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Research Paper on Network Automation

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Abstract-In this paper the conception, feature and Technical Composition of NETWORK AUTOMATION is expounded, and the development process and present research status of smart grid home and abroad as well as the practical significance of developing smart grid in China are introduced. The paper analyzes the characteristics and direction of China's NETWORK AUTOMATION development, and point out that the development of NETWORK AUTOMATION requires the development of many network automation technologies and the building of grid structure, and detailed describes the realization of the self-healing function as well as distributed power generation technology.

I. INTRODUCTION

In recent years, in face of growing pressure on resources and the environment, and in order to solve the distributed energy grid connection, while building a more secure, reliable, environmentally friendly and economic power system, many countries put forward the network automation development plans. Smart grid applies many new technologies, such as grid control technology, information technology and management techniques, and covers power generation, transmission, substations, power distribution, electricity, scheduling and information of all aspects of power systems, thereby achieving a high degree of integration and unity of power flow, information flow and business flow.

II. CONCEPT

So far, there is no uniform definition about smart grid in the word, and the focus of the development of smart grid also varies. The goal of American network automation is to address the aging of the distribution network, improve service levels, and enhance user interaction. The focus of the development of network automation in Europe is to promote renewable energy use, so that the power industry meets the efficient, flexible, environmentally friendly and conducive to market-oriented and other requirements.[1,2]

Tianjin University, Academician Yu Yixin gives the following definition: Smart Grid is a fully automated power network, in which each user and node can be real-time monitored, and make sure of the two-way flow of the current and information on every point from power stations to the client. Through the extensive use of distributed intelligence , broadband communications and the integration of automatic control system, smart grid can ensure that the market transactions online in real time, as well as seamless connectivity and real-time interaction among all members of power system.[3]

III. THE MAIN FEATURESOF NETWORK AUTOMATION

A. Self-Healing

It is continuous on-line assessment and pre-control of power grid failure, as well as the failure of the automatic recovery.

B. Interactive

The system can achieve the intelligent interactions between grid Corporation and customers to achieve energy flow, information flow and capital flow two- way interaction.

C. Strong

Namely better identify and respond to man- made and natural disasters, protection, information security.

D. Optimization

Namely Improve asset utilization, effective in reducing operation and maintenance costs and investment costs, reduce power losses.

E. Compatibility

Centralized power generation, distributed power generation and energy storage unit is compatible.

F. Integration

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It includes process optimization, information integration and the standardization and refinement of the management.

IV. THE COMPARISON BETWEEN EXISTING AND NETWORK AUTOMATION

For the power system in the new century facing challenges of the distributed power grid, power grids, the low utilization factor, as well as the application of digital technology, the concept of smart grid has been put forward. Compared with the traditional power grid, smart grid in all aspects of power system has obvious advantages and characteristics. Table 1 provides the comparison between the current grid and smart grid.

Table I comparison between the current grid and smart grid

	Current Grid	Smart Grid
Communication	No orone-way	Two-way
Interaction with the user	seldom	Many

A. Advanced Metering Infrastructure(AMI)

AMI is a critical infrastructure for its development, its main function is to empower the user, allowing the system to establish contact with the load, and allowing users to support the power grid operation. It includes smart meters, wide-area network facilities, home networking, marking the data management systems, operating checkpoints and so on. Figure 1 describes the interface between the AMI technology and several other technologies.

1) Smart meters serve as a sensor network to achieve information exchange between load-side and network, its main functions are hourly pricing, power quality detection, remote switching function and pre-paid fees function.

2) Communications equipment achieves two-way information Interaction among power companies and the users, whose main means of communication including technology and ZigBee technology.

3) Meter data management system is a analysis database, Able to interact with other information systems. Its main function is to conduct the legitimacy authentication, editing and evaluation for AMI data to ensure that the AMI data taken into the system is complete,and accurate.

4) Run pass is used for the AMI to interact with many other system-level application layers to achieve the various functions.

B. Advanced Distribution Operation (ADO)

The traditional power distribution automation focuses on automatic control of power distribution circuit switch, but ADO Is a complete automation of all control devices and function, with the purpose of achieving self-healing capabilities of smart grid.

Its functions can be divided into:

Advanced Distribution Automation;

Automatic voltage and reactive power control system and power management;

Real-time monitoring of Distribution information and automatic demand response;

To predict and control real-time status of power distribution system;

Distributed energy operation;

Distribution system asset management.

C. Advanced Transmission Operation (ATO)

The goal is to achieve intelligent transmission, and focus on congestion management and reducing the risk of large-scale outages. Its technology components is transmission network compatibility technology and Advanced grid monitoring technology. Among them, transmission network compatibility technology includes special high- voltage transmission technology, superconducting power transmission technology and dynamic fixed transmission line technology. And the transmission network monitoring technology includes wide-area measurement systems and the state detection technology of transmission equipment.

D. Advanced Asset Management (AAM)

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Mainly to achieve the power asset management, significantly improving the power grid operation mode and efficiency.

It mainly divided into four layers: (1) user layer; (2) logic layer; (3) application service layer; (4) system service layer.

Key management is divided into: equipment asset management, defect management, power generation plans and project management, maintenance management, spare parts and industrial equipment management.

V. DOMESTIC AND FOREIGN RESEARCH AND DEVELOPMENT OF SMART GRID

Smart Grid has become the country's development priorities and objectives of the grid, but the country's progress and basis are different. Europe and the United States developed the smart grid research and construction very early, and made a lot of progress. China, Canada, Australia, South and other countries have also started to pay attention to this direction of development of power grid, and actively begin the smart grid research.

National smart grid research-driven factors: energy and environmental issues increasingly serious; grid structure constantly complex; to improve safety and

Efficiency of the power grid operation; improving service quality of power industry; electricity markets open.

A. The U.S Smart Grid

In 2001 the ElectricPower Research created the smart grid alliance to Promote the "IntelliGrid" research. In 2003, the U. S. Department of Energy (DOE) issued a "Grid2030" program that plan the future power grid. 2004 issued the "National transmission technology roadmap",and Grid Wise project launched. At the end of 2007, the United States signed the "Energy and Security Act" to promote the development of smart grid in the policy. In April 2009, the U.S. Government announced smart grid technology investments plan for smart grid development. In June 2009, the United States released a study entitled "IEEE P2030" of smart grid standards and interoperability principles marked the official start of construction of smart grid.

B. The European Smart Grid

Europe has also made a new policy on smart grid. In 2006 the European Council published the plan "European sustainable, competitive and secure energy strategy" , so that smart grid became the key development direction of the European power grid, and smart grid technologies is a part of the plan of Europe Technology Platform (ETP), known as the "smart grid technology platform." Focusing on the future of the European power grid, the objective of smart grid technology platform is to put forward and form the plan of European electricity grid development in 2020 and beyond, to improve the level of service to users and the management of distributed energy generation. Unlike the United States, in order to promote natural gas and other methods widely used in distributed power generation technology, The European Smart Grid will attach attention to distributed generation andmicro-grid.

C. The Chinese Smart Grid

Due to the increasing demand in power, smart grid power systems in China should include power generation, transmission substations, power distribution, electricity and information on all aspects of scheduling, with features of information, digitization, automation, and interaction. In October 2007, East China Power Grid Corporation launched the smart grid project feasibility studies, concerning the Progress of advanced foreign enterprises and research institutions for smart grid research, and put forward the building of smart grid is divided into three phases: from 2009 to 20 I 0 for planning the pilot phase, this stage is to carry out research to develop key technologies and equipment, and the part of tr ml work; from 2011 to 2015 for the comprehensive construction phase, this stage is to initially formed the control and running interactive service system, achieve major breakthroughs and applications in key technology and equipment; From 2016 to 2020 for leading the upgrade stage. 2008 China has begun construction of electricity power users information collection system, plans to use 3-5 years to complete construction of energy information systems as the goal of "full coverage, full collection, all pre-paid". May 2009, China held a special international conference on high-voltage transmission technology, the State Grid Corporation of China published a "strong smart grid" plan to the outside world, and the meeting pointed out that “ultrahigh voltage transmission is critical for the development of smart grid."By 2020 China plans to achieve the staged objective of smart grid development is to achieve optimal allocation of gird resource ,and to achieve "plug and play" distributed power applications, and

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the popularity of smart meters.

VI. THE KEY TECHNOLOGIES INVOLVED IN SMART GRID

A. Strong and Flexible Network Topology

A strong, flexible grid structure is the basis for smart grid. As China's the uneven development of energy distribution and productive forces, in order to meet the needs of economic development, China is to develop long-distance, large-scale Power transmission and resource allocation Optimization. Voltage (UHV) transmission can improve the transmission capacity and reduce transmission losses and increase economic transmission distance, but also have an obvious advantage in saving line corridor area, save project Investment, protect the ecological environment. Therefore, the development of special high-voltage power grid, build power "highway" has become an inevitable choice. With the expansion of the scale grid, the formation of interconnected bulk power system, grid stability and fragility of the security problems are becoming increasingly prominent and requirements on planning and designing the main grid structure be increased. Accordingly, only the flexible grid structure can cope with the ice disaster, war and other unexpected catastrophic events. [12]

B. Smart Grid Communication System

Bi-directional, real-time, integrated communications technology for smart grid must have the following characteristics first, with features of two-way, real-time, reliability. Due to security considerations, in theory, the communication system should be of electricity communication network, isolated with the public network. Second, with advanced technology, it can carry smart grid existing business and future business expansion. Third is with independent intellectual property rights, and with the ability of power business custom development and business scalability.

C. Advanced Power Electronics Technology

Electronics technology is a modem technology by using power electronic devices to transform and control power, and energy-saving effect can be up to 10% to 40%, and reduce the volume of mechanical and electrical equipment, meanwhile be able to achieve the best efficiency. At present, the semiconductor power devices develop in the direction of high-pressure-based, high capacity-oriented, and the power electronics industry has appeared to SVC as the representative of the flexible AC transmission technology, transmission as the representative of the new ultra-high pressure technology, high frequency as the representative of electric drive technology, intelligent switch as the representative of breaking synchronization technology, as well as static var generator(SVG) and the dynamic voltage restorer Policy. Also allow users to rate their own policy, according to the preparation of a timetable for the internal. As the representative of custom power technology etc. It also includes an emergency command system and use of electricity automation user's strategy. Thus wide area measurement system (WAMS) should be an important direction of development as the power monitoring system In the future as technology advances, smart meters also may be used as the router, based on their end-users to promote the of communication, the broadband running business and television signals transmitted. D. Intelligent scheduling technology and wide-area protection system Smart scheduling is an important part of smart grid, smart grid scheduling technology support system is the core of the intelligent scheduling research and construction, which is technical foundation of promoting the ability of Scheduling system to control large power grids and optimize the allocation of resources, Risk Defense, Scientific decision-making management, Flexible and efficient regulation and Market deployment. The key technologies of the intelligent Scheduling include: 1) Fast simulation and modeling (FSM). [13] 2) Intelligent early-warning technology. 3) Optimal scheduling technology, 4) Prevention and control technology, incident handling and incident recovery techniques (such as the Fault Identification and 5) Intelligent Data Mining Techniques. 6) Scheduling decision-making visualization technology. 14 It also includes an emergency command system advanced distribution automation and related technologies, which advanced distribution automation system includes system monitoring and control, power distribution system management functions and interaction with the user (such as load management, measurement and real-time pricing) [3]. F. Distributed Energy Access [l6-23} Distributed energy includes distributed generation and distributed energy storage, and smart grid lies in building the intelligent network system with intelligent judgments, adaptive ability and distributed management, which can monitor and collect power information of the network and the user II real-time, and use the most economic and secure transmission and distribution methods to convey electricity to end-users, in order to achieve energy optimal allocation and utilization ,improve grid operations reliability and energy efficiency. Resources have many different types, including hydroelectric power, wind power, solar power, micro turbines, fuel cells and energy storage devices (such as the flywheel, super capacitors, superconducting magnetic energy storage and sodium sulfur batteries etc.).

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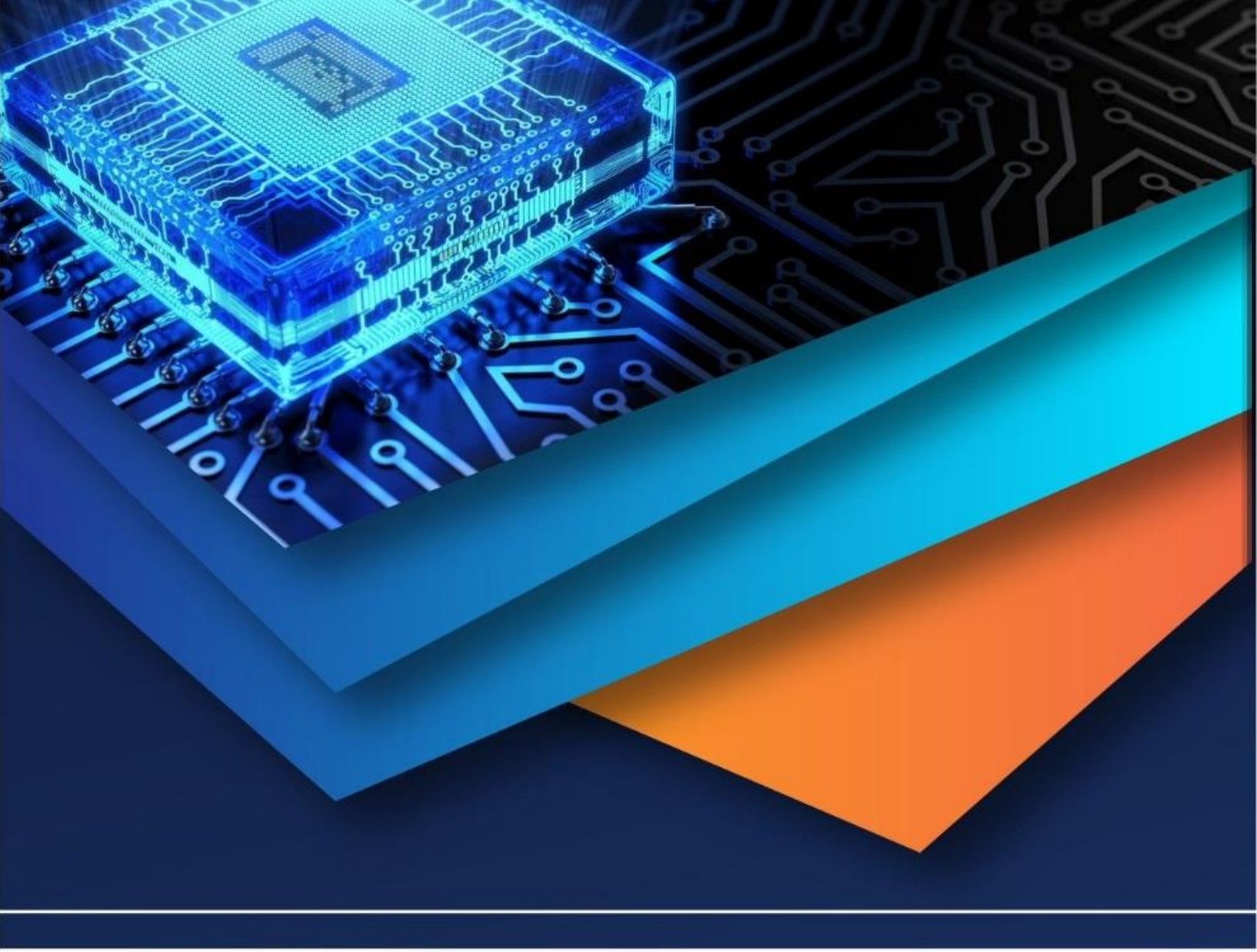
VII. CONCLUSION

With the social and economic development, and increasingly highlighted problems of energy shortages and environmental, it is continually increasing demands for network reliability, and needs of service quality were more diverse, as well as the requirements of power efficiency has improved markedly. Smart Grid has become an important direction of development of a global power industry [3, 24]. First of all, different from the developed countries, China's urban power grids is relatively weak at failure prediction and Treatment and need to be strengthened (2008 disasters (.15Jand advanced distribution automation and related technologies, which advanced distribution automation system includes system monitoring and control, power distribution system management functions and interaction with the user (such as load management, measurement and real-time pricing) [3]. have led to several provinces and cities in China a long time a large-scale power grid blackout highlighted this need). Considering the actual development of our country, one of our focuses on the development of smart grid should be its "self-healing" feature to protect the power grid as a strong grid. Secondly, the power grid is a linkage system with rapid response, in order to assess the linkage effects that the incident may trigger, we need the support timely decision, but there are some problems that the exact grid model calculations requires a long time, but the accuracy of the simplify model is not enough. Therefore the fast simulation and decision-making of the event has become a research hotspot and difficulty. Thirdly, smart grid which can achieve power generation, transmission, distribution and power integrated is a distributed adaptive system, so it is particularly important of the coordination between the central control systems and the adaptive of Distributed Control System. And currently Multi-Agent technology has been widely used. Agent-oriented following the process-oriented and object-oriented is the new software engineering technology [25]. China is developing rapidly with distributed energy generation technologies represented by wind power and photovoltaic power generation, and network operations are an important trend in the development of distributed energy, so another goal of the development of our smart grid should be to solve the system optimization, coordination and control issues after large amounts of distributed grid connection running. In addition, the development of smart grid needs various technologies, including new monitoring techniques and control methods, flexible and reconfigurable network topology, high-speed, bi-directional, integrated communications systems, advanced power electronics technology and distributed power access technology and so on.

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