Application of Energy Storage Technology in Wind Power Grid

Meng Zhang
Electric Power Research Institute, State Grid Shanxi Electric Power Company, Taiyuan 030001, China

Abstract: In the industrialization times, the demand for social electricity is increasing continuously. In order to ease the problem of energy tension and implement Carbon Peaking and Carbon Neutrality Goals, our country works to new energy and coal electricity synergistic development. In December 2022, China's new wind power installed capacity of 365.44 million kilowatts, increasing by 11.2%, which shows a steady development trend. In wind power generation, through the use of energy storage technology, China can rationally allocate a reserve device system, reserve wind power resources, regulate power supply, and enhance the safety and stability of power system operation. This paper introduces several kinds of energy storage technology and discusses the role of energy storage technology in wind power generation, in order to reduce the influence of wind power fluctuation.

Key words: energy storage technology; wind power generation; power system operation

Introduction

Under the background of Carbon Peaking and Carbon Neutrality Goals, how to meet the continuous growth of electricity demand in various industries and ensure the stability of power supply has become an important issue for the sustainable and stable development of society. At present, through the configuration of conventional and new reserve devices, wind enterprises all over China begin to promote energy storage technology achievements, promote the integration of wind farms and energy storage technology, improve the stability and safety of wind power generation, and consequently effectively solve the problem of insufficient regional wind resources. Wind energy volatility ensures that the wind power system can also proceed normally power generation and power supply in the season of low wind. Wind power generation has certain characteristics. For example. wind power generation system power volatility can lead to unstable operation of the power grid system easily, through the use of energy storage technology. Enterprises can effectively inhibit power grid system power fluctuations, enhance the reliability, stability and security of power transmission, meet the regional new energy development needs to better support social production and people's lives. From a long-term perspective, based on the support of energy storage technology devices, the wind power industry will move towards a stable and healthy development path.

I. Type analysis of energy storage technology

1. Battery energy storage

As a traditional means of energy storage, battery energy storage has been developed for a long time, and a variety of batteries with large capacity and wide application scenarios have emerged, and their economy and environmental protection have also been enhanced. First, lead-acid batteries. This kind of battery capacity far exceeds the original battery, the capacity can reach 20MW, with low environmental dependence, low production cost, strong reliability, is widely used in wind power generation system. However, lead-acid batteries do not support the reuse of resources, after reaching the use period, the battery material lacks the value of secondary utilization, and does not support pollution-free treatment, it is difficult to meet the needs of ecological civilization construction. Second, nickel-metal hydride batteries. This battery initially appeared in the field of electric vehicles, but environmental factors restrict the level of battery energy conversion. Once the current is too large, the discharge energy density will decrease significantly. The third is lithium-ion batteries. Compared with lead-acid batteries, lithium batteries have high power density and energy density and fast charge and discharge speed, but there are difficulties in large-scale integration. Fourth, all-vanadium flow batteries. In the electrolyte environment, mercury through chemical reaction, realize the battery discharge, this battery low cost, high charging and discharging efficiency, has application value.

2. Flywheel energy storage

From the basic principle, flywheel energy storage is mainly to convert electrical energy into mechanical energy with the help of an electric drive device, and save the kinetic energy in the accelerating mass device. When there is a power supply demand, based on the principle of kinetic energy to electric energy, the kinetic energy of the flywheel will become the energy source of the generator. In the process of energy storage, the traditional flywheel has a serious energy loss problem, but the new flywheel energy storage device integrates new composite materials and superconducting magnetic levitation technology, which not only controls the volume of the device, but also greatly reduces the energy loss. With the advantages of convenient maintenance, unrestricted charge and discharge times, clean and pollution-free, coupled with the energy conversion rate of nearly 90%, flywheel energy storage technology is suitable for wind power generation systems, and has broad application prospects in large wind farms. With the development of new energy power generation technology, many researchers continue to develop flywheel energy storage technology to make up for the shortage of wind power generation power instability and ensure the stable operation of the power system. At present, a new flywheel energy storage scheme has appeared in the power field, and enterprises can use the modular combination method to improve the efficiency of flywheel energy storage charge and discharge. In the field of flywheel energy storage research, in order to meet the requirements of large-scale grid-connected era, researchers began to develop grid-connected flywheel energy storage system, the use of high-strength flywheel materials and new loss bearings, greatly improving the efficiency of flywheel energy storage charge and discharge, flywheel energy storage system to modular, large capacity, high speed direction.

At the same time, in order to play the role of flywheel energy storage technology on wind power generation system, researchers according to the relationship between flywheel energy storage density and rotor structure, by optimizing the rotor structure, improve the flywheel energy storage capacity, change the flywheel radius, and pursue the highest speed, so that it can be more suitable for wind power generation system. In addition, due to the characteristics of weak pollution and strong flexibility, flywheel energy storage technology is very friendly to the natural environment, and technical personnel are convenient to operate, which is convenient to improve the operating level of wind power generation system.

3. Supercapacitor energy storage

Based on the electrochemical double layer theory, supercapacitors make use of huge pulse power to make the power grid operation more stable. In the state of charging, driven by the charge attraction, the electrolyte ions of opposite sex are adsorbed on the surface of the electrode, which generates a double charge. The super capacitor energy storage device has a simple structure and does not produce toxic substances during operation, which ensures environmental protection to a great extent. At the same time, this energy storage method will generate a strong current in a limited time, and the charging time is short. However, the application of supercapacitor energy storage technology also has certain limitations. In order to maintain an efficient charging state, this energy storage technology limits the voltage during the charging cycle, if only a single capacitor voltage is configured, it is difficult to meet the technical requirements.

4. Superconducting energy storage

Superconducting coil as the medium, superconducting energy storage technology through magnetic field energy to achieve charging and discharging. In the energy storage link, super energy storage can absorb the magnetic field energy in the DC current, and release the magnetic field electric energy in the discharge link, so this technology is also named superconducting magnet energy storage. Superconducting energy storage has the advantage of fast energy storage, and does not produce a lot of energy loss during energy storage, which also makes it support long-term storage of electric energy, which greatly improves the energy utilization rate. At the same time, the superconducting energy storage device has strong dynamics, can quickly respond to the instructions of the power system, and has application value in various new energy power generation fields. At present, enterprises can use superconducting energy storage technology to compensate power and adjust frequency, so that the stability of the power supply system is greatly improved.

II. The role of energy storage technology in wind power generation

1. The role of double battery energy storage

At present, in order to effectively suppress the power volatility of wind power systems, technicians can use power smoothing methods and energy storage devices. However, after using the power smoothing method, the wind power system will not be able to maintain a high level of wind energy collection efficiency. Relatively speaking, the energy storage device can collect excess electric energy in the wind power system, so technicians can use the energy storage function of the energy storage system to collect electric energy, uninterrupted transmission of electric energy, to ensure the continuity of power grid transmission. With the development of battery energy storage technology, researchers have introduced a dual-time-scale coordinated control scheme, so that battery energy storage devices break through the restricted use period, so that it can play a long-term power control role. At the same time, the operating cost of wind power generation has also attracted the attention of researchers. At present, a large battery energy storage device composed of multiple batteries has been launched, and the internal battery energy storage unit can adapt to different wind power. On this basis, the researchers launched a dual battery energy storage technology scheme, which integrates two battery devices, respectively responsible for charging and discharging. When the grid dispatching power is lower than the wind power, the rechargeable battery will be in the state of energy storage, when the wind power is lower than the grid dispatching power, the discharge battery replaces the rechargeable battery and enters the state of operation. According to the power level of wind power and power grid, the dual battery device can switch the charge and discharge state at any time to avoid the need for a single battery to assume the charge and discharge function, so that the battery energy storage device has a longer service life, and can transmit stable electric energy to the power grid according to the power dynamics.

2. The role of hydrogen fuel energy storage

Based on the development goal of dual-carbon strategy, wind power generation system and hydrogen fuel energy storage technology are moving towards integration. Based on electrochemical energy storage, hydrogen fuel energy storage technology can use the chemical energy in the fuel and oxidizer to convert and output into electric energy. The energy storage capacity of hydrogen fuel is infinite. According to the classification of electrolyte materials, hydrogen fuel energy storage device contains the following three kinds: alkaline fuel energy storage device, proton exchange membrane energy storage device, methanol fuel energy storage device, the working principle of the above energy storage device is similar, composed of electrolyte, anode and cathode, the main difference is reflected in the electrolyte. In the field of wind power, proton exchange membrane fuel energy storage technology is more widely used. From the operating principle, it adopts the operating principle of reverse electrolysis of water, so that hydrogen enters the anode and oxygen enters the cathode, and then reacts with the catalyst and the proton exchange membrane to produce electricity. This energy storage device supports metallization, liquefaction and compression energy storage, and the energy storage time is long. In the wind power system, the hydrogen energy storage device is composed of fuel energy storage, electrolytic cell and hydrogen storage tank. When the wind energy is concentrated, the electrolytic cell produces hydrogen through the reaction of electrolytic water and stores it in the hydrogen storage tank. After the tank reaches the highest capacity, the remaining electric energy is converted into the load; When the wind energy is insufficient, the hydrogen energy storage device provides electrical energy to the power system through the hydrogen-oxygen reaction, and improves the stability of the wind power system.

At present, with the in-depth development of hydrogen fuel technology, researchers are constantly looking for alternative materials to reduce component costs, and hydrogen fuel energy storage has a good space for development in the future.

3. The role of hybrid energy storage

At present, many wind farms use batteries as energy storage devices, but batteries have problems such as large environmental hazards, low power density and short service life. In this regard, technicians can use mixed energy storage technology to combine supercapacitors and battery devices. In the development of supercapacitor technology, researchers found that carbon nanotubes have higher mechanical strength, chemical stability and electrical conductivity, and developed carbon nanotube supercapacitors, which can support at least 100,000 deep charge and discharge times. At the same time, supercapacitors have high power control efficiency, high power density, long service life and other characteristics, no maintenance can be long-term energy storage, technical personnel should take into account the technical and economic energy storage device, the use of active, passive structure, the establishment of parallel complementary hybrid energy storage device, integrated the advantages of the above two energy storage methods, making the energy storage device use longer, Improve the energy conversion efficiency. Once the wind power system has an operation failure, the hybrid energy storage device can be quickly started, join the wind power system operation link, through fast charging and discharging, make up the power demand at the grid-connected load stage, and balance the wind power system. Ensure the balance of wind power generation system and improve the reliability of power supply. Supercapacitors are similar to battery energy storage. Traditional supercapacitors mostly use metal oxides, activated carbon fibers and other materials as electrode materials.

III. The application prospect of energy storage technology in wind power generation

In the era of vigorously developing new energy technologies, the proportion of new energy power generation in the country's total power generation continues to increase. As a new energy, the installed capacity of wind power will increase by 37.63 million kilowatts in 2022, and its importance in the power generation industry is becoming increasingly prominent. However, due to the randomness and instability of wind energy, many wind power industries have developed energy storage fans and wind farm energy storage devices to further make up for the power supply service shortcomings of wind power industry. In the future power supply service industry, the integration of energy storage technology and wind power generation system will be more and more in-depth, and the role of energy storage technology will no longer be limited to "peak cutting and valley filling", and improving economic benefits will be a major development trend. At the same time, in the new era, the power industry has appeared wind power and solar cell array complementary service program, in different scenarios, technicians can be based on the number of wind resources, configure a certain amount of solar panels, make up for the lack of wind power development. Under this technical scheme, technicians can focus on the all-weather power generation goal, collect the operation law of wind-solar complementary power stations, and reasonably equip energy storage devices. In recent years, in order to improve the use efficiency of energy storage technology and devices, give play to the auxiliary role of energy storage technology for wind power generation, and improve the efficiency of peak load balancing of wind power generation, relevant units and technical personnel still need to continue to promote the research and development projects of energy storage devices from both economic and technical aspects.

IV. Conclusion

To sum up, wind resources are an important part of available renewable resources, but the randomness and volatility of wind speed will interfere with the normal output power. Through the combination of wind power generation technology and energy storage technology, technicians can set scientific energy storage configuration scheme, restrain power fluctuations, and improve the stability of wind power generation. Therefore, in the wind farm, the relevant industries should recognize the application value of a variety of new energy storage technologies, by playing the role of dual battery energy storage, hydrogen fuel energy storage and hybrid energy storage schemes, and constantly improve the energy storage capacity to meet the stable operation needs of wind power generation and grid connection needs, and improve the practicability and feasibility of energy storage technology schemes.

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