

The Application of Advanced Power Electronic Technology in Smart Grid

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Abstract: With the rapid development of social economy, smart grid construction has received more and more attention. The use of advanced power electronics technology will continue to strengthen power grid technology, so as to better ensure the stability of power supply, further increase energy conservation and emission reduction technologies, and ensure the effective use of resources. Therefore, it is necessary to focus on strengthening research, and it is necessary to strengthen the use of advanced power electronics technology in power grids. This paper mainly analyzes the demand for power electronics technology in smart grids, and focuses on the analysis and research of advanced power electronics technologies in smart grids. The application of various advanced power electronic technologies in smart grids is analyzed in this paper.

1. Introduction

In the process of constructing power grids and power grids, advanced power electronic technologies are needed. Therefore, for the construction of the entire power grid, the research and application of advanced electronic power technologies are particularly important, and even have a bearing on the economic development of our country. With the rapid development of the society, the level of information of the power grid has been continuously improved. In the new era, the demand for the power market is getting higher and higher. It is very important to further strengthen the smart grid construction of the electric enterprise. Judging from the current situation, there are still many problems in the construction of smart grids for power companies, and this needs our attention. The application of information technology, digital technology and control technology is of great significance. It can effectively meet the development needs of enterprises. At present, China's power grid companies are constantly making innovations in order to better promote the development of smart grids, enabling them to continue to develop in the direction of digitization, automation, and information [1].

2. Smart grid demand for advanced power electronics

2.1. The need to strengthen the optimization of the power grid and ensure the safety of the power grid

The smart grid is an interactive system. The grid must have the best response and adaptability to changes in the system, user needs, and changes in the environment. The power electronics technology is a powerful means to make the grid respond quickly and take appropriate measures. At present, advanced power electronic technologies in China's power grids have been fostered in HVDC, FACTS, and other related industries through various forms of independent innovation. They are improving the transmission and distribution capabilities of power grids, improving the power quality of power grids, reducing fault losses and shortening faults. Some results have been achieved in terms of post-recovery time. The future development and development of smart grids will inevitably put new demands on the further development of advanced power electronic technologies [2].

The grid structure of China's power grid is relatively weak, and there are still many places that need to be adjusted and upgraded in the fields of transmission and distribution. It is necessary to increase the research and development of flexible AC transmission devices and strengthen the grid structure of the power grid. From the perspective of the development of the world's power grid, the interconnection of large power grids is an inevitable trend in the future development of power grids. The structure of China's AC-DC interconnected large-scale power grids has become increasingly complex, and the difficulty of operation control has gradually increased. In addition, extreme natural disasters in China are frequent, and extreme external disasters cause catastrophic damage to the safe and reliable operation of large-scale power grids. Under this circumstance, advanced power electronic devices, as an important system control method, can be used to regulate the distribution of power flows in transmission and distribution networks, enhance the structure of grids, suppress the spread of power grid failures [3], and improve the self-healing of power grids under various fault conditions. "Competence, thereby improving the level of safe and stable operation of China's large power grids and better supporting economic and social development."

2.2. Analysis of demand for power electronics technology in smart grid

Although the smart grid power electronics technology has made some progress, there are still many problems that need to be solved.

2.2.1 Safe and stable operation of power grid equipment

The safe operation of power electronic equipment is a problem that is urgently needed to be solved in the current smart grid. Although China has a relatively stable power grid structure, there are still certain problems. This requires improving the requirements for power grid construction and strengthening the use of advanced power electronic devices so that the output quality of the power grid can be effectively improved. Especially with the rapid development of social economy, the demand for electricity will increase [4].

Conversion formula is as follows:

$$L \frac{di_{La}}{dt} + Ri_{La} = u_a - e_a$$

$$L \frac{di_{Lb}}{dt} + Ri_{Lb} = u_b - e_b$$

$$L \frac{di_{Lc}}{dt} + Ri_{Lc} = u_c - e_c$$

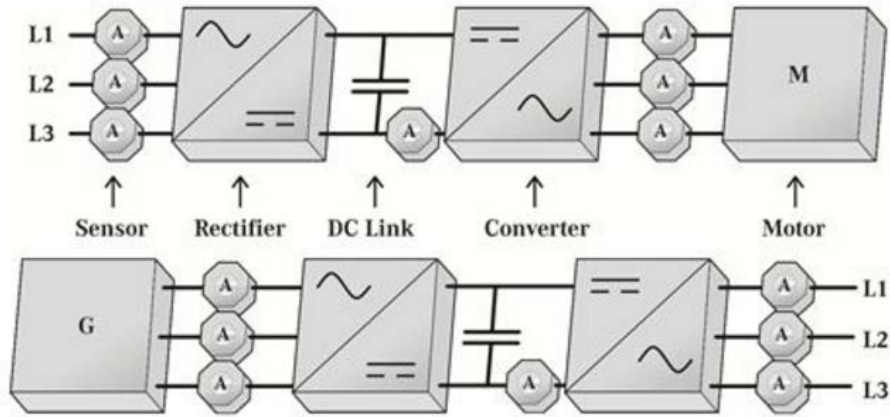


Fig. 1 Conversion of three currents in power electronic equipment

The construction of large power grids will also become an inevitable trend for the development of China's power industry, which means that the structure of the power grid will gradually become more complex. In addition, China has a vast territory and relatively complex climatic conditions, which makes the power grid face a complex environment. These problems need to be solved and improved through advanced power electronics, and advanced electronic devices are used to regulate the power system. The power grid structure is effectively enhanced, and the fault recovery ability and resistance of the power grid are enhanced, thereby reducing or preventing the proliferation of power grid faults, ensuring the safe and stable operation of the smart grid, and ensuring the safety of power usage.

2.2.2 Ensure the power quality of smart grid

In the current era of large-scale background, the demand for electric energy is continuously increasing. At the same time, the requirements for the quality of electric power are also increasing. If the output electric energy can not meet the demand for electricity, it will greatly affect the operation of the entire grid, affecting the economy. Benefits and social benefits. Therefore, it is imperative to improve the quality of electricity in the power grid through the application of advanced power electronic equipment so as to promote the development of social economy while improving transmission efficiency [5].

2.2.3 Optimize the Smart Grid Resource Configuration

As the material foundation for the development of human society as a whole, energy is the driving force behind the rapid and steady economic growth. However, with the depletion of conventional fossil energy sources, the problem of ecological balance in the earth and environmental pollution problems have become increasingly prominent, threatening people's survival and development. Therefore, the development and utilization of clean, pollution-free and renewable energy sources are strongly promoted and promoted, including solar energy, wind energy, and tidal energy. Although China has a wealth of energy, due to resource distribution, population

and other factors, the per capita possession is lower than the world level. In addition, China's energy development and utilization are relatively difficult, and it is even more difficult to solve the problem of energy use. In particular, China is in a period of rapid economic development and high energy consumption, which further highlights the contradictory relationship between economic development and environmental pollution. This requires that in the future development of our country, we must implement a sustainable energy development strategy. Therefore, as one of the renewable clean energy sources, electric energy receives more attention and actively develops the electric power industry. Through the application of advanced power electronic technologies, it ensures the safe and reliable construction of the smart grid and enables the electric energy resources to realize large-scale long distance transmission. to optimize the allocation of energy resources, and then effectively improve the national energy shortage

3. Application of advanced power electronics in smart grid

3.1. Application of flexible AC transmission technology

The application of flexible AC transmission technology needs to focus on strengthening the control of modern technology, so that it can continuously improve transmission control of the grid structure, achieve monitoring purposes, and continuously improve the transmission capacity of the grid to ensure the overall performance of the power system. UHV power transmission and transformation is a very important part of the smart grid construction. In the construction of smart grid, it is necessary to attach great importance to the isolation of distributed energy and the access of new energy sources. The use of flexible AC transmission technology in the application process has a very important role. , Can effectively control the loss of electrical energy, but also can continuously improve the overall performance, to achieve reasonable control purposes.

3.2. Application of HVDC transmission technology

As far as the current situation is concerned, HVDC transmission technology is mainly to carry out current conversion, and then carry out overall transmission. The main method used for this technique is the independent control of the active and reactive power in the self-commutation mode, so that the grid control can be reasonably performed. The use of this technology is mainly the use of rectifier devices for power generation conversion, so as to obtain the corresponding DC. When it reaches the target, the DC power will be converted into AC power by the invert, and the power output will be converted by the commutation voltage. The application of this technology can not only transport electricity, but also ensure the normal operation of the grid. In the long-distance transport of electricity, using this technology can meet people's needs. Since the 1990s, the DC transmission technology has been further developed. It effectively solves many problems in wind power generation and promotes the development of power grids. Therefore, it is necessary to focus on strengthening research.

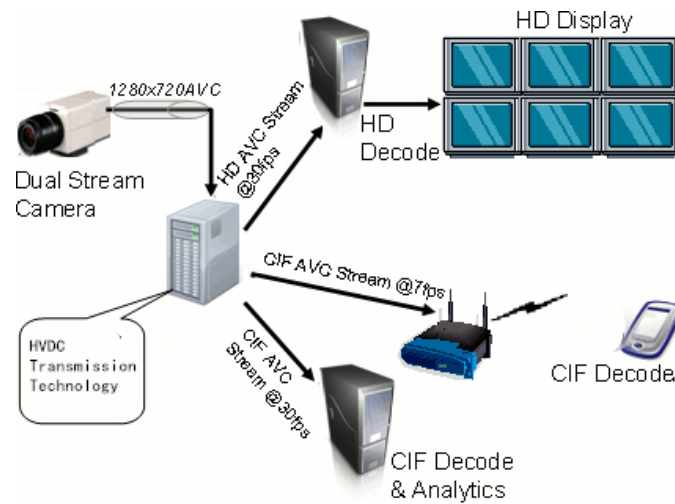


Fig. 2 Advanced HDVC Transmission Technology in smart grid

3.3. Application of power quality technology

The main role of the application of power electronic technology in smart grid is to further improve the quality of electric energy. From the current situation, it is mainly applied in such countries as the United States, Japan and India, and the power quality technology applied in these countries is mainly Use a dynamic voltage regulator. The application of industrial power quality technology in China is becoming more and more extensive. In applications, it is necessary to continue to adopt the problems of optimization and optimization, so as to further improve the overall quality. At present, scientific economic analysis and analysis standards and sound industry laws and regulations will be established during actual operations, and at the same time, various levels will be divided so as to effectively ensure the overall economic performance. In order to further improve the power quality, it is necessary to strengthen the control of the power quality controller, which can effectively regulate the power, effectively guarantee the user's power quality, and at the same time be able to better promote the development of power companies.

3.4. The use of static reactive compensation technology

The static reactive power compensation technology belongs to the more typical flexible AC transmission technology, and its main function is to perform voltage regulation control of the power system, which can better ensure that the power system wants to run. The application of this technology can effectively control the reactive power flow and further improve the overall transportation capacity. Not only that, the application of this technology can also better ensure the overall stability, and continuously enhance the low-frequency oscillation damping. As far as the current situation is concerned, this technology has also been widely used. It not only can effectively solve the transmission and distribution, but also can further improve the overall power quality and better ensure the normal operation of the power grid, so further strengthen its research. very necessary.

3.5. Application of FACTS technology in smart grid

FACTS technology is based on the power electronic equipment, further integration of modern control technology, can be more flexible and rapid control of transmission lines, help to improve the transmission capacity and transmission stability. China's energy distribution is reversely distributed.

To be able to achieve large-scale energy transfer, it is necessary to further improve the transmission capacity of the line and ensure the quality of transmission. At the same time, the effects of system oscillations and voltage instability must also be addressed. The current FACTS technology's own rapid control and adjustment capabilities and system compatibility have achieved considerable results in practical applications.

3.6. SVC technology application in smart grid

SVC technology is a flexible AC transmission device. It plays an important role in practical applications. It can dynamically adjust the system voltage according to the actual situation to keep the voltage stable. At the same time, it can also increase the transmission capacity and provide reactive power for the subsequent DC invert. Promote system stability has been effectively improved. SVC technology is an effective and effective technical solution to the current transmission problem. Since its introduction into the country, it has been continuously improved and innovated.

The construction of the 100MvarSVC demonstration project in Anshan, Anshan, Reckoning province, has marked that China has fully mastered the SVC technology and has greatly promoted the construction and development of smart grids. Due to the outstanding advantages of SVC technology reactive power compensation, it can improve the transmission quality of the power grid, improve transmission capacity, and promote the safe and stable operation of the power grid, which can better meet the needs of different levels of power grid construction in China. The application of SVC technology promotes the development of China's power grids in the direction of intelligence, automation and information.

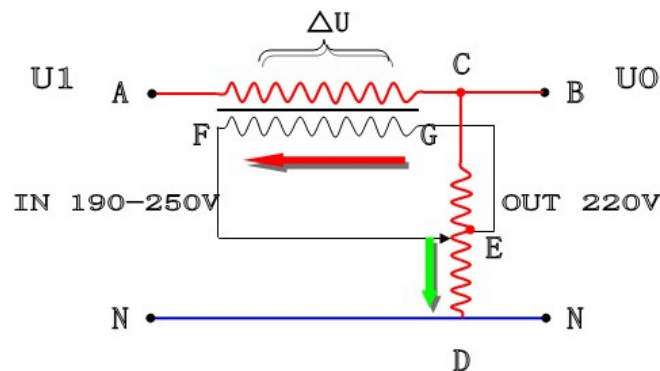


Fig. 3 SVC Technology Schematic

3.7. TCSC technology application in smart grid

TCSC technology is a kind of flexible AC transmission technology that is continuously innovated and improved on the basis of conventional series compensation technology. The advantages of TCSC technology are outstanding in practical applications. While improving the power transmission capacity of the power grid, it is also possible to optimize the system operation mode and reduce the power consumption as much as possible to ensure that the system can operate stably. As one of the world's most advanced transmission technologies, the flexible AC transmission technology can improve the power transmission capacity of the power grid while maintaining the safety and stability of the power grid operation, and is more suitable for application in UHV power grids. It has a great deal for the construction and development of smart grids in China. profound influence.

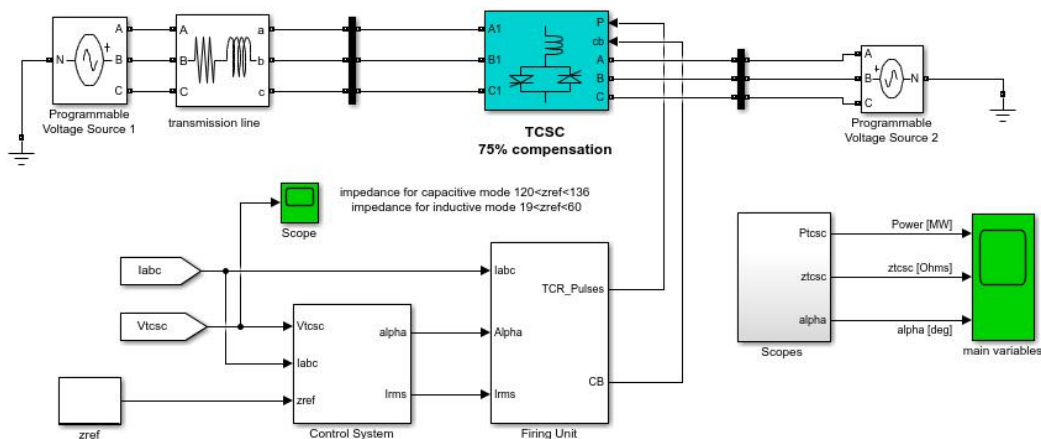


Fig. 4 TCSC Technology Application in Smart Grid

3.8. Application in ensuring the reliability of power electronic devices in smart grid

The application of power electronics technology in power systems has made great progress, but at present there is no sound large-scale reliability and economic evaluation system for power electronic devices. How to evaluate the adaptability of power grids and the economic benefits brought by power electronic devices when large-scale application of power electronic devices becomes a problem to be solved urgently. The safe use of power electronics is an important issue for smart grids. Due to the large number of power electronic commutation technologies, harmonic instability and synchronous motor self-excited torsional vibration or sub synchronous resonance problems have occurred in the system. This is power electronics and HVDC. One of the key issues in the system has been related research work in China. In addition, the insufficiency of the existing simulation technology also limits the development of power electronics technology. A unified simulation platform for power electronics must be established to deeply explore the characteristics of power electronic devices in the power grid, ensure the reliability of power electronic devices, and improve the reliability of power systems.

4. Conclusion

All in all, the application of advanced power electronics technology in smart grids is not only in order to comply with the trend of smart grid development, but also to ensure the safe and stable operation of smart grids, thereby meeting the needs of social-economic development for electricity, and protecting the natural ecological environment. The quality of transmission has also been improved. Therefore, it is necessary to strengthen the application of advanced power electronics in smart grids.

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