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Application of Power Information Communication in Smart Grid

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Abstract

With the acceleration of my country's power grid informatization process, the construction of intelligent power grids is becoming more and more perfect. In the current power grid informatization development, the application of power information and communication technology has also shown good results and values. How- ever, how to better ensure that information and communication play a role in the smart grid is particularly important, which is a problem worthy of in-depth study and discussion.

Keywords

Power communication; Smart grid; Power system; Power supply and distribution

Introduction

In modern power systems, power communications are a crucial component. Power systems also place high demands on grid security, and communications systems provide exceptional security. In smart grids, communication systems are increasingly widely used. Therefore, secure and reliable power communications are crucial for ensuring a secure and stable power supply. Power communications underpin the market-based operation of the power sector, and the development of power systems has driven my country's smart grid. As the power market continues to improve, the safe operation of the power system is becoming increasingly important, while also placing greater emphasis on cost-effectiveness and efficiency to ensure stable operation.

1. Overview of Power Information Communication and Smart Grid

1.1 Overview of power information communication

The power information communication system is an important part of the power system. It plays a very critical role in the entire process of power generation, transformation, transmission and distribution in the power system, and is a special communication service. There are many links in the production and use of electricity. To ensure the dispatching and centralized management of each link, economical and safe transmission and distribution can be achieved. Therefore, reliable communication methods and good communication systems are necessary as a guarantee (Yang, 2020). Since power communication and distribution networks have common business objects and interdependent entity structures, they are closely related to smart grids. Power information communication has also promoted the development of informatization and automation in the power market. At the same time, modern control methods play an increasingly important role in the modernization process of the power system.

1.2 Overview of smart grid

Smart grids primarily focus on processing all power-related data and information within power systems, including

power generation, transmission, and transformation. By integrating advanced management, control, and information technologies, these technologies can be combined to make power production and transmission safer, more reliable, more economical, and more practical. Smart grid development is a primary goal for major power companies, integrating advanced technologies with diverse business operations through various means to maximize economic benefits. Security is the most fundamental and critical requirement of smart grids. Any factor in the network can impact grid security. Therefore, smart grids must be able to address these issues promptly and rapidly to ensure grid stability.

2. Relationship between Power Information Communication and Smart Grid

In the new historical period, the use of power systems is inseparable from the power information communication network. From this point of view, the connection between smart grids and power information communication is becoming increasingly close. With the development of society and economy, power companies have actively carried out market-oriented operations, improved the power information communication network, maximized its functions, and improved the level of social services. From the current research situation, in China's traditional power system, the application of power lines and power line carriers is relatively common. They are the main means of realizing power information communication. Their application scope is relatively specific. Their main function is to handle emergencies and realize the command and dispatch of emergencies (Gao, 2020). However, with the development of power companies, the load of power systems is also gradually increasing. The traditional dispatching method mainly relies on telephone dispatching, resulting in the inability to operate quickly and conveniently. Therefore, under this situation, especially with the emergence of ultra-high frequency, microwave and other power communications, with the increase of national investment, the scale of power grid construction continues to increase, the dispatching and management of power grids are becoming more and more complicated, and with the popularization of computers, the degree of automation of power dispatching is also getting higher and higher. From this point of view, China's power grid construction scale and technical level have made great progress, and the combination of smart grids and power information communication will become closer and closer.

3. The Role of Power Information Communication in Building Smart Grids

3.1 Power information communication promotes the establishment of intelligent optical fiber communication networks

An intelligent optical fiber network (ION) is a transmission and communication network capable of automatic switching, offering greater flexibility and efficiency than traditional communication methods. In practical applications, ION leverages dynamic structural components at the user end to proactively request service. Based on this, ION utilizes signaling instructions to effectively control power communications, enabling intelligent transmission of power system data and information. With the advent of fiber-optic communication networks, the transmission speed of power communication networks has been significantly improved, thereby reducing service time and significantly shortening user wait times.

3.2 Power information communication provides the most basic access network for smart grid

The smart grid access network refers to the network of access terminals that provides power supply companies' customers with a variety of power supply options and interacts with them through information and communication. The smart grid access network utilizes a PLC-based power information channel, a unique communication technology that plays an irreplaceable role in building intelligent networks. Furthermore, current domestic power information transmission systems mostly utilize wireless or wired broadband networks provided by telecommunications companies, which together form the basic access network for smart grids.

3.3 Power information communication provides services for the production and operation of smart grids

Smart grid construction is based on a fast, two-way information and communication network, employing modern control, ranging, and sensing technologies to achieve comprehensive control of the power system. Power information and communication are crucial in every aspect of smart grid operations, including production, operations, and management. With the rapid development of smart grids, users can now operate, manage, and construct smart grids without being constrained by time and space, achieving true compatibility between data and voice networks and truly

realizing the integration of data and voice networks.

4. Smart Grid Requirements for Power Information Communications

With the development of intelligent networks, the number of network types is increasing, and network operations are becoming increasingly complex. This requires full-process, all-round monitoring and analysis of the power grid, as well as the collection and processing of various dynamic data. Smart grids require the power information and communication system to have the following functional modules:

4.1 SIS system

The SIS, or Instant Information System, processes and analyzes operational data from the power system. Based on internet technology and supplemented by the State Grid, it makes power information publicly available and plays a crucial role in protecting and isolating it.

4.2 EMS system

EMS, or Element Management System, primarily aggregates real-time data from monitoring and acquisition systems within the power network, categorizes it according to its emergency response capabilities, and transmits more urgent data to real-time information systems. Because the volume and type of information vary, the transmission interface speeds also vary. Therefore, in emergencies, real-time data can be transmitted promptly and efficiently, further improving the efficiency of emergency response.

4.3 Electricity metering system

The demand for electricity in smart grids far exceeds that of traditional grids. Smart grids must not only have conventional metering functions, but also have the ability to accumulate data in different time periods and perform two-way metering. This is very important for the electricity billing and energy control of smart grids. In addition, smart grids must also have functions such as automatic collection, pre-processing, remote transmission, and storage. In addition, analysis and statistics are prerequisites for the future integration of smart grids and new energy networks (Jiang, 2021).

4.4 Demand-side management system

Current smart grids rely on wireless public networks to exchange information with a wide range of electricity users. Consequently, the number of end users (and, consequently, network nodes) is large, while the scale of services is relatively small. Advanced communications technologies, such as those enabling real-time and accurate understanding of electricity users, are the current direction of smart grid development.

5. Application of Information and Communication in Smart Grid

5.1 Application of information and communication in smart grid transmission

Smart grid transmission is a critical component in power system operations, especially as the scale of current smart grids continues to expand. As communication distances increase, power system transmission demands are also increasing. Therefore, the development of smart grids must receive substantial attention. To improve power transmission efficiency, it is essential to ensure the orderly implementation of condition monitoring. Real-time monitoring of various faults and issues, along with intelligent analysis of abnormal faults, ensures the normal operation of smart grids and further enhances transmission accuracy. This condition monitoring also requires the transmission and processing of relevant information, which involves the use of information communication and the adoption of appropriate communication methods to ensure that information communication meets basic transmission, distribution, and control requirements, truly improving transmission capabilities and meeting the diverse needs of users.

5.2 Application of information communication in smart grid substation

Smart substations play a crucial role in the operation of smart grids, and their practical application relies on the support of information and communications. Within smart grids, information technology is applied across multiple

areas, including sensing, control, and communication. These areas all require effective control through information technology, ensuring both safe and reliable operation of the smart grid. To prevent power system failures within smart grids, intelligent analysis and processing of various faults are required to maximize the efficiency of the power system.

5.3 Application of information and communication in smart grid distribution

The distribution link in a smart grid aims to optimize the distribution network's structure and improve its operational reliability. Simultaneously, it rationally configures existing distributed power sources and energy storage units to improve system efficiency and meet user requirements. In this process, the application of information technology primarily aims to better monitor the operation of the smart grid, thereby improving system efficiency. It plays a particularly important role in the analysis and processing of various data.

5.4 Application of information and communication in smart grid security

For smart grids, network security is crucial, directly impacting the overall grid's operational efficiency and the safety of its users. The scientific application of communication network technologies not only ensures network security but also improves overall performance. With the increasing importance of information security, a comprehensive monitoring system is essential in smart grids to encrypt and protect all data, maximizing its value.

5.5 Application of information and communication in the new energy field

Energy in nature is primarily divided into two categories: renewable and non-renewable. For example, wind and solar energy are renewable and can be recycled indefinitely. However, resources like coal and oil, which cannot be regenerated for a long time after extraction, are non-renewable. The development of smart grids aims to eliminate the overuse of non-renewable energy and expand the application of renewable resources. This requires in-depth research on the integration and control of renewable energy sources to ensure their smooth integration into the grid. Therefore, to achieve automatic grid voltage and power adjustment after the integration of renewable energy sources, the establishment of corresponding standard power information and communication interfaces is necessary. Furthermore, power information and communication systems can effectively control the generation process of renewable energy.

5.6 Application of information and communication in electricity business processes

Compared with traditional power systems, smart grids have a higher degree of automation in practical applications. This technology can promote the rapid, accurate and timely collection and organization of relevant data by power systems, and conduct rapid analysis on them, thereby promoting the optimization of various businesses. For example, automatic meter reading, measurement, billing and other tasks are all completed under the full use of power communication technology. In actual use, the device can obtain the status of equipment in various areas of the power grid in real time, including user measurement data. After collecting relevant information, it is analyzed and organized through the network, classified according to emergency situations, and there will be corresponding client support when it is used (Zhang, 2022).

6. Key Points for the Application of Power Information Communication in Smart Grids

In order to ensure that power information communication is fully utilized in smart grids, the following goals must be achieved: First, power information communication is the main communication means of smart grids, so its functions must be fully utilized. Therefore, it should be incorporated into the overall planning of the entire smart grid and built into an open network platform to achieve interconnection with smart grid equipment; second, power information communication technology can be applied to the end of the smart grid, such as in power generation equipment, power supply equipment and even end-user equipment. Its reliability and defensiveness are important guarantees for ensuring the safety and stability of the power grid; finally, we must increase support for power information communication, coordinate in all aspects of power grid construction, accelerate the integrated construction of smart grids, and promote the informatization and automation development of smart grids.

7. Conclusion

Currently, information and communication technologies in smart grids are primarily used in power distribution,

transmission, and transformation, and are also widely utilized in areas such as grid security, playing an irreplaceable role in urban construction and development. However, since modern smart grid technology is still in its early stages and has only been around for a short time, practical implementation is bound to encounter some challenges. Furthermore, my country's application of smart grid technology must keep pace with the times and adapt to the trends of the times and technological development. Only through continuous breakthroughs and innovation can we successfully complete the construction of the nation's smart grid and better safeguard its economic development.

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