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Research on Power Electronics Technology in Modern Power Grid

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Abstract: Power electronics technology is a technology that uses power semiconductor devices to transform and control power. It is a new and applied subject that integrates electronic technology, control branch technology and power technology. Power electronics technology is mainly manifested in energy saving, material saving, automation, intellectualization and electromechanical breakdown. It meets the requirements of sustainable development and facilitates people's life. Now, it is developing towards high-frequency application technology, modularization of hardware structure, digitization of control technology and greening of product performance. The application of modern electronic power technology has brought new opportunities to China's economy and greatly separated China's comprehensive national strength.

1. Introduction

Power electronics technology is a technology that uses power electronic devices to exchange and control power. At present, it has been applied to various fields. In smart grid, power electronics technology makes the whole power system operate intelligently and reduces the manual operation of personnel. In new energy and new material industries, the application of power electronics technology accelerates the research process. In green lighting industry, the application of power electronics technology realizes real energy saving, environmental protection and reduction. Unnecessary waste of resources. In short, power electronics technology has involved all aspects of our lives. Based on my years of learning experience, the author studies and discusses the power electronics technology in modern power grid.

2 Power Electronics Technology in Modern Power Grid

2.1 Flexible AC Transmission Technology

Flexible AC Transmission System (FACTS), also known as flexible AC transmission technology, is

a new technology proposed by N.G. Hingorani in 1986. It once defined FACTS as all practical applications of power electronics technology for transmission except DC transmission. This new technology is the product of the combination of modern power electronics technology and power system. Its main content is that in the main parts of the transmission system, the main parameters of the transmission system (such as voltage, phase difference, reactance, etc.) are controlled flexibly and quickly by using power electronics devices with separate or integrated functions, so as to realize transmission. Reasonable distribution of transmission power can reduce power loss and generation cost, and greatly improves the stability and reliability of the system.

The main functions of FACTS can be summarized as follows: 1) to control the power flow in a wide range; 2) to ensure that the transmission capacity of transmission lines approaches the thermal stability limit; 3) to transmit more power in the control area and reduce the thermal standby of generators. (4) relying on limiting the influence of short circuit and equipment failure to prevent cascade trip of lines; (5) damping power system oscillation.

2.2 HVDC transmission technology

High Voltage DC (HVDC), simply speaking, is the technology of converting alternating current into direct current through converters, and then sending it out through direct current transmission lines. At the receiving end, the direct current is converted into alternating current, which enters the receiving end alternating current network. HVDC transmission system consists of converter station, grounding pole, grounding pole line and DC transmission line. Converter station is a device for connecting AC side and DC side, that is, a converter for converting between AC and DC. The converter consists of converter transformer, converter, control pole trigger device, control protection device and other auxiliary devices. Like AC lines, DC lines are composed of conductors, ground wires, insulators, fittings, towers, foundations and grounding devices. The design of ground wire, foundation and grounding device is the same as that of AC. AC conductor is three-phase system, but correspondingly it is called pole in DC system. When AC system transmits electricity, three-phase must run simultaneously. In DC system, each pole can transmit electricity independently and can operate unipolarly.

The advantage of HVDC technology is that it does not increase the short-circuit capacity of the system to facilitate the asynchronous interconnection of the two power systems and the interconnection of the power systems with different frequencies; the power modulation of DC system can improve the damping of the power system, suppress low-frequency oscillation, and improve the transmission capacity of AC transmission lines running in parallel. But this technology also has a very obvious disadvantage, that is, it is difficult for HVDC transmission lines to lead out branch lines, most of which are only used for end-to-end transmission.

2.3 Customized Power Technology

Custom Power (Custom Power) was proposed by EPRI in 1992. It integrates high-power power electronics technology with distribution automation technology, and configures the required power for users on the basis of users' requirements for power reliability and power quality, i.e. power electronic devices or static (static/solid) controllers. Voltage distribution system, in order to provide power to users sensitive to power quality to meet the reliability level and power quality level required by users.

In order to improve the quality of reactive power regulation in distribution network, a static var generator has been developed for distribution network. It consists of energy storage circuit, power electronic device conversion circuit and transformer. Its function is to quickly adjust the voltage,

generate and absorb the reactive power of the power grid, and suppress voltage flicker. This is one of the key equipment of "customized power". In addition, the combination of static var generator and solid state switch can keep the voltage constant during the transient process of power grid failure. Another key device is the dynamic voltage restorer, which consists of DC energy storage circuit, converter and transformer connected in series in the power supply line. According to the detected voltage waveform of the circuit, the converter generates compensation voltage to keep the synthetic voltage dynamic constant. Whether short-term voltage drop or over-voltage, dynamic voltage restorer can keep the voltage on the load dynamic constant.

2.4 Energy Conversion Technology

The development trend of energy conversion technology applied in modern power grid is the utilization of renewable energy such as wind energy and solar energy, and the grid-connected operation of large-scale intermittent power supply and micro-grid. The key technologies of application include energy conversion technology of large-scale intermittent power supply, key technology of cluster power regulator, large-scale charging technology of large current, medium-voltage and high-power fan converter technology, frequency conversion technology of pumped storage start-up, energy feedback system of rail transit, bidirectional energy conversion technology of electric vehicle and power grid. And so on. Low-carbon economy based on low energy consumption, low pollution and low emissions is the direction of future social development. One of its core is the innovation and application of energy conversion technology.

2.5 Static Reactive Power Compensation Device

SVC technology is mature and widely used. It was mainly used in large users with impact load in the early stage of China. In recent years, it is also used to improve the stability of the main grid and the transmission capacity of the power grid. There are two main types: thyristor switched capacitor (TSC) and thyristor controlled reactor (TCR). The advantage of substituting thyristor for common contacted switch is that the switching process without impulse current, overvoltage and capacitor connection is completed at the zero-crossing point of thyristor voltage, while the switching of capacitor is completed at the zero-crossing point of thyristor current, so that the capacitor can be switched on and off arbitrarily and frequently, and there is a series of reactance in the capacitor circuit, which can limit the discharge current and prevent it. Generate subharmonic resonance. TSC can only realize stepwise regulation, and its application is usually in distribution system. Thyristor controlled reactor (TCR) consists of a controllable reactor and capacitor in parallel. Thyristor controls the current of the reactor. When the system voltage is low and reactive power is needed, TCR reduces the reactance current. When the system voltage is high and reactive power is needed to be absorbed, TCR increases the reactance current and TCR itself generates harmonics. Therefore, filter is often used to replace part of the shunt capacitor, and TSC TCR can also be used. Both TSC and TSC can be adjusted separately, that is to say, reactive power can be compensated quickly according to the voltage or reactive power requirement of each phase. Therefore, they all have the effect of improving the system asymmetry, and can still work normally when the system asymmetric fault occurs, supporting system voltage.

3 Application of Modern Power Electronics Technology in Power Grid

The flexibility and controllability of smart grid are two manifestations of smart grid. The key to improve the flexibility and controllability of power grid is the improvement of power electronics technology, which must have flexible transmission technology and corresponding efficient energy

storage technology. Power electronics is the key technology of smart grid. Mastering high-capacity power electronics technology is the core technical support to realize smart grid. Every breakthrough of power electronics technology indicates a great step forward in the smart grid.

The main structure of smart grid includes material network, smart grid equipment and smart operation server. Material network is the general term for the application of physical network in all levels. It is not only the carrier of strong smart grid, but also the key of smart grid. Power grid support points include energy savings stations, substations, compensation stations, distribution network control stations, etc. Energy savings stations are stations for power storage, substations are the basic stations for power conversion, compensation stations are stations equipped with stable voltage devices, and distribution network control stations are for information processing, optimization and decision-making. Sites that can control operations. Energy savings station, substation, compensation station and distribution network control station are the basis of smart grid automation, and are also the key sites to realize smart grid control application equipment. Smart grid equipment is the key technology to build a reliable and robust smart grid, which can realize the flexible transmission of the grid. For example, AC system and flexible intelligent AC transmission system in smart grid equipment, smart grid equipment is a powerful support for safety and economic requirements, and also an important way to achieve reliability and efficiency of smart grid. Intelligent Operating Server can realize power transmission and information exchange, which is also a reliable technology to further enhance the flexible management of smart grid, and can provide a variety of supply, provide users with more access experience, which is also a manifestation of the humanization of smart grid.

Intelligence of advanced power electronics technology is an important means of smart grid. It is also the direction of power system development in various countries. At present, the widely used technologies are HVDC technology, FACTS technology and SVC technology, which can improve transmission capacity and stability respectively, and realize smart grid. Monitoring and control, communication, protection and other functions. These technologies are the result of the exploration and development of power electronics technology. Advanced power electronics technology not only needs power stabilization technology and power reserve technology, but also requires breakthroughs in key technologies of grid-connected new energy generation.

4 Application Prospect of Power Electronics Technology

Power electronics technology has an indelible contribution on the road to modernization of power system. We all know that in the high voltage power transmission project, after the power plant generates electricity, the current is transformed through transformer and then transmitted. The purpose of this is because the higher the voltage is under a certain current condition. The smaller the current is, the smaller the loss is in the process of transmission, and a large amount of current can be saved. Because of the converter characteristics of power electronics technology, especially in the development of UHV transmission technology, power electronics technology is used to apply thyristor converter to both rectifier and receiver currents of DC transmission terminal. To a certain extent, the problem of excessive current loss caused by long-distance and large-capacity transmission current has been solved. This measure has made a great contribution to China's power industry and made a crucial step for China's power system. At the same time, it has been widely used in synchronous generator excitation system and AC motor variable frequency speed regulation, new energy generation and smart grid applications.

Therefore, the future FACTS technology, HVDC technology and SVC technology will play an irreplaceable role in smart grid, but there is no doubt that they need to achieve greater innovation in intelligence. In the future, FACTS technology will focus on the research of UHV TCSC technology,

UHV TCR technology, static synchronous compensator technology, UPFC key technology and FACTS coordinated control technology. In order to meet people's increasing power demand, another core of the future power grid is energy storage capacity. In order to achieve super-large-capacity transmission, the receiving end must be a powerful AC system, which provides enough short-circuit current for the system. Short-circuit current needs the receiving end to be able to withstand strong load. Therefore, a strong receiving end system will become the next. An important research topic.

5 Conclusion

Power electronics technology has penetrated into our lives, and our food, clothing, housing and transportation are closely related to it. Over the years, it has brought many conveniences to our life, made our life colorful, improved the national living standard, and made us really enjoy the happiness brought by science and technology. At present, in our country, the research of power electronics technology has been further developed, and some achievements have been achieved in industry, processing industry, energy industry, material industry, manufacturing industry and other related fields. This technology will be strengthened and will develop towards a more scientific and modern direction. I believe that in the future, more people will enjoy the benefits of this technology, and more technology will enter our daily life.

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