy storage
Electric energy can be converted into chemical energy, potential energy, kinetic energy, electromagnetic energy and other forms of storage, according to its specific way can be divided into physical, electromagnetic, electrochemical, thermal storage, chemical and other types. Among them, physical energy storage includes pumped storage, compressed air energy storage and flywheel energy storage; electromagnetic energy storage includes superconducting, supercapacitor and high energy density capacitor energy storage; electrochemical energy storage includes lead acid, nickel hydrogen, nickel chromium, lithium ion, sodium sulfur and liquid flow battery energy storage; thermal energy storage includes phase change energy storage; chemical energy storage includes hydrogen production and so on.

3. Regional renewable energy control strategy
Under normal conditions, different strategies are adopted to achieve power balance through autonomous mode and cooperative mode respectively; when abnormal operation occurs, emergency control measures are taken to mitigate the risks in emergency mode, so that the system can be restored to the first two operation modes; when emergency strategy fails and the system fails. In the recovery mode, the system is self-healing by adopting the fault handling strategy.

According to the different realities of distributed generation and load, the autonomous mode is preferred; when the local energy supply and load demand cannot be balanced, the cooperative mode is adopted; when the cooperative control strategy fails, the system enters the stage of risk operation, the emergency mode is adopted; when the system fails, the recovery mode is adopted.

Under security constraints, the autonomous mode control center issues control objectives to each region according to the principles of economic optimum or efficiency optimum, and each region absorbs all kinds of energy locally under the control objectives, and regularly informs the control center of regional load and energy situation through the data platform, and the control center is responsible for monitoring and network operation status. Security constraint check. There is no interaction between energy and load in the autonomous mode, so the regulation means are limited.

When the autonomous mode cannot achieve the energy balance within the region, it will switch to the inter-regional cooperative optimal scheduling mode and enter the multi-source cooperative optimal scheduling mode. Multi-source cooperative optimal dispatching mode: when the region cannot be balanced internally, it needs to balance the energy between regions under network security constraints (such as voltage constraints). Each region can transfer the energy or load under the unified dispatch, and regularly inform the regional load and energy situation. The control center also needs to monitor the operation status and check the network security constraints. The key technologies involved are similar to the autonomous mode, but the main difference from the previous scenario is the cross-regional sharing and cross-regional sharing of information such as user energy consumption behavior, energy supply and consumption prediction, regulatory decision-making and execution instructions. Load flow routing for volume routers.

When the autonomous or cooperative dispatching strategy fails or emergencies occur, the system may enter the risk operation stage, and then enter the multi-source operation emergency risk mitigation mode and multi-source operation emergency risk mitigation mode. And the potential failure of the system in the future, make the system running abnormal, such as voltage limit, line overload and so on, may make the system exceed the expected risk and enter an emergency control state.
4. Regional renewable energy coordination and optimization

"Source-network-load-storage" coordinated optimization mode and technology refers to the operation mode and technology of power supply, power grid, load and energy storage, which can improve the power dynamic balance ability of power system more economically, efficiently and safely through a variety of interactive means, so as to realize the maximum utilization of energy resources. This mode includes source, network, load, storage overall solution operation mode.

Accurate prediction of wind and photovoltaic power is an integral part of the energy internet. Power prediction is not only a simple meteorological prediction based on meteorological satellite data, but also covers the real-time meteorological monitoring data and the historical operation data of the power station. Through the self-learning function of the software, it uses a variety of complex mathematical algorithms. The accurate prediction of PV generating capacity is derived. By integrating operational data, weather data, meteorological data, power grid data, power market data, and so on, the energy Internet platform can not only match supply and demand information in real time, integrate decentralized demand, form energy trading and demand response, but also perform large-scale data analysis, load forecasting, power generation forecasting and machine learning. Forecast and plan for energy demand in advance under different circumstances. If it can be absorbed in the region, the optimal generation plan can be formulated by optimizing the operation of scenery and water points in the region. In the planning stage, we need to get the best plan for starting and stopping the hydropower project. Inter-regional coordination and optimization is achieved through inter-regional transferable load. The problem to be solved in the date planning stage is how to determine whether inter-regional load transfer is needed and when to implement load transfer. Coordinating the evaluation of optimization effect, taking the new energy consumption and power grid reliability as the main evaluation indicators, through the comparison calculation before and after optimization, the optimization effect is evaluated.

5. Conclusion

In the future, the energy Internet will be transformed from energy-oriented to information-oriented, based on the full application of the Internet of Things, large data and cloud computing technology, with the characteristics of artificial intelligence. Apart from the large-scale application of information technology, the energy Internet depends on the construction of open energy trading markets such as electricity and gas, and constrained index trading markets such as carbon emissions and energy saving. Standardized and personalized service modes combining the needs of various types of users will generally rise.

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