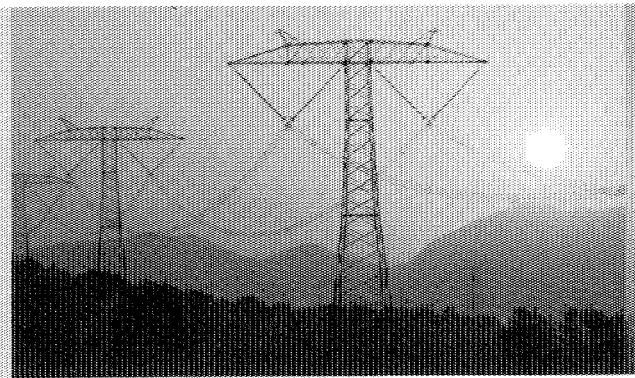
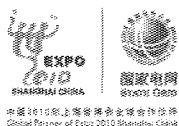




STATE GRID
CORPORATION OF CHINA



SGCC Framework and Roadmap for Strong & Smart Grid Standards



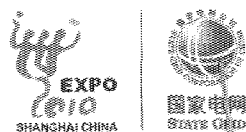
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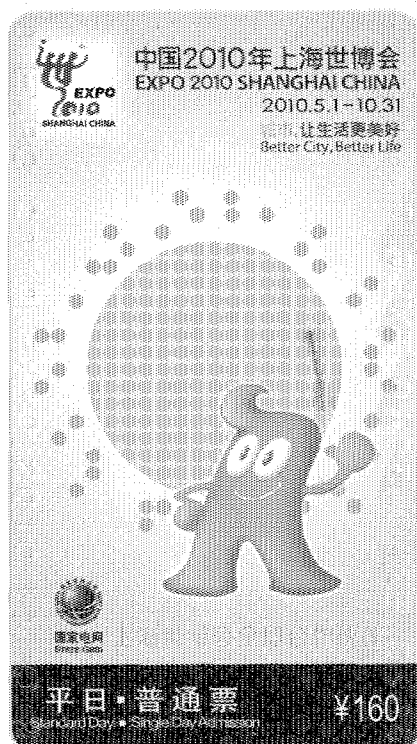
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Preface

Entering the 21st century, a broad consensus has been reached to develop low-carbon economy, promote ecological civilization and realize sustainable development. As a result, the global energy development pattern is experiencing substantial changes, and a new round of energy revolution has unveiled.

This revolution focuses on developing clean energy, protecting energy safety and addressing environmental problems. As a significant part in energy supply, power grid is vital for the development of clean energy, and its development pattern is faced with notable challenges. A large amount of research and practice have been done in the world. As a result, the concept of smart grid takes shape and smart grid becomes a common path for the world power industry to address future challenges.

The Chinese government attaches great importance to the development of smart grid. Chinese President Hu Jintao, when giving a speech at the 15th Academician Conference of Chinese Academy of Sciences on June 7th 2010, pointed out that China aimed to “build a smart, highly efficient and reliable grid system that covers both urban and rural areas”. Chinese Premier Wen Jiabao stated in the Government Work Report in March 2010, that “China will work hard to develop low-carbon technologies; promote application of highly efficient, energy-conserving technologies; develop new and renewable energies; and enhance development of smart grid”.

Faced with new challenges in energy sector, State Grid Corporation of China (SGCC) officially put forward the strategy of building a world-leading strong and smart grid with ultra high voltage grid as its backbone and subordinate grids coordinated at various voltage levels, featured as being IT-based, automated, interactive, based on independent innovation. Up to now, remarkable progress has been made in this regard. By 2020, a smart grid that is robust and reliable, economical and efficient, clean and environment-friendly, transparent and open, user-friendly and interactive is to be established. Since August 2009, SGCC has started 228 demonstration projects of 21 categories in 26 provinces and municipalities. By now, the demonstration projects have been progressing smoothly.

The emerging smart grid has great prospects. The existing standards are not sufficient to meet all the requirements of smart grid. An open and well-established standard architecture is in urgent need.

In March 2009, SGCC started the research on smart grid standard framework. A special working group consisting of over 180 experts was set up. Many of them are from China Electric Power Research Institute (CEPRI), a fully owned subsidiary of SGCC. Based on smart grid demonstration projects and after reviewing thousands of standards, 781 existing international standards and 769 existing domestic standards were intensively studied. The requirement of smart grid and its gap with existing standards was clearly identified.

Incorporating comments from various stakeholders, SGCC Research Report on Smart Grid Standard Framework and Roadmap was completed and released.

The Report expounds the formulating principles, concept model and overall structure of the standard framework, and puts forward a smart grid standard framework and roadmap suitable for China's national characteristics. It consists of 8 domains, 26 technical fields and 92 series of standards. The 8 domains include overall planning, power generation, transmission, substation, distribution, utilization, dispatching, and ICT. This framework is subject to amendment based on the future requirement for smart grid construction and technological development.

Based on SGCC smart grid research findings and standard framework, taking IEC smart grid standardization roadmap and international standardization gap into consideration, SGCC set priorities for international standards and prepared new working item proposals for IEC.

Smart grid standard framework and roadmap serves as the guideline for SGCC to develop corporate smart grid standards, as well as important reference for industrial, national and international standards. Thus, SGCC will develop corporate standards accordingly, actively participate in the formulation of industrial and national standards in China, and make contribution to international standardization.

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1. Overview

1.1 Development Background of Smart Grid

1.1.1 Forthcoming Age of Intelligence

Over the last 200 years, the world has gone through three Industrial Revolutions marked by steam engine, electricity and computer and nuclear energy technologies respectively. The arrival of Steam Engine Age, Electricity Age and Information Age has greatly liberated productivity and accelerated the development of human society.

Looking through the course of social development, a new round of technological revolution ensued every global crisis. After the global financial crisis, many countries have stepped up their efforts to develop clean energy resources, smart grid and internet of things in order to deal with climate change, guarantee energy security and boost economic development. Many intelligent technologies and inventions have been adopted extensively throughout the society. Traditional industries, infrastructure and public sectors have become more intelligent, and emerging industries such as new material and EV, are experiencing rapid development. All these herald the advent of a new age dominated by smart and intelligent design and devices—Age of Intelligence.

1.1.2 Integration of Clean Energy Requires Strong and Smart Grid

Since the arrival of Age of Steam Engine, fossil fuels like coal, oil, natural gas have gradually replaced traditional biomass energy, such as firewood. The exploitation of energy sources has shifted from biosphere to geosphere, which carries great historical significance but leads to energy depletion. It is estimated that if human society continues to follow current energy consumption, major fossil fuel resources will be in grave shortage by the middle of next century. All countries in the world face common task to ensure secure, economical, clean and sustainable energy supply. How to leverage advanced technologies, accelerate the adjustment of energy strategy and utilize new energy sources has become a common concern. Since the start of this century, clean energy has witnessed immense development. From 2000 to 2009, the installed capacity of wind energy in the world grew at an average of 26.1% each year, and doubled every three years. The growth of solar energy is even higher, with installed capacity rising at 36.5% a year, doubling every two years.

In China, clean energy has been developing at an unprecedented speed since 2005. The installed capacity of wind power grew from 1270 MW to 17580 MW in 2009, with a remarkable annual growth rate of 92%. The installed capacity of solar energy is also developing very fast, at 44% per year, doubling every two years. The Chinese government pledged to reduce CO₂ emissions per unit of GDP by 40-45% by 2020, and increase the proportion of non-fossil fuel in primary energy source to 15%. To meet the target, an additional of 130 GW wind power, and 19.70 GW solar power need to be installed, which

will require an annual growth of 20% and 40% respectively. In the next decade, clean energy will continue to grow at high speed.

Due to the intermittence and randomness of renewable energy resources like wind energy and solar energy, the fast and large-scale development of renewable energy sources poses great challenge to the grid safety. Focusing on current needs while keeping an eye on the long-term development, SGCC must step up the development of a power grid with higher carrying capacity, greater security-level and wider range of resource allocation so as to meet socioeconomic requirements.

The construction of strong and smart grid will provide great support for utilizing renewable energy sources in large-scale, reducing the dependence on fossil fuel and enlarging the scope and dimension of energy resources. To a certain extent, the massive use of renewable energy sources and the development of smart grid are at the core of a forthcoming revolution of energy development pattern.

1.1.3 Strong and Smart Grid is Needed to Tackle Climate Change and Environment Deterioration.

In the last few decades, global climate change and worsening ecological environment have cast serious impact on many countries. Smart grid plays an important role to cope with this common problem. On the generation side, massive use of clean energy sources is promoted, and the percentage of fossil fuel consumption is lowered to effectively control greenhouse gas emission by enhancing grid's capability to integrate and optimally allocate clean energy sources. On user side, power consumption efficiency is improved, power consumption pattern is optimized and energy resources are conserved by enlarging the proportion of electricity in energy end-use and encouraging the use of electricity instead of coal, oil and natural gas. The upgrade of smart grid and adoption of smart operation control technologies will optimize the dispatching and operation of power system, achieve rational use of power resources, reduce network loss as well as make the grid environmental-friendly.

1.1.4 Smart Grid is Needed to Optimize Allocation of Energy Resources.

China's energy resources and load centers are unevenly located. Over 2/3 of economically viable hydropower resources are located in the Southwest of China; 76% of coal reserve is located in China's Northern and Western regions, like Shanxi, Inner Mongolia, Shaanxi and Xinjiang; Wind power is concentrated in Inner Mongolia, Xinjiang, Hexi Corridor of Gansu and north part of Northern China; Solar energy is rich in Qinghai Tibet Plateau, North of Gansu and Ningxia, and South of Xinjiang. On the other hand, the energy consumption are concentrated in more developed Eastern and Central China. Due to the restrictions of land, environment and transportation, it is difficult to construct large amounts of new power plants in the eastern parts of China. China's western regions have rich power generation resources but limited power load, thus making it difficult to consume power locally. The characteristic of energy distribution in China requires long-distance, large-capacity power transmission and flexible power flow control capabilities. In other words, China needs to develop UHV transmission technology and flexible power transmission technology to address this issue.

1.1.5 Social Development Put Higher Requirement on Smart Grid.

The profound changes brought by smart grid will not only be confined to energy sector. Substance, energy and information are the fundamental elements that make up the objective world. Smart grid realizes the integrated transmission of energy and information. As smart grid evolves further, it may be converged with the internet of things, internet to form a highly-integrated social platform of energy and information flow, which will lead to functional revolution of power grid with extensive and far-reaching impact way beyond our imagination. At present, the role of smart grid mainly consists of:

(1) Building an open energy system. End-users can flexibly connect and disconnect their electrical appliances with the grid, and actively participate in grid operation adjustment as well. Energy flow will no longer be only one-way from supply-side to demand-side, but rather a two-way energy flow in which EV and PV generation can supply power back to the grid.

(2) Promoting the integration of information network. By connecting optical power fiber to the home, an open public network platform will be established to provide network connection for telecommunication, internet, TV and radio, and etc. Currently, users can access the internet, use digital telephone and watch HDTV programs through optical power fiber.

(3) Realizing real-time control of smart appliances. Through optical power fiber, PLC and other communication methods, smart grid can achieve friendly interactions with end-users by interactive terminals to offer users timely power consumption information of smart appliances such as air-conditioner, heater, and electric cooker. Therefore, the users can adjust their power use according to the grid load condition. In this way, power consumption will be more intelligent.

(4) Making the society smarter. An intelligent public platform, which highly integrates smart grid, internet of things and internet network, will accelerate the development of smart home, smart building, smart community, smart transportation and smart city, and make our planet smarter.

1.2 General Objectives and Development Stages of Strong and Smart Grid

In order to deal with climate change, countries around the world are increasingly committed to developing smart grid, promoting clean energy, ensuring energy security and improving energy efficiency. Some countries have formulated the strategic framework of smart grid, identified key R&D areas, and put forward stimulus policies. Smart grid witnesses robust development all over the world, with constant changes and innovations. In China, smart grid begins to enter new phase of all-round development. Because of the difference in national conditions and practical needs, countries have different understandings of the concept of smart grid with various emphases. Based on China's practical condition, SGCC put forward the strategy to build a strong and smart grid with UHV grid as the backbone and coordinated

development of subordinate grids at all levels, featured as being IT-based, automated and interactive; SGCC will follow the principle of overall planning, unified standards, pilot project first, comprehensive progress; it has compiled the Outline of Smart Grid Planning, and laid down the plan for special subjects, including SGCC masterplan, the plan for grid smartness, distribution grid, communication network and information network.

Being IT-based is the fundamental approach to achieve high integration, sharing and utilization of real-time and non-real-time information for smart grid; Being automated is an important means of strong and smart grid, which comprehensively improves automation level of grid operation and control by highly efficient user data acquisition and integrated applications; Being interactive is the inherent requirement of strong and smart grid, which achieves friendly interaction and effective coordination among different parts of the grid by real-time information communication and analysis so as to improve user-experience, promote safe, efficient and environment-friendly power consumption.

The major features of smart grid are:

(1) “Strong” and “smart” are two basic requirements for modern grid development. “Strong” is the foundation while “Smart” is the key. The two are correlated and indispensable from each other.

(2) Strong and smart grid is an intelligent power system, encompassing power generation, transmission, transformation, distribution, consumption and dispatching. Each of these parts needs to be well coordinated to bring the advantage of the overall system to full play.

(3) Strong and smart grid marks a remarkable shift in the function of power grid. The role of power grid will expand in an all-round way. It is no longer simply a carrier and platform for the transmission and distribution of electricity, but rather a highly integrated intelligent platform for internet of things, internet network, communication network, radio and TV networks. At the same time, the boundary between generation-side and demand-side will blur. Therefore, strong and smart grid will not only constitute an important material foundation for socio-economic development, but become the nerve centrals of modern society.

SGCC will implement the construction of strong and smart grid in three stages, following the principle of “overall planning, unified standards, pilot project first, comprehensive progress”.

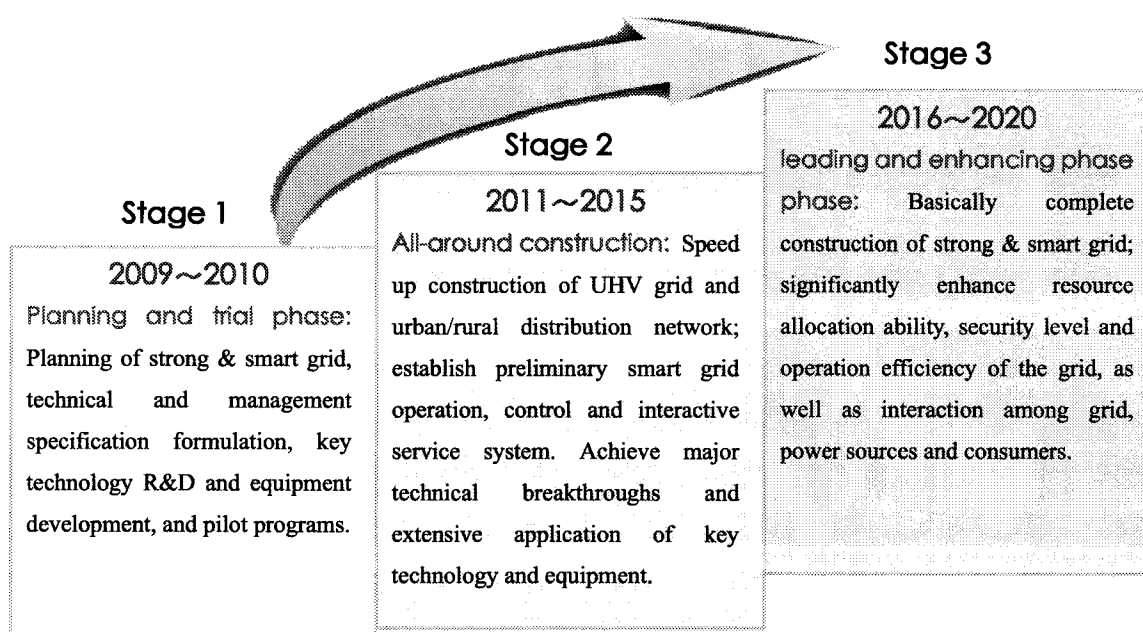


Figure 1-1, three stage development of strong and smart grid

Stage 1 (2009-2010) – planning and trial phase: To establish masterplan, carry out key technology research and key equipment development, and proceed with demonstration projects.

Stage 2 (2011-2015) – all-round construction phase: to formulate standards and requirements for strong and smart grid; to evaluate construction progress based on the needs and technical development of smart grid, continuously amend development plan, and construct smart grid in full-scale.

Stage 3 (2016-2020) – leading and enhancing phase: to evaluate the construction of smart grid in full-range, further enhance the capability of China's strong and smart grid in an all-around way, based on application needs and technical development.

1.3 Pilot Projects of Strong and Smart Grid

During the construction of strong and smart grid, there are many pressing issues that need solution in each domain such as generation, transmission, transformation, distribution, consumption and dispatching as well as overall construction. Some of the new design, research methodology, technical roadmap and standards need to be verified in tests. Well-scheduled and implemented pilot project can effectively address the above-mentioned issues and lay a solid technical and engineering foundation for the roll-out of strong smart grid construction.

In August 2009, following the principle of seeking breakthroughs in key areas and implementing in appropriate regions, SGCC chose projects with good conditions, high feasibility and extensive exemplary effects as the first batch pilot projects. They included 9 key projects such as Shanghai World Expo Smart Grid Comprehensive Pilot Project, Wind,

Solar and Energy Storage and Integration Pilot Project as well as Transmission Line Status Monitoring Center Pilot Project. At present, the first batch pilot projects have all started, with most technical standards and design specification having been completed.

In February 2010, in order to step up the construction of strong and smart grid, SGCC summarized the findings from the first batch of pilot projects and identified the second batch projects, which are:

(1) Four of the first batch pilot projects, which has been rolled out in full-scale and with relevant technical standards primarily completed, is ready to expand to other regions, namely, smart substation pilot project expansion, distribution automation pilot project expansion, EV charging facilities pilot project expansion and smart dispatching technical supporting system pilot project, etc.

(2) Twelve greenfield projects covering all parts and ICT platform of smart grid, featured as being IT-based, automated, and interactive, and able to significantly enhance smart grid technology and SGCC productivity, mainly include Sino-Singapore Eco-City Smart Grid Demonstration Project, Large-capacity Wind Power Forecast and Operation and Control Pilot Project, Transmission Line Patrol Helicopter/ Unmanned Helicopter Smart Patrol Pilot Project.

Standards serve as important support for pilot projects. Considering the pioneering, experimental, and complex nature, smart grid pilot projects require a complete and systematic standard system to unify all interfaces and communication protocols, etc. The formulation and revision of key technical standards are in urgent need for pilot project. Specifying main design plan, technical principles and interfaces can on the one hand provide guidance for pilot project construction, coordinate operation and control, so as to meet the project schedule; and on the other hand help make timely revision to guarantee the project's pioneering role in demonstration and technical innovation, which is of full support for China's smart grid overall roll-out.

1.4 The Significance of Establishing a Standard Framework for Smart Grid

1.4.1 Standard Framework Provides Technical Guideline for the Construction of Smart Grid

The construction of smart grid will bring profound changes to the form and function of power grid. The existing standards can no longer meet the demand of future grid. A corresponding standard framework for smart grid needs to be developed to provide uniform technical support.

By establishing a standard framework of smart grid, the planning, designing, construction, operation and equipment manufacturing can be well managed, thus ensuring an orderly and overall development of smart grid and related emerging industries.

The standard framework can provide technical specifications for equipment manufacturers, system integrators, grid constructors and other stakeholders involved in the building of smart grid, ensure compatibility of all kinds of electric equipment and units, guarantee the quality and progress of smart grid construction, and realize interoperability of electrical power systems.

Standard framework is an institutional guarantee for smart grid construction. The establishment of an advanced and complete standard framework at an early date will not only ensure the construction of smart grid in a scientific, systematic and practical manner from the very beginning, but also provide institutional support for its sound development.

1.4.2 Standard Framework Serves as the Technical Guideline for Smart Grid

Standard framework of smart grid must not only be compatible with the existing technologies and products, but also adapt to future innovation and application with systematicity, logic, openness and expandability.

Standard framework of smart grid can effectively guide the drafting of specific standards. The uniformity of the standards is conducive to market competition. In return, market competition can further enhance technical development and protect customer interests. Therefore, the establishment of standard framework will facilitate the transfer of leading technologies into standards, and provide the technical guideline and reference for the smart grid development.

1.5 The Stages and Objectives for Smart Grid Standardization

According to SGCC's strategic target and overall deployment and implementation plan for smart grid development, the standardization of smart grid will roll out in three stages.

Stage 1 (2009-2010): to establish a framework and support pilot projects. In this stage, the plan for standard formulation of smart grid will be completed, and a preliminary standard framework should be established. The work will focus on developing or amending key technical standards needed for pilot projects, and ensuring the completion of pilot projects in due time.

Stage 2 (2011-2015): To improve the standard framework and support full-scale construction. The main task of this stage is to renew and amend the existing standards, complement necessary standards, and primarily complete the smart grid standard framework. The work focus will be put on promoting advantageous areas of domestic smart grid standards into international standards and support full-scale construction of smart grid.

Stage 3 (2016-2020): To develop the standards into world-leading ones. In this stage, smart grid standard will be improved and optimized, and domestic standards should be promoted into international standards in an all-around way.

2 . The Current Research and Studies on Smart Grid International Standards

At present, many international standard organizations and institutions are actively conducting related researches on smart grid standards, including the International Electrotechnical Commission (IEC), the National Institute of Standards and Technology (NIST) and the Institute of Electrical and Electronics Engineers (IEEE). Besides, related researches have been carried out in European and Asian countries.

2.1 Progress of IEC Researches

In order to promote the development of smart grid, IEC Standardization Board (SMB) set up the Smart Grid Strategy Working Group (the 3rd strategy working group, SG3) to be responsible for formulating IEC smart grid standard system.

SG3 deems that the IEC should be responsible for researching and developing smart grid standards, and focus on the standards of the interfaces and interoperability of different products. Considerations should be focused on common needs. Standardization on details should be avoided in order not to hinder technological innovation and development.

Core standards are crucial to smart grid standard system. They are important for applications and solutions of smart grid, and are applicable for all the major technological fields of smart grid. The five core standards recommended by SG3 are given in Table 2-1, including standards of open architecture, interoperability, network security, etc.

Table 2-1 Core smart grid standards recommended by IEC

No	Core Standards	Subjects
1	IEC 62357	About open architecture-SOA (Service Oriented Architecture) Applicable scope : energy management system ; distribution management system
2	IEC 61970	CIM (Common Information Model) Applicable scope : energy management system; distribution management system; distribution system automation; distributed generation; advanced measurement infrastructure
3	IEC 61850	Substation automation Applicable scope : energy management system; distribution management system; distribution system automation; distributed generation; advanced measurement infrastructure
4	IEC 61968	Distribution management
5	IEC 62351	Network security

SG3 analyzes and investigates the smart grid standards system systematically according to the general and professional technical fields.

(1)The general technical fields include: Communication, security and planning;

(2)The technical fields include: high voltage direct current transmission (HVDC)/flexible alternating current transmission system (FACTS);blackout prevention/energy management system(EMS);advanced distribution management system; distribution automation; smart substation automation; distributed energy sources; advanced metering infrastructure (AMI); demand side response and load management; smart home and intelligent building; electricity storage; electrical vehicles; state monitoring; electromagnetic compatibility; low voltage equipment installation and large scale renewable energy connection, etc.

2.2 Research progresses of the NIST

The research of smart grid standards system in the US is dominated by NIST. In order to build the smart grid technical standards system, NIST assembled a large number of experts and scholars to study the interoperability standards of smart grid, aiming to build a technical framework which coordinates the different protocols and standard models and realizes the interoperability of different devices and systems.

In April 2009, NIST announced a three-stage plan for developing the key standards of smart grid. The goal of first stage is to urge the utilities, manufacturers, customers, standard developers and other relative parties to reach an agreement on smart grid technology standards. The task of the second stage is to establish an organization to coordinate the development of other standards and solve the integration problems between the current systems and new technologies. The goal of the third stage is to make an overall testing and verification plan, which can assure that the systems and equipments in smart grid comply with the relative standards of security and interoperability.

NIST carried out further studies and issued the NIST Framework and Roadmap for Smart Grid Interoperability Standards (Release 1.0) in January, 2010. In this report, NIST described the concept models of smart grid, which cover 7 domains, namely the bulk generation, transmission, distribution, customers, operations, markets and service providers; elaborated the smart grid construction principles and methods via the concept models, and identified 75 existing standards applicable (or maybe applicable) for continuous development of smart grid .

NIST deems that in the end hundreds of codes and standards may be needed for smart grid, but 8 fields should be considered in priority: demand response and energy utilization efficiency, wide-area situational awareness, electricity storage, advanced metering infrastructure, distribution system management, information security and network communication.

NIST identified 15 high and advanced absent standards as well as computer security standard. NIST also formulated detailed working plan and organization task, and identified the priority action plan and target from 2009 to 2010. They are:

- (1) Smart meters upgrading standard (accomplished);
- (2) Commonly used codes of price and product definition (in the early of 2010);
- (3) Mutual dispatch mechanism of energy exchange (in the early of 2010);
- (4) Commonly used information model of distribution network management (in the end of 2001);
- (5) Standard demand response signal (in the early of 2010);
- (6) Energy utilization information standard (in the middle of 2010);
- (7) Mapping object of DNP3 and IEC 61850 standards (in the year of 2010);
- (8) Synchronous coordination of IEEE C37.118 and IEC 61850 with precision time (in the middle of 2010);
- (9) Model mapping of transmission and distribution system (in the end of 2010);
- (10) Usage guideline of smart grid IP agreement subassemblies (in the middle of 2010);
- (11) Usage guideline of smart grid wireless communication (in the middle of 2010);
- (12) Network interconnection guideline of energy storage; (in the middle of 2010);
- (13) Interoperability standard of supporting charging electric vehicle (in the end of 2010);
- (14) Standard meter data diagram (in the end of 2010);
- (15) power line carrier communication standard of home apparatus (in the end of 2010).

2.3 Research progresses of the IEEE

IEEE is also making great efforts on smart grid research. In March 2009, IEEE approved the formation of the Working Group P2030, whose main responsibilities and research emphases are: to provide technical guidance on the understanding and definition of interoperability between power systems and terminal electrical apparatuses/users, to pay close attention to the solutions of integrating energy, information and communication technologies, to study how to realize the seamless operation of power generation, transmission and utilization processes by adopting communication technology, to study the definitions of related interfaces, to provide new methods for building more reliable and flexible power systems, to advance the development of new standards of smart grid and the redaction of existing ones.

In June 2009, the Working Group P2030 held its first meeting. Its first stage task is mainly to develop the *IEEE P2030 standards draft- interoperability between power systems and terminal electrical apparatuses/users in smart grid based on information and communication technologies (IEEE P2030 standards draft for short)*. The purpose of developing this standards draft is to provide knowledge base for understanding the interoperability between power systems and terminal electrical apparatuses and users in smart grid, including its definition, characteristics, functions, evaluation guidelines, and applications of engineering principles, etc.

2.4 Research progresses of other major institutes

In March 2010, the European Committee for Electrotechnical Standardization (CEN-CENELEC) held an informal meeting, discussed the standardization of the smart grid

technology in Europe. A working group was formed during the meeting to promote the research on smart grid standards.

German smart grid technology standard roadmap selected 11 important standards, most of which are IEC standards, such as IEC 62357, IEC 60870, and IEC 61970/61968. Besides, German working group also listed several standards of building automation, smart meter reading and electrical engineering, such as IEC 62443, and ISO/IEC 14543, etc.

In order to promote the research and development of smart grid standards, the Ministry of Economy, Trade and Industry of Japan (METI), which is a major institute responsible for making the industrial and energy policies in Japan, formed a strategic working group on smart grid technology standardization. METI deems there are 7 key technical areas for smart grid, namely Wide Area Situational Awareness (WASA), demand side response, system side energy storage technology, electric vehicles, automatic metering infrastructure (AMI) and distribution grid management. The working group identified 26 key technical fields that should be first paid attention to, and established international strategies for standards development in these fields.

3. SGCC Framework and Roadmap for Strong and Smart Grid Standards

3.1 The Constitutional Principles of the Framework and Roadmap for Strong and Smart Grid Standards

The framework mainly complies with the following principles:

(1) Systematicity

The framework is expected to coordinate relevant technologies in different technical fields; to provide guidance to grid companies, power consumers and equipment manufacturers; to support development and utilization across different industries and regions; and to offer unified solutions to related technical issues and connecting different segments of the power system, so that the effectiveness and interoperability could be guaranteed. Based on the principle of systematicity, the framework and roadmap should be a complete system by taking into consideration multiple perspectives and various components, so that it will be able to guide the making and amendment of smart grid standards.

(2) Logics

The application of smart grid technology includes data acquisition, information transmission and processing, control decision-making, etc. In order to ensure coordination of different standards, it is crucial that the logic between different areas of smart grid standards should be considered, especially standards for interfaces, so that the standard system can play a comprehensive role.

(3) Openness

The framework should be an open system, and can be timely updated and expanded. It shall also adapt to development needs of smart grid technologies, and always keeps moderate advancement.

3.2 The Conceptual Model of the Framework and Roadmap for Strong and Smart Grid Standards

In order to analyze and study smart grid's needs for technical standards, and demonstrate interconnections between different standards, a conceptual model of the framework was established based on energy flow and information flow. The conceptual model abstracts those pending issues in the framework. It is divided into 8 domains. Each domain is composed of actor and application. Actor refers to equipment, system and application program, etc.; application refers to the tasks executed by one or several actors in one specific domain, such as solar power generation, user information collection, and energy management, etc.

3.3 The General Structure of the Framework and Roadmap for Strong and Smart Grid Standards

The framework is a hierarchical system. It consists of 8 domains, 26 technical fields, 92 series of standards and a number of specific standards. It is expected to provide guidance and instruction for research and development of smart grid standards.

In the framework, the first layer is domain. There are 8 domains, including general and planning, generation, transmission, substation, distribution, utilization, dispatching, as well as ICT.

The second layer is technical fields. There are totally 26 technical fields, focusing on major development direction of smart grid study and key areas of project construction. The division of different technical field follows a series of SGCC's guidelines, including *Planning of Smart State Grid*, *Smart Grid Key Technology Research and Study*, *Key Smart Grid Equipment (System) Development Planning*, etc.

Technical fields included in each domain are:

- (1) General and Planning: smart grid methodology and interfaces, planning and design;
- (2) Generation: coordination of conventional power sources and power grid, large scale new energy integration, large capacity energy storage integration;
- (3) Transmission: ultra high voltage power transmission, flexible HVDC, FACTS, status and operation monitoring of transmission line;
- (4) Substation: smart substation;
- (5) Distribution: distribution automation, distributed generation integration, distributed energy storage system integration;
- (6) Utilization: bi-directional interactive service, power utilization information collecting, smart energy utilization service, charging and discharging of electric vehicles, smart utilization detection;
- (7) Dispatching: smart grid dispatching support system, centralized monitoring and control of power system operation;
- (8) ICT: transmission network, communication network at distribution and user side, service network, communication support network, smart grid information platform, communication and information security.

The third layer is standard series. There are totally 92 series, covering “general”, “engineering construction” (including design, refurbishment, acceptance and test), “operation and maintenance”, “equipment and material” etc.

The fourth layer is specific standards.

3.4 First Batch of SGCC Smart Grid Core Standards

Based on researches on relevant domestic and international standards and analysis of its correlation and importance to smart grid, 22 key standards with close relation to smart grid construction, strong systematicity and wide coverage were identified as the first batch of standards recommended by SGCC. The core standards play an important role in supporting the framework, and is subject to further adjustment as needed in the future. The first batch of core standards and its relationship with national and international standards are shown in Tab.3-1.

Tab. 3-1 the first batch of core standards and its relationship with national and international standards

No.	Name	National standards	International standards
1	DL 755 Guidelines for Power System Stability	N/A	N/A
2	Terminology and Methodology of Smart Grid	N/A	IEC 62559
3	Q/GDW 392 Technology Regulations on Integration of Wind Farm into Power Grid	GB/Z 19963	N/A
4	Technology Regulations on Integration of Photovoltaic Power Station into Power Grid	GB/Z 19964	N/A
5	DL/T 837 Assessment Regulations on Reliability of Transmission and Distribution Facilities	N/A	N/A
6	Q/GDW 241~244 Standard Series on Online Monitoring System of Overhead Transmission Lines	N/A	N/A
7	Q/GDW 383 Technology Guidelines for Smart Substation	N/A	N/A
8	DL/T 860 Standard Series on Substation Communication network and System	N/A	IEC 61850
9	Q/GDW 382 Technology Guidelines for Distribution Automation	N/A	N/A
10	DL/T 1080 Interface of Power Company Data Exchange Platform-Distribution Management System	N/A	IEC 61968

11	Specifications on Open Geographical Data Interoperability	N/A	OGC Open GIS
12	Technology Regulations on Integration of Distributed Generations into Power Grid	N/A	IEEE 1547
13	Q/GDW 354~365 Standard Series on Intelligent Ammeter	N/A	N/A
14	Q/GDW 233~ 238, 397~400 Standard Series on Electric Vehicle Charging and Discharging	GB/T 18487	IEC 61851
15	DL/T 890 Standard Series on Application Program Interface of Energy Management System(EMS)	N/A	IEC 61970
16	IEC 60870 Standard Series on Transmission Control Protocol	GB/T 18700	IEC 60870
17	GB/T 22239 Fundamental Requirements of Information System Security Level Protection	GB/T 22239	N/A
18	IEC 62351 Power System Management and Associated Information Exchange-Data and Communications Security	N/A	IEC 62351
19	IEC 62357 Power System Control and Associated Communications - Object Model, Service Facilities and Protocol Architecture with Reference	N/A	IEC 62357
20	ISO/IEC 27000 Standard Series on Information Security Management System	GB/T 22080, GB/T 22081	ISO/IEC 27000 Series
21	ISO/IEC 15408 Information Technology Security Evaluation Criteria	GB/T 18336	ISO/IEC 15408
22	GB/T 20279 Safety Technology Requirements on Network and Isolated Parts of Terminal Equipment	GB/T 20279	N/A

Note: Standards with no code in Tab 3-1 are pending for official release.

3.4.1 Guidelines for Power System Stability

In the development process of smart grid, ensuring grid security and power system stability is still the most fundamental requirement. The application of new technologies and new equipments in smart grid, while improving the power grid observability and controllability, increases the complexity of power grid.

Based on power source connection, grid structure, voltage and reactive power control, reactive power balance and compensation, grid and power source coordination, blackout

prevention, service restoration, etc, DL 755 *Guidelines for Power System Stability* proposes basic requirements to guarantee the power system security and stability, and specifies simulation calculation. This document was issued in 1981, and revised in 2001.

3.4.2 Terminology and Methodology of Smart Grid

Compared with the traditional power grid, many new concepts, equipments and technologies are introduced into smart grid, incorporating energy, information and communication system. The terminology and methodology for the development of smart grid should be studied and proposed to specify the application of new knowledge, methods and technical principles.

This series of standards need to use the domestic and international research results for reference, define smart grid terms, specify smart grid concepts, terminology, contents, features, etc, and constitute the methodology to effectively guide smart grid development.

3.4.3 Technical Specifications for Wind Power Integration

The development plan of wind power has been put forward in China, and several 10GW-level wind power bases will be built in the near future. To meet the requirements for large-scale wind power integration, technical rules on coordinated operation between wind farms and grids should be formulated.

The national standard GB/Z 19963 *Technical Rule for Connecting Wind Farm to Power Network* is under revision. Q/GDW 392 Technical Rule for Connecting Wind Farm into Power Grid was issued by SGCC in December 2009. In this standard, technical requirements were provided related to wind power integration, such as active power, reactive power/voltage regulation, LVRT and power quality.

3.4.4 Technical Specifications for Interconnecting Photovoltaic (PV) Station with the Grid

To meet the demand of interconnecting large-scale PV generation with the grid while ensuring the safe and stable operation of the grid and PV power station, relevant technical specifications need to be developed.

Chinese national standard GB/Z 19964 Technical Specification of Interconnecting PV Power Station with Electric Power System is about to be revised. SGCC corporate standard of Technical Specification of Interconnecting PV Power Station with the Grid will be released soon. The main contents include the control of active power, reactive voltage regulation, response to abnormal conditions of electric power system, low-voltage tolerance performance, security and short circuit prevention, electricity metering, ICT, testing, etc.

3.4.5 Guideline for Evaluation on Transmission Facility Stability

The reliability index is significant for learning the operation status of transmission and transformation facilities. It quantifies the availability of the facilities, and is a measurement for all sections of operation including planning and design, manufacturing, installation and commissioning, production and operation, repair and maintenance, and production management.

The DL/T 837 *Reliability Evaluation Code for Transmission and Distribution Facilities* stipulates the calculation and evaluation methodology for the reliability index, etc. It can be applied in reliability statistics calculation, analysis and evaluation for transmission and transformation facilities.

3.4.6 Standards on Overhead Transmission Line Monitoring Technology

Online monitoring of power transmission equipment is one of the important methods to lower operation and maintenance costs, increase operation reliability and optimize equipment's operational status.

Q/GDW 242~245 *Technical Specifications of On-line Monitoring System for Overhead Transmission Line* stipulates the following contents:

- monitoring scope, technical requirements, testing items and methodology for online conductor temperature monitoring system of overhead transmission line;
- system composition, technical requirements, testing items and methodology for online meteorological monitoring system of overhead power transmission line;
- technical requirements, testing items and methodology, data processing, dynamic bending stress measurement for aeolian vibration online monitoring system of overhead transmission line;
- technical requirements, primary function, inspection methodology, installation and commissioning, acceptance, operation and maintenance responsibilities, and packaging, storage and transportation requirements for online monitoring system of overhead transmission line.

3.4.7 Technical Guide for Smart Substation

As an important part of the smart grid, smart substation boasts of security, reliability, low expenses, economic efficiency, and environment-friendliness.

Q/GDW383 *Technical Guide for Smart Substation* standardizes the related terms, definitions, designs, operation and maintenance, debug and evaluation, etc.

3.4.8 Standards for Communication Networks and Systems in Substations

DL/T860 *Communication Networks and Systems in Substations*, (Identically adopted as IEC61850) includes the general requirements, information exchange models, communication service interfaces, and conformity testing, etc.

3.4.9 The Code on the Technology for Distribution Automation

Distribution automation plays an important role in smart grid, which integrates various communication means to realize the monitoring and control of the distribution system.

Q/GDW 382 *The Code on the Technology for Distribution Automation* specifies architecture, basic functions, technical specifications for distribution automation system, and provides requirements for design, functionality, configuration and other technical aspects.

3.4.10 Utilities Application Integration—the System Interface of Distribution Management

The smart grid is intended to realize the combination of information flow and business flow. The information of distribution management system needs to be obtained from different professions. Therefore the standard of system interfaces for distribution management is very important.

DL/T 1080 *Utility Application integration -System Interfaces for Distribution Management* (IEC 61968 adopted) specifies the interface message definition and distribution general information model of all professional management application systems in utilities. It also supports the integration of applications from various distribution management systems.

3.4.11 Open Geodata Interoperability Specification

It is necessary to establish a unified specification on service invocation and system integration for integrating spatial information and business information in Power Grid GIS Platform so as to serve the multi-business application system of utilities.

The Open Geodata Interoperability Specification (Open GIS) is a Geo-information Interoperability framework presented by OGC (Open GIS Consortium). Open GIS framework consists of 3 parts: Open Geodata Model, Open Services Model and Information Communities Model. OGC formulates data service specification, such as Web Coverage Service Specification, Web Map Service Specification and Web Feature Service Specification. For convenience of spatial data description and network transmission, OGC also presents Geographic Markup Language as well as Catalog Service Specification and metadata standard.

3.4.12 Standard of Distributed Generation Integration to the Distribution Network

Large amount of distributed generation integration has significant impact on power system dispatching, operation and control. To guarantee the security and stability, and to promote coordinated development of power system and distributed generation, it is necessary to develop a technical standard for distributed generation integration.

SGCC's *Technical Specification for Integration of Distributed Generation to the Grid* is to be released. It specifies the basic requirements for integration of distributed generation, such as power quality, system reliability, system protection, communication interface and security standards.

3.4.13 Standards for Smart Meters

Smart meter plays an important role in smart power utilization. Based on relevant research results, and in accordance with the requirements of the strong and smart grid, SGCC has developed a series of standards on smart meters. The standards incorporate current status of power metering and communications technology as well as the requirements of production, operation, and management.

The series of standards Q/GDW 354~Q/GDW 365 have specified types, functionalities, and technical requirements of smart meters as well as the information exchange security of the meters with tariff-control function. Meters are categorized into 12 types, including 8 types of three-phase smart meters (0.2s, 0.5s and class 1), 4 types of single-phase smart meters (class 2).

3.4.14 Standard Series for Charging and Discharging of EVs

The development of electric vehicles (EVs) technology and industry is inseparable with the development of charging devices and the construction of charging system. It is necessary to develop technical standards to specify the EV charging facilities, charging interface, communication protocols, etc.

GB/T 18487 *Electric vehicle conductive charging system* adopts by equivalent to IEC 61851. Aiming at the need of EV charging and discharging infrastructure construction, and combined with the research and operating experience in recent years, SGCC has published a series of standards on EV charging infrastructure in 2008~2010 (Q/GDW 233~Q/GDW 238, Q/GDW 397~ Q/GDW 400, Q/GDW 478, etc.). The standards cover the design and construction requirements of EV charging station and charging/discharging facilities.

3.4.15 Standard Series of Application Program Interfaces for Energy Management System

In order to develop smart grid, problems in power dispatching system, such as the lack of horizontal and vertical coordination, difficulties in overall coordination, low operational efficiency, must be solved. It is necessary to unify standards of basic data, models, graphics and other resources.

DL/T 890 *Energy Management System Application Program Interface* standard series (IEC 61970 adopted) is a basic professional standard in power dispatching. Based on the standard series, dispatching systems at all levels can be interconnected, to form a wide-area and coordinated network to ensure that dispatching departments can obtain all real-time information of the grid, and proceed online global analysis of the static and dynamic security and stability.

3.4.16 Standard Series of Transmission Control Protocol

Establishing an efficient and unified dispatch communication system is the basic requirement of information sharing and coordinated operation.

IEC 60870-5-101,102,103,104 standard series provides specific provisions and definitions to communication between the dispatching centers and remote devices. Although corresponding national / industrial standards have been developed in China, it is necessary to further specify unified transmission communication protocols between the substation process layer and the dispatch center.

3.4.17 Specifications for Classified Protection of Information System Security

All information systems in smart grid must comply with the security requirements for classified protection.

GB/T 22239 *Information security technology - Baseline for classified protection of information system security* defines a set of security technology and management requirements. Based on GB/T 22239, a family of classified protection standards is being developed.

3.4.18 Power System Control and Associated Information Exchanges - Data and Communication Security

Since smart grid puts forward higher requirements in security of power system data communication and information exchange, it is important to secure the data communication protocols.

IEC 62351 *Power System Control and Associated Communications - Data and Communication Security* aims at security of the control systems communication protocols. It specifies the reinforcement and upgrade to regular protocols by security technologies such as encryption, authentication, etc.

3.4.19 Power System Control and Relevant Communications - Object Models, Service Facilities and Protocol Reference Architecture

Smart grid requires interoperability between various systems. The system construction and integration should be based on unified semantics (data models), unified grammars (protocols) and unified concepts of network, which need to establish a centralized and coordinated architecture model of utility system.

IEC 62357 *Power System Control and Associated Communications - Reference Architecture for Object Models, Services and Protocols* describes the system integration needs in energy utilization area. It includes unified data models, services, and protocols, which lay the foundation for efficient application integration. This architecture consists of a series of communication standards, including IEC 61968 and IEC 61970, etc., providing semantic data models, services and protocols for communication between systems and subsystems.

3.4.20 ISMS Standards

Smart grid cyber security includes information security technical safeguard and security management. It is needed to address all the risks of information systems, and establish an information security management system that is open to update.

ISO/IEC 27000 series are the most universal information security standards which provide best practice recommendations on information security management, risks and controls within the context of an overall Information Security Management System (ISMS). GB/T 22080 and

GB/T 22081 in China are developed based on ISO/IEC 27001 *Information security management systems -- Requirements* and ISO/IEC 27002 *Code of Practice*.

3.4.21 Evaluation Criteria for IT Security

A large number of IT systems and devices will be applied in smart grid, and the security of software and hardware must be evaluated.

ISO/IEC 15408 specifies structural design for the security and realization of software and hardware, and is important in IT production/system security design, testing methodology. GB/T 18336 in China is developed based on ISO/IEC 15408, which defines a set of IT security protocols.

3.4.22 Technical requirements for security of cyber and terminal equipment separation components

As logical network separation devices are used more and more frequently in power industry, the security of separation devices should be specified to standardize the designing.

GB/T 20279, *Information Security Technology Security Techniques Requirements of Separation Components of Network and Terminal Equipment*, identifies the security requirements of separation components based on the security levels defined in GB 17859 Classified Criteria for Security Protection of Computer Information System.

4 SGCC Framework and Roadmap for Strong and Smart Grid Standards

The framework and roadmap is comprised of 8 domains (general and planning, generation, transmission, substation, distribution, utilization, dispatching and ICT), 26 technical fields, and 92 series of standards.

4.1 General and planning

Two key technical fields are focused, i.e. smart grid methodology and interface, smart grid planning and design.

4.1.1 Methodology and interface of smart grid

Smart grid methodology and interface provide knowledge for understanding smart grid, as well as guidance for overall planning and development of smart grid. It also provides technical specifications for interoperation between energy and information systems, between power systems and users/power equipment. The field includes two standard series: terminology and methodology of smart grid, and interfaces among variable parts of smart grid.

4.1.1.1 Terminology and methodology of smart grid

Terminology and methodology of smart grid includes: terminologies, definitions, specifications; methodologies that coordinate each section of smart grid and enable interoperation, all of which serve to guide coordinated work of researchers and engineers in smart grid construction.

IEC 62559 standard Energy System Development Planning Demand and Intellective Method provides methods for automation, self-healing and high efficiency of power system. *IEEE P2030 standard draft: Interoperation between power systems and terminal equipments/users based on information and communication technology in Smart Grid* will function as the knowledge base for understanding the interoperation between power system and users/terminal power equipment. The above two standards can serve as a good reference in developing this series of standards.

4.1.1.2 Interface standards of smart grid

Power generation, transmission, substation, distribution, utilization, and dispatching are essential to make interface standards that enable inner information communication in each of the above 6 parts and the inter-communication among them.

The series include: DL/T 1080 *Power Enterprise Application Integration and System*

Interfaces of Distribution Management (adopting IEC 61968); DL/T 890 *Application Program Interface of Energy Management System* (adopting 61970); DL/T 860 *Communication Network and Systems of Substation* (adopting IEC 61850). These standards specify interfaces between each part, whereas information integration interface standards are still to be developed.

4.1.2 Planning and design of smart grid

Main parts of the previous technical guidelines for power grid planning, such as grid construction principles, security and stability criteria, analysis and calculation standards of power systems are still applicable to smart grid. However, supplements and revisions are required in other aspects such as renewable energy integration, coordination between power source and grid, coordinated development of different voltage levels of power grid, as well as enhancing the interactive and self-healing capability of power grid. This technical field includes planning and design of smart transmission grid and smart distribution grid.

4.1.2.1 Standards on planning and design of smart transmission grid

Planning and design standards for smart transmission grid should provide technical specifications for the planning and design of the smart transmission grid and relevant subjects, which include planning, security and stability, grid configuration, security and stability analysis and calculation methods and technical economics evaluation, etc.

Planning standards of the transmission grid are usually compiled by each nation, trans-national electric power reliability organizations, national electric power regulatory authorities, or power grid companies. There is no universal international planning standards for transmission grid right now.

The existing standards that guide transmission grid planning mainly include: DL 75 *Guide of Security and Stability for Power System*, Q/GDW 268 *Specification of Planning and Design Contents and Procedure of State Grid Corporation of China*, Q/GDW 212 *Technical Standard for Power System Reactive Power Compensation Configuration of State Grid Corporation of China*, Q/GDW 271 *Specification of Planning and Design Contents and Procedure for Power Transmission Systems of Large Plant of State Grid Corporation of China*, Q/GDW 272 *Specification of Design Contents and Procedure for System Access of Large Plant of State Grid Corporation of China*, etc.

This series of standards need to be supplemented in renewable energy integration, coordination between grid and power source, and coordinated development of different voltage levels of the power grid.

4.1.2.2 Standards on planning and design of smart distribution grid

This series of standards provide technical specifications and principles for planning and

design of the smart distribution grid, including planning, design, power supply reliability, smart distribution grid configuration, analysis and evaluation of the smart distribution grid, etc.

International standards on planning and design of smart distribution grid are usually included in the license of distribution companies, and often compiled by electric power regulatory authorities or reliability organizations. There are no universal planning standards for distribution grids.

The existing domestic standards that guide planning and design of the distribution grid mainly include: DL/T 5118 *Guide for Planning and Design of Rural Power Grids*, Q/GDW 156 *Guide for Planning and Design of Urban Power Grids*, Q/GDW 370 *Technical Guide for Urban Distribution Grid*, Q/GDW 435 *Technical Guide of Reactive Power Compensation for Rural Power Grid*, Q/GDW 125 *Technical Guide of Construction and Upgrading for Urban Power Grids of State Grid Corporation of China*, etc.

This series of standards need to be supplemented in renewable energy integration, self-healing capability and interaction of power grid, etc.

4.2 Generation

Three technical fields are focused on: coordination between conventional power source and grid, larger-scale renewable energy and large-capacity energy storage system integration.

4.2.1 Coordination between conventional power source and grid

This technical field covers two standard series –coordination between power source and grid, and its test.

4.2.1.1 Standards on coordination of conventional power source and grid

This series of standards define the technical requirements for control and protection system performances of conventional generating units.

This series of standards include GB/T 7409.3 *Excitation System for Synchronous Electrical Machines-Technical Requirements of Excitation System for Large and Medium Synchronous Generators*, DL/T 583 *Specification for Static Rectified Excitation Systems and Devices for Large and Medium Hydraulic Generators*, DL/T 650 *Specification for Potential Source Static Exciter Systems for Large Turbine Generators* and DL/T 843 *Specification for A.C. Exciter Rectifier Excitation System for Large Turbine Generators*, etc.

This series of standards need to be supplemented in control and coordination between power source and grid, primary frequency regulation of power system and generating units, automated generation control, etc.

4.2.1.2 Standards on coordination test between conventional power source and grid

This series of standards specifies the regulations on testing of generating unit voltage and frequency control characteristics, testing of coordination between generating unit protection and power grid, testing of self-adaptive excitation and damping control, modeling and testing of generating unit, excitation, speed control and loads, coordination test of grid equipment protection, testing of parameter tuning of power system stabilizer, testing of coordinated control of generator control system.

This series of standards include GB/T 9652.2 *Test Acceptance Codes of Governors and Pressure oil Supply Units for Hydro-turbines*, DL 490 *Specification of Installation and Acceptance of Static Rectifier Excitation System and Devices of Large/middle-scale Hydro Generator*, Q/GDW 143 *Guide for Setting Test of Power System Stabilizer*. GB/T 9652.2 *Test Acceptance Codes of Governors and Pressure Oil Supply Units for Hydro-turbines* was drafted by combining the main contents of IEC 60308 *Hydraulic Turbines - Testing of Control Systems* and China's hydropower construction experience.

This series of standards need to be supplemented on leading phase testing of large scale synchronous generator, modeling and testing of generator, excitation, speed control and loads, etc.

4.2.2 Large-Scale Renewable Energy Integration

In contrast to distributed connection mode of renewable energy in foreign countries, renewable energy generation in China are usually developed in large-scale and concentrated mode and connected to high-voltage power grid via long-distance transmission to remote load centers. According to future planning, seven 10 GW-level wind power bases and even more 1GW-level wind power bases will be built, and large-scale PV generation bases will be built in Tibet, Qinghai, etc. The large-scale renewable energy integration will impose great impact on dispatch, operation and control of power grid. Technical standards on grid connection of large-scale renewable energy should be formulated to ensure safe and stable operation of power system with large-scale wind power integration as well as promote the coordinated development of power grid and renewable energy. This technical field covers large-scale renewable energy integration, grid code compliance testing of large-scale renewable energy generation, operation and control of large-scale renewable energy generation, control and protection system for grid connection of large-scale renewable energy as well as monitoring and control equipment for large-scale renewable energy generation.

4.2.2.1 Standards on Large-scale Renewable Energy Integration

To ensure the safe and stable operation of power grid with large-scale wind power integration, rational requirements for renewable energy integration should be put forward.

This series of standards include GB/Z 19963 *Technical Tule for Connecting Wind Farm to*

Power Network and Q/GDW 392 *Technical Rule for Connecting Wind Farm into Power Grid*. The former is under revision. The latter provides requirements for active and reactive power regulation performance, LVRT, etc.

Technical specifications for PV station connecting to power grid developed by SGCC are now pending for release, focusing on grid connection of PV station on active and reactive power regulation performance, LVRT, impact on power quality of grid, etc.

4.2.2.2 Standards on Grid Code Compliance Testing of Renewable Energy

The grid code compliance testing of renewable energy is an effective means to prove whether renewable energy generation fulfills the technical requirements for integration so as to ensure safety and stability of power grid operation.

This series of standards includes grid code compliance testing for wind farms and that for PV stations. *The Test Specification of Wind Farm Grid Integration and The Test Procedure of PV Station Grid Integration*, which are under compilation by the SGCC, specify scope, method and procedure of wind farm and PV station integration testing.

In this series of standards, test standards of LVRT and grid code compliance of wind farm and PV station will be specified.

4.2.2.3 Standards on Operation and Control for Large-scale Renewable Energy Generation

The random and variable nature of power output from wind energy and PV affect the safety and stability of power grid operation. Requirements for operation and control performance of renewable energy generation should be put forward regarding the large-scale renewable energy integration.

DL/T 666 *Code on Operation of Wind Power Plant* is included in this series of standard, focusing on the requirements of operation and maintenance of wind farm equipment and specifies the contents and methods of normal operation and maintenance as well as principles and methods of emergency treatment. However, it needs to be revised to meet operation requirements given the rapid development of wind power. *Technical Specifications for Operation and Control of Wind Farm* is under drafting by SGCC, in which requirements for calculation/analysis and operation/control of wind power will be put forward.

This series of standards are to be supplemented.

4.2.2.4 Standards for Monitoring and Control System of large-scale renewable energy generation

Real-time supervision of renewable energy generation and unified, coordinated control of renewable energy generation with other energy systems (such as thermal plants and energy storage systems, etc.) are key measures to ensure grid security and stability after large-scale

integration of renewable energy generation.

This series of standards cover wind farm and PV station monitoring and control system functional codes, which will provide technical specifications for the overall structure, main functions, technical requirements, etc.

This standard series is to be developed.

4.2.2.5 Standards on Monitoring and Control Equipments for Large-scale Renewable Energy Generation

This series of standards need to be developed in order to realize interconnection and interface of renewable energy monitoring and control equipment with other systems, equipment or devices in smart grid.

This series of standards cover wind farm and PV station monitoring and control equipment, which provide the technical specifications on their monitoring, communication interface, relay protection, etc. IEC 61400-25 Wind Turbines - Part 25: *Communications for Monitoring and Control of Wind Power Plants* is considered as a reference when drafting this standard series.

This series of standards are to be developed.

4.2.3 Large-capacity Energy Storage System Integration

Large-capacity Energy Storage technology is important for improving the transmission capacity to accommodate the intermittent power supply. Standards for large-capacity energy storage system integration need to be developed to regulate the integration features, feature tests, operations and controls, monitoring system functions, monitoring equipment, etc. This technical field includes five series of standards: large-capacity energy storage system integration, feature tests of large-capacity energy storage system, operation and control of large-capacity energy storage system integration, functional codes of monitoring system for large-capacity energy storage system and monitoring equipment.

4.2.3.1 Standards on Large-capacity Energy Storage System Integration

Connecting large-capacity energy storage system to power grid, and regulation performance of active power, reactive power, voltage and frequency have major impacts on grid safety and stability. This series of standards specify the technical requirements for large-capacity energy storage system integration.

SGCC is developing *Battery Energy Storage Power Plant Technical Specifications* to provide technical requirements for battery storage system connected to power grids.

4.2.3.2 Standards for Grid Code Compliance Testing of Large-capacity Energy Storage System

The power and energy feature of large-capacity energy storage system impose significant impacts on the control and operation of the power system. The grid code compliance test can testify whether equipments meet the technical codes of power grid. This series of standards mainly specify the testing methods of parameters such as capacity, dynamic character, efficiency, etc. of large-capacity energy storage system and provide technical requirements for testing equipment.

This series of standards are to be developed.

4.2.3.3 Standards on Grid Connection Operation and Control of Large-capacity Energy Storage System

This series of standards take into account grid-connection performance of intermittent renewable energy and set technical requirements for the operation, dispatch and control of large-capacity energy storage system.

This series of standards are to be developed.

4.2.3.4 Standards on Functional Codes for Monitoring System in Large-capacity Energy Storage System

In order to achieve a coordinated control between large-capacity energy storage system and other systems in smart grid, monitoring system is required to supervise the large capacity energy storage system in real time. This series of standards mainly specify the overall framework, basic functions and technical parameters of the monitoring system.

This series of standards need to be developed.

4.2.3.5 Standards on Monitoring Equipments for Large-capacity Energy Storage System

In order to realize interconnection between monitoring equipment for large-capacity energy storage system with other energy systems, equipment or devices in smart grid, standards of monitoring equipment in large-capacity energy storage system need to be developed.

4.3 Transmission

Smart grid power transmission is composed of several patterns, such as VSC-HVDC, FACTS, long-distance and large-capacity UHV transmission.

4.3.1 UHV Transmission

A unique power transmission pattern, with UHV grid as backbone network and coordinated

development of subordinate grids, is an important approach to realize long distance and large capacity power transmission. This is also an essential part of smart grid. UHV transmission standards consist of eight series, including UHV AC/DC design, construction, equipment, and operation, etc.

4.3.1.1 Standards on UHV AC Design

Based on the technical features of UHV AC power grid, this series of standards set technical specifications for planning and design, including principle for over-voltage and insulation coordination, technical measures for voltage and reactive power regulation, substation design, overhead power transmission line survey and design, etc.

This series of standards mainly include the following national standards: GB/Z 24842-2009 *Overvoltage and Insulation Coordination of 1000kV UHV AC Transmission Project*, GB/Z 24847-2009 *Technical Guide on 1000kV AC System Voltage and Reactive Power*, and SGCC corporate standards: Q/GDW294-2009 *1000kV Substation Design Standard*, Q/GDW178-2008 *1000kV Overhead Power Transmission Line Design Standard*, Q/GDW298-2009 *Technical Specification for 1000kV Overhead Transmission Line Exploration and Survey*, etc.

This series of standards are being supplemented mainly on transmission line large span, CSR, and series compensation, etc.

4.3.1.2 Standards on UHV AC System Equipment and Test

This series of standards provide specifications for power transformer equipments, including transformers, reactors, potential transformer/ current transformer (PT/CT), arrestors, switches, etc., line equipment such as fittings and insulators, protection and monitoring devices, as well as guidance for on-site test method of special equipments.

This series of standards mainly include the following national standards: GB/Z 24843-2009 *Technical Specification of 1000kV Single Phase Oil-immersed Auto-transformer*, GB/Z 24844-2009 *Technical Specification for Oil-immersed Shunt Reactor of 1000kV AC System*, GB/Z 24836-2009 *Specification for 1100 kV Gas-insulated Metal-enclosed Switchgear*, GB/Z 24838-2009 *Specification for 1100kV Alternating-current High-voltage Circuit-breakers*, GB/Z 24841-2009 *Technical Specification for Capacitor Voltage Transformers of 1000kV AC System*, GB/Z 24837-2009 *Specification for 1100kV Alternating-current Disconnectors and Earthing Switches*, GB/Z 24845-2009 *Specification of Gapless Metal-oxide Surge Arresters for 1000kV AC System*, GB/Z 24840-2009 *Technical Specification for Bushing of 1000kV AC System*, GB/Z 24839-2009 *Technical Specification of Post Insulators for 1000kV AC System*, GB/T 24834-2009 *Technical Specification for Fittings of 1000kV AC Overhead Transmission Line*, GB/T 24833-2009 *Technical Specification for 1000kV Substation Automation System*,

and company standards of SGCC: Q/GDW295-2009 *Technical Specification for 1000kV AC Current Transformer*, Q/GDW291-2009 *The Technical Specification of Fittings for 1000kV Substation*, Q/GDW325-2009 *Technical Specification for 1000kV Transformer Protection Devices*, Q/GDW326-2009 *Technical Specification for 1000kV Reactor Protection Devices*, Q/GDW327-2009 *Technical Specification for 1000kV Transmission Line Protection Devices*, Q/GDW329-2009 *Technical Specification for 1000kV Breaker Protection Devices*, Q/GDW328-2009 *Technical Specification for 1000kV Busbar Protection Devices*, Q/GDW311-2009 *Technical Specification for Electric Test of 1000kV UHV AC Fittings*, etc.

This series of standards are to be supplemented on 1000kV CSR, oil-SF6 immersed bushings, composite hollow insulators, overhead transmission line composite insulators, electrical equipment on-site test, transformer on-site PD measurement, CT/PT on-site examination, line power frequency parameter on-site measurement, electrical test for fittings, etc.

4.3.1.3 Standards on UHV AC Engineering Construction

This series of standards provide specifications for project construction techniques, equipment acceptance, construction quality inspection and evaluation, acceptance, initiation, and system commissioning, etc.

This series of standards mainly include Q/GDW193-2008 *Guide for the Construction Technology of the Assembly and Erection of the Steel Towers of 1000kV Overhead Transmission Line*, Q/GDW155-2006 *Guide for the Construction Technology of Tension Stringing of 1000kV Overhead Transmission Line*, Q/GDW154-2006 *Guide for the Earth Wire Fittings Hydraulic Pressure Construction*, Q/GDW192-2008 *Criterion on Construction and Acceptance for 1000kV Power Transformer, Oil-immersed Reactor and CT/PT*, Q/GDW195-2008 *Criterion on Construction and Acceptance for 1000kV High-voltage Electric Apparatus (GIS, HGIS, Disconnecter, Arrester)*, Q/GDW164-2007 *Criterion on Construction and Acceptance for 1000kV Framework & Stent*, Q/GDW198-2008 *Criterion on Construction and Acceptance of 1000kV Busbar Devices*, Q/GDW153-2006 *Criterion on Construction and Acceptance for 1000kV Overhead Transmission Line*, Q/GDW189-2008 *Regulations on Inspection and Assessment on Construction Quality of Electrical Apparatus in 1000kV Ultra-high Voltage Substation*, Q/GDW163-2007 *Regulations on Inspection and Assessment on Construction Quality of 1000kV Overhead Transmission Line*, Q/GDW310-2009 *Standard for Hand-over Test of 1000kV Electric Equipment Installation Engineering*, Q/GDW285-2009 *Specification for Start-up & Completion Acceptance of 1000kV AC Transmission & Distribution Projects*, etc.

This series of standards are under supplementation on 1000kV substation monitoring and control system acceptance, 1000kV AC power transmission and transformation engineering system commissioning, etc.

4.3.1.4 Standards on UHV AC Engineering Operation and Maintenance

This series of standards provide specifications for UHV AC system operation, maintenance, management, live working, overhaul, and technical supervision, etc.

This series of standards mainly include the following released national standards: GB/Z 24835-2009 *Regulation of Operation and Maintenance for 1000kV Gas-insulated Metal-enclosed Switchgear*, GB/Z 24846-2009 *Preventive Test Standards of 1000kV AC Electrical Equipments* and SGCC corporate standards Q/GDWZ211-2008 *Operation Code for 1000kV UHV AC Substation*, Q/GDWZ210-2008 *Operation Code for 1000kV UHV AC Overhead Transmission Line*, Q/GDW324-2009 *Technical Guide for Live Working on 1000kV Transmission Line*, Q/GDW239-2009 *Inspection Specification for 1000kV Power System Protection Relay and Automation Device*, etc.

This series of standards are under supplementation on UHV equipment (transformer, reactor, AC measurement equipment, GIS) overhaul, 1000kV equipment technical supervision, live working tools, clothes, and devices, etc.

4.3.1.5 Standards on UHV DC Design

This series of standards refer to some basic standards that would be used in UHV DC project design. It mainly contains system performance, electromagnetic environment, insulation coordination, pollution categorization, test, etc., and consists of three parts of contents, i.e. synthesis, converter station, and transmission line.

This series of standards mainly include GB/T 13498-2007 *Terminology for High-voltage Direct Current (HVDC) Transmission*, *HVDC Transmission System Performance*, *The Guide for Insulation Coordination of $\pm 800\text{kV}$ DC System*, *The Limit Value of Electromagnetic Environment at $\pm 800\text{kV}$ UHV DC Converter Station*, *The Electromagnetic Environment Parameter Limit for $\pm 800\text{kV}$ UHV DC Transmission Line*, *Guideline for $\pm 800\text{kV}$ UHVDC Transmission Project System Design*, *Technical Specification for Earth Electrode of $\pm 800\text{kV}$ DC Transmission System*, *Technical Code for Design of $\pm 800\text{kV}$ Converter Station*, *Provisional Technical Code for Design of $\pm 800\text{kV}$ Overhead Transmission Line*, *DC Pollution Classification*, etc.

4.3.1.6 Standards for UHV DC System Equipment

Targeted at the technical specification and guidelines for each equipment applied in UHV DC project, this series of standards give specific illustration of equipment performance and service conditions, and at the same time provide specifications and guidance for tests and measurement methods of equipments used in UHV DC project.

This series of standards mainly include *Technical Specification of Converter Transformers*

for ± 800 kV UHVDC Applications, Technical Specification of Dry Type Smoothing Reactors for ± 800 kV UHVDC Applications, Technical Specification of Oil-immersed Smoothing Reactors for ± 800 kV UHVDC Applications, General Specification for ± 800 kV and Below HVDC Converter Valve, Technical Specification of 6-inch Thyristor for ± 800 kV UHVDC Applications, Technical Specification of Metal Oxide Arrester for ± 800 kV UHVDC System, Technical Specification of DC Bushings for ± 800 kV HVDC System, Technical Specification of Post Insulators for ± 800 kV DC Systems, Technical Parameter and Performance Specification of ± 800 kV UHVDC Arrester, Technical Specification of DC Transducers for ± 800 kV UHVDC Applications, Technical Specification of DC Filter Capacitor for ± 800 kV UHVDC Systems, Technical Specification of AC Filter Capacitor for ± 800 kV UHVDC Systems, Technical Specification of AC/DC PLC Filter for ± 800 kV UHVDC Systems, Technology Specification of Direct-current Disconnectors and Earthing Switches for ± 800 kV Converter Station, Technical Specification of the Cap and Pin Insulators for ± 800 kV DC Systems, Technical Specification of ± 800 kV DC Rod Suspension Composite Insulators, Technical Specification of Fittings for ± 800 kV UHVDC Transmission Line, String Insulator Units of the Cap and Pin Type Insulators with Composite Shed to be Used in High Voltage DC Transmission Lines, Control and Protection of ± 800 kV Ultra-high-voltage Direct Current (UHVDC) Transmission System, The Anti-jamming Requirement for the Secondary Equipment in the ± 800 kV DC Convert Station, Electrical Test Specification of Thyristors for ± 800 kV UHVDC System, Measuring Method of Total Electric Field and Ion Current Density Under DC Lines and at Converter Stations, Measurement Method for DC Radio Interference, Icing Flashover Test Method on High Voltage Insulators to be Used in DC System, Test Techniques of DC Electrode Earth Resistance, Earth Potential Distribution, Step Voltage, and Broken Stream, Test Techniques of Converter Transformer On-site Partial Discharge, Test Method of Conductor Visual Corona and Corona Noise in Converter Station, Code of Control, Protection, Metering, and Scheduled Maintenance for ± 800 kV DC Transmission System, Artificial Pollution Test Method on High Voltage Insulators Used in DC System, etc.

4.3.1.7 Standards on UHV DC Engineering Construction

This series of standards mainly cover project construction, such as DC transmission line and converter station construction regulation, equipment acceptance test, system commissioning regulation, etc.

This series of standards mainly include *Code for Construction and Acceptance of ± 800 kV DC Converter Station, Guide of Supervision on Main Equipment for ± 800 kV UHVDC Converter Station, Code on Quality Inspection and Evaluation of Engineering Construction of ± 800 kV Converter Station, Code for Construction Quality Checkout and Evaluation of Electric Devices for ± 800 kV and Below DC Converter Station, Code for Construction and Acceptance of Electric Devices for ± 800 kV and Below DC Converter Station, Code for Construction and Acceptance of Earth Electrode of ± 800 kV and Below DC Transmission System, Code for*

Construction Quality Checkout and Evaluation of $\pm 800\text{kV}$ and Below Overhead Transmission Line, Code for Construction and Acceptance of Overhead Line of $\pm 800\text{kV}$ and Below DC Transmission System, Code for Construction Quality Checkout and Evaluation of Earth Electrode of $\pm 800\text{kV}$ DC Transmission System, Code on Engineering Construction and Acceptance Inspection of Valve Hall of $\pm 800\text{kV}$ Converter Station, Code for Installation and Acceptance of HVDC Equipment in $\pm 800\text{kV}$ Converter Station, The Code On Installation and Acceptance Inspection of $\pm 800\text{kV}$ Converter Transformer, The Code on Installation and Acceptance Inspection of $\pm 800\text{kV}$ Converter Valves, Code for Installation and Acceptance of AC Filters in $\pm 800\text{kV}$ Converter Station, Code for Installation and Acceptance of Busbar in $\pm 800\text{kV}$ Converter Station, Code for Installation and Acceptance of Electric Panel and Cabinet, Control Wiring Diagram in the Converter Station, Code for Construction Quality Checkout and Evaluation of Earth Electrode of $\pm 800\text{kV}$ DC Transmission System, Code for Construction and Acceptance of Overhead Earth Electrode Line of $\pm 800\text{kV}$ DC Transmission System, Guidelines for Installation Process of Large Equipment of $\pm 800\text{kV}$ Converter Station, Guidelines for $\pm 800\text{kV}$ Converter Station Frame Assembly Process, Guidelines for Construction Processes of Busbar and Jumper Wiring of $\pm 800\text{kV}$ Converter Station, Construction Technology Guide for $\pm 800\text{kV}$ Overhead Transmission Line String Under Tension, Construction Technology Guide for Assemble and Erection of Steel Towers of $\pm 800\text{kV}$ Overhead Transmission Line, Guidelines for Initiation and Completion Acceptance of $\pm 800\text{kV}$ and Below HVDC Power Transmission Projects, Standard for Handover Test of $\pm 800\text{kV}$ HVDC Equipment, Standard for Delivery Acceptance and Test of Electrical Secondary Equipment of $\pm 800\text{kV}$ UHVDC Converter Stations, System Test Code for $\pm 800\text{kV}$ HVDC Transmission Project, etc.

4.3.1.8 Standards on UHV DC Project Operation and Maintenance

This series of standards mainly cover system operation and maintenance, such as HV DC transmission line and converter station operation guideline, equipment reliability evaluation, live working, scheduled maintenance of protection and metering.

This series of standards mainly include *Guideline for $\pm 800\text{kV}$ DC Converter Station Operation Specification Compilation, Operation Code for $\pm 800\text{kV}$ DC Overhead Transmission Line, Operation Code for $\pm 800\text{kV}$ UHVDC Converter Station, Preventive Test Code of Equipment for $\pm 800\text{kV}$ and Below DC Transmission System, Evaluation Code for $\pm 800\text{kV}$ DC System Reliability, Operation Code for HVDC Overhead Transmission Line, Technical Guide for Live Working in $\pm 800\text{kV}$ DC Transmission Lines, Maintenance Criterion of $\pm 800\text{kV}$ DC Overhead Transmission Line, Administration Criterion for $\pm 800\text{kV}$ Converter Station Overhaul, Maintenance Criterion of $\pm 800\text{kV}$ DC Converter Station Equipment, Guide for Converter Station Equipment Routing Inspection, Guide for Converter Transformer and Smoothing Reactor Overhauling, Guide for Converter Station Operation Specification Compilation, Guide for OCT Technical Supervision, Guide for DC Measuring Equipment Overhauling, Guide for DC Switching Device Overhauling, Guide for Valve Overhauling,*

Guide for Filter and Shunt Capacitors Overhauling, Guide for DC Control and Protection System Overhauling, Guide for Converter Valve Water Cooling System Overhauling, etc.

4.3.2 VSC-HVDC

VSC-HVDC technology has a strong edge in new energy grid connection, distributed generation grid connection and sequestered island power supply. It can effectively improve power system stability and power quality. This technical field includes the following four series of standards: VSC-HVDC guideline, VSC-HVDC construction, VSC-HVDC operational control and VSC-HVDC equipment.

4.3.2.1 Series of Standards on VSC-HVDC Guideline

VSC-HVDC technology will be used widely in smart grid construction. This series of standards include VSC-HVDC technology application guidelines, VSC-HVDC system and key equipments functional requirements, and overall requirements of VSC-HVDC system and key equipment testing, evaluation, testing, inspection, operation and maintenance.

This series of standards are to be developed.

4.3.2.2 Series of Standards on VSC-HVDC Project Construction

To meet the demand of VSC-HVDC project construction in China, technical specifications need to be developed for VSC-HVDC project construction. This series of standards mainly cover VSC-HVDC project design, implementation, commissioning, acceptance criteria and procedure codes.

This series of standards are to be developed.

4.3.2.3 Series of Standards on VSC-HVDC Operational Control

To provide guarantee for safe, reliable and efficient operation of VSC-HVDC system and key equipment, VSC-HVDC operational control standards need to be developed to regulate VSC-HVDC system operation, maintenance, repair, preventive testing, risk assessment and state evaluation, to ensure the operation safety, reliability, stability and efficient.

The above standard series are to be determined.

4.3.2.4 Series of Standards on VSC-HVDC Equipment

SGCC has developed a series of VSC-HVDC equipment standards, which has played a positive role to promote the HVDC transmission technology development in China. To further promote VSC-HVDC equipment research and application, based on the above standards, we need to develop the standards for VSC-HVDC equipments to formulate the functional requirements and specifications for the said subject.

IEC 62501 *Voltage Source Converter Valves for HVDC Transmission--Electrical Testing* can serve as a reference.

This series of standards are to be complemented.

4.3.3 FACTS

FACTS (hereinafter short for Flexible AC Transmission System) technology can improve stability, controllability, operating performance and power quality of the power transmission and distribution system. The related standards for the technology contain FACTS Technology Guidelines, Erection Standard of FACTS, FACTS Control Operation and FACTS Devices Standard.

4.3.3.1 FACTS Technology Guidelines

FACTS Technology Guidelines mainly concern about its application, basic function specifications of key devices and testing, evaluation, inspection, maintenance of key devices, etc.

The standard series includess GB/T 6115.1 *"Series capacitors for power systems--Part1:General Principles"* (With IEC 60143.1), which formulates specification in detail for the function and technology characteristics of the Series Capacitor.

SGCC is now engaged in developing *"Design Guidelines for Series Compensation"*, *"Specification Guidelines for CSR Functions"*, etc. This standard series is to be supplemented and improved.

4.3.3.2 Erection Standard of FACTS

This standard series will mainly regulate FACTS engineering design, project implementation, site tests and acceptance inspection, etc.

The standard series includess GB/T 20297 *"Static Var Compensator Field Tests"* and Q/GDW 177 *"The Regulations on the Technical Supervision About Static Var Compensator "*.

SGCC is now organizing experts to edit *"EHV CSR Site Trials Specifications"* and *"Site Acceptance Inspection Procedures for SC Banks Control & Protection System"*, etc. This standard series is to be supplemented and improved.

4.3.3.3 FACTS Control Operation

This standard series will regulate operation, maintenance, examination, precaution tests, risk assessment and state estimation, etc.

The standard series contains DL/T 1090 *"Reliability Evaluation Code for Series Compensation System"*, etc. The details of reliability evaluation items and methods for series compensation system are given in the above standard.

SGCC is now editing *"Operation Maintenance Specifications for Fixed Deicing System"* and *"SC Banks Primary Equipments Precaution Testing Procedures"*, etc.

This standard series is to be supplemented.

4.3.3.4 FACTS Devices Standards

SGCC has developed a series of FACTS devices related standards. To achieve the industrialization of FACTS key devices, it is required to further supplement. The standard series includes standards for the following devices: SVC, CSR, STATCOM, TCSC and FCL, etc which will be introduced in the Construction of Smart Power Grid in China on aspects of FACTS technical and design specifications.

The standard series includes GB/T 6115.2~3 *"Series Capacitors for Power Systems--Part 2~3"* (with IEC 60143.2~3), GB/T 20298 *"The Functional Specification of Static Var Compensator"*, DL/T 1010 *"High-voltage Static VAR Compensator"* and Q/GDW 241 *"Chain-circuit Static Synchronous Compensator"*.

SGCC is now preparing *"Technical Conditions for Fixed Deicing System"*, *"FCL Control & Protection System Specifications"*, *"EHV CSR Control & Protection System Specification"*. IEC60143.4 *"Series Capacitors for Power Systems--Part 4: TCSC Device"*, which is under formulation, is of important reference value for the standard development of related TCSC devices in China.

This standard series is to be supplemented.

4.3.4 Power line status and operating environmental monitoring

One of the targets for smart power grid construction is to provide information-based and digital sharing data of power line operation management and maintenance, and to realize the power line status monitoring, operational monitoring, intelligent inspection techniques, power line safety, and efficient inspections. This part of technical standards involve the following key points: monitoring system construction, operation management and monitoring equipment.

4.3.4.1 Standards of power line status and operation environmental monitoring system construction

To meet the demands of power line status and operation environmental monitoring system construction and to promote the application of power line status and environmental monitoring technologies, it is necessary to carry out the related standards. The standard series includes the power line status and operating environmental monitoring system design,

implementation, on site commissioning and acceptance specification.

SGCC is now preparing *"Acceptance Specification of On-line Monitoring System for Transmission Line"*, which will specify the acceptance methodology and technical requirement on power line on-line monitoring system.

This standard series is to be supplemented.

4.3.4.2 Standards of power line status and operation environmental monitoring system management

It is necessary to formulate control standards of power line status and operation environmental monitoring system to ensure power line status and operation environmental monitoring system and related key equipments safety, stability and efficient operation.

The standard series includes DL/T837 *"Reliability Evaluation Code for Transmission and Distribution Installation"*, which specifies the items and methodology on transmission and transformation facilities evaluation.

SGCC is now preparing *Maintenance Specification of On-line Monitoring System for Transmission Line and Guidelines of Transmission and Transformation Equipment Risk Assessment*. This standard series is to be complements.

4.3.4.3 Standards of power line status and operation environmental monitoring system facilities

Power line monitoring facilities and systems manufactories have their own separated systems, which means different brands of facilities use different communication protocol, data interfaces and functional performance. Hence, the above facts lead to problems such as information distributed and construction duplicated for the operation and maintenance departments. Furthermore, there are low levels of system connectivity and information integration problems on the existing regional focus monitoring systems. To address above issues, it needs to formulate standards for the power line on-line monitoring facilities.

The standard series includes DL/T 1006 *Patrol System for Power Transmission Line*, Q/GDW 242 *Technical Specifications of On-line Conductor Temperature Monitoring System for Overhead Transmission Line*, Q/GDW 243 *Technical specifications of on-line weather monitoring system for overhead transmission line*, Q/GDW 244 *Technical specifications of on-line monitoring system of aeolian vibration for overhead transmission line*, Q/GDW 245 *General technical specifications of on-line monitoring system on overhead transmission line*.

SGCC is now preparing *Technical specifications of on-line monitoring system of equivalent icing thickness for overhead transmission line and Database specification of on-line monitoring system for overhead transmission line*. This standard series is to be complements.

4.4 Substation

In this framework, this area focuses mainly on smart substation application technologies.

4.4.1 Smart Substation

Substation has the function of voltage transformation, power flow collection and distribution as well as voltage regulation. Smart operation of substation is the basis for the final realization of smart grid. This technical field consists of five series of standards, including technical guideline, construction, operation and control, automation system functional codes and smart substation equipment.

4.4.1.1 Technical Guide for Smart Substation

Q/GDW383 *Technical Guide for Smart Substation* standardizes relevant terminologies and definitions, and clarifies the technical principles and system structures of smart substation. It also gives technical requirements for main equipment, system and auxiliary facilities in smart substation, and specifies the functional design, commissioning and acceptance, operation and maintenance, testing and evaluation of smart substation.

This Guide was released in 2009.

4.4.1.2 Series of Standards on the Construction of Smart Substation

This series of standards provide technical specifications for the design, testing, acceptance of smart substation, and upgrade of conventional substation in operation.

This series of standards include DL/T 1101 *Acceptance Specification of 35kV~110kV Substation Automation System*, Q/GDW 393 *Specification of Design for 110(60) kV~220kV Smart Substation*, Q/GDW 394 *Specification of Design for 330kV~750kV Smart Substation*, Q/GDW Z 414 *Technical Specifications for Smartness Upgrade of Substation*, Q/GDW 214 *Code of Administration for Site Acceptance Test of Computerized Monitoring and Control System of Substation*, etc.

This series of standards are to be supplemented.

4.4.1.3 Series of Standards on Operation and Control of Smart Substation

This series of standards provide technical specifications for the operation, control and condition-based maintenance of smart substation. The operation standards specify the control modes, block modes and abnormal & fault treatment modes of control system. The condition-based maintenance and overhaul standards specify testing items of various equipments, route inspection cycle, implementation conditions and technical requirements of maintenance, contain condition-based maintenance strategy and online evaluation methods of substation equipment in operation.

This series of standards include DL/T 969 *Guideline of Substation Operation*, DL/T 587 *Code for Operating Management of Microprocessors-Based Relaying Protection Equipment* and Q/GDW 422 *SGCC Technical Code for Setting Power System Relay Protection*.

This series of standards are to be completed.

4.4.1.4 Series of Standards on functional codes of the automation system of smart substation

This series of standards provide technical specifications for functions of systems such as measurement, relay protection, monitoring and control system, automation control, etc. in smart substation.

The measurement standards cover data acquisition and processing. The relay protection standards specify the configuration principle, technical requirements and implementation principle. The monitoring and control system standards define the system structure and functions. And the automation system control standards include the ICT standards between the substation and its related systems, as well as the automatic system control standards.

The smart substation relay protection standards include GB/T 14285 *Technical Code for Relaying Protection and Security Automatic Equipment*, DL/T 478 *General Specifications for Static Protection, Security and Automatic Equipment*, DL/T 995 *Testing Regulations on Protection and Stability Control Equipment* and Q/GDW 396 *Models of Relay in Substation Based on IEC61850 Standards*.

The smart substation monitoring standards include DL/T 5149 *Technical Code for Designing Computerized Monitoring and Control System of 220-500Kv Substations*, etc.

The standards for ICT between substation and relevant systems include DL/T 860 *Communication Networks and Systems in Substations* (adopting IEC 61850) , DL/T 890 *Energy Management System Application Program Interface* (adopting IEC 61970) , DL/T 1080 *System Interfaces For Distribution Management* (adopting IEC 61968) and Q/GDW 431 *Guideline for the Site Commissioning of Automation Systems in Smart Substation*.

IEC 61499 and IEC 61588 can be referred when implementing control on distributed systems and high precision clock synchronization. IEC 62439 and IEC 62351 can be referred when developing smart substation design standards and safety standards.

This series of standards are to be completed.

4.4.1.5 Series of Standards on Smart Substation Equipments

This series of standards cover technical requirements, functions, applicable conditions, structural dimension, EMC, and mechanical characteristics about the equipments in the smart substation. These equipments include electronic instrument transformer, circuit breaker/HGIS, reactor, merging unit, control unit and smart units, etc.

This standard series includes: (GBT-20840.7) Instrument Transformers- Part7: *Electronic Voltage Transformers* (Identically adopted as IEC 60044-7), (GBT-20840.8) Instrument Transformers-Part8: *Electronic Current Transformers* (Identically adopted as IEC 60044-8), Q/GDW Z 410 *Technical Guide for Smart Electric Equipments*, Q/GDW 426 *Technical Specification for Merging Unit of Smart Substation*, Q/GDW 427 *Technical Specification for Control Unit Technical in Smart Substation*, Q/GDW 428 *Technical Specification for the Intelligent Unit of Smart Substation*, Q/GDW 429 *Technical Specification for the Network Switch of Smart Substation*, Q/GDW 430 *Technical Specification for Intelligent Control Cabinet of Smart Substation*, etc.

This series of standards are to be supplemented.

4.5 Distribution

Advanced distribution automation is an importance foundation of smart distribution system. Along with the development of smart grid, massive number of primary and secondary smart equipment will be applied while a lot of distributed generation and energy storage system will be connected to the distribution grid. The operation, control and management modes of the distribution grid will be subject to significant changes. In order to satisfy the needs of developing and operating smart distribution grid, in the framework and roadmap of smart grid standards, this part mainly focus on three key technical areas: distribution automation, distributed generation integration and energy storage system integration to distribution grid.

4.5.1 Distribution automation

Based on primary grid and equipment, the distribution automation takes the distribution automation system as the core, comprehensively uses various communication modes, and achieves monitoring, control and overall management of the distribution system through information integration with relevant application systems.

In addition to implementing distribution SCADA, feeder automation and distribution network power analysis system (PAS), advanced distribution automation supports the self-healing control (including fast simulation and early warning analysis, etc.), distributed generation/energy storage system/micro-grid access, economic optimized operation and other new function.

This technical field includes five series of standards, which are: the guidelines on the technology for distribution automation; the standard on the construction for distribution automation system; the standard on the operation control; series of standards on the function specification for main station and the standard on the equipment for distribution automation system.

4.5.1.1 The Guidelines on the technology for Distribution Automation

Distribution automation is an important part of smart grid. Q/GDW 382 *The Guidelines on the Technology for Distribution Automation* specifies the overall framework, basic functions and

technical specifications, and it also proposes technical requirement in principle on relevant areas of the design, functionality, configuration and operations for distribution automation system.

4.5.1.2 Series of Standards on Developing Distribution Automation

Based on *The Guidelines on for Distribution Automation*, this series of standards provide the technical specification for the development of distribution automation system under different scale and different conditions; clarify the direction and principle of distribution automation construction, and put forward the technical requirements for the construction and refurbishment of distribution automation under different demands.

This series of standards is subject to be supplemented and completed. SGCC is preparing *Technical Guide for Distribution Automation Construction and Refurbishment*, which proposes technical provisions for the construction and refurbishment of distribution automation with operational specifications of the design, acceptance, testing technology.

4.5.1.3 Series of Standards on the Operation and Control of Distribution Automation

Based on the information integration of distribution grid, the smart distribution operation control makes comprehensive data analysis using real-time and quasi-real-time data source, monitors the operational status of distribution grid, quickly identifies the operational weakness of distribution grid, and eventually achieves the smart monitoring, self-healing control and network optimization.

This series of standards includes DL/T 1080 *System Interfaces Series Guidelines for Distribution Management* (adopting IEC 61968). This guideline is applicable for the interoperability of smart distribution application level.

4.5.1.4 Series of standards on the Functionality Specification for Distribution Automation Main Substation System

Distribution automation main station system faces a lot of new application demands, such as the integration of distributed generation and energy storage systems, as well as the self-healing control. Standards needs to be developed on functionality specification for distribution automation system with orientation to the smart grid by specifying the functionality, adjustment and testing, acceptance, planning and design and evaluation techniques of the distribution automation system.

This series includes DL/T 814 *Function Specification of Distribution Automation Systems*. It specifies the architecture and main technical specification of distribution automation system.

This series of standards are to be supplemented.

4.5.1.5 Series of standards on the equipment for distribution automation

The existing governing standards on the equipment for distribution automation do not meet the demand of distribution acquisition and control terminals. Therefore it needs to be studied and further developed. This series includes smart equipment interfaces, terminal functionality of smart distribution, technical requirement, commissioning and testing, acceptance, and the data communication protocols etc.

This series includes DL/T 721 *Remote Terminal Unit of Distribution Automation System* and provides technical requirements, functionality specifications, test methods and inspection rules for remote terminals of distribution automation system.

This series of standards are to be supplemented.

4.5.2 Distributed Generation integration to Distribution grid

Distributed generation integration poses new requirements on operational management of distribution. This area covers main standards for distributed generation (micro-grid) integration, technical specification of distributed generation integration, characteristics testing standards, operation and control standards, monitoring system functionality and equipment standards.

4.5.2.1 Series of Standards on technical Specification for Distributed Generation Integration

Distributed generation and micro-grid integration improves energy efficiency and provides emergency power supply, at the same time it also brings challenges to the reliable operation of the grid. The existing standards lack technical specifications of distributed generation and micro-grid integration. This part are specified in this series of standards, including the power control, voltage and frequency response, the maximum allowable short circuit current, safety and protection, technical requirements, communication protocol, energy metering, operational inspection and evaluation of the impact on the power quality by distributed generation(micro-grid) etc.

The series of standards are to be developed.

4.5.2.2 Series of Standards on Characteristics Tests for Distributed Generation Integration

Distributed generation integration will significantly impact the distribution grid. It is needed to know the operating characteristics of distributed generation through tests. This series of standards mainly focus on the methods and procedures of these tests on active and reactive power, voltage and frequency characteristics, power quality (flicker, harmonics) effect and its low voltage ride through (LVRT)of the distributed generation.

The series of standards are to be developed.

4.5.2.3 Series of Standards on Distribution Grid Operation Control for Distributed Generation Integration

The control and operation technology for distributed generation integration include coordinated control technology and island running control technology. In order to implement effective control when connected with distributed generation, it is necessary to develop operation control standards for the distributed energy. This series of standards mainly specify the computing model, operation arrangements, power balance, active power/frequency control, reactive power/voltage control and emergency control of the distributed generation integration.

This series of standards need to be supplemented and completed. SGCC is organizing to develop *The Technical Requirements of the Distributed Generation Integrated to the Grid*. The specification will provide the technical requirements of the distributed generation on the power quality, power control, voltage frequency response, the maximum allowable short circuit current, safety and protection and operational testing etc.

4.5.2.4 Series of Standards on Functionality Specification for Monitoring System of Distributed Generation

The functionality of distributed generation may be applied to newly-built master station system. It may also be applied to the functional extensions of the distribution automation system. This series of standards specify the real-time data collection and monitoring, distributed power control and live operational management.

The series of standards are to be developed.

4.5.2.5 Series of Standards on Monitoring Equipments for Distributed Generation

This series of standard mainly specify monitoring equipment interface, communication protocol, testing and integration compliance testing procedures and control programs, reliability level etc.

The series of standards are to be developed.

4.5.3 Distributed Energy Storage System Integration

Many distributed energy storage systems will be an important adjustable energy source in the distribution grid. The energy storage system integration can improve the power efficiency and power service reliability, and it can also change the power service mode. This technological field includes technical specification, characteristics testing standards, operation and control standards, monitoring system functionality and equipment standards for distributed energy storage integration.

4.5.3.1 Series of Standards on Technical Specification for Distributed Energy Storage Systems Integration

This series of standards primarily specify technical requirements for distributed energy storage systems integration, covering integration modes, power quality of access points, active/reactive power control, voltage/frequency characteristics etc.

The series of standards are to be developed.

4.5.3.2 Series of Standards on Integration Characteristics Test for Distributed Energy Storage Systems Connecting to Distribution Grid

Testing the power, energy and other properties of distributed energy storage systems integrated to the distribution grid is the foundation mastering the integration characteristics of energy storage systems and then controlling them effectively. This standard mainly specifies test methods, test procedures, and technical requirements of test equipment while testing the characteristic parameters of energy storage systems, such as capacity, dynamic characteristics, efficiency etc.

The series of standards are to be developed.

4.5.3.3 Series of Standards on Operational control of Distributed Energy Storage System Integration

Through the regulation and the control of EMS, distributed energy storage system integration can improve the utilization efficiency of power energy, and improve the reliability of power supply. This series of standards mainly specify technical requirements for charging and discharging, operational status, dispatching, control etc. of energy storage systems.

The series of standards are to be developed.

4.5.3.4 Series of Standards on Functionality specification for Monitoring System of Distributed Energy Storage System

The monitoring system of distributed energy storage system is the extended function of distribution automation. It can realize real-time data collection and monitoring of the energy storage system. To realize the unified and harmonious control between distributed energy storage systems and other energy systems of smart grid, it is needed to monitor and control the status of energy storage systems. This series of standards mainly specify technical requirements for the basic functionality, technical specification etc. of monitoring system.

The series of standards are to be developed.

4.5.3.5 Series of Standards on Monitoring Equipment for Distributed Energy Storage System

The monitoring equipment of distributed energy storage system includes a variety of data collection terminal equipment. Due to a large number of distributed storage equipment and complex operation environment, standards are needed to be developed on smart terminals of energy storage equipment.

This series of standards mainly specify technical requirements on the interfaces of monitoring equipment, data communication protocols, integration compliance test and control programs etc.

This series of standards are to be developed

4.6 Power Utilization

Among the smart grid standards framework, this technical field focuses on 5 key areas: two-way interactive services, power consumption information collecting, smart power consumption services, EV charging and discharging and smart metrology.

4.6.1 Two-way Interactive Services

Two-way interactive services are an important feature of smart grid's information, automation, and interaction functionalities. The construction of two-way interactive services platform can better meet user demand for smart power consumption and a large variety of services, improve the capacity of power system to deal with emergencies. Two-way interactive services platform consist of the provincial-level power supply service centers, supply service portal website and smart service centers. The technical areas include 3 series of standards: the construction of two-way interactive service platform, operation and management, and terminal equipment and system.

4.6.1.1 Series of Standards on the Construction of Two-way Interactive Services Platform

This series of standards provide the technical specification for the provincial-level power supply service center, web service portal, and smart service centers. To enable two-way interactive services, the standards on the construction of provincial-level power supply service centers specify the requirement for layout, hardware and software configuration and functions; the standards on 95598 power supply service portal lay down the requirement for portal models, technical architecture, configuration and system security protection; the standards on smart service center construction, based on its practical needs, specify the requirement for the layout, personnel, system configuration and so on.

This series of standards is to be developed.

4.6.1.2 Series of Standards on Operation and Management of Two-Way Interactive Services Platform

The series of standards are aimed at standardizing the two-way interactive services platform operation and management, establishing the operational and management system, reinforcing the operation and management responsibilities, clarifying the contents, improving operation and management level. The standard series should provide the technical specifications for two-way interactive services platform duties, operation and maintenance, evaluation, etc.

The series of standards is to be developed.

4.6.1.3 Series of Standards on Equipment and System for Two-way Interactive Services Platform

This series of standards mainly include the standards on self-service terminal and system standards of power utilization and multi-channel payment system. Based on the practical needs of self-service, the first part of standards provide the technical specifications for the appearance, function, interface, configuration and data storage of terminal equipment and

systems; the second part, based on various payment methods and the demands for two-way payment, provides the technical specifications for functionalities, interface, configuration, data storage and so on.

This series of standards is to be developed.

4.6.2 Power consumption information collecting

Power consumption information collecting system provides a reliable data infrastructure for smart power consumption services, enhance the management of utility, and support two-way interaction service. This technical field includes 3 series of standards, which are power consumption information collecting system construction standards, operation and management standards, terminal device and system standard.

4.6.2.1 Series of Standards on Construction of Power Consumption Information Collection System

In order to standardize the construction of power consumption information collecting system, realize unified, highly efficient, real-time and reliable information collecting, this series of standards needs to be developed to specify system layout, construction and acceptance test.

The series of standards contains Q/GDW 378 *Power User Electric Energy Data Acquisition System Design Guideline*, Q/GDW 379 *Power User Electric Energy Data Acquisition System Testing Technical Specification*, Q/GDW 380.1 *Power User Electric Energy Data Acquisition System Management Specification Part 1: Master Station Construction*, Q/GDW 380.2 *Power User Electric Energy Data Acquisition System Management Specification Part 2: Communication Channel Construction*, Q/GDW 380.3 *Power User Electric Energy Data Acquisition System Management Specification Part 3: Data Acquire Terminal Construction*, etc.

4.6.2.2 Series of Standards on Operation and Management of Power Consumption Information Collection System

In order to standardize the operation and management of power consumption information collecting system and guarantee the timeliness and accuracy of collection and billing control of system, this series of standards should provide the technical specifications for operation and maintenance, evaluation and inspection of power consumption information collecting system.

This series of standards include Q/GDW 380.4 *Power User Electric Energy Data Acquisition System Management Specification Part 4: Master Station Operation*, Q/GDW 380.5 *Power User Electric Energy Data Acquisition System Management Specification Part 5: Communication Channel Operation*, Q/GDW 380.6 *Power User Electric Energy Data Acquisition System Management Specification Part 6: Data Acquire Terminal Operation*, Q/GDW 380.7 *Power User Electric Energy Data Acquisition System Management Specification Part 7: Acceptance*.

4.6.2.3 Series of Standards on Equipment of Power Consumption Information Collecting System

This series of standards mainly contain the data acquisition terminal standards and system standards and smart meter standards. The standards stipulate specifications, basic function, technical parameter and performance index. Smart meter standard should provide the technical specifications for the function, performance index, communication module and information exchange security of every kinds of single phase and three phase meters with all accuracy levels.

The series of standards of power consumption information collecting system mainly adopt IEC 62051-62054, 62058-62059. The series of standards contain DL/T 698.1~2 *Data Acquisition and Management System for Electrical Energy standard series*, DL/T 698.31~35 *Data Acquisition and Management System for Electrical Energy standard series*, DL/T 698.41 *Data Acquisition and Management System for Electrical Energy Part4-1: Communication protocol- Master station communication with data acquisition terminal*, DL/T 698.42 *Data Acquisition and Management System for Electrical Energy Part 4 -2: communication protocol—concentrator downward communication*, Q/GDW 373 *Power User Electric Energy Data Acquire System Functional Specification*, Q/GDW 374.1~3 *Power User Electric Energy Data Acquire System Technical Specification standard series*, Q/GDW 375.1~3 *Power User Electric Energy Data Acquire System Type Specification*, Q/GDW 376.1 *Power User Electric Energy Data Acquisition System Communication Protocol Part 1: Master Station Communication with Data Acquire Terminal*, Q/GDW 376.2 *Power User Electric Energy Data Acquisition System Communication Protocol Part 2: Concentrator Local Communication Module Interface*, Q/GDW 377 *Power User Electric Energy Data Acquire System Safety Protection Specification*, Q/GDW 354 *Functional Specification for Smart Electricity Meters*, Q/GDW 355 *The Type Specification for Smart Single Phase Electricity Meters*, Q/GDW 356 *The Type Specification for Smart Polyphase Electricity Meters*, Q/GDW 357 *Technical Specification for Class 0.2S Polyphase Smart Electricity Meters*, Q/GDW 358 *Technical Specification for Class 0.5S Polyphase Smart Electricity Meters*, Q/GDW 359 *Technical Specification for Class 0.5S Prepayment Polyphase Smart Electricity Meters with Telecommunication*, Q/GDW 360 *Technical Specification for Class 1 Prepayment Polyphase Smart Electricity Meters with Telecommunication*, Q/GDW 361 *Technical Specification for Class 1 Prepayment Polyphase Smart Electricity Meters with Carrier-wave*, Q/GDW 362 *Technical Specification for Class 1 Prepayment Polyphase Smart Electricity Meters*, Q/GDW 363 *Technical Specification for Class 1 Polyphase Smart Electricity Meters*, Q/GDW 364 *Technical Specification for Single Phase Smart Electricity Meters*, Q/GDW 365 *Security Techniques of Information Interchange Authentication Specification for Smart Electricity Meters*, etc.

4.6.3 Smart Energy Consumption Services

Aiming at improving end-user service level, smart energy consumption is to monitor the users' real-time power consumption and realize orderly power consumption management and

smart energy efficiency management, based on users' energy demand and supply. This technical field include smart building and community, operation management, equipment and systems.

4.6.3.1 Series of Standards on Construction of Smart Building and Smart Community

SGCC needs to construct power optical fiber communication network, carry out two-way interactive power and energy consumption services, and establish interaction channels with the users to lay the foundation for building the smart building and smart community. In order to standardize the construction of smart building and smart community, the standards for the construction methods, main functions, inspection procedures of smart building and smart community need to be developed.

The construction standards of smart building and smart community need to be developed.

4.6.3.2 Series of Standards on Operation and Management of Smart Building and Smart Community

In order to standardize the smart building and smart community operation and management, improve energy efficiency throughout the community, ensure user security, stability and reliable use of electric energy, and achieve the orderly interaction with the grid, the smart building and smart community operation and management standards is to be developed. The series of standards should provide the technical specifications for smart building and smart community operation and management content, processes and measures.

The operation and management standards of smart building and smart community is to be developed.

4.6.3.3 Series of Standards on Equipment and System of Smart Building and Smart Community

The series of standards mainly include smart building and smart community equipment standards and smart energy utilization system standards. The former should provide the technical specifications for the basic functions of smart building and smart community equipment, electrical interface, communication protocol and control methods; the latter should provide the technical specifications for the main function of users' energy utilization systems, data model, information exchange, system architecture, communication interfaces and protocols.

The series of standards is to be supplemented.

4.6.4 Electric Vehicle Charging and Discharging

Electric vehicle charging and discharging infrastructure, which can achieve bi-directional energy conversion between the grid and electric vehicle, is an important component of smart grid. These technical fields include three standard series, which are construction, operation management, equipment and system of charge and discharge infrastructure.

4.6.4.1 Series of Standards on Construction of Electric Vehicle Charge and Discharge Infrastructure

Electric vehicle charging and discharging infrastructure have different types, which include DC charging and discharging station, battery swap station, AC charging spot and so on. In order to standardize the construction of electric vehicle charge and discharge infrastructure, relevant standards need to be developed. This series of standards provide technical specification for the design, site selection and layout, power supply, equipment selection, construction requirements, acceptance and so on.

The series of standards include Q/GDW 236 *General Technical Requirements of Electric Vehicle Charging Station*, Q/GDW 237 *Layout Design Guideline of Electric Vehicle Charging Station*, Q/GDW 238 *Power Supply System Criterion of Electric Vehicle Charging Station*, Q/GDW 478 *Technical Guide for Electric Vehicle Charging Infrastructure Construction* and so on.

The series of standards is to be supplemented.

4.6.4.2 Series of Standards on Operation and Management of Electric Vehicle Charging and Discharging Infrastructure

For the effective management of electric vehicle charging and discharging infrastructure and its safe and reliable operation, the operation and management standards of electric vehicle charging and discharging infrastructure need to be developed to provide technical specification on the operation, procedures and settlement management.

The series of standards is to be developed.

4.6.4.3 Series of Standards on Equipment, Interface and System of Electric Vehicle Charging and Discharging Infrastructure

The series of standards on electric vehicle charging and discharging and monitoring system mainly cover electric vehicle bi-directional charger, bi-directional charging interface, and bi-directional charging monitoring system. The series of standards of electric vehicle bi-directional charger provide technical specification on the technical conditions, basic parameters and basic functions. The standards of electric vehicle bi-directional charging interface provide technical specification on the technical index, physical parameters, communication protocol and data transmission of the interface, and so on. The standard of electric vehicle bi-directional charging monitoring system provides technical specification on the basic functions, system architecture, data model, security protection of the monitoring system and so on.

The series of standards include Q/GDW 233 *General Requirements of Electric Vehicle Off-board Charger*, Q/GDW 234 *Electric Vehicle Off-board Charger Specification for Electrical Interfaces*, Q/GDW 235 *Electric Vehicle Off-board Charger Communication Protocols*, Q/GDW 397 *Off-board Bi-directional Charger for Electric Vehicles General Technical Requirements*, Q/GDW 398 *Off-board Bi-directional Charger for Electric Vehicles Specification for Electrical Interfaces*, Q/GDW 399 *AC Power Supply Device for Electric*

Vehicles Specification for Electrical Interfaces, Q/GDW 400 Bi-directional Electricity Billing Device for Electric Vehicles Technical Specification and so on.

The series of standards is to be supplemented.

4.6.5 Quality Testing of Smart Power Utilization

As an important technical support, the series of standards include testing and measurement of metrology equipments and power utilization equipments. In order to further complete inspection system of smart power utilization, to ensure the security and reliability of metrology equipments and power utilization equipments, it is necessary to constructing a comprehensive measurement system with full function. It should include 3 standard series which are constructions of smart power utilization measurement, operation and management, and relevant devices.

4.6.5.1 Series of Standards on Construction of Quality Testing System of Smart Power Utilization

In order to clarify the functions of quality testing system of smart power utilization, matching principles of smart metering devices need to be developed. Meanwhile, in order to specify the construction of smart power utilization measurement system and build a comprehensive quality testing system of smart power utilization, the series of standards on construction of smart power utilization measurement system need to be developed to define the test objectives, test items, test methods and so on.

The series of standards is to be developed.

4.6.5.2 Series of Standards on Operation and Management of Quality Testing System of Smart Power Utilization

In order to specify the operation and management of quality testing system of smart power utilization, to ensure its safe, reliable and efficient operation, to realize the full-process management of measuring instrument, operation and management standard of quality testing system of smart power utilization need to be developed, which defines the management content, procedures and measures.

The series of standards is to be developed.

4.6.5.3 Series of Standards on Devices of Quality Testing System of Smart Power Utilization

The series of standards mainly include testing of smart metrology equipment, and testing of smart utilization equipment. The former defines the testing environment, testing function, technical specification of test devices which is used to measure the metrology equipment; the latter defines the testing environment, testing function, technical specification of test device which is used to measure smart utilization equipment.

The series of standards is to be developed.

4.7 Dispatching System

This technical field in the smart grid standards framework focuses on 2 key areas. The first is smart grid dispatching supporting system; the other is grid operation centralized supervisory control system.

4.7.1 Smart Grid Dispatching Supporting System

The hierarchy of smart grid dispatching technology standard system is divided into basic information standards and functional specifications. The functional specification consists of the basic platform and applications specifications. The basic information standards are the “common language” of information exchange for all applications. The functional specifications lay down a series of specifications for basic dispatching platform and its applications based on the analysis of the present needs and future development of smart grid. The series of standards include the basic information for dispatching supporting platform, functional specification for basic platform, and specifications for application functions.

4.7.1.1 Series of Standards on Basic Information

The interoperability and joint control of dispatching systems among national, regional, provincial and prefectural levels depend on the advanced telecommunication protocols. The standardization of the telecommunication protocols is the basis for integrated and coordinated operation of smart dispatching.

The series of standards include:

GB/T 18700.1 *Telecontrol Equipment and Systems Part 6-503: Remote Control Protocol TASE2 Service and Protocol compatible with ISO standards and ITU-T recommended standards* (adopting IEC 60870)

DL/T 890 *Energy Management System (EMS) Application Program Interface* (adopting IEC 61970)

DL/T 634.5 101 *Telecontrol Equipment and Systems Part 5-101: Basic Remote Task Supporting Standards* (adopting IEC 60870)

DL/T 719 *Telecontrol Equipment and Systems Part 5-102 : Total Electric Energy Transmission Companion Standards* (adopting IEC 60870)

DL/T 667 *Telecontrol Equipment and Systems Part 5-103: Relay Protection Equipment Information Interface* (adopting IEC 60870)

DL/T 634.5 104 *Telecontrol Equipment and Systems Part 5-104: DL/T 634.5 101 network access based on standard transmission protocol subset* (adopting IEC 60870)

DL/T 476 *Application Layer Protocol of Real Time Data Communication Protocol of Power System.*

This series of standards is to be supplemented.

4.7.1.2 Series of Standards on Basic Platform Function

The standards on basic platform function provide specifications on the grid model, data, section, network communication, human machine interface, and system administration.

In accordance with the specification, on horizontal level, the dispatching control center should integrate all kinds of applications and coordinate with other information system in its operation. On hierarchical level, the integrated operation of different level dispatching system could be implemented; the source-end maintenance and system sharing of the grid model, data and graphs could be realized.

SGCC is drafting power system data description specification (E), power grid graphic description specification (G), simple service description specification (S) and power grid device data model naming specification, etc.

This series of standards is to be completed.

4.7.1.3 Series of Standards on Applications Function

This series of standards focus on 4 aspects: the specifications of real time supervisory control and pre-alarm applications, dispatching scheduling applications, contingency checking applications, and dispatching management applications. SGCC is developing the *Wind power forecast system functional specification* and other standards.

This series of standards is to be completed.

4.7.2 Unified Supervisory Control System for Grid Operation

At present, the operational model of transmission and distribution is shifting to “unified supervisory control center and operation and maintenance station”, which requires the development of appropriate communication protocol standards, unified supervisory control center architecture specifications, and application functional specifications. The following 3 series of standards are included: the construction specifications, the operation specifications and system functional specifications.

4.7.2.1 Series of Standards on Construction of Unified Supervisory Control System

To specify the architecture for unified supervisory control system, the construction standards should be developed to cover the design, construction, acceptance, and test aspect.

This series of standards is to be developed.

4.7.2.2 Series of Standards on Operation of Unified Supervisory Control System

In order to ensure the timely, accurate, reliable, stable and highly efficient supervisory control of substation and distribution, technical specification on the communication architecture and the data model between control centers and substation/distribution should be developed.

The information communication and data model standards between control centers and substation and distribution should be given priority in standardization work.

This series of standards is to be developed.

4.7.2.3 Series of Standards on System Functional Specification

With the construction of Integrated smart distribution and control supporting system, the unified control will be achieved, comprehensive management of dispatching, supervisory and control of the distribution equipment will be established, intensive and precise management of distribution network in an economical and efficient way.

The series of standards focus on providing descriptions and definitions of the functional specification for the integrated dispatching and control support system for distribution network.

This series of standards is to be developed.

4.8 Information and Communication Technology

In the smart grid technical standards framework, this technical fields focus on seven key areas: transmission network, power distribution and consumption side communication network, service network, communication supporting network, information platform for smart grid, information application platform for smart grid, and communications and information security.

4.8.1 Transmission network

Transmission network covers power generation, management and operation of all levels. It is the foundation for smart grid communications. This technical area is composed of special optical cable technology and transmission network technology.

4.8.1.1 Series of Standards on Transmission Network Technology

The transmission network standards provide technical specification on transmission network design, construction, inspection, testing, operation and maintenance, etc. This standard series include GB/T 7611 *Bit-rate Digital Network Electrical Interface Characteristics*, YD/T 1238 *SDH-based Multi-service Transport Node Technical Requirements* and YD/T 5095 *SDH*

Long-haul Optical Transmission System Engineering Design.

This series of standards are to be completed.

4.8.1.2 Series of Standards on Special Power Cable Technology

The technical standards for the special power cable provide the technical specifications on the product model, structure, technical requirements, parameters, the corresponding test methods and acceptance requirements of special optical cable.

The standard series include DL / T 832 *Optical Fiber Composite Overhead Ground Wires*, DL / T 766 *Technical Requirements and Testing Method of Helical Fittings for OPGW*, DL / T 788 *All Dielectric Self-supporting Optical Fiber Cable* and DL / T 767 *Technical Requirements and Testing Method of Helical Fittings for ADSS*.

SGCC is formulating *Optical Fiber Composite Phase Conductor, Testing Method of Splice Closure for OPPC* and other related standards.

This series of standards are to be completed.

4.8.2 Power Distribution and Consumption Side Communication Network

Smart grid puts higher requirement on the service scope of the distribution and power consumption side communication network. This technical area contains power distribution communication standards and power consumption side communication standards.

4.8.2.1 Series of Standards on Communication Technology of Power Distribution

This series of standards provide technical specifications for the design, construction, acceptance check, test and operation management of distribution network communication

This series of standards include DL/T 790 *Distribution Automation Using Distribution Line Carrier Systems* (adopting IEC 61850), DL/T 860 *Communication Networks and Systems in Substations* (adopting IEC 61850) and YD/T 1007 *Allocation of Transmission Performance Objectives in Access Network*.

This series of standards are to be supplemented.

4.8.2.2 Series of Standards on Power Consumption Side Communication Technology

This series of standards provide technical specifications for the design, construction, acceptance check, test and operation management of power consumption-side communication.

SGCC is developing *Broadband over Power Line Communication Standard for Low Voltage, Guideline for Wireless Communication in Smart Grid, Optical Fiber Composite Insulated Power Cable for Low Voltages, Standard on Connecting Power Optical Fiber to Household*,

and so on.

This series of standards are to be complemented.

4.8.3 Service Network

The communication service network of smart grid puts new requirements on the protection, security control, measurement of electrical communication, and at the same time raises new requirements on construction, operation and management, equipment and materials of general services, such as voice, data and video. This technical field includes designated service communication technology and general service communication technology.

4.8.3.1 Series of Standards on Designated Service Communication Technology

Designated service communications standards provide technical specification on the design, construction, inspection, testing, operation and maintenance of special services like the protection, security control, and measurement of power communication.

This series of standards include GB/T 17246 *Power System Communication Business Guideline* and DL/T 524 *Relay Dedicated Power Line Carrier Transceiver Technology Conditions*.

This series of standards are to be completed.

4.8.3.2 Series of Standards on General Service Communication Technology

General service communication technology standard provide technical specification on the design, construction, inspection, testing, operation and maintenance of general power communication services like voice, data and video.

This series of standards include IEEE 802.3 *Information Technology--Systems Telecommunications and Information Exchange, LAN and MAN Specifications, Part 3: Access Method with Collision Detection Carrier Detection Multiple Access (CSMA / CD) and Physical Layer Specification*, YDB 004 *Next Generation Network (NGN) Business General Technical Requirements*, YDB 005 *Next Generation Network (NGN) IP Multimedia Services Technical Requirements*, YDB 007 *Next Generation Network (NGN) PSTN/ISDN Analog Business Technical Requirements*, YD / T 1823 *IP TV Service System General Technical Requirements*, etc.

4.8.4 Communication Supporting Network

The construction and optimization of communication supporting networks need technical specification on the management system for smart grid communication platform. This technical fields includes one series of standards on smart grid communications network management system.

4.8.4.1 Series of Standards on Smart Grid Communications Network Management System

This series of standards provide technical specifications for the planning, design and implementation of smart grid communication network system.

The standard series include the YD/T 1289.1 *Synchronous Digital Hierarchy (SDH) Transport Network Management System Technical Specification*, YD/T 1350 *Technical Specification of Wavelength Division Multiplexing (WDM) System Network Management Interface*, etc.

This series of standards are to be supplemented.

4.8.5 Information Platform of Smart Grid

Information platform of smart grid provides information service support for other technical domains, including mobile information accessing, data transmission, information integration and exchange, centralized data storage and processing, information display, etc. This technical field includes five series of standards, which are series of standards on Integrated Information Model for Smart Grid, series of standards on Information Network Construction, series of standards on Power Grid Geographic Information Services Platform, series of standards on Mobile Operation Platform, series of standards on Enterprise-level Centralized Data Management Platform.

4.8.5.1 Series of Standards on Integrated Information Model for Smart Grid

To achieve convergence of "power flow, information flow and business flow", the data in production control area and enterprise management area should be integrated. To solve this problem, it is necessary to establish an integrated information model which could cover the two areas. The main requirements include an All-in-one Information Model which could describe all the entities and their relationships related with smart grid; and a Data Exchange Model which covers the communal data between multi-information systems and embedded applications, by defining the syntax, semantics and exchange-mode.

This series of standards include CIM model part in DL/T 890 (adopting IEC 61970) and CIM model part in DL/ T 1080 (adopting IEC 61968). The former is used to achieve integration among EMS developed by different manufacturers, while the latter is aimed for data exchange between different application systems.

This series of standards are to be completed.

4.8.5.2 Series of Standards on Information Network Construction

Information network construction standards are aimed to regulate the planning and design of information network of SGCC. This series of standards offer safe, reliable and stable support for various business applications, and ensure designed networks meeting all kinds of

application demand. Information network construction standards provide technical specification for the design, construction and renovation of enterprise information networks and substations information network.

This series of standards include Q/GDW 401 *Specification of Design for SGCC Substation Network*, Q/GDW 402 *Specification of Plan and Design for SGCC Power Supply Enterprise Information Network*, Q/GDW 134 *Specification for Information Network IP Address Coding in SGCC* and so on.

4.8.5.3 Series of Standards on Power Grid Geographic Information Services Platform

Power grid geographic information services platform (hereinafter referred to as "Grid GIS platform") offers structuralized management and graphical displays of power grid resources, and provides grid graphics and analysis services for all kinds of business applications with service oriented architecture. To achieve the integration of geographic data and business data and to provide the services for various kinds of business applications in power enterprise, the unified service accessing and system integration standards need to be developed. This series of standards provide technical specification on the grid GIS platform's design, construction, information display, and the interaction and integration mode with other systems.

This series of standards includes *OpenGIS Web Map Service (WMS) Implementation Specification*, *OpenGIS Web Feature Service (WFS) Implementation Specification* and *OpenGIS Geography Markup Language (GML) Encoding Standard*. Those standards provide technical specifications for the interoperable framework and interfaces of geographic information.

SGCC is building Internal Power Grid Geographic Information Services Platform for the corporation, and is developing *Grid GIS Platform Service Calling Specification* and *The Specification for the Integration of Grid GIS platform and Business application*.

This series of standards are to be completed.

4.8.5.4 Series of Standards on Mobile Operation Platform

Mobile Operation Platform, used as the terminal application platform, manages on-site meter reading, line and equipment inspection, on-site meter installation and checkout, and supports mobile devices data accessing of the enterprise, thereby improving the efficiency of the site-work of power grid construction workers. This series of standards put forward technical requirements on evaluation, access and service invoking for mobile terminals.

SGCC is working on *"The Services Calling Specifications for Mobile Operation Platform"*, which aims to regulate the secure and effective access to such mobile terminals as laptops, mobile phones and PDA.

This series of standards are to be completed.

4.8.5.5 Series of Standards on Enterprise-level Centralized Data Management Platform

Enterprise-level data centralized management platform includes enterprise-level data centers and centralized disaster recovery center. This series of standards provide technical specifications for the design, construction and management as well as data access and massive data processing of enterprise-level data centralized management platform.

SGCC is working on *Typical Design Standards for Data Center*, *Specifications for the Construction of Disaster Center* and *Typical Design Standards for Real-time Database* as well as other standards, including cloud-computing standards.

This series of standards are to be completed.

4.8.6 Communication and Information Security

Communication security refers to the security of electric power communication network, particularly the security of physical layer and link layer; information security refers to the security of information assets, i.e., security of information and related carriers and equipments. This technical field consists of four series of standards, including communications network security protection technology, information systems and devices cyber security technology, cyber security evaluation code and Information security management system.

4.8.6.1 Series of Standards on Communication Network Security Protection Technology

This series of standards provide technical specifications for the design, construction, inspection, testing, operation and maintenance management of the security protection of communications network.

The standard series include YD/T 1742 *Security Protection Requirements for Access Network*, YD/T 1744 *Security Protection Requirements for Transfer Network*, YD/T 1752 *Security Protection Requirements for Supporting Network*, etc.

SGCC is formulating Wireless Communications Security Guideline for Electric Power System, Security Protection Technical Specification for Access Network of Electric Power Communication.

This series of standards are to be supplemented.

4.8.6.2 Series of Standards on Cyber Security of Information Systems and Devices

It is necessary to standardize cyber security technologies involved in smart grid on network, system and devices levels.

On network level, this series of standards include Q/GDW 365 *Security Techniques of Information Interchange Authentication Specification for Smart Electricity Meters and power system control and associated communication security standards Data and Communication Security* (adopting IEC 62351) which is being developed right now. For boundary protection, there is GB/T 20279 *Security Specification for Cyber and Terminal Equipment Network Separation Devices*. In the field of information system, we have Q/GDW 377-2009 *Safety*

Protection Specification for Power User Electric Consumption Data Acquisition System and National standard Guide to Cyber Security Controls of industrial Control SCADA Systems. In addition, ISA99 series (which is likely to be adopted in IEC 62443), DHS Catalog and NIST SP 800-53 can be used in ICS protection as reference. In terms of power equipments, IEEE Standard 1686 *Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities, and Security Protection Specification on Secondary Electrical System* can be used as reference (State Electricity Regulatory Commission No.5 Instruction).

This series of standards are to be supplemented.

4.8.6.3 Series of Standards on Cyber Security Evaluation

There will be lots of software and hardware supporting the deployment of information systems in smart grid, and the security of the software and hardware must be considered when they are being designed and developed. All of the information systems in smart grid must comply with the baseline for classified protection (GB/T 22239). Evaluation of both information system cyber security and information system classification protection security are to be standardized in smart grid.

Regarding system development and design as well as system security assessment, this series of standards include GB/T 18336 *Evaluation Requirement on Information Technology-Security Technology-Cyber Security* (adopting ISO/IEC 15408), GB/T 22239 *Basic Requirement on Cyber Security-Information System Classification Protection*, etc. The formulation of other standards of security classification protection of information system, such as *Testing and Evaluation Procedure Guide for Classified Protection of Information System* and *Testing and Evaluation Requirements for Classified Protection of Information System* are still in progress. These standards can serve as the guide for security classification protection in smart grid.

This series of standards are to be supplemented.

4.8.6.4 Series of Standards on Information Security Management System

Smart grid information security contains not only security techniques but also information security management. It is necessary to set up an information security management system which can continuously be improved to mitigate the associated cyber security risks faced by smart grid.

This series of standards include GB/T 22080 *Requirement on Information Technology-Security Technology-Cyber Security Management System* (adopting ISO/IEC 27001), GB/T 22081 *Practical Management Rules for Information Technology-Security Technology-Cyber Security* (adopting ISO/IEC 27002), ISO/IEC 27002 is by far the most widely adopted cyber security standards, the basic requirements and specifications of which can play a great role in the security management of smart grid.

This series of standards are to be supplemented.

5. International Standardization of Strong and Smart Grid

5.1 Overview

As a major promoter in the development of smart grid, SGCC attaches great importance to the standardization of smart grid technologies in addition to its effort in the R&D and practice. SGCC experts are actively involved in IEC SG3 and IEEE P2030 working groups, and have contributed to the drafting of IEC Smart Grid Roadmap. After analyses and studies on IEC and IEEE framework and relevant standards, SGCC put forward current priorities for the international standardization of smart grid aimed at filling gaps based on its research achievements and standardization progress.

5.2 UHV AC Power Transmission

5.2.1 Background

The power demand is growing rapidly along with the development of economy. Voltage level has been upgraded to meet the increasing demand of bulk capacity and long distance transmission.

UHVAC transmission has significant advantages of long-distance, large capacity, low loss, and smaller line corridor. In theory, the transmission capability is in direct proportion to the square of operation voltage and in inverse ratio to the line impedance, which increases with line length.

Natural load of one circuit 1000kV UHVAC transmission line is about 5000MW, which is 5 times than that of one circuit 500kV transmission line. Converted from 1000kV UHV AC to 500kV, the impedance is lowered to 1/4. The system stability and transmission capability are improved. Given the same transmission power, the transmission distance of 1000kV UHVAC transmission line is 3 times longer than 500kV EHVAC transmission line. Higher transmission voltage and lower current can reduce line loss. Given the same conductor cross-section and transmission capacity, the UHV line loss is approximately 1/3 of conventional 500kV lines. The corridor width of UHVAC double circuit on the same tower and single circuit on cathead tower are 75m and 90m respectively, and the unit corridor transmission capability will be 133MW/m and 62MW/m respectively, which is around twice higher than the same type of 500kV transmission lines.

Since the 1960s, Russia, Japan, USA, Italy, and other countries have launched studies on UHV transmission technologies because the need of electric power and transmission capacity is growing, obtaining transmission corridor is becoming more difficult, and short-circuit is reaching the ceiling. Several laboratories and test centers have been constructed to study on overvoltage, audible noise, radio interference, and ecological effect and so on. 1000kV

UHVAC transmission projects or test bases were constructed in former USSR and Japan.

In recent years, the power load in China has increased rapidly owing to sustained economic growth. Meanwhile, the energy resource and productive force development are distributed in an imbalanced manner. Over a long period, conventional thermal and hydro power will still be the main power source. In China, over 75% of exploitable water energy resource is located in Southwest, over 2/3 of coal resource in Northwest, whereas over 2/3 of power load is concentrated in Eastern developed regions. The energy bases in the West are approximately 500km to 2000km away from the load centers in the East. Therefore, long distance and large capacity transmission should be the development trend of China's power grid.

At the end of 2004, SGCC put forward the grid construction strategy that taking UHV network as the backbone with coordinated development at each level of the grid, aiming to boost intensive exploitation of large thermal, large hydro, large nuclear and large renewable energy power station, and to optimize energy and resource allocation. On January 6th, 2009, 1000kV Jindongnan -Nanyang-Jingmen UHV AC Demonstration Project, with the total length of 640km, was put into commercial operation. Up to now, it has been safely operated for more than 500 days.

Other countries with fast economic growth like India also plan to develop UHV AC transmission.

5.2.2 Market Demand

AC transmission has a long history, and there has been plenty of experience on engineering design, construction, commissioning, operation and maintenance, equipment manufacturing, etc. Technologies and standards in this field have been well established. With the upgrading of voltage level and increasing of transmission capacity, UHV AC grid construction is faced with new technical challenges. Several key technical barriers need to be overcome, including overvoltage and insulation coordination, control of electromagnetic environment index, VFTO, secondary arc control, reactive power balance, voltage stability, UHVAC equipment manufacturing and testing, UHVAC equipment operation and maintenance, etc. SGCC has obtained several significant breakthroughs, which has not been covered by former EHV standard system. Therefore, SGCC began to develop UHVAC standard framework to provide guide for the construction of follow-up UHV projects.

In order to promote the development of UHVAC transmission technology, it is needed to revise the existing international standards or develop new international standards in consideration of China's experience in UHVAC projects.

5.2.3 Objective and Strategy

In order to satisfy the requirement of UHV technology development, IEC and CIGRE have set up joint working groups to undertake researches and produce UHV AC standard roadmap. The framework of UHV AC international standard development is shown as follows:

(1) Divide existing IEC TCs related to UHV technology into three categories: general

standards (TC8, TC 28), product standards I (TC14、TC17、TC36、TC37、TC38、TC42), and product standards II (TC7、TC11、TC57、TC95、TC1、TC3、TC73、TC99、TC112) .

(2) Based upon China's experience in the UHV AC project, to analyze technical development trend and the requirement for standards and technical specifications.

(3) To develop and revise related standards within the working scope of each TC.

5.2.4 Action Plan

SGCC has started UHVAC standardization work in respect of equipment and test, and has planned to submit 3 proposals to IEC, including:

(1) Specification for 1000kV series compensation equipments of transmission line

UHVAC series compensation devices can effectively enhance the transmission capability, save transmission corridor and reduce project cost. The standard to be developed will put forward requirement for UHVAC series compensation devices, insulation coordination, parameter configuration, control and protection system, main electrical connection system, supporting platform, structure design. It will standardize the requirements and specifications for type test and delivery test of main equipments including capacitor, spark gap, damping device, bypass circuit breaker and fiber column, etc.

(2) Specification for 1000kV controllable shunt reactor

As one of key technologies for constructing UHVAC power grid, controllable shunt reactor technology of EHV or UHV system can restrain overvoltage, extinguish secondary arc and adjust dynamic reactive power. The standard to be developed is supposed to make specifications for main body parameters, accessory parameters (including bypass circuit breaker, voltage transformer, current transformer, metal oxide arrester, rectifier transformer and silicon controlled rectifier), protection system, test, insulation and transportation of high impedance transformer type and 1000kV magnetic-control type controllable shunt reactors, etc.

(3) Guide of hand-over test of 1000kV equipment

On-site hand-over test of 1000kV main equipment can ensure effective inspection and check on quality, transportation and installation. The standard to be developed will provide scientific and rational test items, test methods and criteria, taking into consideration technical parameters and characteristics of 1000kV equipment and features of various equipment, so as to figure out potential defects in the course of transportation and installation to ensure reliable operation of UHVAC equipment.

5.3 EHV/UHV DC Power Transmission

5.3.1 Background

HVDC transmission is featured by flexibility, controllability, cost-effectiveness and

environment-friendliness. It has significant advantages in large-capacity and long-distance transmission, and the interconnection of power systems. UHVDC power transmission technologies have been widely adopted, and more than 100 DC projects have been initiated and put into operation since 1980, covering Asia, South America, North America, Africa, and Europe. China has completed ten ± 500 kV HVDC projects, two ± 800 kV HVDC projects (Xiangjiaba-Shanghai and Yunnan-Guangdong). ± 800 kV Jinping-Sunan, ± 660 kV Ningxia-Shandong, ± 500 kV Humeng-Liaoning and ± 400 kV Qinghai-Tibet interconnection are under construction. More EHV/UHVDC transmission projects will be built in future. ± 1000 kV UHVDC transmission projects are being considered, and planning of some long-distance trans-national transmission projects is underway. Indonesia has planned a ± 500 kV HVDC transmission project. Korean Peninsula-Chejudo submarine cable HVDC transmission project has been planned by South Korea. One 3×600 MW back-to-back HVDC interconnection project is already on the schedule in Saudi Arabia. In America, especially South America, a 600 MW back-to-back interconnection project is to be built by Brazil and Uruguay. In addition, a double circuit ± 600 kV HVDC transmission project is under construction in Brazil, with the capacity of each circuit being 3600 MW and the transmission distance of up to 2375 km. In North America, some voltage source type HVDC transmission projects are under construction and multi-terminal HVDC grids are being planned. Besides, in Southern Africa, construction of a ± 800 kV HVDC transmission project has been put on the schedule. In Europe, the English Channel submarine cable project is under refurbishment. Power transmission capacity between northern and south central Europe has to be strengthened due to construction of wind farms, and the alternative schemes include construction of new DC transmission projects, and transforming existing AC lines into DC ones. Moreover, a large number of new DC transmission projects intended for connecting distributed generation, especially connecting wind power generation to the main power grid, are also under planning or construction.

5.3.2 Market Demand

Many countries have plenty of experience in performance index, engineering design, equipment manufacturing, construction, commissioning, operation, repair, and maintenance of HVDC projects. However, there are often discrepancies in different projects regarding technical specifications and requirements because DC projects are isolated from each other. As of now, there have been no unified standards.

Establishing and improving standard framework is of great significance for HVDC power system planning, engineering design, construction, operation, maintenance, equipment design and manufacturing, and equipment test. As for new DC project, the constructor can put forth reasonable requirement for performance index in accordance with standards and specifications. Under the guidance of standards, designers can provide specifications for DC equipment, manufacturers can conduct design, production and test of the equipment, utilities can carry out on-site tests and commissioning, and technologies can be improved and cost can be cut down during maintenance.

5.3.3 Objective and Strategy

IEC/TC115 has been established to develop HV (UHV) DC power system related standards. The secretariat of TC 115 has been set up at SGCC. With close cooperation with other TCs, such as TC 8, TC 14 and SC 22F, TC115 is promoting standardization in the field of HVDC power transmission, and has put forward a complete E/UHV DC standard system and roadmap. According to the existing UHV DC standard system, SGCC is actively polishing national standards, industrial standards, and corporate standards, and at the same time promoting UHVDC international standards.

5.3.4 Action plan

Five IEC HVDC NPs have been prepared by SGCC, including

- 1) General Guidelines for the Design of Ground Electrodes for High-voltage Direct Current (HVDC) Links;
- 2) Electromagnetic Environment Criterion for High-voltage Direct Current (HVDC) Overhead Transmission Lines;
- 3) Reliability and Availability Evaluation of HVDC Systems;
- 4) External Insulation Correction for D.C. Systems in High Altitude Area;
- 5) Criteria for the System Design of the UHVDC System.

Among them, the first two NPs have been approved by IEC, and the compilation work has started. The third NP has been submitted by Sweden NC, and SGCC has recommended experts to join the working group. The fourth and fifth NP will be put forward at TC 115 plenary meeting in October, 2010.

(1) External Insulation Correction for D.C. Systems in High Altitude Area

The external insulation performance of equipment in high-altitude areas greatly influences the system security and stability. Aiming at the requirement of DC system in high-altitude areas (2000~5500m), the technical guideline of external insulation correction for DC systems in high altitude area has been prepared, including correction methods for flashover of typical air gaps of DC transmission lines and converter stations, and flashover along the surface of polluted insulators.

(2) Criteria for the System Design of the UHVDC System

The packaged design of HVDC power system is vital in the preliminary stage of a project, which acts as a connection between the feasibility study and the engineering design to secure the final completion of design of DC projects. In-depth study on DC systems is performed based on the functional specifications and basic conditions of DC systems in order to determine the technical requirements for the equipment of DC systems. Through the packaged design, main wiring schemes, main circuit parameters (basis of equipment specifications), overvoltage insulation coordination requirements of DC systems are clearly defined, and finally the technical specifications for all the AC/DC equipment in converter stations will be established.

None of IEC standards has defined the main design task, applicable methods and criteria for

this design stage. Only some world famous manufacturers such as ABB, Siemens and Areva provide solutions in this aspect, however, which are confined to their own equipment without broad applicability. The DC system design, which involves some special criteria and design experience, is relatively complicated. Therefore refinement is necessary to facilitate the design and operation of HVDC systems.

5.4 User Interface

5.4.1 Background

Research and practice work of smart power consumption have been started in many countries in order to promote new energy, energy saving, emission reduction and improve the grid operation efficiency and the quality of power supply service. By means of measurement, control and two-way interaction, consumer participation and demand response can be realized. Thus, the customers' power consumption pattern is transformed to promote energy saving and emission reduction; the proportion of the clean electricity in end use is increased to improve energy efficiency. Smart home, smart building, distributed power generation, load management and EV, etc. are becoming the hotspots of smart power consumption research and application.

Organizations and manufacturers in the USA, Japan, Germany, UK, France, China and many other countries have done massive researches and practices in the field of smart home. Thousands of manufacturers have developed relevant standards or products. The gross industrial output value related to smart home has increased rapidly. Apart from multimedia network and electronic appliance remote and auto control, smart home should include the function of modulating the working pattern of home appliances via broadband telecommunication platform. The effective combination between traditional concept of smart home and smart grid will realize two-way interaction of power supply and information control.

In the field of smart building, the USA, Canada, France, Germany, China and other countries have already launched researches on new energy power supply and new type of electric equipment, covering equipment manufacturing and operation of solar power, wind energy, geothermal, energy storage, reactive power compensation, active filter and home electronic system, and have achieved many research results and operation experience. The construction of smart buildings can not only reduce power outage scope and shorten outage duration, but also improve power supply quality, provide better service and secure economic operation of the distribution grid, and improve economic and social benefits.

The research and application of distributed power generation in the world especially in the USA, Japan, the EU countries have been rapidly developed, and the proportion of the distributed power generation in the electricity market of various countries is rising year by year. Building Integrated PV (BIPV) has been in operation in Beijing, Shanghai, Guangzhou, Baoding, Hangzhou and other cities in China and has been largely applied in the "Golden Sun" project in 2009.

The power load management technology is widely used in the USA, Japan, France, China and other countries. Meanwhile, power consumption proportion of industrial and commercial customers goes up rapidly in many countries. For instance, the proportion in China is up to 70%. Therefore, the load management technology for industrial and commercial customers has exciting prospects for application around the world.

The research and construction of power supply and charging systems of EV are the foundation for its application and industrialization. Many countries such as the USA, Germany, Japan and China are all striving to develop EV and its standard roadmap.

5.4.2 Market Demand

Smart power consumption has a promising future and great market potential. It is urgently needed for IEC to establish smart grid user interface standards to meet the market and grid demands.

Corporate, industrial, and international standards related to smart home power consumption mainly focus on internal network of home appliances and their remote control and etc. Many home appliances are not compatible since many manufacturers have made their own standards which are different from each other. The situation has become severe obstacle to the technical development and the market extension for smart home. Meantime, the interaction between smart grid, users and home appliances needs standardization for the communication and user interfaces and etc. As a result, the establishment of the relevant international standards will help construct real-time telecommunication link between home appliances and the grid, and achieve two-way interactive smart power consumption model.

Smart building includes equipment and system related to power control service, such as new energy power supply system (wind power, PV and etc.), smart home appliance (smart lighting, smart pump station), smart power utilization measuring device (smart circuit breaker, smart meter), smart energy efficiency management equipment (smart energy analyzer, active filter, reactive compensator), smart interactive equipment and etc. The power control service of smart building is closely related to the reliability, operation and control of the equipment. It is necessary to establish an international standard of the system interface with the equipment from the perspective of smart power utilization. Smart building standards include ISO/IEC 14543-3, ISO 16484, EN 13321, EN 13757, EN 50090, EN 50428, EN 50491 and EN14908-1. Besides, the USA and China have produced some standards on smart building, such as ANSI/ASHRAE 135 and GB/Z 20965. Nevertheless, the existing standards do not cover the interface between smart building appliances and system and fail to meet the need of the development of smart building.

There are many types of distributed generation, covering different power generation characteristics, wide voltage range at generation side, and wide range of capacity from a few kW to tens of MW. Thus, the integration and control of distributed generation is different from that of the traditional power grid. The design, reliability, maintenance and operation, control and protection of distributed generation integration and control are closely related to system operating characteristics. However, there are only 2 existing IEC standards related to

customer side distributed generation integration and control, which are IEC 61968 Application Integration at Electric Utilities-System Interfaces For Distribution Management and IEC 61850-7-420 Communications Networks and Systems For Power Utility Automation-Basic Communication Structure-Distributed Energy Resource Logical Nodes, far from being able to meet the needs of distributed generation market development.

There are 7 IEC standards related to load management including IEC 62056-46, IEC 62056-47, IEC 62056-62, IEC 62052-21 IEC TR 62056-41, IEC TR 62056-51 and IEC TR 62056-52. These standards mainly focus on measurement, billing and load control device and a few data exchange standards, which cannot meet the need of managing the power demand according to the fluctuation of load and price by industrial and commercial users. Absence of standards on interface and communication protocol for industrial and commercial users is detrimental to the promotion and application of two-way power load management technology, as well as energy conservation and emission reduction.

The existing IEC standards on EV include IEC 60782, IEC 60784, IEC 60785, IEC 60786, IEC 61851-1, IEC 61851-21, IEC 61851-22, IEC 62576, IEC 61982-1, IEC 61982-2, IEC 61982-3, IEC 62196-1, IEC 62196-2(in the works). Besides, there are 6 ISO/TC22/SC21 standards which are related to EV. And the national and industrial standards have been also made in the USA, Japan and China in this field. IEC TC69 focuses on the actuation and charging systems, TC21 focuses on the performance tests of batteries, TC22 focuses on the design and application of semiconductor converters, and TC23 focuses on the vehicle connectors. The above standards do not cover the communication interface between EV and smart grid.

The existing international standards on smart power consumption are shown in table 5-1.

Tab.5-1 Existing International Standards on Smart Power Consumption

Technical Field	TC	Standard No.	Standard
Smart Home	IEC/TC72	IEC 60730-1	Automatic electrical controls for household and similar use - Part 1: General requirements
	IEC/TC72	IEC/TS 62318	Multimedia systems and equipment - Multimedia home server systems - Home server conceptual model
	IEC/TC72	IEC 62457	Multimedia home networks - Home network communication protocol over IP for multimedia household appliances
	IEC/TC72	IEC 62480	Multimedia home network - Network interfaces for network adapter
	IEC/TC72	IEC 62481-1	Digital living network alliance (DLNA) home networked device interoperability guidelines - Part 1: Architecture and protocols
	IEC/TC72	IEC 62481-2	Digital living network alliance (DLNA) home networked device interoperability guidelines - Part 2: DLNA media formats

Technical Field	TC	Standard No.	Standard
Smart Building	ISO/IEC JTC 1/SC 25	ISO/IEC 14543-3	Information technology -- Home Electronic System (HES) architecture
Distributed Generation	IEC	IEC 61968	Common Information Model (CIM)
	IEC	IEC 61850-7-420	Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes
Electric Vehicle	IEC TC21	IEC 61982-1	Secondary batteries for the propulsion of electric road vehicles - Part 1: Test parameters
	IEC TC21	IEC 61982-2	Secondary batteries for the propulsion of electric road vehicles - Part 2: Dynamic discharge performance test and dynamic endurance test
	IEC TC21	IEC 61982-3	Secondary batteries for the propulsion of electric road vehicles - Part 3: Performance and life testing (traffic compatible, urban use vehicles)
	IEC TC23	IEC 62196-1	Plugs, socket-outlets, vehicle couplers and vehicle inlets- Conductive charging of electric vehicles-Part1: Charging of electric vehicles up to 250 A a.c. and 400 A d.c.
	IEC TC23	IEC 62196-2-X (work in process)	Plugs, socket-outlets, vehicle couplers and vehicle inlets- Conductive charging of electric vehicles-Part2-X: Dimensional interchangeability requirements for pin and contact-tube vehicle couplers
	IEC TC69	IEC/TR 60783	Wiring and connectors for electric road vehicles
	IEC TC69	IEC/TR 60784	Instrumentation for electric road vehicles
	IEC TC69	IEC/TR 60785	Rotating machines for electric road vehicles
	IEC TC69	IEC/TR 60786	Controllers for electric road vehicles
	IEC TC69	IEC 61851-1	Electric vehicle conductive charging system - Part 1: General requirements
	IEC TC69	IEC 61851-21	Electric vehicle conductive charging system - Part 21: Electric vehicle requirements for conductive connection to an a.c./d.c. supply
	IEC TC69	IEC 61851-22	Electric vehicle conductive charging system - Part 22: AC electric vehicle charging station
	IEC TC69	IEC 62576	Electric double-layer capacitors for use in hybrid electric vehicles - Test methods for electrical characteristics

Technical Field	TC	Standard No.	Standard
Power load management	IEC/TC13	62056-46-2007	Electricity metering - Data exchange for meter reading, tariff and load control - Part 46 Data link layer using HDLC protocol
	IEC/TC13	62056-47-2006	Electricity metering – Data exchange for meter reading, tariff and load control – Part 47: COSEM transport layers for IPv4 networks-Edition 1.0
	IEC/TC13	62056-62-2006	Electricity metering –Data exchange for meter reading, tariff and load control –Part 62 Interface classes
	IEC/TC13	62052-21-2004	Electricity metering equipment (a.c.) - General requirements, tests and test conditions - Part 21: Tariff and load control equipment
	IEC/TC13	62056-41-1998	Electricity Metering - Data Exchange for Meter Reading, Tariff and Load Control - Part 41: Data Exchange Using Wide Area Networks: Public Switched Telephone Network (PSTN) with LINK+ Protocol-First Edition
	IEC/TC13	62056-51-1998	Electricity metering - Data exchange for meter reading, tariff and load control - Part 51: Application layer protocols
	IEC/TC13	62056-52-1998	Electrical metering - Data exchange for meter reading, tariff and load control - Part 52: Communication protocols management distribution line message specification (DLMS) server

5.4.3 Objective and Strategy

SGCC has conducted notable researches and pilot projects related to smart power consumption according to the company strategy for smart grid construction.

SGCC has developed the service platform and related software and hardware for smart power consumption. It has initiated several pilot programs in Beijing and Chongqing. Smart home based on smart power consumption service realizes the interaction between the grid and users, provides access to real-time power consumption information, and encourage customers to use solar, wind and other clean energy. In addition, SGCC Pavilion in Shanghai Expo site has set up smart power consumption service booth. A smart community with 132 households has been built, including a showroom with a smart interactive terminal, smart appliances, home safety protection device, water-gas-electricity meters reading and information service platform. In 2010, SGCC set up two smart home pilot projects on community-scale. From 2011 to 2015, China will introduce step price and peak-valley price nationwide.

SGCC has initiated technical researches on smart building, and has built smart building pilot project.

SGCC has conducted many researches on distributed generation integration, wind and solar complementary power generation, etc. The monitoring and control terminal and system for

distributed generation have been completed and put into operation.

In the field of power load management, SGCC has already started the research and application of user data collection system, collection terminal and metering.

Combining research, pilot project construction and standardization, standard on interface between smart grid and users should cover smart home, smart building, distributed generation, EV and load management, etc., and mainly includes the standard interface connecting users and the required two-way interaction data model and standard interfaces between utilities, service providers and the consumers, the priorities should be well shown in Table 5-2.

Tab.5-2 Main Standards on Customer-side Interface

Technical field	Standard
Smart Home	Standard of Information Interaction Communication Interface between Smart Home and Power Grid
	Standard of Information Interaction User Interface between Smart Home and Power Grid
	Control Protocol of Information Interaction Interface between Smart Home and Power Grid
	ZigBee/Home Plug Smart Energy Standard
Smart Building	Access required and Communication Standard of Smart Building New energy supply System
	Interface Specification and Communication Standard of Smart Building System
	Interface Specification and Communication Standard of Smart Building Measurement and Control Equipment
	Service Interface, Data model and Communication protocol of Smart Building Interaction Equipment
	Interface Specification and Communication Standard of Smart Building Energy Efficiency Management Equipment
Distributed Generation	Specification for Customer Side Distributed Generation Management System Function
	Main Station Software and Terminal Unit Technical Condition of Customer Side Distributed Generation Management System
	Technical requirement of Customer Side Distributed Generation into Power Grid
	Communication Interface of Customer Side Distributed Generation Protection and Control System
Electric Vehicle	Interface Specification of Non-car electric vehicle charger
	Interface Specification of Electric Vehicle Charging pole
	Network Information Model of Electric Vehicle Charging Facilities
	Communication protocol between Electric Vehicle and Smart Grid
	Information Interaction Interface between Electric Vehicle and Smart Grid

Technical field	Standard
Load Management	Interface Standard among Large Customers Load Management Systems
	Communication Protocol, Communication Interface and Local Communication between Large Customer Load Management System Main Station and The Terminal
	Standard for Information Security and Protection Technology of Large Customers Load Management System
	Service Standard of Smart Grid Large Customer Interactive
	Testing Technology Specification of Load Management System, Terminal and Communication Unit
	Testing Requirement for Security and Reliability of Large Customers Load Management Terminal

5.4.4 Action Plan

SGCC has carried out standardization of smart grid consumption interface in smart equipment, distributed generation integration and demand response based on the scope and content of international standard organizations such as IEC and ISO, and according to the market demand analysis of smart home, smart building, distributed generation, load management and EV. It intends to submit three new item proposals to IEC, including:

(1) Standard of Exchange Interface between Demand-Side Smart Equipment and the Grid

In order to realize uniformity and security of the exchange interface between demand-side smart equipment and the power grid, relevant content of the exchange interface needs to be defined and described under the general framework of smart grid from the perspective of power system. In this way, the requirement for coordination and control of demand-side equipment is met, and the coordination of all demand-side equipment in respect of customer-side generation, power consumption and energy storage is realized, to provide unified, efficient, safe demand-side service and management.

This series of standards establish data model and description of demand-side equipment by using object-oriented modeling technology to meet the requirement of the current application and the future expansion. It also satisfies the requirement of open interoperability between demand-side equipment and power grid. The standard mainly contains general requirement, information interaction mode, data definition, communication protocol, safety protection and relevant test cases.

(2) Standard of Demand Side Energy Source Interconnection with the Grid

Distributed generation is developing rapidly as a means to combat energy and environmental pressures. Various forms of demand-side power sources, such as wind power, PV, cooling heating and power united supply, especially BIPV, are introduced to meet the needs of commercial and industrial users, buildings and households and have developed rapidly in recent years. Since IEC has no relevant standard, standards satisfying the coordination and control of customer power and power grid are urgently needed, which can wide industrial and market needs.

The series of standards meet the requirements of the coordinated development between demand-side generation and the power grid, satisfying the standardization demand of the grid, customers, access system integrators and consumers in the power sector. It is necessary to take into account the power system expansion planning and system reliability as well as the compatibility and mutual influence between customer-side power source and the grid, such as the limitation of interconnection capacity, reactive output and voltage regulation capability, power efficiency, power quality responsibilities, system relay protection, the timing of the customer-side generation into the grid, the system islanding detection capability and so on. The standard covers the customer-side generation, the local distribution grid and customer-side power source interconnection with the automated control system, measurement, monitoring, dispatch communication, and demand response, security protection, testing, operation and maintenance, etc.

(3) Power Demand Response Standard

Power demand response is closely related to Distributed Energy Management System, Advanced Metering Infrastructure, Home and Building Electronic Systems/Building Automation and Control Systems. But there is an international standard gap in this area, which is unfavorable to the development of power demand response technology. Therefore, it is necessary to define and describe related content of power demand response, under the general framework of smart grid, to standardize demand response function of each smart system, promote rational power utilization and improve economic operation of power grid.

This standard is developed to provide unified communication model between smart systems and grid in demand response, to standardize basic function, physical interface, performance index, dispatching principle and method. The standard covers smart home, smart building, EV, distributed energy storage and security protection technology, and puts forward requirement for safety protection in demand response, to guarantee the security of each system. At meantime, the standard is open for future expansion.

5.5 Electric vehicles

5.5.1 Background

The development of new energy vehicles represented by EV becomes an important approach to save energy, reduce emission, alleviate dependence on oil and address the energy and environmental problems. Governments around the world attach great importance to the development of EV. As the power supply of EV, charging infrastructure is essential for the development of electric vehicles.

EV has three charging patterns: AC charging, DC charging and replaceable battery. EV users can get their vehicles charged during parking time through the low voltage distribution grid, or get power supply by replacing batteries. The high power DC charging is mostly used when emergency occurs, or for large commercial vehicles.

The planning and layout of EV charging infrastructure must be coordinated with the grid construction. Large-scale connection of charging facilities to the grid pose notable impact on

the grid, including transmission and distribution capacity, power quality, equipment utilization efficiency, protection parameter setup and so on. Therefore, to improve the efficiency of the power grid and EV charging infrastructure, the real-time operating state of power grid and EV charging demand must be carefully considered to guarantee EV charging in an orderly way.

Meanwhile, EV can be used as mobile storage units in future. The charging infrastructure will be the integral parts of the smart grid. With the development of the smart grid and EV, batteries will become mobile energy storage units of the smart grid. By rational control of two-way charging, peak load shifting can be realized, grid's capacity to integrate renewable energy generation can be improved, and grid operation efficiency can be increased.

Thus, the construction and operation of EV charging infrastructure is closely related to the power grid in the future. As an integral part of the smart grid, the construction of EV charging infrastructure must be combined with the smart grid construction.

5.5.2 Market demands

Construction of China's EV charging infrastructure starts from pilot projects. Combined with the pilot projects of the Ministry of Science and Technology, charging facilities have been built in electric bus stations in Beijing, Shanghai, Hangzhou and Hunan. In 2008, the world's largest electric bus charging station was built for the Beijing Olympics, providing power supply for 50 electric buses. In 2010, the world's largest electric bus charging station was built Shanghai to provide power supply for 120 electric buses during the World Expo.

SGCC actively develops EV charging infrastructure. Since 2006, SGCC has carried out researches on key technologies such as EV charging, mutual impact between charging and supply system, and construction of charging infrastructure. Up to now, SGCC has built 57 charging stations, utilized 112 EVs and helped to establish 15 electric bus lines. In addition, SGCC has decided to carry out the construction of EV charging infrastructure in 27 provinces (municipalities and autonomous regions). 75 public charging stations and 6209 charge poles will be built in 2010.

Large-scale construction of EV charging infrastructure needs technical support. Relevant standards need to be developed to regulate the equipment, its integration pattern and interface with the grid.

The existing international standards on EV charging are not unified. A total of 23 national/international standards on charging interface, charger, charging station have been released, among which there are 5 IEC standards, 7 U.S. standards, 9 Japanese standards, and 2 German standards.

China has published 4 national standards, of which GB/T 18487 series are identical to IEC 61851 series; GB/T 20234 adopt IEC 62196-1 as reference.

SGCC actively develops standards related to charging infrastructure. From 2008 to 2010, SGCC has released Q/GDW 236-2008 Electric Vehicle Charging Station General Technical

Requirements and other 10 corporate standards. Among them, Q/GDW 397-2009 Electric Vehicle Off-board Bi-directional Charger General Technical Requirements and other 3 standards are the first batch of standards on EV bi-directional energy conversion in China.

At present, IEC EV standards have gaps in charging/discharging facilities, interface, monitoring management model, communication protocols, metering and billing. Therefore, it is in urgent need to develop relevant standards.

5.5.3 Objectives and strategy

In the cooperation with power grid, automobile, battery, and electrotechnical industries, a series of standards on EV charging infrastructure need to be developed, including: basic standards on EV charging infrastructure, standards on performance and test method of key equipment, interface and communication standards, charging station construction and design standards, operation and management standards. The standards will coordinate and promote the development of EV and smart grid standard roadmap, and provide supports for the construction and operation of EV charging infrastructure.

On the basis of domestic and overseas researches, pilot projects, and standardization work on EV and smart grid, the following standards should be taken as priorities, shown in table 6-3.

Table 5-3 Standards formulation plan for electric vehicle and smart grid

Technical field	Standard
Electric vehicles	Off-board bi-directional charger for electric vehicles Technical specifications
	AC power supply device for electric vehicles Technical specifications
	Specifications for electric vehicle bi-directional charging interface
	Communication protocol for electric vehicle bi-directional charging interface
	Technical code for monitoring system of electric vehicle charging station
	Communication Protocol for monitor system of electric vehicle charging station
	Technical specifications for battery swap station of electric vehicle
	Electricity metering and billing specifications for electric vehicle bi-directional charging infrastructure

5.5.4 Action Plan

Based on the needs of market demand and technical development, SGCC submitted 3 NPs to IEC in hope of providing necessary support for smart grid development and EV industrialization.

(1) General Technical Requirements for Off-Board Charging and Discharging Equipment

EV charging and discharging equipment can achieve bi-directional interactive control, and realize energy and information exchange between EV as energy storage unit and the grid. In smart grid,, off-board bi-directional charger can adjust the battery charging and discharging parameters according to the information provided by the grid, and realize load adjustment and

peak load shifting, so as to achieve the objective of economic and rational power use. There are gaps in existing IEC standards, therefore it is in urgent need to produce standards to standardize the design and application of off-board bi-directional charger.

This series of standard aims to specify the main requirements for off-board bi-directional charger, covering basic structure, control mode, functional and technical requirements, the connection between the grid and EV.

(2) EV Charging supervisor system

The research and construction of EV charging infrastructure is the foundation of EV application and industrialization. In China, a lot of experience and achievement have been obtained through pilot EV charging stations. Charging monitoring system is necessary in charging station to provide safe and efficient charging service. Computer and network technology are applied in the supervisor system to monitor the operation status of charging equipment and charging process. At present, IEC standards have gap in this field. It is in urgent need to develop standards to standardize the design and application of monitoring system for EV charging station.

The series of standard aims to specify the main requirements on the monitoring system of the EV charging station, including system structure, network configuration, data collection and monitoring objects, technical parameters and network security.

(3) Electric Vehicle Charging and Discharging Metering and Billing Equipment

The research on EV charging and discharging metering and billing equipment is fundamental to EV application and industrialization. Metering and billing equipment is an essential equipment for the charging station to enable commercial running. At present, IEC standard has gap in this field. It is in urgent need to develop standards to standardize the design and application of EV charging and discharging metering and billing equipment.

The series of standard aims to specify the main requirements of EV charging and discharging metering and billing equipment, covering the basic structure, connection mode, communication interface, related functional and technical requirements.

5.6 Smart Dispatching

5.6.1 Background

With the development of the UHV interconnected power grid and 750kV power systems, China is building a power grid with the largest scale, the strongest transmission capacity and the most complicated operation in the world. It becomes a greater challenge to operate and control such large power grid. More functional and intelligent analysis is needed to better support the stable and secure operation of this grid. More comprehensive information and analysis are required to accommodate the development of the integrated power grid. Refined and scientific tools for decision making are also needed. Coordination and standardized management of the core business flow in all levels of dispatching centers need to be enhanced.

More powerful disaster prevention capability of the dispatching system is needed to cope with frequent natural and man-made disasters. The stability and maintainability of the automation system are also needed to be improved.

However, the existing technical support system for power grid dispatching fails to meet the requirements of the power grid development and the main shortcoming is the lack of support for integration technologies. Seen from the trend of relevant technical development, the existing dispatching application systems mainly focus on specific functions while ignore integrity. The practicability of the online application functions should be improved. Automatic preparation and security checking of the day-ahead dispatching schedule lack the coordination between higher and lower level dispatching centers. Basic automation infrastructure needs to be improved. Development of backup dispatching centers lags behind, which cannot meet the requirements of stable operating the 3-C (Northern, Eastern and Central China) synchronous interconnected UHV power grid. Therefore, the dispatching system's capability of controlling the power system and optimizing the resources allocation should be widely enhanced in order to improve the operation management and strengthen the security protection, risk resistance and emergency response of the power grid.

Following several large-scale blackouts across the world, the Very Large Power Grid Operators Association (VLPGO), a voluntary initiative of the world's largest Power Grid Operators from China, U.S., Russia, U.K., France, Italy, Japan and India etc., investigated the problems existing in the power grid operation and dispatching automation systems, carried out researches on the development of a new generation of power dispatching automation systems and issued a white paper titled EMS Architect for the 21st Century in 2008. Based on power grid operation and the power market system development, the white paper proposed a series of new requirements for the operation and control of the power grid including Service Oriented Architect (SOA), unified message bus, standard data model, unified Man Machine Interface (MMI) and network security architecture, etc. However, no unified technical support system for interconnected power grid dispatching have been designed and operated yet.

In response to these circumstances, SGCC is developing Smart Grid Operation Supporting System (SG-OSS) . It has the following technical features:

(1) Integrity. The characteristics of the five-level dispatching structure in China and their correlations are well considered to modulate the function and standardize the interfaces. The supporting platform of the system is more open, more flexible and more friendly. Sharing of the real-time data, graphics, prevention analysis results and application functions is realized in the whole system. It will meet the requirements of the dispatching system for smart grid and the backup dispatching system, and will realize the integrated operation of the state dispatching center, the 3C regional dispatching centers and all the provincial dispatching centers (in SGCC).

(2)Standardization. The system fully supports the advanced international and national technical standards, and supports the latest IEC standard series, including IEC 61970, IEC 61850, IEC 61968 and IEC 62351, etc. SGCC is dedicated to promote the innovation in

standardization. It has actively participated in developing new international standards and plans to prepare the IEC standards on model description, simple service, dynamic message, graph description and naming rules within IEC Technical Committee 57 (IEC TC57).

(3)Advancement. International cutting-edge technologies including SOA, zone-based security architecture, equipment-oriented standard model and unified visual MMI are introduced in the system.

(4)Security. Based on the principles of the security protection for the secondary part of power system and according to corresponding requirements of China's regulations on Classified Protection of Information Security, the system adopts the advanced security technologies based on the security certificates and security tags for dispatching and strengthens the security protection of the supporting platform and all application functions. All the computers, communication equipment, operating systems and databases conform to the security requirements. The base platform and four types of application software in the system are independently developed by Chinese companies. A security protection system is built to integrate the operation and control functions in a dispatching center and integrate the systems among the five-level dispatching centers, covering all directly dispatched substations and power plants.

5.6.2 Market Demand

Following the trend of relevant technical development, existing dispatching application systems mainly focus on specific functions while ignore integrity. The practicability of the online application functions should be improved. Automatic preparation and security checking of the day-ahead dispatching schedule lack the coordination between higher and lower level dispatching centers. Automation infrastructure needs to be improved. Development of backup dispatching centers lags behind, which cannot meet the requirements of stable operating the large power grid. The main international standards on smart dispatching include:

Table 5-4 Main international standards on smart dispatching

IEC 61970-1	Principles and basic requirements
IEC 61970-2	Dictionary, definition library
IEC 61970-301	Common Information Model (CIM) base
IEC 61970-401	Component interface specification (CIS) framework
IEC 61970-501	Common Information Model Resource Description Framework (CIM RDF) schema
IEC 61970-302	Common information model (CIM) financial, energy scheduling and reservations
IEC 61970-402	Component interface specification (CIS) - Common services
IEC 61970-403	Component Interface Specification (CIS) - Generic data access
IEC 61970-404	Component Interface Specification (CIS) - High speed data access
IEC 61970-405	Component Interface Specification (CIS) - Generic eventing and subscription
IEC 61970-407	Component Interface Specification (CIS) - Time series data access
IEC 61970-452	CIM Model Exchange Specification Network Applications
IEC 61970-453	CIM based graphics exchange

The above listed standards still fail to meet the requirements for the development of the power grid. The main shortcoming is the lack of technical support for integration technologies.

5.6.3 Objective and Strategy

The objectives of building smart grid dispatching in China are as follows: An integrated smart dispatching architecture will be formed, with the aim to serve the secure operation of the large UHV power grid, to construct dispatching security defense covering 3 facets composed of grid's year-month off-line network analysis, day-ahead schedule security checking and real-time dispatching, and in order to realize networked data communication, panoramic operation monitoring, dynamic security assessment, dispatching decision refinement, automation of operation & control and optimized coordination of power grid and power plant, with the development of new operation support system for smart grid.

Networked data communication refers to fast and reliable communication of power grid operation information and production management information, as well as to realize system emergency backup via State Grid Dispatching Network (SGDnet), which could provide reliable data communication support for secure and stable operation of large UHV power grid.

Panoramic operation monitoring refers to panoramic supervision and smart alarm on every facet of dispatching, integration, data sharing and visualization of power grid operation and analysis results, knowing the power grid operation status.

Dynamic security assessment refers to an active security defense that can realize online automatic security alarm, aid decision-making and coordination of multi-dimension and multi-level of large power grid operation via steady, dynamic and transient online security analysis and assessment.

Dispatching decision-making refinement refers to the refined and smart dispatching decision and the risk control via the centralized, standardized and streamlined management of core business, such as yearly, monthly maintenance scheduling, day-ahead to real-time scheduling and security check.

Operation control automation refers to the automatic adjustment and control of grid frequency, voltage, power flow and reserve in order to realize integrated and grade-coordinated control of large grid. The implementation is based on unified and coordinated optimization of control strategies, such as AGC, AVC, generator tripping, splitting, and low frequency & low voltage load-shedding.

Optimized coordination of power grid and power plant refers to realizing standardized interconnection, optimized dispatching, and flexible and fast adjustment of conventional and renewable energies, adapting to the rapid development of large-scale renewable energies, especially for wind and solar energy generation.

In order to meet the requirements of "Horizontal integration and vertical linkage", the technical supporting platform of smart grid dispatching should implement data exchange and data sharing at all levels of control centers, and extend the service scope of function

application and graphic interface to all dispatching centers via universal, flexible , simple and effective implementation mechanism. Objectively, the supporting platform should have comprehensive adaptability, the design of which must abide by universal, standardized and open technical principles. Meanwhile, it should reflect diversified demands of grid services and dispatching services since the supporting platform carries the business features of various applications of grid dispatching, in order to adapt to organization feature and the management pattern of “Unified dispatching and graded management”, and unify the technical specifications on data, model and graphic. As a result, the technical objective of “distributed implementation and integrated utilization” should be achieved in dispatching technical support system. The IEC standards in this field should be developed, including CIM/E specification of grid model description, CIM/G specification of grid graphic description, CIM/S specification of generic service description, CIM/M specification of dynamic message encoding, and the proposal of mapping from IEC61850 to TCP.

5.6.4 Action Plan

SG-OSS system developed by SGCC is composed of one supporting platform and four categories of application. SGCC has started the standardization work on CIM/E power system model description, CIM/G graphic description, CIM/S generic service description and CIM/M dynamic message encoding for the supporting platform. Chinese representatives introduced the achievements at IEC TC57 2010 plenary and TC WG13 working group meetings. Four new NPs are about to be submitted to IEC, including:

(1) CIM/E Power System Model Description Specification

Power system data markup language - E language specification (Hereafter referred to as ' the E language') is based on object-oriented abstraction of IEC 61970-301 power system public data model CIM (Common Information Model) and aimed to solve the low efficiency problem of CIM described under XML. The instance data formed by E language is a kind of tagged plain text data. It can describe various kinds of simple or complex data models concisely and efficiently through a few mark symbols and syntax. The more data it process, the more efficient it is. In addition, E language is more suitable for people's habit rather than XML and is simpler in computer processing.

E language combines traditional relationship-oriented data descriptive pattern in power system with the object-oriented CIM. This combination not only retains high efficiency and inherits long-term achievements, but also absorbs the strength of object-oriented method (e.g. class inheritance). Therefore the E language is concise, efficient and fit for the power system. Both E language and XML follow CIM fundamental object class. The power system models described by E language and XML language could realize bi-directional conversion.

(2) CIM/G Power System Graphic Description Specification

Power system graphic description language - G language specification, based on IEC 61970-453 CIM graphics interchange, is a new efficient graphic descriptive language for long SVG text and slow network transmission. It uses XML to describe power flow graphics, line

diagram and etc. for graphics storage and exchange, which is concise and efficient.

(3) CIM/S Common Service Description Specification

In recent years, Service-Oriented Architecture (SOA) has become the development direction of network applications. This architecture accesses the service via the standard access protocol, shields the physical details of the service implementation, increases the system integration capability and shortens the development cycle. SOA is currently using SOAP, the XML-based protocol, due to its readability and flexibility. These successful applications prove SOA is a reliable and mature architecture. However, SOAP is a plain text protocol, therefore it must be interpreted while running, which affects the service access speed. The power industry is credited with the characteristics of large-scale, complex, and real-time, the interpreted mode of SOAP cannot satisfy the applications in the power industry. According to the power industry's applications, CIM/S has been developed based on the improvement of SOAP. The specification adopts the binary-text service access protocol, so that the binary protocol shortens the analytical time and improves service access speed, thus promoting the SOA framework in applications of the power industry.

(4) CIM/M Dynamic Message Coding Specification

Lots of coding rules have been formed, such as ASN.1 (Abstract Syntax Notation One) and CDR (Common Data Representation). Domestic researches have always paid close attention to the development of coding, and have made remarkable efforts. It is necessary to establish coding rules for data transmission and processing in the power industry.

ASN.1 is now applied in data transmission of various fields. A set of standard has been proposed in ASN.1 to solve the general coding problem. It also provides formal, unambiguous, and precise rules in order to describe the object structure independent from specific computer hardware. However, when sending data based on ASN.1 standard, massive communication resources have been consumed by coding and sending detailed data structure information every time. Consequently, the processing time has been prolonged. In order to improve data transmission and processing efficiency, on the basis of the ASN.1 and the CDR, it is proposed to enact the power system dynamic message coding rules by taking the advantages of ASN.1 and CDR.

CIM/ M coding specification is used to describe the messages and services, including message body, service primitives, service parameters and service results. This standard is suitable for applications of fine-grained access program. M encoding inherits the flexibility of ASN.1, high efficiency of CDR and self-description features of XML. It introduces the object-oriented technologies and borrows the generic programming ideas, in order to achieve efficient self-describing object-oriented dynamic message encoding. This standard adopts a mixed coding style which combines the top-level description and structural description. The top-level description depicts the statistical information of the structure description while the structure description depicts the data type, therefore it increases the overall efficiency.

Summary

The release and implementation of SGCC Framework and Roadmap for Strong and Smart Grid Standards will greatly boost the standardization of smart grid technologies in all related areas, promote wide public involvement and facilitate technical innovation and industrial upgrading.

This document, serving as the SGCC roadmap, will effectively standardize and guide the planning, designing, construction and operation of power grid as well as electrical equipment manufacturing, and further promote the development of smart grid and related industries.

SGCC is willing to actively cooperate and exchange ideas with experts both at home and abroad on subjects related to smart grid, to share our experience in its research and construction, to join hands with other stakeholders to follow the latest development trend of smart grid and promote the development of international standards, thereby contributing our efforts to the development of electric power technologies.

Appendix 1 Summary Sheet Framework and Developing Plan for Strong and Smart Grid Standards in SGCC

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
	Overview and Planning				
1	Methodology and interface standards of Smart Grid	Methodology and interface standards of Smart Grid	This series of standards are to be developed	Department of Smart Grid	2010
2	Series of interface standard among each part of Smart Grid		This series of standards are to be developed	Department of Smart Grid	2014
3	Standard series of planning and design of smart transmission grid	Planning and design of Smart Grid	Part of them is valid, the other part is to be developed	Department of Affiliates Management	2011
4	Standard series of planning and design of smart distribution grid		Part of them is valid, the other part is to be developed	Department of Affiliates Management	2011
	Generation				
5	Coordination between conventional power sources and network	coordination between conventional power sources and network	This series of standards are valid		
6	Technique specification series of coordination technology of power sources and network		This series of standards are valid		
7	Series of Technical Rules for Large-scale Renewable Energy Generation Connecting to Power Grid	Grid Connection of Large-Scale Renewable Energy	Part of them is valid, the other part is under developing	Department of Affiliates Management	2010
8	Standard Series of the Grid Code Compliance Testing of Renewable Energy		Part of them is under developing, the other part is to be developed	National Power Dispatching Center	2012
9	Standard Series of Operation and Control Rules for Large-scale Renewable Energy Generation		This series of standards are to be developed	National Power Dispatching Center	2014

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
10	Functional standard series for Monitoring and Control System of large-scale renewable energy generation	Grid-connected Large-capacity Energy Storage System	This series of standards are to be developed	National Power Dispatching Center	2014
11	Standard series of Monitoring and Control equipment for large-scale renewable energy generation		This series of standards are to be developed	Department of Smart Grid	2014
12	Technology standard for Grid-connected Large-capacity Energy Storage System		This series of standards are to be developed	Department of Affiliates Management、Department of Smart Grid	2012
13	Grid-connected Character Testing Series Standard for Large-capacity Energy Storage System		This series of standards are to be developed	National Power Dispatching Center	2014
14	Grid-Connected Large-capacity energy storage system operation control Series Standard		This series of standards are to be developed	National Power Dispatching Center	2013
15	Functional specification standards of monitoring system in Large-capacity energy storage system		This series of standards are to be developed	National Power Dispatching Center	2013
16	Standards of monitoring equipment in Large-capacity energy storage system		This series of standards are to be developed	National Power Dispatching Center	2013
	Power Transmission				
17	UHV AC design standard series	UHV power transmission	This series of standards are valid	Department of UHV Construction	
18	UHV AC system equipment and test standard series		This series of standards are valid	Department of UHV Construction	
19	UHV AC engineering construction standard series		This series of standards are valid	Department of UHV Construction	

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
20	UHV AC engineering operation and maintenance series		This series of standards are valid	Department of UHV Construction	
21	UHV DC design standard series		This series of standards are valid	Department of UHV Construction	
22	UHV DC system equipment and test standard series		This series of standards are valid	Department of UHV Construction	
23	UHV DC engineering construction standard series		This series of standards are valid	Department of UHV Construction	
24	UHV DC system operation and maintenance series		This series of standards are valid	Department of UHV Construction	
25	VSC-HVDC Guideline	VSC-HVDC	This series of standards are to be developed	Department of Production & Technology、Department of Construction、Department of Smart Grid	2012
26	VSC-HVDC construction		This series of standards are to be developed	Department of Construction、Department of Production & Technology	2013
27	VSC-HVDC operational control		This series of standards are to be developed	Department of Production & Technology、Department of Construction	2014
28	VSC-HVDC equipments		Part of them is valid, the others is under developing and to be developed	Department of Construction、Department of Production & Technology	2014

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
29	FACTS Technology Guidelines	FACTS	Part of them is valid, the others is under developing and to be developed	Department of Production & Technology、Department of Construction、Department of Smart Grid	2012
30	Erection Standard of FACTS		Part of them is valid, the others is under developing and to be developed	Department of Construction、Department of Production & Technology	2013
31	FACTS Control Operation		Part of them is valid, the others is under developing and to be developed	Department of Production & Technology、Department of Construction	2014
32	FACTS Devices Standard		Part of them is valid, the others is under developing and to be developed	Department of Construction、Department of Production & Technology	2014
33	Power line status and operation monitoring system construction	Power line status and operation monitoring environmental	This series of standards are to be developed	Department of Production & Technology	2010
34	Power line status and operation monitoring system management		This series of standards are to be developed	Department of Production & Technology	2011
35	Power line status and operation monitoring system facilities		Part of them is valid, the other part is under developing	Department of Production & Technology	2011
	Power Transformation				
36	Technical Guide for Smart Substation	Smart Substation	This series of standards are valid		

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
37	construction standard series of the smart substation		Part of them is valid, the other part is to be developed	Department of Construction、 Department of Production & Technology	2010
38	standard series on the operation control for distribution automation		Part of them is valid, the other part is to be developed	National Power Dispatching Center、 Department of Production & Technology	2011
39	standard series on the function specification for distribution automation system		Part of them is valid, the others is under developing and to be developed	Department of Production & Technology、 National Power Dispatching Center	2010
40	standard series on the equipment for distribution automation		Part of them is valid, the other part is to be developed	Department of Construction、 Department of Production & Technology	2010
	Distribution				
41	The Standard Series on technology regulation for energy distributed generation access distribution grid	Distribution Grid connection of distributed generation	This series of standards are valid		
42	The standard series on grid connection characteristic test for distributed generation		Part of them is under developing, the other part is to be developed	Department of Production & Technology	2010
43	The standard series on grid connection operation control for distributed generation		Part of them is valid, the other part is to be developed	Department of Production & Technology	2011
44	The standard series on functional specification for monitoring system of distributed generation		Part of them is valid, the other part is to be developed	Department of Production & Technology	2011
45	The standard series on monitoring equipments for distributed generation		Part of them is valid, the other part is to be developed	Department of Production & Technology	2012

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
46	The Standard Series on technology regulation for energy distributed generation access distribution grid	Distribution Grid connection of distributed energy storage systems	This series of standards are to be developed	Department of Production & Technology	2012
47	The standard series on grid connection characteristic test for distributed generation		This series of standards are to be developed	Department of Production & Technology	2011
48	The standard series on grid connection operation control for distributed generation		This series of standards are to be developed	Department of Production & Technology	2012
49	The standard series on functional specification for monitoring system of distributed generation		This series of standards are to be developed	Department of Production & Technology	2012
50	The standard series on monitoring equipments for distributed generation		This series of standards are to be developed	Department of Production & Technology	2012
51	The standard series on technology regulation for distributed energy storage systems access distribution grid	Distribution Grid connection of distributed energy storage systems	This series of standards are to be developed	Department of Production & Technology	2012
52	The standard series on grid connection characteristic test for distributed energy storage systems		This series of standards are to be developed	Department of Production & Technology	2013
53	The standard series on grid connection operation control for distributed energy storage systems		This series of standards are to be developed	Department of Production & Technology	2013
54	The standard series on functional specification for monitoring system of distributed energy storage systems		This series of standards are to be developed	Department of Production & Technology	2013
55	The standard series on monitoring equipments for distributed energy storage systems		This series of standards are to be developed	Department of Production & Technology	2013

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
	Electricity Utilization				
56	Two-way interactive services platform construction standard series	Two-way interactive services	Part of them is under developing, the other part is to be developed	Department of Marketing、 Department of Smart Grid	2010
57	Two-way interactive services platform management standard series		This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2010
58	Two-way interactive services terminal equipment and system standard series		This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2010
59	Construction standard series of Power consumption information collection system	Power consumption information collection	This series of standards are valid		
60	Operation and management standards of Power consumption information collection system		This series of standards are valid		
61	Equipment standard series of Power consumption information collection system		This series of standards are valid		
62	Standard series of design and construction of EV bi-directional charging infrastructure	EV bi-directional charging infrastructure	This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2010
63	Standard series of operation and management of EV bi-directional charging infrastructure		This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2010
64	Standard series of EV bi-directional charging equipments, interface and monitoring system		This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2010
65	Construction Standards of intelligent power utilization measurement system	Intelligent power utilization measurement	Part of them is valid, the other part is to be developed	Department of Marketing、 Department of Smart Grid	2010
66	Operation management Standards of intelligent power utilization measurement system		This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2010

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
67	Devices Standards of intelligent power utilization measurement		Part of them is valid, the other part is to be developed	Department of Marketing、 Department of Smart Grid	2010
68	Series of standards on construction of quality testing system of smart power utilization	Quality testing of smart power utilization	This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2011
69	Series of standards on operation and management of quality testing system of smart power utilization		This series of standards are to be developed	Department of Marketing、 Department of Smart Grid	2011
70	Series of standards on devices of quality testing system of smart power utilization		Part of them is valid, the other part is to be developed	Department of Marketing、 Department of Smart Grid	2011
	Dispatching System				
71	The basic information standards series	Smart grid dispatching supporting system	Part of them is valid, the other part is under developing	National Power Dispatching Center	2011
72	The basic platform functional specifications and standards series		This series of standards are under developing	National Power Dispatching Center	2011
73	Applications functional specifications and standards series		Part of them is under developing, the other part is to be developed	National Power Dispatching Center	2011
74	The construction specification standards	Grid operation centralized supervisory control system	This series of standards are to be developed	National Power Dispatching Center、 Department of Production & Technology	2010
75	The operation specification standards		This series of standards are under developing	National Power Dispatching Center、 Department of Production & Technology	2012

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
76	System functional specification standards		This series of standards are to be developed	National Power Dispatching Center、Department of Production & Technology	2010
	Communication & Information				
77	Transmission network technologytechnical standard series	Transmission network	pending	National Power Dispatching Center	2011
78	Sepcial power cable technology technical standard series		Part of them is valid, the other part is to be developed	National Power Dispatching Center	2012
79	Power distribution and communication technology standard specifics	Power distribution and consumption side communication network	Part of them is valid, the other part is to be developed	National Power Dispatching Center	2012
80	Power utilization side communication technology technology series of standard		This series of standards are to be developed	National Power Dispatching Center、Department of Smart Grid	2010
81	Private service communication technologytechnical series of standard	Service network technical series of standard	Part of them is valid, the other part is under developing	National Power Dispatching Center	2011
82	General service communication technologytechnical series of standard		This series of standards are to be developed	National Power Dispatching Center	2013
83	Standard series of Smart Grid communications network management system standard series	Communication supporting network	This series of standards are to be developed	National Power Dispatching Center	2012
84	Series of Standards on Integrated Information Model for Smart Grid	Information Foundation of Smart Grid	This series of standards are to be developed	Department of Information Technology、National Power Dispatching Center	2010

NO.	Series of Standards Title	Technology Area	Status	Responsible Department	Completion Time
85	Series of Standards on Information Network Construction		This series of standards are valid		
86	Series of Standards on Power Grid Geographic Information Services Platform		This series of standards are under developing	Department of Information Technology	2010
87	Series of Standards on Mobile Operation Platform		Part of them is valid, the other part is under developing	Department of Information Technology	2010
88	Series of Standards on Enterprise-level Centralized Data Management Platform		Part of them is valid, the other part is under developing	Department of Information Technology	2013
89	Series of Standards on Communication Network Security Protection Technology	Cyber Security	This series of standards are to be developed	National Power Dispatching Center、Department of Smart Grid	2013
90	Series of Standards on Information Systems and Devices Cyber Security Technology		Part of them is valid, the other part is to be developed	Department of Information Technology	2014
91	Series of Standards on Cyber security Evaluation		Part of them is valid, the other part is to be developed	Department of Information Technology	2012
92	Series of Standards on Information Security Management System		This series of standards are valid		

Appendix 2 Developed and Released Smart Grid standards in SGCC

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
1	DL/T 1080, Application integration at electric utilities-system interfaces for distribution management	Series of standards on the interfaces among each link of smart grid	Terminology and methodology of smart grid	Synthesis and planning	IEC 61968
2	DL/T 890, Energy management system application program interface	Series of standards on the interfaces among each link of smart grid	Terminology and methodology of smart grid	Synthesis and planning	IEC 61970
3	DL/Z 860, Communication Networks and Systems in Substations	Series of standards on the interfaces among each link of smart grid	Terminology and methodology of smart grid	Synthesis and planning	IEC 61850
4	DL 755, Guidelines for power system security and stability	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
5	Q/GDW 268, Regulations on the depth of power grid planning and design	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
6	Q/GDW 212, Technical criteria for reactive power compensation	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
7	Q/GDW 271, Specifications on the depth of planning and design of the sending system of large capacity power plant	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
8	Q/GDW 272, Specifications on the depth of planning and design for connecting of large capacity power plant into power grid	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
9	Q/GDW 404, Specifications on power system stability calculation	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	

SGCC Framework and Roadmap for Strong and Smart Grid Standards

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
10	Q/GDW 156, Guidelines for urban power network planning and design	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
11	Q/GDW 370, The technical guidelines for urban power network	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
12	DL/T 5118, The guidelines for planning and design of rural power network	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
13	Q/GDW 435, The guidelines for reactive power compensation of rural power network	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
14	Q/GDW 125, The technical guidelines for construction and transformation of county power network	Series of standards on the planning and design of smart transmission grid	Planning and design of smart grid	Synthesis and planning	
15	GB/T 7409.3, Excitation system for synchronous electrical machines Technical requirements of excitation system for large and medium synchronous generators	Series of standards on coordination technology of conventional power source and grid	Coordination between conventional power sources and network	Generation	
16	DL/T 583, Specification for static rectified excitation systems and devices for large and medium hydraulic generators	Series of standards on coordination technology of conventional power source and grid	Coordination between conventional power sources and network	Generation	
17	DL/T 650, Specification for potential source static exciter systems for large turbine generators	Series of standards on coordination technology of conventional power source and grid	Coordination between conventional power sources and network	Generation	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
18	GB/T 9652.2, Test code of control systems for hydraulic turbines	Series of standards on coordination test between conventional power sources and network	Coordination between conventional power sources and network	Generation	
19	DL 490, Specification of Installation and Acceptance of Static Rectifier Excitation System and Devices of Large/middle-scale Hydro Generator	Series of standards on coordination test between conventional power sources and network	Coordination between conventional power sources and network	Generation	
20	Q/GDW 143, Guide for Setting Test of Power System Stabilizer	Series of standards on coordination test between conventional power sources and network	Coordination between conventional power sources and network	Generation	
21	Q/GDW 392, Technical Rule for Connecting Wind Farm into Power Grid	Series of Standards on Large-scale Renewable Energy Generation Connection to Power Grid	Grid connection of larger-scale renewable energy	Generation	
22	Technical specifications for PV station connecting to power grid (draft)	Series of Standards on Large-scale Renewable Energy Generation Connection to Power Grid	Grid connection of larger-scale renewable energy	Generation	
23	GB/Z 24842-2009, Overvoltage and Insulation Coordination of 1000kV UHV AC Transmission Project	Series of standards on the design of UHVAC transmission	UHVAC transmission	Transmission	
24	GB/Z 24847-2009, Technical Guide on 1000kV AC System Voltage and Reactive Power	Series of standards on the design of UHVAC transmission	UHVAC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
25	Q/GDW 294-2009, 1000kV Substation Design Standard	Series of standards on the design of UHVAC transmission	UHVAC transmission	Transmission	
26	Q/GDW 178-2008, 1000kV Overhead Power Transmission Line Design Standard	Series of standards on the design of UHVAC transmission	UHVAC transmission	Transmission	
27	Q/GDW 298-2009, Technical Specification for 1000kV Overhead Transmission Line Exploration and Surveying	Series of standards on the design of UHVAC transmission	UHVAC transmission	Transmission	
28	GB/Z 24843-2009, Technical Specification of 1000kV Single Phase Oil-immersed Auto-transformer	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
29	GB/Z 24844-2009, Technical Specification for Oil-immersed Shunt Reactor of 1000kV AC System	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
30	GB/Z 24836-2009, Specification for 1100 kV Gas-insulated Metal-enclosed Switchgear	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
31	GB/Z 24838-2009, Specification for 1100kV Alternating-current High-voltage Circuit-breakers	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
32	GB/Z 24841-2009, Technical Specification for Capacitor Voltage Transformers of 1000kV AC System	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
33	GB/Z 24837-2009, Specification for 1100kV Alternating-current Disconnectors and Earthing Switches	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
34	GB/Z 24845-2009, Specification of Metal-oxide Surge Arresters Without Gaps for 1000kV AC System	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
35	GB/Z 24840-2009, Technical Specification for Bushing of 1000kV AC System	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
36	GB/Z 24839-2009, Technical Specification of Post Insulators for 1000kV AC System	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
37	GB/T 24834-2009, Technical Specification for Fittings of 1000kV AC Overhead Transmission Line	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
38	GB/T 24833-2009, Technical Specification for 1000kV Substation Automation System	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
39	Q/GDW 295-2009, Technical Specification for 1000kV AC Current Transformer	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
40	Q/GDW 291-2009, The Technical Specification of Fittings for 1000kV Substation	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
41	Q/GDW 325-2009, Technical Specification for 1000kV Transformer Protection Devices	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
42	Q/GDW 326-2009, Technical Specification for 1000kV Reactor Protection Devices	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
43	Q/GDW 327-2009, Technical Specification for 1000kV Transmission Line Protection Devices	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
44	Q/GDW 329-2009, Technical Specification for 1000kV Breaker Protection Devices	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
45	Q/GDW 328-2009, Technical Specification for 1000kV Busbar Protection Devices	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
46	Q/GDW 311-2009, Technical Specification for Electric Test of 1000kV UHV AC Fittings	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
47	Q/GDW 320-2009, Guide of Supervision for Manufacturing 1000kV AC Electrical Power Equipments	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
48	Q/GDW 292-2009, The guide of supervision for manufacturing 1000kV transmission line tower, conductors, electric power fittings and OPGW	Series of Standards on UHV AC System Equipment and Test	UHVAC transmission	Transmission	
49	Q/GDW 193-2008, Guide for the Construction Technology of the Assembly and Erection of the Steel Towers of 1000kV Overhead Transmission Line	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
50	Q/GDW 155-2006, Guide for the Construction Technology of Tension Stringing of 1000kV Overhead Transmission Line	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
51	Q/GDW 154-2006, Guide for the Earth Wire Fittings Hydraulic Pressure Construction	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
52	Q/GDW 192-2008, Criterion on Construction and Acceptance for 1000kV Power Transformer, Oil-immersed Reactor and Transformer	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
53	Q/GDW 195-2008, Criterion on Construction and Acceptance for 1000kV High-voltage Electric Apparatus (GIS, HGIS, Disconnecter, Arrester)	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
54	Q/GDW 164-2007, Criterion on Construction and Acceptance for 1000kV Framework & Stent	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
55	Q/GDW 198-2008, Criterion on Construction and Acceptance of 1000kV Busbar Devices	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
56	Q/GDW 153-2006, Criterion on Construction and Acceptance for 1000kV Overhead Transmission Line	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
57	Q/GDW 189-2008, Regulations on Inspection and Assessment on Construction Quality of Electrical Apparatus in 1000kV Ultra-high Voltage Substation	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
58	Q/GDW 163-2007, Regulations on Inspection and Assessment on Construction Quality of 1000kV Overhead Transmission Line	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
59	Q/GDW 310-2009, Standard for Hand-over Test of 1000kV Electric Equipment Installation Engineering	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
60	Q/GDW 285-2009, Specification for Start-up & Completion Acceptance of 1000kV AC Transmission & Distribution Projects	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
61	Q/GDW 284-2009, Commissioning standards for 1000kV AC transmission and distribution system	Series of Standards on UHV AC Engineering Construction	UHVAC transmission	Transmission	
62	GB/Z 24835-2009, Regulation of Operation and Maintenance for 1000kV Gas-insulated Metal-enclosed Switchgear	Series of Standards on UHV AC Engineering Operation and Maintenance	UHVAC transmission	Transmission	
63	GB/Z 24846-2009, Preventive Test Standards of 1000kV AC Electrical Equipments	Series of Standards on UHV AC Engineering Operation and Maintenance	UHVAC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
64	Q/GDWZ 211-2008, Operation Code for 1000kV UHV AC Substation	Series of Standards on UHV AC Engineering Operation and Maintenance	UHVAC transmission	Transmission	
65	Q/GDW 331-2009, Guide for AC 1000kV Protection and Automation device operating management	Series of Standards on UHV AC Engineering Operation and Maintenance	UHVAC transmission	Transmission	
66	Q/GDWZ 210-2008, Operation Code for 1000kV UHV AC Overhead Transmission Line	Series of Standards on UHV AC Engineering Operation and Maintenance	UHVAC transmission	Transmission	
67	DL/T392-2010, Technical Guide for Live Working on 1000kV AC Transmission Line	Series of Standards on UHV AC Engineering Operation and Maintenance	UHVAC transmission	Transmission	
68	Q/GDW 239-2009, Inspection Specification for 1000kV Power System Protection Relay and Automation Device	Series of Standards on UHV AC Engineering Operation and Maintenance	UHVAC transmission	Transmission	
69	Q/GDW 144-2006, Guide for overvoltage protection and insulation coordination of ± 800 kV UHV DC converter station	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
70	Q/GDW 277-2009, The Limit Value of Electromagnetic Environment at ± 800 kV Converter Station	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
71	DL/T 1088-2008, The Electromagnetic Environment Parameter Limit for ± 800 kV UHV DC Transmission Line	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
72	Q/GDW 146-2006, Technical guide for reactive power compensation and allocation of HVDC converter stations	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
73	DL/T 5426-2009, Guideline for $\pm 800\text{kV}$ UHVDC Transmission Project System Design	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
74	GB/T 20989-2007, Determination of power losses in high-voltage direct current(HVDC) converter stations	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
75	Q/GDW 293-2009, Technical rule for designing $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
76	DL/T 436-2005, Technical Guide for HVDC overhead transmission lines	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
77	Q/GDW 296-2009, Technical Code for design of $\pm 800\text{kV}$ overhead transmission line	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
78	DL/T 5340-2006, Technical code for designing of telecommunication lines against danger effects from DC power transmission lines	Series of Standards on UHV DC Design	UHVDC transmission	Transmission	
79	Q/GDW 147-2006, General specification for $\pm 800\text{kV}$ UHVDC Converter transformers	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
80	Q/GDW 149-2006, General specification for $\pm 800\text{kV}$ UHVDC smoothing reactors Part 2: dry-type smoothing reactors	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
81	Q/GDW 148-2006, General specification for smoothing reactors of $\pm 800\text{kV}$ UHVDC applications Part 1: Oil-immersed smoothing reactors	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
82	Q/GDW 288-2009, General specification for $\pm 800\text{kV}$ UHVDC converter valve	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
83	Q/GDW 261-2009, General specification for $\pm 800\text{kV}$ UHVDC 6 inch thyristors	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
84	Q/GDW 276-2009, Technical Specification of Metal Oxide Arrester for $\pm 800\text{kV}$ UHVDC Converter Stations	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
85	Q/GDW 281-2009, Technical specification of D.C. bushings for $\pm 800\text{kV}$ converter stations	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
86	Q/GDW 279-2009, Technical Specification of $\pm 800\text{kV}$ D.C. Post Insulators	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
87	Q/GDW 259-2009, General specification for sensors of $\pm 800\text{kV}$ UHVDC applications	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
88	Q/GDW 289-2009, Technology specification of direct-current disconnectors and earthing switches for $\pm 800\text{kV}$ converter station	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
89	Q/GDW 280-2009, Technical specification of the cap and pin insulators for 800kV D.C. systems	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
90	Q/GDW 282-2009, Technical specification of 800kV D.C. rod suspension composite insulators	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
91	Q/GDW 151-2006, Disc suspension composite sheds insulator string for HVDC transmission lines applications	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
92	Q/GDW 265-2009, Technical specification for Control and protection equipment of $\pm 800\text{kV}$ Ultra-high-voltage direct current (UHVDC) transmission system	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
93	DL/T 1087-2008, Standard of immunity for secondary equipment in $\pm 800\text{kV}$ UHV DC converter stations	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
94	Q/GDW 150-2006, General specification for $\pm 800\text{kV}$ UHVDC wall bushings	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
95	DL/T 1089-2008, Measurement method for total electric field strength and ion current density of the converter station and DC transmission lines	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
96	Q/GDW 300-2009, Measurement Method for Radio Interference of DC Equipments	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
97	Q/GDW 301-2009, Icing flashover test method on high voltage insulators to be used in d.c. system	Series of Standards for UHV DC System Equipment and test	UHVDC transmission	Transmission	
98	Q/GDW 263-2009, Guide of supervision for $\pm 800\text{kV}$ UHVDC electrical equipments	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
99	Q/GDW 217-2008, Code for construction quality checkout and evaluation of $\pm 800\text{kV}$ converter substation	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
100	DL/T 5233-2010, Code for Construction Quality Checkout and Evaluation of Electric Devices for $\pm 800\text{kV}$ and Below DC Converter Station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
101	DL/T5232-2010, Code for Construction and Acceptance of Electric Devices for $\pm 800\text{kV}$ and Below DC Converter Station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
102	DL/T5231-2010, Code for Construction and Acceptance of Earth Electrode of $\pm 800\text{kV}$ and Below DC Transmission System	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
103	DL/T5236-2010, Code for Construction Quality Checkout and Evaluation of $\pm 800\text{kV}$ and Below Overhead Transmission Line	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
104	DL/T5235-2010, Code for Construction and Acceptance of Overhead Line of $\pm 800\text{kV}$ and Below DC Transmission System	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
105	Q/GDW 230-2008, Code for construction quality checkout and evaluation of overhead earth electrode line of $\pm 800\text{kV}$ DC transmission system	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
106	Q/GDW 218-2008, Code for construction and acceptance of valve hall in $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
107	Q/GDW 219-2008, Code for construction and acceptance of HVDC equipment in $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
108	Q/GDW 220-2008, Code for construction and acceptance of converter transformer in $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
109	Q/GDW 221-2008, Code for construction and acceptance of converter valve in $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
110	Q/GDW 222-2008, Code for construction and acceptance of AC filter in $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
111	Q/GDW 223-2008, Code for construction and acceptance of busbar in $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
112	Q/GDW 224-2008, Code for construction and acceptance of electric panel and cabinet, control wiring diagram in $\pm 800\text{kV}$ converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
113	Q/GDW 228-2008, Code for construction quality checkout and evaluation of earth electrode of $\pm 800\text{kV}$ DC transmission system	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
114	Q/GDW 229-2008, Code for construction and acceptance of overhead earth electrode line of $\pm 800\text{kV}$ DC transmission system	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
115	Q/GDW 255-2009, Construction technology guide to the main equipment installation of $\pm 800\text{kV}$ UHVDC converter station	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
116	Q/GDW 256-2009, Guide for construction of lattice frame and support for $\pm 800\text{kV}$ DC substation	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
117	Q/GDW 257-2009, Guide for construction of Busbar and Jumper Wiring of $\pm 800\text{kV}$ UHVDC substation	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
118	Q/GDW 260-2009, Construction technology guide for tension stringing of $\pm 800\text{kV}$ overhead transmission line	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
119	Q/GDW 262-2009, Construction technology guide to the assembly and erection of the steel towers of $\pm 800\text{kV}$ overhead transmission line	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
120	DL/T5234-2010, Guide for from starting to accomplishment checking of $\pm 800\text{kV}$ and Lower level DC transmission project	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
121	Q/GDW275-2009, Hand-over Test of Electric Equipment for $\pm 800\text{kV}$ HVDC System	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
122	Q/GDW 264-2009, Standard for hand-over tests of secondary circuit equipment of converter stations of $\pm 800\text{kV}$ UHVDC transmission project	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
123	DL/T 1131-2009, System Test Code for $\pm 800\text{kV}$ HVDC Transmission Project	Series of Standards on UHV DC Engineering Construction	UHVDC transmission	Transmission	
124	Q/GDW 333-2009, Guideline for $\pm 800\text{kV}$ DC Converter Station Operation Specification Compilation	Series of Standards on UHV DC Project Operation and Maintenance	UHVDC transmission	Transmission	
125	Q/GDW 332-2009, Operation Code for $\pm 800\text{kV}$ DC Overhead Transmission Line	Series of Standards on UHV DC Project Operation and Maintenance	UHVDC transmission	Transmission	
126	Q/GDW 299-2009, Preventive test code for $\pm 800\text{kV}$ UHV DC Equipment	Series of Standards on UHV DC Project Operation and Maintenance	UHVDC transmission	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
127	Q/GDW 302-2009, Technical guide for live working in $\pm 800\text{kV}$ D.C. transmission lines	Series of Standards on UHV DC Project Operation and Maintenance	UHVDC transmission	Transmission	
128	Q/GDW 334-2009, Maintenance Criterion of $\pm 800\text{kV}$ DC Overhead Transmission Line	Series of Standards on UHV DC Project Operation and Maintenance	UHVDC transmission	Transmission	
129	Q/GDW 335-2009, Administration Criterion for $\pm 800\text{kV}$ Converter Station Overhaul	Series of Standards on UHV DC Project Operation and Maintenance	UHVDC transmission	Transmission	
130	Q/GDW 336-2009, Maintenance Criterion of $\pm 800\text{kV}$ DC Converter Station Equipment	Series of Standards on UHV DC Project Operation and Maintenance	UHVDC transmission	Transmission	
131	DL/T 989, Reliability evaluation code for DC power transmission system	Series of Standards on VSC-HVDC Operational Control	VSC-HVDC transmission	Transmission	
132	GB/T 22390, Control and protection equipment of high-voltage direct current(HVDC)transmission system	Series of Standards on VSC-HVDC Equipments	VSC-HVDC transmission	Transmission	
133	GB/Z 20996, Performance of high-voltage direct current (HVDC) systems	Series of Standards on VSC-HVDC Equipments	VSC-HVDC transmission	Transmission	
134	GB/T 6115.1, Series capacitors for power systems--Part1:General Principles	Series of Standards on FACTS Technology Guidelines	FACTS	Transmission	IEC 60143.1
135	GB/T 20297, Static Var Compensator Field Tests	Series of Standards on FACTS Construction	FACTS	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
136	Q/GDW 177, The Regulations on the Technical Supervision About Static Var Compensator	Series of Standards on FACTS Construction	FACTS	Transmission	
137	DL/T 1090, Reliability Evaluation Code for Series Compensation System	Series of Standards on FACTS Control and Operation	FACTS	Transmission	
138	GB/T 6115.2~3, Series Capacitors for Power Systems--Part 2: Protective equipment for series capacitor banks, Part 3: Internal fuse	Series of Standards on FACTS Devices	FACTS	Transmission	IEC 60143.2~3
139	GB/T 20298, The Functional Specification of Static Var Compensator	Series of Standards on FACTS Devices	FACTS	Transmission	
140	DL/T 1010, High-voltage Static VAR Compensator	Series of Standards on FACTS Devices	FACTS	Transmission	
141	Q/GDW 241, Chain-circuit Static Synchronous Compensator	Series of Standards on FACTS Devices	FACTS	Transmission	
142	DL/T 837, Reliability evaluation code for transmission and distribution installation	Series of standards on line status and operation environmental monitoring system management	Line status and operating environmental monitoring	Transmission	
143	DL/T 1006, Patrol system for overhead lines	Series of standards on line status and operation environmental monitoring system facilities	Line status and operating environmental monitoring	Transmission	
144	Q/GDW 242, Technical specifications of on-line conductor temperature monitoring system for overhead transmission lines	Series of standards on line status and operation environmental monitoring system facilities	Line status and operating environmental monitoring	Transmission	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
145	Q/GDW 243, Technical specifications of on-line weather monitoring system for overhead transmission lines	Series of standards on line status and operation environmental monitoring system facilities	Line status and operating environmental monitoring	Transmission	
146	Q/GDW 244, Technical specifications of on-line monitoring system of aeolian vibration for overhead transmission lines	Series of standards on line status and operation environmental monitoring system facilities	Line status and operating environmental monitoring	Transmission	
147	Q/GDW 245, General technical specification for on-line monitoring system on overhead transmission lines	Series of standards on line status and operation environmental monitoring system facilities	Line status and operating environmental monitoring	Transmission	
148	Q/GDW 383, Technical Guide for Smart Substation	Series of standards on Technical guide for smart substation	Smart Substation	Transformation	
149	Q/GDW 393, Specifications of Design for 110 (66) kV~220kV Smart Substation	Series of standards on the construction of smart substation	Smart Substation	Transformation	
150	Q/GDW 394, Specifications of Design for 330kV~750kV Smart Substation	Series of standards on the construction of smart substation	Smart Substation	Transformation	
151	Q/GDWZ 414, Technical Specifications for Smartness Upgrade of Substation	Series of standards on the construction of smart substation	Smart Substation	Transformation	
152	Q/GDW 214, Code of Administration for Site Acceptance Test of Computerized Monitoring and Control System of Substation	Series of standards on the construction of smart substation	Smart Substation	Transformation	
153	DL/T 1101, Acceptance Specification for 35kV ~ 110kV Substation Automation System	Series of standards on the construction of smart substation	Smart Substation	Transformation	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
154	DL/T 969, Guideline of Substation Operation	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
155	DL/T 587, Code for Operating Management of Microprocessor-Based Relaying Protection Equipment	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
156	Q/GDW 422, Setting Guide for Power System Protection of State Grid	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
157	GB/T 14285, Technical Code for Relaying Protection and Security Automatic Equipment	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
158	DL/T 478, General Specifications for Static Protection, Security and Automatic Equipment	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
159	DL/T 995, Testing Regulations on Protection and Stability Control Equipment	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
160	Q/GDW 441, Technical Specifications of Protection for Smart Substation	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
161	DL/T 5149, Technical Code for Designing Computerized Monitoring and Control System of 220-500kV Substations	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
162	Q/GDW 396, Models of Relay in Substation Based on IEC61850 Standards	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	
163	Q/GDW 431, Guideline for the Site Commissioning of Automation Systems in Smart Substation	Series of standards on the operation and control of smart substation	Smart Substation	Transformation	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
164	Q/GDWZ 410, Technical Guide for Smart Electric Equipments	Series of standards on the equipment of smart substation	Smart Substation	Transformation	
165	Q/GDW 426, The Technical Specification for Merging Unit in Smart Substation	Series of standards on the equipment of smart substation	Smart Substation	Transformation	
166	Q/GDW 427, The Technical Specification for Control Unit Technical in Smart Substation	Series of standards on the equipment of smart substation	Smart Substation	Transformation	
167	Q/GDW 429, The Technical Specification for Ethernet LAN Switch in Smart Substation	Series of standards on the equipment of smart substation	Smart Substation	Transformation	
168	Q/GDW 428, The Technical Specification for Intelligent Terminal in Smart Substation	Series of standards on the equipment of smart substation	Smart Substation	Transformation	
169	Q/GDW 430, The Technical Specification for Intelligent Control Cabinet in Smart Substation	Series of standards on the equipment of smart substation	Smart Substation	Transformation	
170	GBT-20840.7, Instrument Transformers -- Part 7: Electronic Voltage Transformers	Series of standards on the equipment of smart substation	Smart Substation	Transformation	IEC 60044-7
171	GBT-20840.8, Instrument Transformers -- Part 8: Electronic Current Transformers	Series of standards on the equipment of smart substation	Smart Substation	Transformation	IEC 60044-8
172	Q/GDW 382, The Guidelines on the Technology for Distribution Automation	Guidelines on the Technology for Distribution Automation	Distribution automation	Distribution	
173	Q/GDW 370, Technical Guide for urban distribution network	Guidelines on the Technology for Distribution Automation	Distribution automation	Distribution	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
174	DL/T 721, Remote terminal unit of distribution automation system	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
175	DL/T 630, Technical requirement for RTU with a.c.electrical quantities input discrete sampling	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
176	Q/GDW 436, Technical specification for Fault Indicator of Distribution Line	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
177	GB/T 14285, Technical code for relaying protection and security automatic equipment	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
178	DL/T 814, Function specification of distribution automation systems	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
179	Q/GDW 126, Rural Power Grid Automation & Telecommunication Construction Technical Guideline	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
180	Q/GDW 338, The typical design specification of rural distribution automation	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
181	Q/GDW 339, The typical application modes of rural distribution automation	Series of standards on the equipment for distribution automation	Distribution automation	Distribution	
182	Q/GDW 354, Functional Specification for Smart Electricity Meters	Series of standards on equipment of power utilization information collection system	Power utilization information collection	Utilization	
183	Q/GDW 355, The Type Specification for Smart Single Phase Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
184	Q/GDW 356, The Type Specification for Smart Polyphase Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
185	Q/GDW 357, Technical Specification for Class 0.2S Polyphase Smart Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
186	Q/GDW 358, Technical Specification for Class 0.5S Polyphase Smart Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
187	Q/GDW 359, Technical Specification for Class 0.5S Prepayment Polyphase Smart Electricity Meters with Telecommunication	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
188	Q/GDW 360, Technical Specification for Class 1 Prepayment Polyphase Smart Electricity Meters with Telecommunication	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
189	Q/GDW 361, Technical Specification for Class 1 Prepayment Polyphase Smart Electricity Meters with Carrier-wave	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
190	Q/GDW 362, Technical Specification for Class 1 Prepayment Polyphase Smart Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
191	Q/GDW 363, Technical Specification for Class 1 Polyphase Smart Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
192	Q/GDW 364, Technical Specification for Single Phase Smart Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
193	Q/GDW 365, Security Techniques of Information Interchange Authentication Specification for Smart Electricity Meters	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
194	Q/GDW 374.1, Power User Electric Energy Data Acquire System Technical Specification Part 1: Data Acquire Terminal of Special Transformer	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
195	Q/GDW 374.2, Power User Electric Energy Data Acquire System Technical Specification Part 2: Centralized Meter Reading Terminal	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
196	Q/GDW 374.3, Power User Electric Energy Data Acquire System Technical Specification Part 3: Communication Unit	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
197	Q/GDW 375.1, Power User Electric Energy Data Acquire System Type Specification Part 1: Date Acquire Terminal of Special Transformer	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
198	Q/GDW 375.2, Power User Electric Energy Data Acquire System Type Specification Part 2: Concentrator	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
199	Q/GDW 375.3, Power User Electric Energy Data Acquire System Type Specification Part 3: Collector	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
200	Q/GDW 376.1, Power User Electric Energy Data Acquisition System Communication Protocol Part 1: Master Station Communication with Data Acquire Terminal	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
201	Q/GDW 376.2, Power User Electric Energy Data Acquisition System Communication Protocol Part 2: Concentrator Local Communication Module Interface	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
202	Q/GDW 377, Power User Electric Energy Data Acquire System Safety Protection Specification	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
203	Q/GDW 373, Power User Electric Energy Data Acquire System Functional Specification	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
204	Q/GDW 378.1, Power User Electric Energy Data Acquire System Design Guideline Part 1: Master Station Software	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
205	Q/GDW 378.2, Power User Electric Energy Data Acquire System Design Guideline Part 2: Terminators Application Software	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
206	Q/GDW 378.3, Power User Electric Energy Data Acquire System Design Guideline Part 3:Technical Scheme	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
207	Q/GDW 379.1, Power User Electric Energy Data Acquisition System Testing Technical Specification Part 1: System	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
208	Q/GDW 379.2, Power User Electric Energy Data Acquisition System Testing Technical Specification Part 2:Data Acquire Terminal of Special Transformer	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
209	Q/GDW 379.3, Power User Electric Energy Data Acquisition System Testing Technical Specification Part 3:Concentrate Meter Reading Terminal	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
210	Q/GDW 379.4, Power User Electric Energy Data Acquisition System Testing Technical Specification Part 4:Communication Unit	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
211	Q/GDW 380.1, Power User Electric Energy Data Acquisition System Management Specification Part 1:Master Station Construction	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
212	Q/GDW 380.2, Power User Electric Energy Data Acquisition System Management Specification Part 2:Communication Channel Construction	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
213	Q/GDW 380.3, Power User Electric Energy Data Acquisition System Management Specification Part 3:Data Acquire Terminal Construction	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
214	Q/GDW 380.4, Power User Electric Energy Data Acquisition System Management Specification Part 4:Master Station Operation	Series of standards on Operation and management of power utilization information collection system	Power Utilization information collection	Utilization	
215	Q/GDW 380.5, Power User Electric Energy Data Acquisition System Management Specification Part 5:Communication Channel Operation	Series of standards on Operation and management of power utilization information collection system	Power Utilization information collection	Utilization	
216	Q/GDW 380.6, Power User Electric Energy Data Acquisition System Management Specification Part 6:Data Acquire Terminal Operation	Series of standards on Operation and management of power utilization information collection system	Power Utilization information collection	Utilization	
217	Q/GDW 380.7, Power User Electric Energy Data Acquisition System Management Specification Part 7:Acceptance	Series of standards on Operation and management of power utilization information collection system	Power Utilization information collection	Utilization	
218	DL/T 698.1, Data Acquisition and Management System for Electrical Energy Part 1 :General Consideration	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
219	DL/T 698.2, Data Acquisition and Management System for Electrical Energy Part2: Technical Specification of Master Station	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
220	DL/T 698.31, Data Acquisition and Management System for Electrical Energy Part 3-1 : Technical Specification of Electrical Energy Data Acquisition Terminal - General Requirement	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
221	DL/T 698.32, Data Acquisition and Management System for Electrical Energy Part3-2: Technical specification of electrical energy data acquisition terminal-Special requirement for data acquisition terminal of power station and substation	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
222	DL/T 698.33, Data Acquisition and Management System for Electrical Energy Part3-4: Technical specification of electrical energy data acquisition terminal - Special requirement for data acquisition terminal of special transformer	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
223	DL/T 698.34, Data Acquisition and Management System for Electrical Energy Part3-4: Technical specification of electrical energy data acquisition terminal-Special requirement for data acquisition terminal of common transformer	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
224	DL/T 698.35, Data Acquisition and Management System for Electrical Energy Part3-5: Technical specification of Electrical energy data acquisition terminal-Special requirement for meter rending terminal of LV customers	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
225	DL/T 698.41, Data Acquisition and Management System for Electrical Energy Part4-1: Communication protocol- Master station communication with data acquisition terminal	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
226	DL/T 698.42, Data Acquisition and Management System for Electrical Energy Part 4 -2 : communication protocol -- concentrator downward communication	Series of standards on equipment of power utilization information collection system	Power Utilization information collection	Utilization	
227	CJ/T 174, Technological Classification of Community Intellectualization System	Series of standards on construction of smart building and smart district	Smart energy utilization services	Utilization	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
228	GB/T 20046, Photovoltaic (PV) Systems – Characteristics of the Utility Interface	Series of standards on equipment and system of smart building and smart district	Smart energy utilization services	Power Utilization	IEC 61727
229	Q/GDW 236, General Technical Requirements of Electric Vehicle Charging Station	Series of standards on construction of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
230	Q/GDW 237, Layout Design Guideline of Electric Vehicle Charging Station,	Series of standards on construction of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
231	Q/GDW 238, Power Supply System Criterion of Electric Vehicle Charging Station	Series of standards on construction of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
232	Q/GDW 478, Technical Guide for Electric Vehicle Charging Infrastructure Construction	Series of standards on construction of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
233	Q/GDW 233, Electric Vehicle Off-board Charger General Requirements	Series of standards on equipment and interface and system of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
234	Q/GDW 234, Electric Vehicle Off-board Charger Specification for Electrical Interfaces	Series of standards on equipment and interface and system of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
235	Q/GDW 235, Electric Vehicle Off-board Charger Communication Protocols	Series of standards on equipment and interface and system of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
236	Q/GDW 397, Off-board Bi-directional Charger for Electric Vehicles General Technical Requirements	Series of standards on equipment and interface and system of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
237	Q/GDW 398, Off-board Bi-directional Charger for Electric Vehicles Specification for Electrical Interfaces	Series of standards on equipment and interface and system of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
238	Q/GDW 399, AC Power Supply Device for Electric Vehicles Specification for Electrical Interfaces	Series of standards on equipment and interface and system of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
239	Q/GDW 400, Bi-directional Electricity Billing Device for Electric Vehicles Technical Specification	Series of standards on equipment and interface and system of electric vehicle charge and discharge infrastructure	Electric vehicle charge and discharge	Utilization	
240	DL/T 634.5 101, Telecontrol Equipment and Systems Part 5-101: Basic Remote Task Supporting Standards	Series of standards on Smart grid dispatching supporting system	Smart grid dispatching supporting system	Dispatching system	IEC 60870
241	DL/T 719, Telecontrol Equipment and Systems Part 5-102: Total Electric Energy Transmission Companion Standards	Series of standards on Smart grid dispatching supporting system	Smart grid dispatching supporting system	Dispatching system	IEC60870
242	DL/T 667, Telecontrol Equipment and Systems Part 5-103: Protection Equipment Information Interface	Series of standards on Smart grid dispatching supporting system	Smart grid dispatching supporting system	Dispatching system	IEC60870
243	DL/T 634.5 104, Telecontrol equipment and systems.Part 5-104:Transmission protocols-Network access for IEC 60870-5-101 using standard transport profiles	Series of standards on Smart grid dispatching supporting system	Smart grid dispatching supporting system	Dispatching system	IEC60870

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
244	GB/T 18700.1, Telecontrol Equipment and Systems part 6-503 : Remote Control Protocol TASE2 Service and Protocol compatible with ISO standards and ITU-T recommended standards	Series of standards on Smart grid dispatching supporting system	Smart grid dispatching supporting system	Dispatching system	IEC60870
245	DL/T 476, Application Layer Protocol of Real Time Data Communication Protocol of Power System	Series of standards on Smart grid dispatching supporting system	Smart grid dispatching supporting system	Dispatching system	
246	GB/T 7611, Bit-rate Digital Network Electrical Interface Characteristics	Series of standards on Transmission network technology	Transmission network	Information and communication technology	
247	YD/T 1238, SDH-based Multi-service Transport Node Technical Requirements	Series of standards on Transmission network technology	Transmission network	Information and communication technology	
248	YD/T 5095, SDH Long-haul Optical Transmission System Engineering Design	Series of standards on Transmission network technology	Transmission network	Information and communication technology	
249	DL/T 832, Optical Fiber Composite Overhead Ground Wires	Series of standards on Special power cable technology	Transmission network	Information and communication technology	
250	DL/T 766, Technical Requirements and Testing Method of Helical Fittings for OPGW	Series of standards on Special power cable technology	Transmission network	Information and communication technology	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
251	DL/T 788, All Dielectric Self-supporting Optical Fiber Cable	Series of standards on Special power cable technology	Transmission network	Information and communication technology	
252	DL/T 767, Technical Requirements and Testing Method of Helical Fittings for ADSS	Series of standards on Special power cable technology	Transmission network	Information and communication technology	
253	DL/T 790, Distribution Automation Using Distribution Line Carrier Systems	Series of standards on Power distribution and communication technology	Power distribution and consumption side communication network	Information and communication technology	IEC TS 61334
254	YD/T 1007, Allocation of Transmission Performance Objectives in Access Network	Series of standards on Power distribution and communication technology	Power distribution and consumption side communication network	Information and communication technology	
255	DL/T 645, Multi-Function Watt-hour Meter Communication Protocol	Series of standards on Power utilization side communication technology	Power distribution and consumption side communication network	Information and communication technology	
256	GB/T 17246, Power System Communication Business Guideline	Series of standards on Private service communication technology	Service network	Information and communication technology	
257	GB/T 15629.3, Information Processing Systems—Local Area Networks—Part 3:Carrier Sense Multiple Access with Collision Detection(CSMA/CD)—Access Method and Physical Layer Specifications	Series of standards on General service communication technology	Service network	Information and communication technology	IEEE 802.3

NO.	Standard Title	Series of standards	Technical field	Area	Corresponding standard
258	YDB 004, Next Generation Network (NGN) Business General Technical Requirements	Series of standards on General service communication technology	Service network	Information and communication technology	
259	YDB 007, Next Generation Network (NGN) PSTN/ISDN Analog Business Technical Requirements	Series of standards on General service communication technology	Service network	Information and communication technology	
260	YD/T 1823, IP TV Service System General Technical Requirements	Series of standards on General service communication technology	Service network	Information and communication technology	
261	YD/T 1289.1, Synchronous Digital Hierarchy (SDH) Transport Network Management System Technical Specification	Series of standards on Smart Grid communications network management system	Communication supporting network	Information and communication technology	
262	YD/T 1350, Technical Specification of Wavelength Division Multiplexing (WDM) System Network Management Interface	Series of standards on Smart Grid communications network management system	Communication supporting network	Information and communication technology	
263	Q/GDW 401, Specification of Design for State Grid Corporation Substation Information Network	Series of standards on Information Network Construction	Information Foundation of Smart Grid	Communication and Information Management	
264	Q/GDW 402, Specification of Plan and Design for State Grid Corporation's Power Supply Enterprise Information Network	Series of standards on Information Network Construction	Information Foundation of Smart Grid	Communication and Information Management	
265	Q/GDW 134, Specification for Information Network IP Address Coding in State Grid Corporation	Series of standards on Information Network Construction	Information Foundation of Smart Grid	Communication and Information Management	

NO.	Standard Title	Serie of standards	Technical field	Area	Corresponding standard
266	YD/T 1742, Security Protection Requirements for Access Network	Series of standards on communication network security protection technology guidelines	Communication and information security	Information and communication technology	
267	YD/T 1744, Security Protection Requirements for Transport Network YD/T 1752, Security Protection Requirements for Supporting Network	Series of standards on communication network security protection technology guidelines	Communication and information security	Information and communication technology	
268	GB/T 20279, Information Security Technology Security Techniques Requirements of Separation Components of Network and Terminal Equipment	Series of standards on Information systems and devices cyber security technology	Cyber Security	Information and communication technology	
269	GB/T 18336, Information Technology-Security Techniques-Evaluation Criteria for IT Security	Series of standards on Cyber security evaluation	Cyber Security	Information and communication technology	ISO/IEC 15408
270	GB/T 22239, Information Security Technology - Baseline for Classified Protection of Information System Security	Series of standards on Cyber security evaluation	Cyber Security	Information and communication technology	
271	GB/T 22080, Information Technology - Security Techniques - Information Security Management Systems - Requirements	Series of standards on Information security management	Cyber Security	Information and communication technology	ISO/IEC 27001
272	GB/T 22081, Information Technology - Security Techniques - Code of Practice for Information Security Management	Series of standards on Information security management	Cyber Security	Information and communication technology	ISO/IEC 27002

Appendix 3: Core Standards for Smart Grid Experimental Project of SGCC

No.	Areas	Technical Fields	Core Standards	Status	Corresponding Experimental Project
1	Generation	Grid Connection of Large-Scale Renewable Energy	Technology Regulations on Integration of Wind Farm into Power Grid	Released (Enterprise Standard)	Wind-Solar-Storage Combined Demonstration Project
2			Deep Regulations on Design Content for Wind Farm Connecting to Power System	Released (Technical Document)	Wind-Solar-Storage Combined Demonstration Project
3			Technology Regulations on Operation Control of Wind Power Grid Integration	Awaiting Authorization (Technical Document)	Large-Scale Wind Power Prediction and Operation Control
4			The Test Specification of Wind Farm Grid Integration	Under Development, and to be Released in 2010	Wind Energy Generation Study and Test Center
5			Technical rule for PV Station Connecting to Power Grid	Under Development, and to be Released in 2010	Wind-Solar-Storage Combined Demonstration Project
6			The Test Procedure of PV Station Grid Integration	Under Development, and to be Released in 2010	Solar Energy Generation Study and Test Center
7		Grid Connection of Large-Capacity Energy Storage System	Technology Regulations on Integration of Large-Capacity Chemical Energy Storage System into Power System	Under Development, and to be Released in 2010	Wind-Solar-Storage Combined Demonstration Project
8	Transmission	VSC-HVDC	Specification on VSC-HVDC Technology	Under Development, and to be Released in 2010	VSC-HVDC
9		Power Line Status and Operating Environmental Monitoring	Technical Specification of Transmission Line Status Monitoring System	Under Development, and to be Released in 2010	Transmission Line Status Monitoring System
10			Technical Specification of Monitoring and Control Center for Transmission and Transformation Equipments	Under Development, and to be Released in 2010	Transmission and Transformation Equipments Status Monitoring System

No.	Areas	Technical Fields	Core Standards	Status	Corresponding Experimental Project
11			Technical Specification of Smart Patrol System for Transmission Line	To be Developed	Smart Patrol System of Copter/UAV for Transmission Line
12	Power Transformation	Smart Substation	Technical Guidelines for Smart Substation	Released (Enterprise Standard)	Smart Substation
13			Technical Specifications for Smartness Upgrade of Substation	Awaiting Authorization (Enterprise Standard)	
14			Technical Guidelines for Smart Electric Equipments	Released (Enterprise Standard)	
15			Specifications of Design for Smart Substation(2 standards)	Released (Enterprise Standard)	
16			The Technical Specification on Equipments in Smart Substation(5 standards)	Awaiting Authorization (Enterprise Standard)	
17			Specification of Automation System of Smart Substation	Under Development, and to be Released in 2010	
18			Specification of Information model and Communication Interfaces of Smart Substation	Under Development, and to be Released in 2010	
19			Guideline for the Site Commissioning of Automation Systems in Smart Substation	Under Development, and to be Released in 2010	
20			Technical Specifications of Protection for Smart Substation	Released (Enterprise Standard)	
21			Models of Relay in Substation Based on IEC61850 Standards	Released (Enterprise Standard)	
22	Distribution	Distribution Automation	Guidelines of the Technology for Distribution Automation	Released (Enterprise Standard)	Distribution Automation
23			Technical Specification for Construction and Reconstruction for Distribution Automation	Released (Technical Document)	
24			Technical Specification on Inspection and Acceptance of Distribution Automation	Under Development, and to be Released in 2010	
25			Typical Design Specification on Rural Distribution Automation	Released (Enterprise Standard)	
26			Typical Application Model on Rural Distribution Automation	Released (Enterprise Standard)	
					Optimization of Manage Model for Business、Distribution and Dispatching of Rural Power Grids

SGCC Framework and Roadmap for Strong and Smart Grid Standards

No.	Areas	Technical Fields	Core Standards	Status	Corresponding Experimental Project
27		Distributed Generation Access into the Distribution Network	Series of Technical Regulation on Distributed Generation Access into Distribution Grid	To Be Developed	Distributed PV Access into Distribution Grid
28	Power utilization	Two-way Interactive Services	Construction Specification of Province-Centralized 95588 Call Center of Power Service	Under Development, and to be Released in 2010	Province-Centralized 95588 Call Center of Power Service
29		Power Utilization Information Collection	Series of Standards on Smart Meter(12 standards)	Released (Enterprise Standard)	Power Utilization Information Collection System
30			Series of Standards on Power Utilization Information Collection System(24 standards)	Released (Enterprise Standard)	Power Utilization Information Collection System
31		Quality Testing of Smart Power Utilization	Specification on Quality Testing of Smart Power Utilization	To Be Developed	Smart Quality Testing Center of Power Utilization
32		Smart Energy Utilization Services	Specification of Smart Socket	To Be Developed	Smart Building/District
33			Series of Standards on Energy Utilization in Smart Building	To Be Developed	Smart Building/District
34		Electric Vehicle Charge and Discharge	Series of Standards on Electric Vehicle Charge and Discharge(19 standards)	12 Standards Released, another 7 to be Released in 2010	Electric vehicle Charge and Discharge Station Extension of Electric Vehicle Charge and Discharge Infrastructure
35	Dispatching system	Smart Grid Dispatching Supporting System	Specification on Data Description of Smart Grid Dispatching Model (G、E、S languages)	Under Development, and to be Released in 2010	Smart Grid Dispatching Supporting System
36			Specification on Basic Platform of Smart Grid Dispatching System	To Be Released	
37			Specification on Applications Function of Smart Grid Dispatching System	To Be Released	

No.	Areas	Technical Fields	Core Standards	Status	Corresponding Experimental Project
38	Information and communication technology	Grid Operation Centralized Supervisory Control System	Wind Power Prediction Functional Specification	Under Development, and to be Released in 2010	Large-Scale Wind Power Prediction and Operation Control
39			Functional specification on Supporting System for the Integration of Distribution Grid Dispatching and Control	Under Development, and to be Released in 2010	Distribution Automation
40			Technical and Functional Specification on Master Station Monitor System of Centralized Supervisory Control Center	Under Development, and to be Released in 2010	Grid Operation Centralized Supervisory Control System
41			Technical Guidelines for Centralized Supervisory Control Center of 500 kV Substation	Under Development, and to be Released in 2010	
42		Power Distribution and Consumption Side Communication Network	Optical Fiber Composite Insulated Power Cable for Low Voltages	Under Development, and to be Released in 2010	Power Line Optical Fiber Access
43			PLC Construction Technical Guidelines	Under Development, and to be Released in 2010	Power Consumption Information Collection System
44		Information Foundation of Smart Grid	Series of Specifications on Power Grid Geographic Information Services Platform(2 Standards)	Under Development, and to be Released in 2010	Information Foundation of Smart Grid and Cyber Security
45		Cyber Security	Baseline for Classified Protection of Information System Security	Released (National Standard)	



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