

## Research on Application of Electric Power Communication in the Smart Power Grids

Qianhui Gang

Jinzhou Power Supply Branch, State Grid Liaoning Electric Power Supply Co. Ltd  
Jinzhou, China  
1421776227@qq.com

### Abstract

*With the rapid development of science and technology in the respect of electric power, the smartness standard of the power grid improves faster and faster. However, the power grid in the past has failed to keep pace with the needs of the current production. Therefore, it is very necessary to run the real-time, two-way, integrated and high speed communication system for the creation of the smart power grid. The article discusses the new requirements of the smart power grid on the electric power communication and the use of electric power communication in the smart power grid. It also elaborates the meanings of the electric power communication and the smart power grid, analyzing the operation condition of the smart power grid at home and the key performance of electric power communication in the smart power grid. Meanwhile, the paper studies fundamentally the real application of the electric power communication in the smart power grid. With the development of the power industry, the communication network is playing an increasingly vital role in the power system as an important part of modern power system.*

**Keywords:** *electric power communication, smart power grids, power system, application*

### 1. Introduction

Now one of the key components in the intelligent system with high science and technology is the smart power grids. So it is necessary to create the smart power grids in the modern communication networks with two-way, high-speed and integrated network operation, meanwhile, the smart power grids also need to synthesize the advanced control measures and methods, including the sensor measures, decision support system and the use of measuring equipment measures. Through these measures and methods, the smart power grids can ensure the security and stability of the operation. In this case, it is very significant to enhance the use of the smart power grids in the electric power communications [1].

Electric power communication network appears in the society in order to guarantee the safe and stable operation of power system. Electric power communication network, relay protection of power system and control system with the security and stability, dispatching automation system are known as the three pillars which insure the safe and stable operation of power system. Currently, Electric power communication network is the foundation of the power grids dispatching automation, the network operating marketization and the modern management; it is also the important means that ensures the security, stability and economic operation of the power grids and the important infrastructure of the power system. The electric power communication network set the high and strict requirements on the reliability of communication and the quickness and accuracy of protecting and controlling information transmission, and the power sector has the special resource advantage for the development of communication, therefore, the

power companies of most countries in the world established the power system communication network in the form of self-built primarily [2].

In recent years, the country emerged policies in order to support the development of the smart power grids. In 2011, our country entered the stage of all-round construction of the smart power grids. And the development of it prompted bidding and procurement activities of the smart meter, accelerating the growth of smart meters in our market [3]. The development of the global smart grids needs to use the new-type meters to bring opportunities for Chinese enterprises. China's smart meters market driven by the state policy and the stimulation of foreign markets will maintain growth momentum in the next few years. Industry forecasts that the shipments of smart meters will reach 97.8 million in 2016.

Electrical communication is a very important part of the modern power system. Power generation, transmission, substation, power distribution and power consumption of the power system are widely distributed in the broader range of places. Power system requires the communication system with special and affordable services in order to ensure economic and safe power supply and reasonable distribution, achieving centralized management and unified dispatching. At the same time, the high quality and reliable means of communication is an important basis to ensure the security and stability of electric power network's generation and power supply, the physical structure and service object of the electric power communication make electric power communication become the inseparable relationship with the grids. Electric power communication mainly serves the commercial operation, automatic control and the modern management, which guarantees the commercial operation of the electricity market. It is also the basis of control system with the security and stability, dispatching automation system and electricity industry diversification, and the premise of the modern management of power system. With the development of power industry, electric power system communication network is playing an increasingly important role as a vital part of modern electric power system.

## **2. Brief Introduction of Electric Power Communication and Smart Power Grids**

### **2.1. Introduction of Electric Power Communication**

The electric power communication is one of the key components of power system and it can guarantee that electric power system is able to run the overall program smoothly based on the supply of special communications services [4]. The production of electric power need a lot of programs in practical use, so we must ensure that these programs can be scheduled uniformly and managed completely, achieving the safety and economy of the power transportation. It is the stability and integrity of the communication means on the basis of communication system and is also the key conditions of safe distribution and safe power supply from power grids. Electric power communication and distribution network route possess the same service goal and the physical structure with each other, making the power grids and electric power communication system closely linked. Meanwhile, electric power communication is also the measure of the commercialization, modernization and automation control in electric power market, playing an increasingly important role on the development of power system towards modernization.

The purpose of the electric power communication network is to guarantee the safe and stable operation of power system. Usually, electric power communication network, relay protection of power system and control system with the security and stability, dispatching automation system are known as the three pillars which insure the safe and stable operation of power system. Electric power communication network is an important means that can ensure the safe, stable and economic operation of power grids and are an

important infrastructure of power system. Moreover, it is also the foundation of the power grids dispatching automation, the network operating marketization and the modern management.

Power system has potential and the resource advantage in the development of the electric power communication. Potential means that electric power communication has the specialized communication network that covers power systems of the whole country and the rich infrastructure of communication network [5]. Resource advantage firstly embodies in long distance transmission; it means that we can use the transmission line winding cable laying, messenger cable, composite cable of ground power special fiber to rapidly form long-distance communication ability. Electric power special optical cable would be broken by forces with the little possibility. So it possesses the high reliability and ripe technology, especially the ground composite fiber optic cable technology that has been widely used at home. Secondly, in the respect of local transmission, the pole and channel of the power system in the city can be used for communications services, playing an important role in the broadband access network.

## **2.2. Introduction of Smart Power Grids**

Smart power grids are the intelligence of the power grids. Smart power grids is based on the existing, high-speed and bidirectional network, and then realizes the reliable, economic, safe and efficient and environmental goal of power grids through the application of the sensing technology, measurement technology, equipment technology, control methods and the decision support system technology [6]. Its main features contain the motivation, the self-healing, including the users, the power quality against attacks to meet the requirements of the user, access by the different forms of generate electricity and the efficient running of electric power market's enablement and asset optimization.

All the information and steps related to the electric power including the power generation, transmission, substation and electricity in the electrical power system are an important part of the smart power grids. The exploration of the smart power grids is to research a new information-measure of power grids management and controlling, at the same time is also to regulate these measures, making power system meet the requirements of automation and intelligence from power generation to the use of the electric power and making the production and delivery of electric power become safer and more economic than before. The smart power grids are the most important goal of power departments, so they use all kinds of means and measures to promote the advanced measures to associate with a variety of business, getting the biggest economic benefits. Safety is the most fundamental requirement of smart power grids, any element in power grids may impact on the safety. Therefore, the smart power grids need to be able to make the quick response to the software and hardware, immediately ensuring the safety of power grids system.

The relationship between the power grids and the electric power communication network is inseparable. With the rapid development of power grids and the requirement of market-oriented operation, it is necessary to make a plan about electric power communication network with full functions and the complete system because of the promotion of the social development and communication technology development to the electric power communication network, forming the benefits of scale and providing the better service for the power grid and the society.

## **2.3. The Present Operation of Smart Power Grids in Our Country**

So far, electric power communication has been 60 years of history in the development of electric power industry at home. Early power system meets the requirements of dispatching process and accident treatment on a smaller scale through communication ways such as the cable and other similar power line carriers [7]. With the growth of the power load, widely distributed power system gradually becomes a large power system.

The running just based on the phone in the past already cannot satisfy the needs of electricity safely.

In the middle of the twentieth century, electric power technology in China has a new development and large-scale applications, so we put forward the higher requirements to the communication channel capacity, transmission quality and reliability. In this context, many kinds of communication mode appear in the society, such as UHF, microwave, coaxial cable of the multiplex carrier, constituting the special communication network that adapts to the application of power system, at the same time, the scale of the network and the capacity of the channel gain the unprecedented development.

In the 1980 s, with the growing of China's electric power system, dispatches management also become more and more complex, so we need the dispatching automation on the basis of the computers. At the same time, the development of communication technology has also been changing with each passing day and a variety of modern communication technology (such as optical fiber communication, digital microwave communications, satellite communications) have been introduced and widely used.

In the 1990s, the special cable technology of the electric power communication has been mature and widely used, communication network such as packet switching, DDN; ATM has also developed very well. Electric power communication network is the foundation of the smart power grids.

### **3. Current Situation of Electric Power Communication and Smart Power Grids**

#### **3.1. Current Situation of Electric Power Communication**

In our country, the power system communication network belongs to a kind of special communication network. The electric power communication system is usually made up of transmission system with the power sector, power plant and substation, exchange system and terminal equipment. Electric power communication network is the command center of the power grids' operation.

The development of the communication contains the following stages.

- (a) From the open wire and coaxial cable to optical fiber transmission.
- (b) From the vertical and horizontal exchange to SPC exchange.
- (c) A few large changes from hardware to software technology.
- (d) From fixed-point communication to mobile communication.
- (f) From the discard analog to digital communication network.

The electric power communication network of our country has a large change with the development of communication technology. Now, with the increasingly competition of information technology, the cross penetration and competition of cross-industry technology has been increasingly obvious, making the electric power communication become reasonably the important infrastructure and the nerve center of power system, and the high-tech pioneers of industry that leads the new trend of the electric power technology. Based on the efforts of many years, the installed capacity of power generation equipment, the amount of generation and power grids scale in our country lead the world, forming the regional, provincial and regional power system with the large power plants and center cities at its core and the transmission lines in different voltage grades as its frame. In order to synchronize the development of the power grids, electric power communication of our country has made great progress in decades, playing an increasingly important role in the modern electric power production and management [8].

### **3.2. Current Situation of Smart Power Grids**

#### **(A) The grids is not safe and stable**

Through the use of the smart grids at present, the unsafe conditions of the grids appear frequently. It means that the physical system may exist the situation of the power balance, the load bus node power balance has problems, or nodes and the load reactive power consumption have the problems of imbalance. The grids become not safe certainly because of the existence of these situations.

#### **(B) The problems of safety management**

In the real use of modern intelligent power, the security problem has always been a crucial problem. If the problem cannot be settled immediately, it is likely to trigger a series of unsafe troubles. Ultimately, because the safety management work does not carry out very well without scientific and reasonable ways; But power units focus on the engineering section, so if you want to pass this way to deal with all kinds of security situations, it is not the actual way. If we don't transform the corrosion and aging of equipment immediately, the potential safety hazard may also exist in the system.

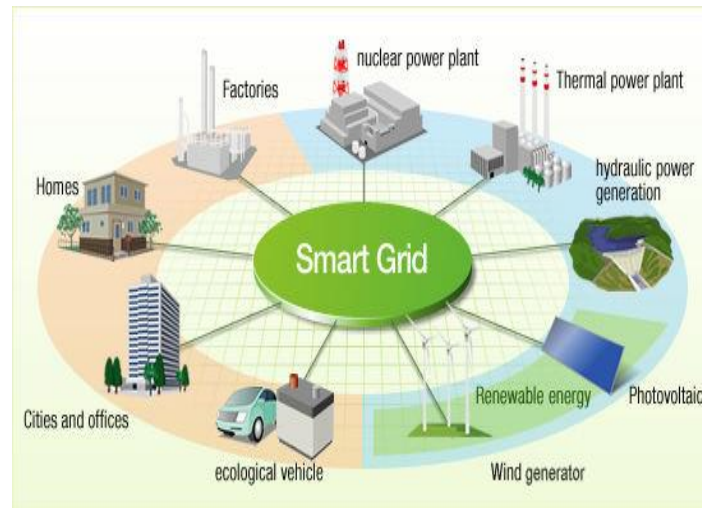
#### **(C) The quality of the operators themselves**

The low level of the operators' quality is also a vital problem. The quality and status of smart power grids will be affected by the operators' quality in practice, the operating level of smart power grids become different because of the quality of the operators.

## **4. The Application of Electric Power Communication in Smart Power Grids**

### **4.1. Application Analysis**

Now, electric power communication becomes the key communication equipment in the smart power grids. The good cooperation between them is also the key problem whether they can promote their levels with each other. Only making a unified plan for the structure of the smart power grids can ensure the safety and stability of the smart power grids. In practice, the electric power communication is an open network system, which needs to have the mutual reliable link between the related equipment. The measures of electric power communication can extend to the end part of the grids system, such as power generation, transmission, substation equipment and the use of power equipment at the end. The electric power communication is safe, stable, it can be resistant to bad attack in the environment and guarantee the safety and stable operation of communication power grids. The use and development of electricity communication should carry out based on increasing fundamental equipment investment, and we need to harmonize power equipment to set up the connection with the environmental protection, promoting the modern electric power network system, and strengthening the overall infrastructure of power grids.



**Figure 1. The Application of the Smart Grids**

Like the traditional electric power industry, the operation of smart power grids can also divide into five parts including power generation, transmission, substation, power distribution and power consumption, however, it is essential to have the information support in the construction and operation of smart power grids. By the cognitive of the industry, the smart power grids have three features including information, automation and interaction, and the Internet of things is the important driving force of these features. The application of Internet technology plays an important role in the information collection, intelligent information processing, and information two-way communication of the smart power grids in power generation, transmission, substation, power distribution and electricity. Through the use of the Internet of things, we can improve the existing transmission capacity and utilization rate of power equipment at all levels, the security and reliability of power grids and the power quality and power efficiency of the user, and provide more intelligent and personalized service for users, which will bring the positive influence on the construction of smart power grids. The application of the smart grids has shown in Figure 1.

#### **4.2. The Function of Electric Power Communication in the Modern Smart Power Grids**

In actual operation, the electric power communication plays a vital role in the smart power grids now, the creation of the smart power grids system in our country is related to the national economy and people lives, which keeps so close relationship with the creation and the implementation of the development of China's new energy. Electric power communication network in the future will certainly be universal coverage of the whole electric power system, which can communicate with the users very well. The creation of the electric power communication system is a fundamental construction project in the building program of smart power grids now. As the key point of electric power operation and management work in the modern system of smart power grids and the key guarantee of the modern power grids' scheduling, the construction of substation automation, the marketization of network and the modern management, the electric power communication plays an increasingly important role in order to ensure the stability, security and economy of its operation.

It is obvious that power communications platform is the fundamental method of the smart power grids in the creation of its system. The key structure of electric power communication private network contains the power generation, the transmission, the

substation and the power distribution system, and also includes the electricity, the scheduling system. If we want to enhance the use of electric power communication in the modern smart power grids, we must know about the fundamental device of the supporting communication, the value of electric power network and their related steps. In order to pay more attention to the electric power communication in the construction of smart power grids, it must become a crucial research emphasis in the creation and the development process of power system, which also completed the effective use and the sustainable development of the electric power communication in the smart power grids. Through the international cooperation and the moderate introduction of the advanced measures of electric power communication abroad now. It is fundamental and guaranteed to create a scientific and reasonable system of power network for the use of modern electric power communication in the smart power grids.

Electric power communication plays an important role in the smart power grids. As the private network of power communications for supporting the smart power grids, the private network will realize the complete coverage in the whole links of power system and the two-way interaction with customers because the construction of smart power grids is related to national economy and people's livelihood and the national energy strategy. At the same time, the private network construction of the power communication in the smart power grids is a major infrastructure project related to the national security and energy strategy. The demand of the smart power grids for electric power communication is embodied in the following aspects:

(a) In the smart power grids, power communications platform is not only a communication channel but also an important part of smart power grids, which need to make the unified plan with the business of smart power grids;

(b) The electric power communication platform is open network architecture with a general communication standard. The information between the devices can be exchanged and operated with each other.

(c) The electric power communication network can be extended to power generation, electricity transmission & transformation facilities and terminal equipment, such as electricity grids, which can support the data acquisition, protection and control business of the smart power grids;

(d) The good reliability and confidentiality of electric power communication platform can resist the hacker or unlawful attack. Electric power communication is the core backbone of the smart power grids in the production, operation and management of electric power enterprise, and is also the basis of power grids dispatching automation, network operations and management modernization, the important means of the guarantee of the stability, safety and economic operation of the power grids. Electric power communication private network platform is the extremely important means to support the construction of the smart power grids, being composed of the power generation, transmission, substation, power distribution, and utilization and scheduling. We must understand the importance of the establishment of the comprehensive of sin and power network, carefully sorting out the thoughts and points of them.

The basis of the smart power grids is to build a high-speed, bidirectional, real-time, integrated communication system; any characteristic of smart power grids is inseparable from the communication system. The data acquisition, protection and control of the smart power grids need the support of communication system. The Establishment of the communication system is the first step of the smart power grids. High-speed, bidirectional, real-time, integrated communication system can make the smart power grids become the large infrastructure of the dynamic, real-time information, power exchange interaction. After the completion of system, it can improve the supply reliability of the power grids

and the utilization rate of assets, flourishing the electric power market, resisting the attack and eventually improving the value of the power grids [9].

## **5. The Problems and Challenges of Electric Power Communication in the Smart Power Grids**

In the smart power grids, the communications platform is not only communication channel but also an extremely important part of the smart power grids, so we need to cooperate with the business of smart power grids and make the unified plan. Electric power communication platform is open network architecture and the universal communications standards. The information between the devices can be exchanged and operated with each other. The electric power communication network can be extended to power generation, electricity transmission & transformation facilities and terminal equipment, such as electricity grids, which can support the data acquisition, protection and control business of the smart power grids; The existing problem is the lack of mass, two-way, real-time communication access network. The challenges the electric power communication faces under the condition of the smart power grids is the following respects:

(a) To grasp the foundation and the indigenous innovation, and it is wrong that we are not worth the candle. The root of the smart power grids is energy conservation and emissions reduction. The root of the electric power communication is to ensure the production. The indigenous innovation is the basic national policy of the country. Anyone of the rapid development of economy in the history is inseparable from the technology innovation. Energy industry represented by the smart power grids is the main body of the next generation of technological innovation and economic development. Specific measures: firstly holding the distribution network and large users, then slowly grasping residents' users and smart meters. The residential users is not sensitive to the power's price in China, and the reform of the electricity market in China is not thorough, in addition, the electric power communication in China has no right of the operation [10].

(b) A serious shortage of human resources, communications personnel and related professional resources: in the last five years, communication resources and equipment at least tripled, and the quantity of communications professionals increase slowly; the construction of communication access network in the smart power grids is not available.

## **6. Conclusion**

In the creation and development of the smart power grids system, electric power communication has the crucial influence on it. Based on the uniqueness and the large-scale characteristics of the smart power grids industry, it is important to make power communication become perfect for creating the excellent, high efficiency modern system of smart power grids. This is the trend that can also show the value of electricity communication measures in the modern intelligent power grids.

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### Author



**Qianhui Gang**, had received the B.E. degree from Shenyang Institute of Engineering, Liaoning, China in 2013 and will get a Master's degree from Northeastern University. She is currently working in Jinzhou Power Supply Branch, State Grid Liaoning Electric Power Supply Co. Ltd.

