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## On the application of advanced power electronics technology in smart grid

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### ABSTRACT

The ultimate goal of smart grid is digitalization, automation, interaction and informatization. If we want to establish smart grid, we must depend on advanced power electronics technology. With the development of the society and the progress of era, the development of economy and science and technology are also very rapid. Therefore, the demand for energy is growing, and the average power grid is aging fast. That leads to the high accident rate and based on the reasons above, in order to meet the needs of times development, our country must use the advanced smart grid, on the basis of the advanced sensing measurement and communication technology. The advanced power electronics technology is the key to smart grid construction. The construction of smart grid really plays an important role in society.

### KEYWORDS

Power electronics technology; Smart grid.



## INTRODUCTION

With the continuous development of our country, the demand for energy is also growing. Along with the economic development and the progress of the era, the increasing scientific and technological level lead to increasingly serious the resources and environment problems nowadays. The development of the power grid will confront greater difficulties. Establishing a smart grid is the inevitable choice of the electric power development, but the establishment of the smart grid must rely on modern information technology and reasonable control of technology and communication. Only the development of smart grid can get the world to continuously meet the needs for the future development of energy. At present, the national power grid has the independent innovation as the development of the fundamental basis points, to have construction of informatization, automation, interaction characteristics of smart grid. The establishment of a smart grid for the sustainable development of our country has important strategic significance. Strong Safety Function

## ADVANTAGES OF POWER ELECTRONICS TECHNOLOGY

### Strong safety function

Smart grid itself is an interactive system. Therefore, in the process of running, the power grid changes all the time in order to adapt to the change in the system and the environment and to meet the demand of customers. Because of this, the smart grid requires excellent response ability and good adaptability. Power electronics technology can rightly meet demand for safety performance of the smart grid. At present, the power grid in the power electronics technology is basically done via different forms of independent innovation. In relevant industries we have created fostering points, and have made some progress in various aspects, such as the ability to improve the power grid transmission and distribution, to reduce the fault loss, to improve power grid power supply quality and to shorten the recovery time after fault and so on. We really have made new breakthrough. Estimating from current situation, in the future, the construction of the smart grid in China is bound to put forward new requirements of the advanced power electronics technology so as to promote the continuous development of power electronics technology.

China's power grid space truss structure is relatively weak in comparison with some other countries. In the aspects of carrying electricity and distribution, we still need to improve our skills. Hence, currently, we must put more efforts on transmission equipment research and development. The development of the power grid, interconnection of large power grid is the inevitable trend of the future of power grid development all over the world. Direct current (dc) of our country's large power grid structure is complicated, so the difficulty of control will also be increased accordingly. In addition, the natural disasters in our country are very frequent, so the power grid safety performance will be affected by this feature. In this case, we must use the advanced power electronics technology to improve the safety of power grid in our country. Power electronics technology can effectively adjust the current distribution of power grid, enhance space truss structure of power grid in our country and reduce the spread of the power grid failure rate. Moreover, the advanced power electronics technology can effectively improve the power grid under various fault self-healing ability, improve the operation of the power grid in China from overall level and can better contribute to social development.

### The promotion of renewable energy

The spatial distribution of energy in our country is not balanced, wind energy and PV energy is mainly distributed in northeast, north China, northwest and north region, by 2020 China's wind power will reach 100 ~ 150 gigawatts (gw). The size of the photovoltaic power generation will reach 20 gw. China will then focus on the development of large quantities of thousands of kilowatt wind power station, and the development characteristics of the solar power station simultaneously. In the face of

renewable energy's discontinuity and uncertainty, the security and stability of the power grid will face a bigger challenge. Thus we want to establish a smart grid, realizing the scheduling and control of renewable energy. The implement of the controlling power is the premise to promote the development of renewable energy. To realize the scheduling and control of the renewable energy, we have to use the advanced power electronics technology. It can effectively guarantee the renewable power of mass transportation, improve the power grid in order to improve the clean energy, and increase the proportion in total energy consumption, reducing the pollution of the environment.

### Improvement of electric power quality

With the continuous development of economy and the overall progress of science and technology, productivity is also in constant increase. The power grid transmission of power quality problem has got more and more attention from people. Relevant data show that in the United States, due to the power quality problems, the loss has reached hundreds of billions of dollars a year. In addition, users' participation degree of electric power market is more and more deep, which leads to the closer connection between the power supply the user. So how to improve the utilization ratio of energy is what we should all be concerned. Using the advanced power electronics technology and equipment will be beneficial to solve the problem of power grid transmission quality. Apart from this, the use of power electronics technology can improve the distribution efficiency of the power grid, the realization of the maximum for users with high quality, and the electricity supply for colleges and universities. The chart below shows the specific situation (see Figure 1):



Figure 1 : The economic loss is decreasing year by year, which means the quality of electric power is getting better.

### Stronger security performance

At present, the applications of the power electronics technology in power systems has made great progress, but, so far our country has no further breakthrough on the power electronics equipment to evaluate the reliability of the system. So the problem to be solved now is to set up a perfect system for electronic electronics equipment to evaluate the safety and reliability. To safely use electronic electronics equipment is one of the important tasks in establishing a smart grid, because in the process of the operation of the power grid there will be a large number of electronic power converter technologies. Therefore, our country has begun the research work in the field to deal with stability problems. At present problems still exist in the simulation technology of our country. These problems hindered the power electronics technology development. That's why we must establish a unified, perfect electronic power simulation platform, and carry out thorough researches in order to facilitate the promotion of the comprehensive reliability of the power systems in China.

### Beneficial to energy conservation and emission reduction

Research shows that it is an extremely arduous historic work for the electric power enterprises to carry out the energy conservation and emission reduction work. This requires long-term efforts and struggle. Also the increasingly serious environmental pollution leads to the urgent need of clean energy for all countries, not only because clean energy will not cause environmental pollution, but

also because it is helpful to the establishment of the smart grid. At present, China's demand for the clean energy is increasing constantly, much higher than the requirement of environment. Therefore we must break through the power electronics technology to realize the leap-forward development of the power grid in our country. The technical bottleneck, power electronics technology can effectively improve the power electronics equipment stability and the reliability in the transmission process, improve the power grid transmission capacity. In this way, it will save resources, realizing energy conservation and emission reduction.

Along with the development of science and technology, the impact of power electronics technology's energy conservation and emission reduction has become more and more obvious (see Figure 2).

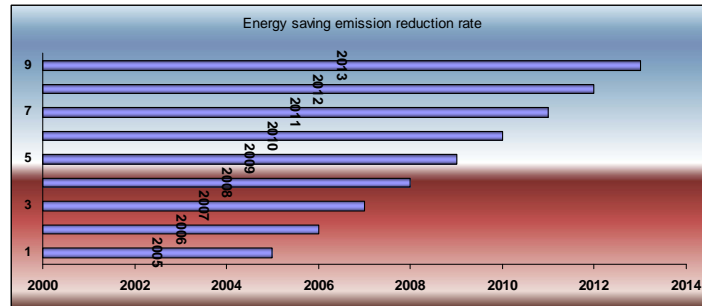


Figure2 : Energy saving emission reduction rate

As the chart shows, the impact of power electronics technology's energy conservation and emission reduction has become stronger, so has its benefits. Therefore, we need to put more efforts on the research of power electronics technology.

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## THE FEATURE OF POWER ELECTRONICS TECHNOLOGY

All under control: It is a device based on the run control of common brake pipe research and its development. It has made great breakthrough on the function, and has realized the full automation in the device, getting rid of the previous complex commutation circuit. The process of transmission has become simpler. High frequency: it refers to the implementation of integrated circuit devices while improving the machine's working frequency. In other words, we now do a lot more work than before so the total work also increases. From a certain point of view, this characteristic is also conducive to energy conservation and emission reduction. Integrated: It means integrating components of many units in order to achieve better future management. High efficiency: High frequency will directly affect the production efficiency of the device. The higher working frequency will also lead to higher working efficiency. While the devices conduction voltage of the power electronics drops, the conduction loss will also decrease. Instead, it will greatly enhance operation efficiency, and will further enhance the work efficiency of the device.

## THE FACTS SKILL OF SMART GRID

### Overview of FACTS

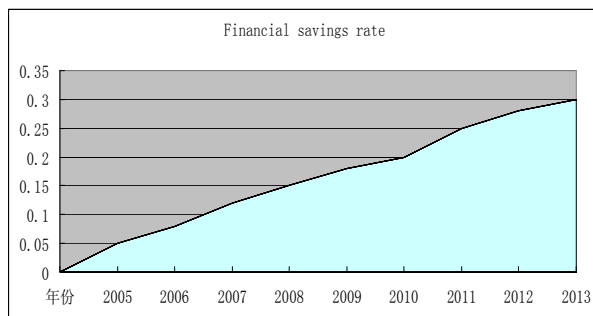
FACTS technology refers to the skill which uses electronic electronics equipment as the foundation and combines modern control technology to realize the control of the power grid. It is applied to achieve the power grid transmission capacity, stability and reliability to the purpose of maximizing a set of power electronic control technology. With the increasing of China's comprehensive

national strength, the electric power development in our country has made great progress. For example, in the field of power electronic devices, our country has developed greatly. With the development of power electronics devices, FACTS technology has been transformed from the device of static reactive power compensator which relies on the plate from the original control to unified power flow controller technology. It is a great leap.

Is not hard to see that China's energy distributed and distribution of demand is a reverse one. So objectively energy calls for a wide range of a shift in strategy. This will require a substantial boost transmission capacity and bearing capacity, such as west power to east project. It requires power grid to have more strengthened transmission capacity and the ability to resist disasters. At the same time, in the trend of the regulation and control, voltage instability and other issues also need to be solved in the process of energy transmission. FACTS technology can control and adjust most of the problems of the power transmission grid. Its powerful control function is needed for establishing a smart grid in our country.

**The Application of SVC**

SVC is a kind of transmission equipment. Its most remarkable characteristic is the strong flexibility. It has broad functions such as adjusting the voltage, controlling current, improving the stability of transmission system and strengthening the increase transmission capacity and so on. It is a new method to help our country to establish a smart grid. China imported several sets of SVC equipment from other countries in the 1980s and in 2004, under the auspices of the national power grid; the electric power research institute of China independently developed a set of SVC equipment. Research and development success marks THAT China has fully mastered the SVC system manufacturing technology. The next few years, through the unremitting efforts, SVC power system popularized in our country. SVC has the function of reactive compensation and the trend of optimization, which can not only improve the power grid transmission capacity and transmission efficiency of power quality but can also; improve the power grid security and stability. In addition, it is also suitable for various levels of power grid. The SVC technology has promoted the process of power grid in the intelligent direction in our country. By the year 2009, 20 sets of SVC have been put into use, saving a lot of fiscal expenditure of the government. One set of equipment has saved more than one thousand millions RMB. Below is the Figure 3 about the rate of the growth of the amount of fiscal expenditure SVC saved in these years:



**Figure 3 : Growth of the amount of fiscal expenditure SVC saved in these years**

It is obvious that it goes in a positive direction. Therefore, we should promote the use of SVC technology to reduce expenditure of the state.

**The Application of FACTS**

With the continuous development of economy, productivity is also in constant increase. That leads to a increase in the demand for energy. So our country's power grid is expanding constantly, which caused some problems, such as the short circuit system and the excessive current. Based on the continuous development of FACTS technology, also due to the nationwide promotion, in 2006 and 2007, respectively, the independent research and development of 500 kv controllable shunt reactor and the first set of 500 kv magnetic control shunt reactor were put into use. This symbolized that our country's power grid research has achieved new breakthroughs.

### CONCLUSION

Advanced power electronics technology can effectively improve the integrated function of the power grid. For example, it can "strengthen the bearing capacity of the power grid, optimize of the power grid, protect the security of the power grid transmission, promote the renewable resources, improve the quality of the power grid transmission, and improve reliability of power electronic systems". So the power electronics technology is the foundation of the construction of smart grid. In other words, the development of power electronics technology is the fundamental guarantee of long-term development and is also the intrinsic motivation.

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