IEC Standardization Trends Related to Energy Infrastructure

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Abstract

The globalization of corporate activities and the expanding markets of emerging economies in recent years has made international standardization more important than ever. This article describes the standardization activities of the International Electrotechnical Commission concerning direct current power supply systems as part of international standardization efforts in the field of energy, which has been the focus of attention in recent years. The main trends in the field of smart grid communities are also introduced.

Keywords: IEC, energy infrastructure, DC power

1. Introduction

The energy shortages caused by the major earthquake disaster that occurred in eastern Japan in March of 2011 and the need to avert global warming and other environmental issues have led the NTT Group to focus more attention on the field of energy, in addition to the field of information and communication technology (ICT) that has been our traditional focus. NTT Facilities has been the most actively engaged in international standardization activities related to energy in combination with their on-going work in technological development, various kinds of field testing, and commercialization studies. This article introduces the main trends in international standardization in the field of energy based on the activities of the International Electrotechnical Commission (IEC) concerning the direct current (DC) power supply that the NTT Group has been recommending [1].

2. Background on the need for international standardization [2]

The importance of international standardization became clear with the introduction of the 1995 WTO/TBT (World Trade Organization/Technical Barriers to Trade) Agreement and the 1996 WTO Government Procurement Agreement, which oblige nations to use international standards as the basis for procurement standards. The advanced nations of Europe and North America have placed importance on conducting vigorous international standardization activities to strengthen their international competitiveness. Many countries have also been actively trying to use international standardization as a strategic tool with a view to cultivating emerging markets. Japan, too, has placed importance on ensuring that international standards are set as a component of a long-term strategy. In Japan's revitalization strategy, too, there is a need to take the lead in international standards in fields where Japan has strength, including smart grids and energy-efficient infrastructure.

3. IEC and its organizational structure [3]

IEC is an international organization that sets standards for electrical and electronic technology; it was established in 1906 and comprises member National Committees that represent individual countries. Japan is represented by the Japanese Industrial Standards Committee (JISC), which serves as an umbrella for about 300 associations and scientific societies within Japan that are engaged in drafting and studying international standards for various specialized fields. About 7000 IEC standards have been set, and expansion

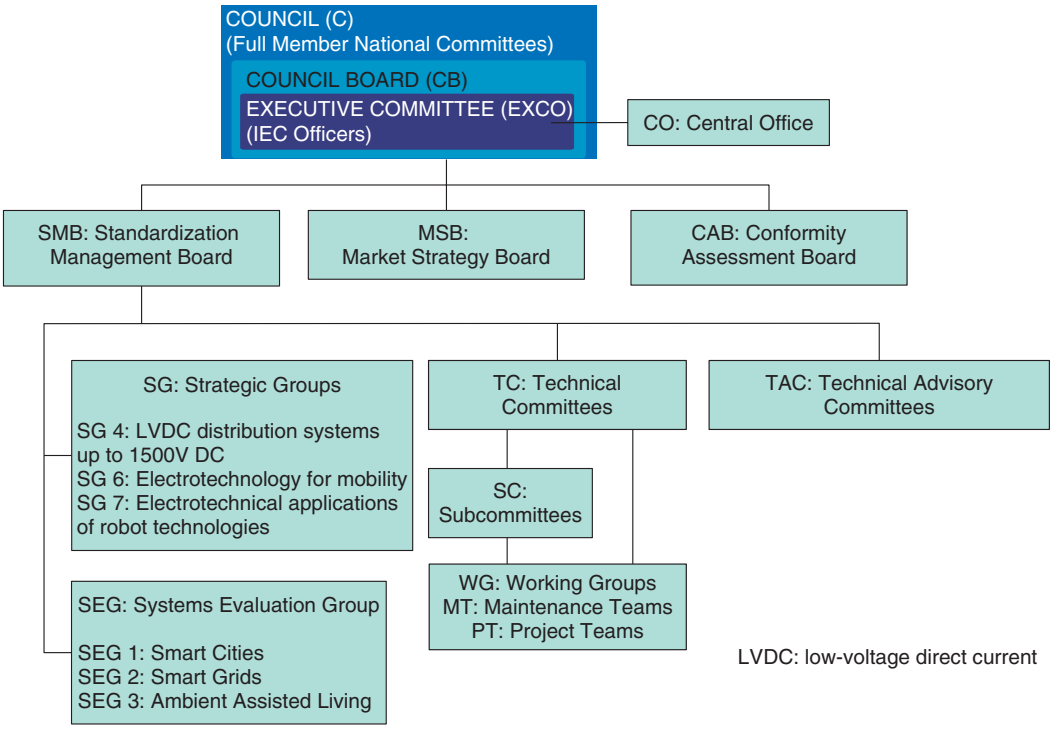


Fig. 1. Organization of the IEC.

of standards for electric vehicles, storage batteries, and smart grids, as well as for semiconductor devices, home electronics, and other fields that are deeply linked to energy infrastructure and equipment is expected in the future.

The organizational structure of the IEC is shown in **Fig. 1**. Within the IEC, there are over 100 Technical Committees (TCs) and Subcommittees (SCs) that cover all sub-fields of technology.

The IEC also includes Strategic Groups (SGs) that are set up for limited periods of time to put together proposals on the direction, issues, and recommendations concerning international standards. It has also been recognized that standardization based on entire systems is necessary, and therefore, the IEC has decided to set up Systems Committees (SyCs) for establishing standards for systems that span multiple TCs/SCs rather than simply the conventional TCs/SCs that deal only with individual products.

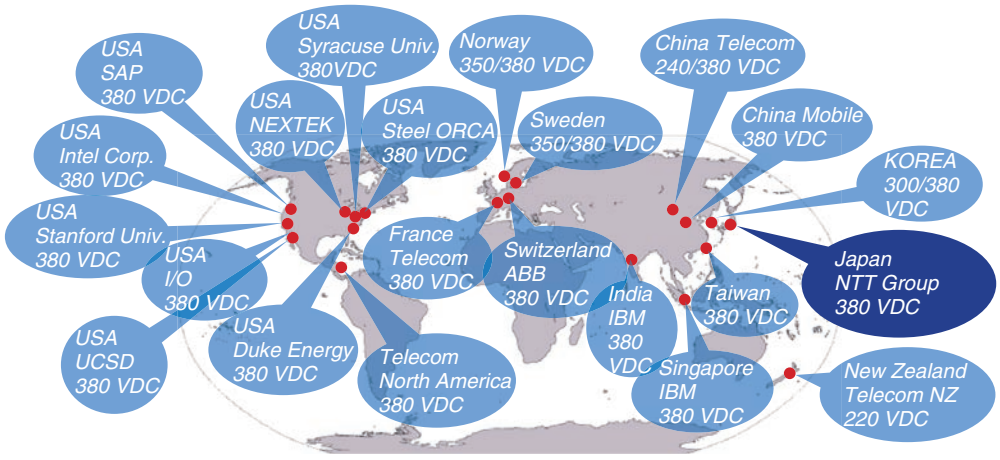
The Systems Evaluation Groups (SEGs) are set up prior to setting up SyCs. They conduct feasibility studies to investigate the future potential for creating international standards in particular fields. The results of these studies by SEGs serve as the basis for the future establishment of SyCs.

4. Activities concerning DC power sources

The NTT Group began seriously studying high-voltage DC power supply systems in 2000. With the acceleration of commercial introduction within the NTT Group in 2014, we have made progress in long-term technological development. Those activities are now expanding in various countries around the world as well as in Japan (**Fig. 2**), and there is a need for international standards for worldwide compatibility. Below, we introduce the standardization activities concerning DC power supplies within the IEC.

4.1 SG 4 activities

The DC power supply systems that have been attracting attention in recent years have applications in many fields other than ICT, and development as energy systems for commercial buildings, future residential buildings, distributed power systems, and charging of electric vehicle batteries is expected. Building on such work, the Swedish National Committee (SENC) proposed that the IEC set up an SG to study the standardization of DC distribution systems up to 1500 V, and the approved SG 4 (LVDC (low-voltage DC) distribution systems up to 1500 V DC in



UCSD: University of California, San Diego
VDC: volts direct current

Fig. 2. Introduction and testing of high-voltage DC power systems.

relation to energy efficiency) started activities in 2009, which include considering the IEC standards required for DC power supplies, creating a road map, and analyzing market trends.

4.2 TC and SC activity

In addition to SG 4, various other activities for actual standardization have begun within the IEC. Examples showing the scope and present situation of international standardization studies related to DC distribution as of May 2014 are shown in **Fig. 3**.

Because of the need for standards concerning uninterruptable power systems, rectifiers, and power converters, SC 22E and SC 22H respectively began activities in 2013 and 2014. If those activities result in international standards, we can expect future promotion of the universal use of DC power supplies and expansion of the practical range and markets for them by JISC as well as by the IEC.

SC 23E is working on DC breakers for wiring and short-circuit breakers. Outside the field of ICT, the introduction of mega-solar facilities and photovoltaic (PV) panels for ordinary homes and buildings is expanding rapidly. Because PV panels output direct current, their characteristics when a short circuit occurs differ from those of alternating current (AC) power sources. For that reason, specifications are needed that are optimized for DC and are different from the specifications for circuit breakers for AC or for both AC and DC. An expected result of the SC 23E activities is the issuing of circuit breaker specifications that further improve the safety of DC power sources.

TC 23/WG 8 activities for DC socket and plug standardization began in 2009. These efforts include the 400 volt DC (VDC) socket and plug specifications developed by both NTT Facilities and Fujitsu Components, which served as the basis for draft international standards. Currently, the AC systems being used in various countries and areas lack uniformity and vary in frequency, voltage, and socket and plug shape. DC power sources are expected to be introduced in greater numbers in the future, and thus, international standardization to ensure uniformity of shape and regulation will benefit many of the involved parties.

Furthermore, grounding and protective systems for regulating safety and preventing electric shocks, as well as equipment and instrumentation, are important for DC systems just as they are for conventional AC systems. In the IEC, TC 64 is charged with setting and managing regulations for electrical installations and protection against electric shocks. In TC 64, too, discussions on DC power sources, including grounding and protective systems, are in progress.

With the recognition that the scope of future studies includes DC power meters, load equipment switches, charging systems for electric vehicles, DC microgrids (small power grid systems capable of functioning autonomously), and DC power distribution in residential or commercial buildings, regions, etc., we expect specific standardization discussions in those

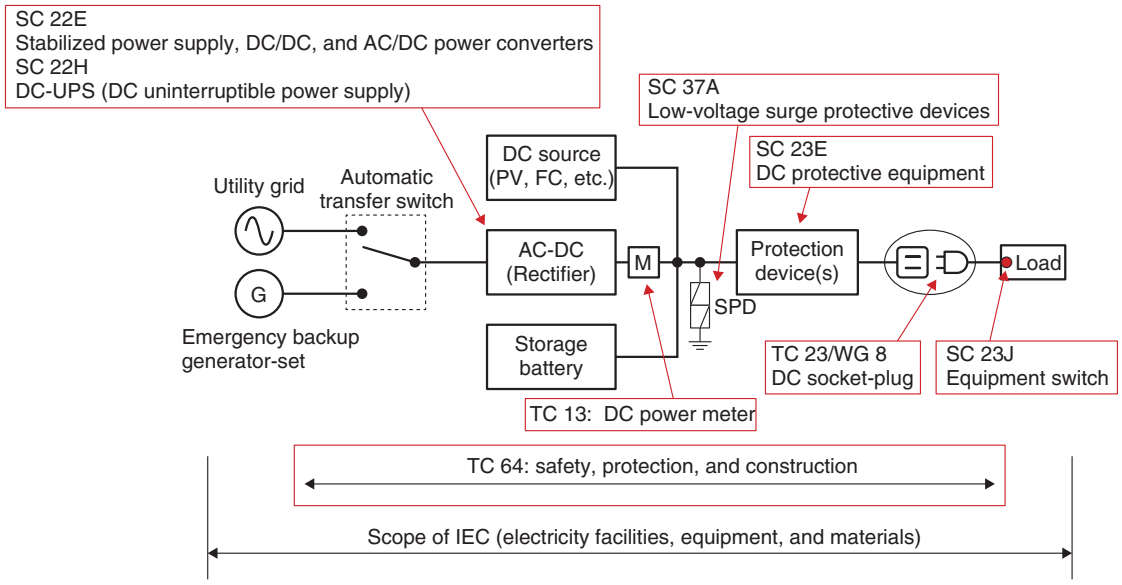


Fig. 3. Current scope of IEC studies on DC power supplies.

areas to proceed in addition to the activities depicted in Fig. 3.

5. Efforts in the field of (smart) energy infrastructure

IEC work on international standardization of smart grids is accelerating. IEC communities involved with smart grids are listed in **Fig. 4**. Japan, too, has taken an interest in this field, and various activities are underway. IEC activities concerning smart grids and smart cities are described below.

5.1 TC 120 Electrical Energy Storage Systems

In October 2012, the IEC approved the formation of a new Technical Committee for storage batteries and other EES (electrical energy storage) systems (TC 120) that connect to smart grids. This new committee was proposed by Japan, and Japan is serving as the secretary, while Germany is the convener. The results of experiments being conducted in various countries that are relevant to businesses involved in constructing environmentally friendly smart communities are expected to serve as the basis for future international standards.

5.2 SEG 1 Smart Cities

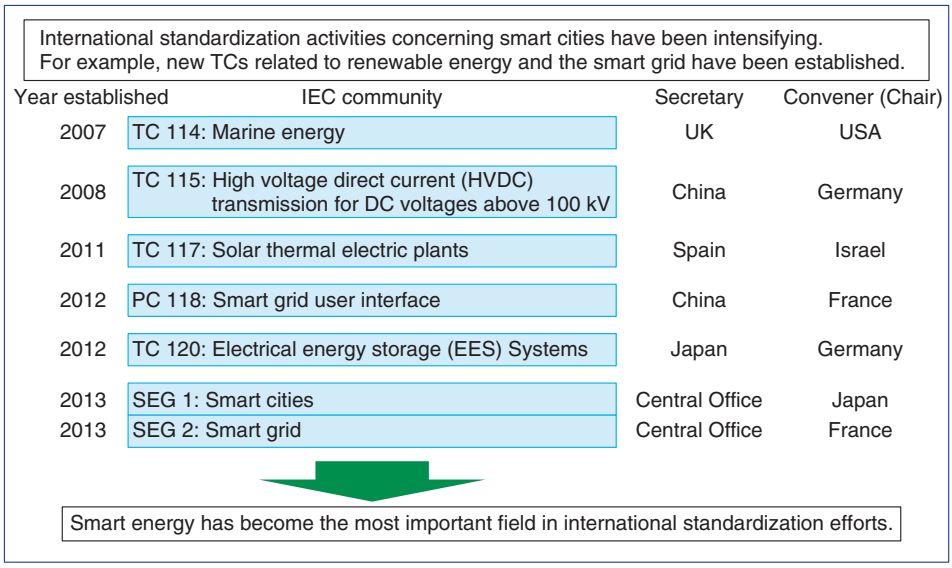
Japan, Germany, and China have made joint proposals involving smart cities, and those proposals have been approved. SEG 1 Smart Cities has been set up, and studies on the feasibility of international standards have begun within the IEC. The role of infrastructure in city functions is important in terms of business continuity planning, and discussions on the technical requirements that will become necessary from the viewpoint of future international standardization are planned.

SEG 1 is planning activities that include compiling descriptions of the activities within IEC and ISO (International Organization for Standardization), establishing the standardization scope and categories, evaluating marketability, defining terms, conducting case studies, creating a standardization road map, and collecting relevant information.

5.3 SEG 2 Smart Grid (formerly SG 3)

SG 3, which has been discussing smart grids, has been reorganized as SEG 2 in order to begin establishing international standards. As mentioned in section 3, the reorganization is part of the progression from SG to SEG to SyC. Exchanges of opinions and vigorous discussions in this field are expected, with the goal of establishing future IEC standards.

In SEG 2, further discussions in the field of smart grids, including smart energy, are anticipated in order to prepare for the future transition to an SyC. In addition, the SEG is expected to provide coordination and guidance on system level standards in the area of smart energy, including heating/cooling and the use of gas and electricity.



Source: Recreated by the author based on the document "Strengthening International Standardization Policy for 2014," Ministry of Economy, Trade, and Industry of Japan, October 2013 (in Japanese).

PC: Project Committee

Fig. 4. Efforts to strengthen (smart) energy infrastructure.

Cooperation with SEG 1, future SEGs, related IEC internal organizations, and with ISO and ITU (International Telecommunication Union) is also anticipated.

6. Future developments

In the IEC, international standardization concerning energy infrastructure in relation to smart grids is actively underway, and the Japanese government is also placing importance on such activities. The IEC is also working on standardization of the DC power supply as a smart grid subsystem, and standardization work is proceeding in coordination with the activities of ITU-T (ITU-Telecommunication Standardization Sector) and ETSI (European Telecommunications Standards Institute), etc.

Increasing the efficiency and convenience of energy systems will be beneficial to many parties. The cooperation of international standards organizations, scientific associations, and the members of the NTT Group is more important than ever before, and it is necessary to continue to promote international standardization activities in this field well into the future.

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He received his B.Eng. and M.Eng. in electrical engineering from Yamagata and Niigata Universities, respectively, in 1990 and 1992, and his Ph.D. in electrical engineering and computer science from Nagoya University in 2011. He joined NTT in 1992. He has a background as a research engineer and has more than 18 years of experience in the design, development, and operation of reliable power systems for telecom and datacenters. He is currently working with 380-VDC systems for NTT and its customers, as well as researching aspects of smart grids.

He is a member of The Institute of Electrical and Electronics Engineers (IEEE), the Institute of Electrical Engineers of Japan (IEEJ), the Institute of Electrical Installation Engineers of Japan (IEIEJ), and the Institute of Electronics, Information and Communication Engineers (IEICE). He is also very active in many standards bodies in areas associated with power systems. He is a member of the IEC SMB (Strategic Management Board) SG 4, a member of the Green Grid Power sub-working group, chair of the IEC SC 22E Japanese NC, and a recent past secretary of the IEEJ Investigating R&D Committee into DC power distribution.

He was awarded the IEEE PELS (Power Electronics Society) INTELEC 3rd best paper award in 2009, the outstanding paper prize from IEEJ in 2010, the best paper award of IEIEJ in 2013, and the Scientific Award of the Japan Society of Energy and Resources in 2013. He was also awarded the Hoshino Award of IEIEJ in 2014.