History of CIGRE

The Japanese National Committee of CIGRE

1. Power Industries before advent of Japanese National Committee of CIGRE

An epoch-making event occurred in 1882 in Ginza, Tokyo, where the Tokyo Electric Light Company, preceding the foundation of the company, demonstrated illumination with an arc lamp, as shown in Figure 1. This was the very first time an electrical light had been seen in public. In 1883, the foundation of the company was approved by the governor of Tokyo. The first electrical power, however, was only delivered four years later in 1887 due to financial difficulties.

The company was reported to be a sort of venture business started with 200,000 yen in capital. Although it was then common for the government to found industrial facilities such as iron works, cotton-spinning works, and telecommunication facilities, the Tokyo Electric Light Company was privately founded.

Small 25-kW direct-current generators provided the electrical power, which were only capable of delivering electricity within a range of roughly 2 km. Power stations had to be built within the vicinity of consumers. However, large alternators were then introduced and power stations with larger capacities were instigated. The Asakusa thermal power plant was founded in 1895. The area was then remote from city centers. The alternator used was made in Germany and it was the origin of the 50-Hz frequency presently used in eastern Japan.

However, the Osaka Electric Light Company founded in 1889 had already introduced alternators and started to use American alternators in 1889, which was the beginning of the 60-Hz frequency presently used in western Japan. These are the reasons Japan has both 50 and 60 Hz even now.

During the period between 1890 and 1900, many illumination companies emerged all over Japan and there were 33 by 1896. with a total of 220,000 lights powered by electricity.

However, the number of companies was later reduced through mergers and acquisitions. In the 1930s, five major electrical companies remained in the major cities of Tokyo, Nagoya, and Osaka. Nevertheless, there was still competition.

World War II played a significant role in electricity markets. The government established Japan Electric Generation and Transmission Company (JEGTCO) in 1939 to control the generation and transmission of electricity. Companies were established for distribution in nine areas. From the technical point of view, JEGTCO eliminated unnecessarily overlapping facilities owned by competing companies. Another advantage of government control was that the commercial frequency was merged to 50 Hz in the east and 60 Hz in the west of Japan.

After the war, these companies were restructured, where JEGTCO insisted on controlling the power industry. Distribution companies, however, insisted on one consolidated company that would control the generation, transmission, and distribution of electricity for each of the nine blocks. This proposal was first rejected by the Diet. Yet in 1951, due to orders by the cabinet, nine companies started to generate, transmit, and deliver electricity.

The Japanese National Committee of CIGRE (JNC) came into effect two years later.

Fig. 1 “And God said, let there be light”- Genesis 1:3- Advent of electric light (Tokyo, 1882)
(in possession of Electric Power Historical Museum, Tokyo Electric Power Company)

2 Advent of Japanese National Committee of CIGRE and its Activities

The very first session of the CIGRE was held in 1921, and three Japanese delegates reportedly attended the meeting. Japan kept sending delegates to CIGRE sessions up to 1938 but stopped all international activities after that due to World War II.

After the war, Shigenari Miyamoto (Toshiba), Hirokichi Yoshiyama (Hitachi), and Shoichi Saba (Toshiba) saw the importance of international collaboration, and contacted the CIGRE Central Office in 1952. This turned out to be the main motivating force for forming the Japanese National Committee of CIGRE. Japan was fortunate to have had such remarkable predecessors as only seven years had passed since the war had terminated and most citizens had not recovered from the devastation and only cared about personal issues.

The Japanese National Committee (JNC) was officially established in October 1953. They sent eight delegates to the 15th CIGRE session in May 1954. The delegates were headed by Setsuo Fukuda (University of Tokyo). It was the first session attended by the Japanese after the war.

The history of JNC can be divided into five consecutive periods, and the activities of each of these are explained below. Table 1 shows the records of the JNC chairman, and the activities and committee/council members for CIGRE.

(1) Period (I)

Chairmen: Messrs. Y. Anzo and R. Takai (1953–69)

Twelve years after the JNC was founded, the International Electrotechnical Commission (IEC) decided to hold its General Assembly in Japan. Taking advantage of this international meeting, the JNC tried to host a Study Committee (SC) meeting in Japan the same year, i.e., 1965. SC8 (Lightning and Surges) was the first target but at last SC17 (Rotating Machines) was held in

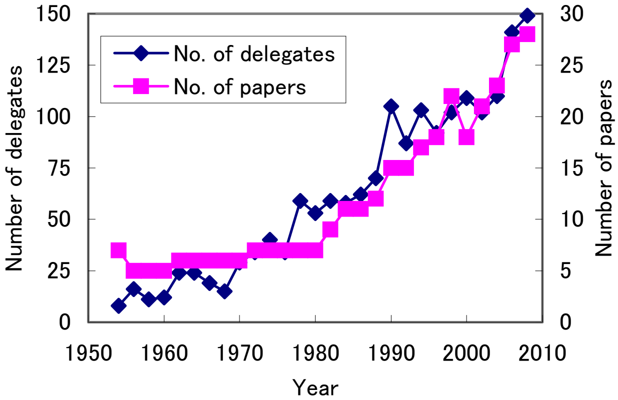
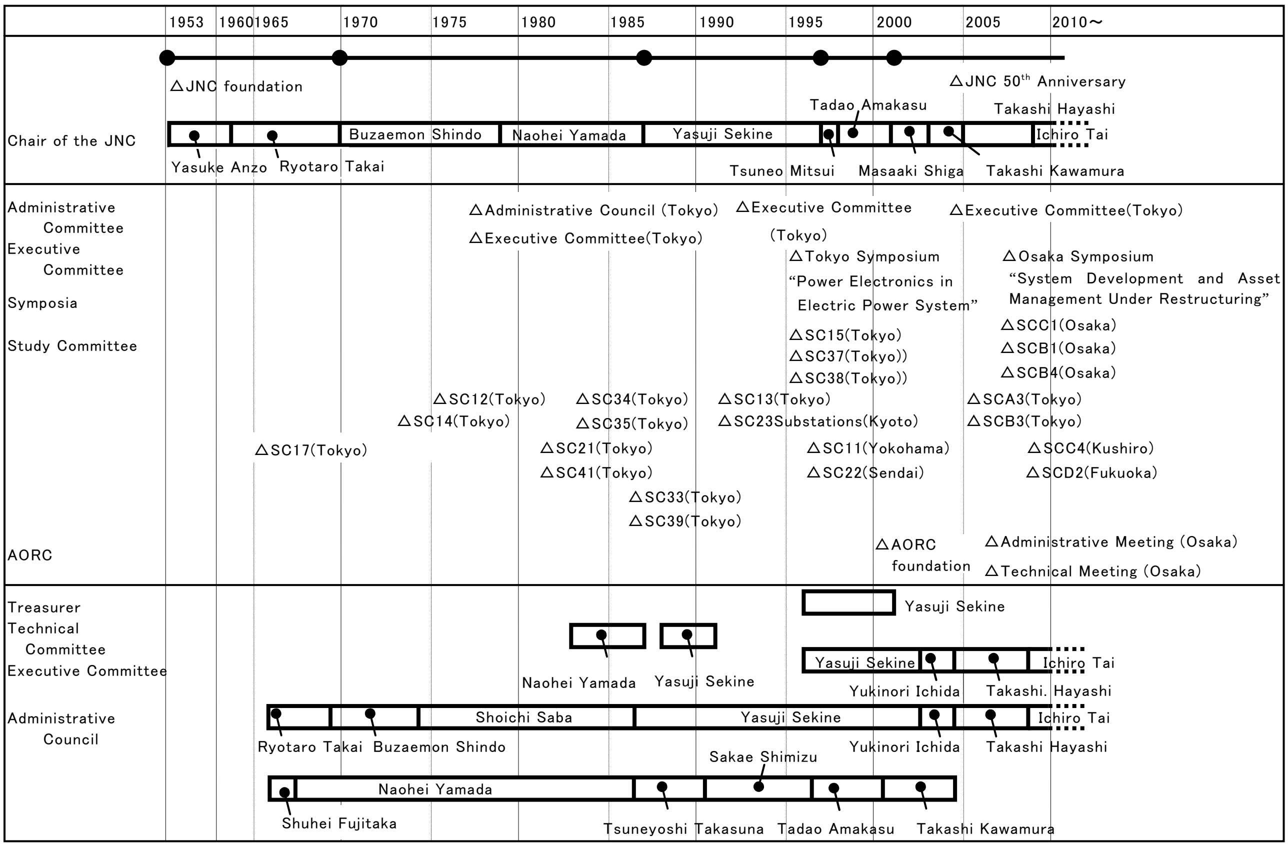


Fig. 2 Numbers of delegates and papers from Japan for CIGRE sessions

Table 1 Activity of the Japanese National Committee of CIGRE



1965. There were 23 attendees from 12 overseas countries who met for the meeting and they participated in a technical visit to the Sakuma Frequency Converter (FC) Station, which connected 60-Hz electricity from the west and 50 Hz from the east of Japan. This was the first international meeting of CIGRE in Japan.

In 1966, Japan was allowed to send two administrative council members. Messrs. R. Takai and S. Fujitaka were the first Administrative Council members from JNC.

(2) Period (II)

Chairmen: Messrs B. Shindo and N. Yamada (1970-86)

In the 1970s, international participation by the JNC became more active. This is best demonstrated by the numbers of SC meetings hosted by JNC such as SC14 (HVDC Links) in 1973, SC12 (Transformers) in 1975, SC21 (HV Insulated Cables) and SC41 (Future of Electric Power Transmission & Systems) in 1981, SC34 (Power System Protection & Local Control) in 1983, and SC35 (Power System Communication & Telecontrol) in 1983.

The Administrative Council (AC) meeting was held in Japan in 1977. The AC members from Japan were Messrs. N. Yamada and S. Saba and it was the first AC meeting held in countries other than continental Europe, the United Kingdom, or Russia. Although Japan is located in the Far East and is far away from many member countries, many overseas attendees took part in the meeting. Mr. G. Jancke, then President of CIGRE, and other AC members visited Japan. This collaboration certainly worked to internationalize the Japanese power industry. Although the executive committee (EC) meeting was also held, Japan had no EC members.

(3) Period (III)

Chairman: Prof. Y. Sekine (1987–96)

JNC's contribution to CIGRE increased drastically during this period, especially in terms of quantity and quality. SC meetings for SC33 (Power System Insulation Coordination) and SC39 (Power System Operation and Control) were held in 1987. SC13 (Switching Equipment) and SC23 (Substations) were held in 1991, SC15 (Materials for Electrotechnology) was held in 1993, and SC37 (Power System Planning and Development) and SC38 (Power System Analysis and Techniques) were both held in 1995.

The EC meeting was hosted by JNC in May 1992. JNC Chairman Prof. Y. Sekine attended as one of the EC members. The President Mr. J. Lepecki and other EC members enjoyed a technical visit to Akagi and Nishi-Gunma, where UHV transmission facilities that had been developed were inspected. They also enjoyed visiting an HV underground substation in Takanawa, located within central Tokyo.

The first CIGRE symposium hosted by JNC was held in 1995 with the theme of "Power Electronics in Electric Power Systems". This was just four months after the tragic Great Hanshin-Awaji Earthquake, which had occurred in January. The keynote speech was delivered by Mr. K. Morii who was a vice chairman of the Kansai Electric Power Company. He reported the damage caused by the earthquake, and stressed the importance of supplying electricity without interruption to electric equipment even after such a disastrous incident. Additionally, a videotape was played that revealed how badly the earthquake had devastated the power-supply system in certain areas and how hard engineers had struggled to restore the system after damage. The video recording seemed to have impressed the audience who offered words of encouragement.

The frequency converter at the Shin-Shinano substation and adjustable-speed pumped storage system at the Okawachi power station were chosen for the technical visit. These are good examples to demonstrate the introduction of power-electronics technologies to power systems. Prior to the symposium, SC37 (Power System Planning and Development) and SC38 (Power System Analysis and Techniques) meetings were held at the same venue. Many of the attendees took part in both the symposium and SC meetings, which resulted in cost savings by JNC and Cigreans. As a matter of fact, the symposium was a great success both in technical and financial terms. It was a good opportunity for JNC to convince the CIGRE of its capabilities for hosting such events.

The number of accepted papers had remained at around seven before this period but increased to 15 in 1990, making JNC third in the number of accepted papers among all countries. JNC came first in having 17 papers published in 1994. This was the result of continuous effort made by all JNC members and that of systems such as referee reading by JNC. Attendees from Japan had a fellowship banquet during the CIGRE session. Two purposes of the banquet were to exchange information and to get better acquainted with each other. In 1994, this banquet was expanded to an international party hosted by JNC inviting important CIGRE members from overseas. Unofficial casual conversation at parties definitely works well in enabling real exchanges of information.

Formal translation for the name of CIGRE was officially fixed in 1989, which was "Kokusai Daidenryoku System Kaigi". Before this, we had several other translations in Japanese.

(4) Period (IV)

Chairmen: Messrs. T. Mitsui and T. Amakasu (1997–2000)

After Prof. Y. Sekine's tenure, Mr. T. Mitsui was elected chairman in 1997. Mr. T. Amakasu replaced the latter in 1998. Even though the chairman of the JNC had been elected from universities before Mr. Mitsui. Mr. Amakasu was the first chair elected from manufacturers. After this, the chair of the JNC was alternately elected from utilities and manufacturing companies.

JNC's activities were stable and successful during this period. SC11 (Rotating Machines) was held in Yokohama and SC22 (Overhead Lines) was held in Sendai, both in October 1997. The main topics were superconducting generators in SC11 and the development of overhead lines in Japan including UHV in SC22.

During this period, the ex-chair Prof. Y. Sekine not only served as a member of the AC but also of the EC. He also served as the Technical Committee and Treasurer; he was the first Asian to serve as an executive member of the CIGRE's Central Office. He was chosen as an honorary member in 2000. In the same year, a preliminary meeting to establish the Asia-Oceania Regional Council of CIGRE (AORC) was held under Japanese leadership, which was fully supported by the idea of "region" stipulated in CIGRE's master plan. As a matter of fact, AORC was the first regional council established in CIGRE.

(5) Period (V)

Chairmen: Messrs. M. Shiga, T. Kawamura, T. Hayashi, and I. Tai (2001-Current)

CIGRE introduced a tenure system for the Administrative Council during this period. The members were elected in a biannual vote. To further motivate the national panel, JNC encouraged the hosting of CIGRE meetings such as SC meetings and working groups (WG) and set a target to host two SC meetings every two years. JNC also encouraged the recruitment of new members. The number of collective members (II) was increased to 11 compared to the former two. The number of individual members reached over 100 in 2002. The JNC website was created and a mailing service was also started then.

In the same year, CIGRE reorganized 15 SCs to 16 SCs. The JNC elected 16 regular members according to this reorganization.

The AORC was approved by CIGRE's head office in February 2001. The first meeting was held in Bangkok, Thailand in March. The founding chair Prof. Y. Sekine presided over a meeting in Cairns (Australia) and in Seoul (Korea). He chaired the 2002 AORC session in Malaysia.

In 2004, JNC celebrated its 50th anniversary and published an almanac. For the anniversary, Prof. Y. Sekine made a commemorative speech celebrating the achievements of the last half-century. The speech was recorded on DVD and delivered to JNC members and attendees. In the same year, an EC meeting of CIGRE was also held in Tokyo. There were 26 overseas participants who attended the meeting and the one-day technical visit was to Higashi Uchisaiwaicho substation.

Since 2005, JNC has been inviting WGs systematically to Japan. SCA3 (High Voltage Equipment) and SCB3 (Substations) were held in Tokyo in 2005. SCB1 (Insulated Cables), SCB4 (HVDC and Power Electronics), SCC1 (System Development and Economics), and a symposium in Osaka were held in 2007. The theme of the symposium was "System Development and Asset Management Under Restructuring"

Mr. S. Mori, the president of Kansai Electric Power Co., Mr. T. Katsumata, the chairman of the Federation of Electric Power Companies of Japan, and Mr. E. Shoyama, the chairman of the Japan Electrical Manufacturers' Association were the keynote speakers. The presence of the three impressed the importance of CIGRE to the press reporters. The symposium was attended by 339 participants and all the events were very successful. The attendees visited the Kii-Channel HVDC Link including the Kihoku converter station. The first AORC meeting in Japan was also held in Osaka.

As the latest events, SCC4 (System Technical Performance) and SCD2 (Information Systems and Telecommunication) were held with colloquia in 2009. For SCC4, 103 attendees met in Kushiro, Hokkaido while 291 met in Fukuoka for SCD2. Each of the numbers is rather large for an event on a single SC.

3. Current Japanese National Committee of CIGRE

As of December 2009, JNC has 35 collective members (I), eight collective members (II), two honorary members, and 254 individual members. Collective members include universities, institutes, utilities, and manufacturers. While all the JNC activities are basically supported by the voluntary contributors of JNC members, some of the power industry based organizations are playing very

important role to enhance JNC activities.
The examples are the Federation of Electric Power Companies (FEPC), the Japan Electrical Manufacturer's Association (JEMA), the Electric Technology Research Association (ETRA) and the Institute of Electrical Engineers of Japan (IEEJ). FEPC is an association composed of 10 electric power companies. JEMA consists of major Japanese manufacturing companies in the electrical industry including power and industrial systems, home appliances, and related industries. ETRA members are not limited to utilities and/or manufactures but it contains general infrastructure firms and power consumers. Compared to these, IEEJ is more scientific corporation with a membership of scholars and engineers. Japanese Cigreans belong to several of these associations and provide cutting-edge technical outcomes. IEEJ based R&D committee through 1980s and 1990s is a good example, where members of Japanese national panel (JNP) of SC33 (Current C4) contributed to develop a highly accurate method of analyzing lightning surges. It enabled lightning-surge voltages to be accurately predicted in power systems. In conjunction with hardware technologies, the research enabled a global standard for the insulation design of power systems.
As like, depending on the technical field, other associations and JNC cooperates to facilitate and develop the exchange of engineering knowledge as regards

4. Contribution of Individuals to CIGRE
- CIGRE Title and Award Holders -

Table 2 lists honorary members and Table 3 lists members who received TC awards. Table 4 lists distinguished members. JNC has matured to periodically produce these illustrious members. As of February 2010, JNC has two honorary members, 21 TC award holders, and 27 distinguished members.

5. Technical contributions by JNC to CIGRE

Figure 3 outlines the history of peak electricity demand and transmission voltage in Japanese markets. After World War II, when the nine new electrical power companies inherited Japan Electric Generation and Transmission Company's mission, the highest transmission voltage was 154 kV. After World War II, consumption of electrical energy increased drastically. It has been growing ever since. The highest transmission voltage in 2009 is 500 kV even though some commercially operated equipment is already rated at 1,100 kV and ready for UHV operation.

Table 2 Honorary members

1990	1995	2000	2005	2010
		△ Yasuji Sekine		
			△ Takashi Hayashi	

Table 3 Technical committee award holders

	1995	2000	2005	2010
△ Takashi Hayashi				
	△Masayuki Ieda(SC15)			
	△Zensuke Iwata(SC21)			
	△Shunichi Ito(SC23)			
	△Yuji Kubota(SC22)			
	△Kazuhiro Takahashi(SC37)			
	△Katsuhiko Naito(SC33)			
		△Toshikatsu Tanaka(SC15)		
		△Makoto Tari(SC11)		
		△Hiroki Ito(SCA3)		
			△Masayuki Nagao(SCD1)	
			△Makoto Yagi(SCC1)	
			△Masaru Ishii(SCC4)	
			△Akihiro Ametani(SCC4)	
			△Susumu Sakuma(SCB1)	
			△Yukichi Sakamoto(SCB2)	
			△Koji Kawakita(SCB3)	
			△Yukiyasu Shirasaka(SCA2)	
			△Takeshi Yokota(SCB3)	
			△Hitoshi Okubo(SCD1)	
			△Masayuki Yamasaki(SCD2)	

Table 4 Distinguished members

1990	1995	2000	2005	2010
	△Shoichi Saba			
	△Iwao Miyachi			
	△Masayuki Ieda			
	△Yasuji Sekine			
	△Sakuro Tsurumi			
	△Tatsuo Kawamura			
	△Yuzo Ozaki			
		△Akihiro Ametani		
		△Katsuhiko Naito		
		△Tsuneyoshi Takasuna		
		△Yoshihide Hase		
		△Misao Kobayashi		
		△Taizo Sato		
		△Junichi Toyoda		
		△Eiichi Tamaki		
		△Shunichi Ito		
		△Kazuhiro Takahashi		
		△Makoto Tari		
			△Shinichi Iwamoto	
			△Toshikatsu Tanaka	
			△Teruo Fukuda	
			△Nobuo Fukushima	
			△Tadao Amakasu	
			△Tsuneo Mitsui	
			△Teruyoshi Mizutani	
			△Yukinori Ichida	
			△Shosuke Mori	

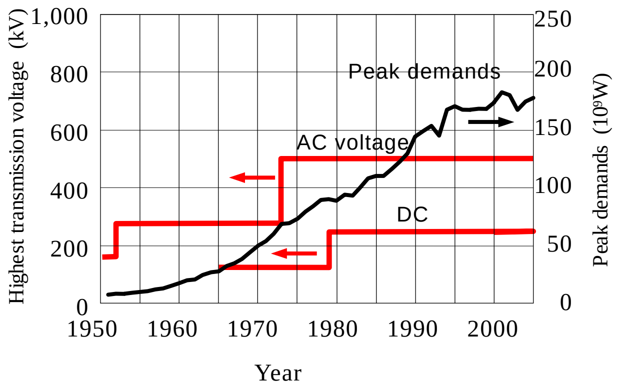


Fig. 3 DC/AC transmission voltage and peak demand of Japan

5.1 Outstanding inventions in Japan

Japan has developed and delivered technologies to the world. Here are two examples of outstanding Japanese inventions. Another example is the utilization of an invention proposed by others.
A varistor using a zinc oxide element as an overvoltage protection device for low-voltage circuits was developed in 1970. Applying its outstanding nonlinear characteristics to high-voltage circuits, a 66-kV-class zinc oxide arrester (the metal oxide varistor: MOV) was then developed in 1973. In several years, the MOVs came to be a global standard, and IEC-60099-4 "Metal-oxide surge arresters without gaps for a.c. systems" was established in 1991 (SCC4).
A cross-linked polyethylene (XLPE) insulated power cable is another example. It was favorable for fire protection and ease of maintenance. The first XLPE cable was laid in 1988. The XLPE cable with 27-mm wall thickness and straight through joints was laid in 2000 as the "Shin Toyosu Line". for 500 kV and 40 km long, which is a monumental achievement in the world (SCB1).
As the last example, a cutting-edge variable-speed pumped storage system for hydropower went into operation in 1990 at 85MVA, 13.8kV, 130-156rpm. Variable-speed operation could enable a hydro-generator -motor to control fluctuating frequencies that are also caused by renewable power sources. As of 2009, 9 units have been already in use. The principle of the system was proposed in another country, the practical use is surely realized in Japan. The new stabilizing scheme is now under the spotlight (SC A1).

5.2 Other outstanding technologies associated with each Japanese National Panel

SCA1
Since nuclear-power plants were incorporated in the 1970s and used for base-load operations, thermal and hydraulic power plants were operated to meet variations in load. Due to this, the turbo-generators for thermal power plants faced severe operating conditions such as daily start and stop (DSS). Because of this, Japanese National Panel (JNP) of SCA1 had to have augmented generator technologies to ensure greater reliability. Utilizing high-thermal-conducting insulation is a good example where Japan originated the technique, which drastically improved the reliability of generators. In later technology, superconducting generators were developed and connected to the actual grid and tested. The capacity of 81 MVA is still the highest in the world for a superconducting generator.

SCA2
Japan has concentrated on technology involving high-power-density transformers and the prevention of faults caused by natural disasters.
Techniques of gas insulation, gas diagnosis, and flame-retardant liquids are some of those that have been reported. Maintenance and diagnostic techniques such as analysis of dissolved gas have also been reported. Of these, topics that have been highlighted are static electrification and the development of UHV transformers.
In the 1970s, static electrification faults were experienced for the first time at energizing 500-kV transformers. Since then, Japan has been a leader in investigating this phenomenon, and countermeasures and the effects of aging are new items. Results have been continually reported. The prevention of static electrification caused faults is a key technology to develop compact transformers with high power density.
In UHV technology, UHV transformers of practical size have been developed and field tested. The results of long-term tests have been continually reported.

SCA3
Life-cycle cost of switching equipment has become a main concern of SC A3 due to increased numbers of aged equipment as well as severe competition caused by deregulation in the electrical power industry. First and second international surveys to investigate failures in circuit breakers were carried out in 1974 and 1988. The result showed that low failure rate on gas circuit breakers in Japan was outstanding. The third international investigation was started in 2004, and its scope was expanded to deal with disconnecting switches, earthing switches, and instrument transformers in addition.

In conjunction with the construction of UHV transmissions in China and India, IEC asked CIGRE to investigate the technical requirements for UHV substation equipment. WG A3.22 was formed for this reason and Mr. Hiroki Ito of Mitsubishi Electric Corp. contributed as a convener. In 2008, WG A3.22 submitted Technical Brochure 362 on “Technical requirements for substation equipment exceeding 800 kV” and the final report was submitted in 2009.

SCB1

Japan has been fortunate enough to lead in the field of cable technologies for high-voltage use.

Before the development and wide use of XLPE cables, polypropylene laminated paper (PPLP) insulated oil-filled (OF) cables were developed. These cables have eliminated loss significantly. A 500-kV OF cable was laid on the bridge for the Honshu-Shikoku interconnection line.

Super-conducting cables have been developed and studied that are insulated for low temperatures and have thermally insulated conduits for the temperature of liquid nitrogen. JNP-SCB1 successfully conducted a long-term aging test on a 66-kV triplex cable system in 2001. A manufacturer and a laboratory conducted a test on a 77-kV 500-m-long single core cable in 2004. JNP took part in the “Albany project” in the US in 2006 and the project started transmission via superconducting cables.

In 2011, 66-kV/200-MVA/250-m-long superconducting cables are to be field-tested in an actual grid in Japan.

SCB2

The application-oriented development of composite fiber-optic ground wire (OPGW) technology, has taken place in Japan. JNP-SCB2 has led the approach to design by achieving large short-circuit current capacity in compact size by using silicon fiber. JNP has also led in systematic methods of evaluating and testing OPGW characteristics. Particularly in terms of electrical characteristics, JNP has played a key role in establishing analysis techniques to determine the temperature of OPGW components when short-circuit current is passed through them, as one way of measuring the various properties OPGW is required to meet.

Even though multiple and diverse OPGW structures have been developed, consideration of electrical characteristics has been a critical factor in evaluation to determine the present OPGW structure. The methods used for evaluation and testing in Japan have directly been adopted such as the short-circuit and arc-resistance tests specified in the IEC standards.

JNP-SCB2 have also made further contributions in the area of maintenance technology in recent years, especially by offering a technique for detecting corrosion parts of OPGW.

SCB3

A topic unique to Japan is the requirement for high power density at substations because designated areas are limited in large cities. For this reason, technologies that have originated in Japan involve compactness at substations. JNP-SCB3 reported on thermal design for 12,000-A bus lines in 1974. European members reportedly had doubts over such a large rating. In 1976, JNP reported on Hybrid-GIS (H-GIS) to achieve compact substations. In due course, H-GIS started to be used worldwide. The low failure rates of GIS in Japan were highlighted in the 1990s and JNP contributed to manufacturing and quality control of GIS. JNP also reported a UHV test field and a 275-kV gas-insulated underground substation in downtown Tokyo. JNP-SCB3 has been conducting further trials on compact GIS substations in the last decade and means of disaster prevention. The result of these studies will continue to be reported.

SCB4

Light triggered thyristors (LTTs) and LTT applied valves represent HVDC technologies that originated in Japan. The world’s first LTT was utilized for a thyristor valve to replace a 125-kV module at the Sakuma FC Station in 1983. Improved LTTs were introduced at the Shin-Shinano FC Station in 1992 and they have been used in all HVDC projects in Japan since then. The capacity increased from 6 kV–2.5 kA to 8 kV–3.5 kA for Kii-channel HVDC Link. As LTTs reduce the number of parts to 1/10 of those in electrically triggered thyristors (ETTs), they enable systems to be downsized with a great deal of reliability.

Other technologies that have originated in Japan are voltage source converters (VSC) based flexible AC transmission systems (FACTS) and HVDC systems. The world’s first STATCOM equipment started commercial operation in 1991 at the Inuyama Switching Station. Three 53-MVA voltage source converters were installed as a three-terminal back-to-back (BTB) system in 1998, and through 1999, extensive field testing was carried out at the Shin-Shinano substation where 50/60 Hz power systems are interconnected. The multiterminal VSC BTB system test was an epoch-making event in the technological history.

SCB5

A power system stabilizing system was designed to prevent the risk of out-of-step, abnormal frequency, and voltage collapse before any of the phenomena became critical accomplished by rapidly controlling the generator or load. This technology has progressed despite major blackouts such as that in the Kansai area due to the Mihoro cliff failure in 1965, and that due to the voltage collapse in the Tokyo area in 1987. The technology has also been acknowledged worldwide.

Other countries have also suffered from various blackouts and special protection schemes (SPSs) became major concerns worldwide. WG34.08, or “Isolation and Restoration Policies”, was formed in 1999. Mr. Masanori Matsuura of the Chubu Electric Power Company acted as a convener and in 2002 the WG published “Isolation and restoration policies against system collapse”. This was the very first occasion where an SPS had been internationally examined.

A new system of protection called the wide area protection system (WAPS) has recently been proposed. Japan originally produced a system for stabilizing power and still continues to contribute to incorporating cutting-edge technologies.

SCC1

One of the remarkable contributions that Japan has made in the area of power-system planning has been to apply DC transmission to bulk-power transmission.

Bulk-power-transmission systems have been required in advanced countries since the 1960s because large-capacity power plants have become major energy sources along with the rapid increase in the demand for power. Bulk-power-transmission systems, which were economically advantageous, were increasingly required in power development and transmission projects that needed long recovery times for investment in the mid 1990s, because deregulation had been introduced to electric-power industries throughout the world. Under such conditions, JNP-SCC1 as a convener of WG37-22’s “Bulk Power Transmission” has clarified issues with DC transmission in power-system operation, compared DC transmission with AC transmission through case studies of various HVDC projects including the Kii channel project, and has finally established the concepts underlying the process of determining optimal power systems for bulk power transmission.

SCC2

Japan developed a real-time control system for stabilizing power system for the first time throughout the world, by using its on-line transient stability control (TSC) system. This system uses on-line data obtained from energy management system/supervisory control and data acquisition (EMS/SCADA), and carries out periodical calculations on transient stability. The on-line system can react flexibly and effectively, based on the actual status of the power system. Also, it has enabled the maximum Available Transfer Capability (ATC) to be increased, as well as facilitating highly secure operation of the power system.

Japan has carried out a research project on a wind farm to stabilize fluctuations using a battery energy storage system (BESS), which was reported at the CIGRE Session in 2008. The project focused on the development of controls to minimize the capacity of a BESS. One of the controls developed by the project was to maintain the battery-charging level within an appropriate range. If the charging level is not regulated, it exceeds the upper or lower limit. “State-of-charge feedback control” has contributed to reduced energy capacity for a BESS while maintaining stable operations.

SCC3

Technologies discussed in this SC that have originated in Japan were countermeasures against corona noise in the vicinity of transmission lines, countermeasures against aeolian noise, and measurements and analyses of audible noise produced by corona discharge from UHV transmission lines. To bolster these contributions, JNP-SCC3 published “Radio interference research in Japan with special reference to E.H.V. transmission” and “Interference produced by the corona effect of electric systems”. JNP developed countermeasures against aerolian noise, which was technology that originated in Japan. This was fully reported as the “Development of low noise conductors for 1,000-kV transmission”.

The scope of the SC incorporated all environmental aspects in 2002 and “Utilities Practices in a Sustainable Development Performance Indicator” was published to take into account this new aspect. The Japanese utility companies approach to transmission and distribution were incorporated in this document.

SCC4

Japanese researchers proposed the up-and-down method in the 1960s, which enabled an accurate estimation of 50% flashover voltage (V50) with a little number of examinations, instead of the then used interpolation method. A highly accurate method of analyzing lightning surges using Electro-Magnetic Transients Program (EMTP) was developed in 1980s and 1990s. Then, gas-insulation apparatus using SF6 gas realized compact-designed power apparatuses. Combining the analysis, the zinc oxide arrester, and the gas insulated apparatus, a new technique of designing insulation was developed. This streamlined insulation design in the power systems ranging from 66/77 kV to 500 kV. The each of up-and-down method, zinc oxide arresters, and the proposed design technique became a global standard and widely used.

A transmission line arrester (LA) was developed in the late 1980s aiming to prevent double circuit outages caused by lightning. In particular, the transmission line arrester with an external series gap (EGLA), which was developed in Japan, has been widely applied to systems from 22-kV to 500-kV systems, mainly applied to 66/77-kV systems. EGLA has been gradually adopted throughout the world for its excellent performance.

SCC5

Deregulation of the power market in Japan commenced in 1995, when wholesale was liberalized. Retail sale for large and medium commercial and industrial sectors has also been liberalized since 2000. Deregulation has contributed to reduction of electricity prices.

In 2005, Electric power system council of Japan (ESCJ) was established to ensure the fairness and transparency of the transmission network usage. ESCJ is a private and neutral organization designated by the government. It establishes grid codes and surveys the compliance of the participant to the network with the published rules in order to enhance competition through multi-regional markets taking into account power system reliability.

In 2005, Japan Electric Power Exchange (JEPX) also started its transaction, including multi-regional spot and forward markets, which are supported by congestion management mechanism provided by ESCJ. JEPX has also been operating multi-regional intra-day markets since 2009.

SCC6

The autonomous demand area power system (ADAPS) consists of loop power-flow controllers, which utilize power-electronics technology to control the power flow and maintain an appropriate system voltage, and supply and demand interfaces, which play the role of smart meters. This new type of power-supply system was proposed as a technology that could not only solve problems with the massive introduction of DER/RES, but would also utilize them.

The microgrid demonstration was presented at the 41st and the 42nd CIGRE sessions. This microgrid system with a total capacity of 610 kW had been demonstrated for two years in the city of Hachinohe, located in northeastern Japan. The system supplied electricity to end-users with complete RES, which consists of photovoltaic, wind turbine, and bio-gas engine generators. The output fluctuations of intermittent generators were compensated for by controllable resources such as bio-gas engines and a storage battery. One-week of islanding operation was also carried out and it was demonstrated that an adequate power quality for voltage and frequency was maintained by using four-layered EMS during this period.

SCD1

Many original electrical insulating material related technologies have come from Japan. Among them, the following are outstanding and now contribute as useful and necessary tools in industries and academia all over the world. In 1980's, computers were introduced in partial discharge (PD) measurement and the phase angle resolved PD measurement technique was developed in Japan. This technique became a trigger and impacted further development of PD based electrical insulation diagnostics of electric power apparatus. In 1990's, the visualization of charge behavior inside electrical insulation materials, which was one of the dreams of electrical insulation researchers and engineers, came to be realized by the development of Pulsed Electroacoustic (PEA) method in Japan. This method is now used all over the world and has become a common tool to investigate space charge distributions inside solid insulating materials. In IEC the standardization of PEA method is now in progress under the leadership of Japan.

SCD2

Japanese EPUs have been constructing state-of-the-art IP networks integrating systems such as supervision and control of electric power systems. Cutting-edge IP technologies enable very flexible and cost-effective use of networks and ensure efficient performance and excellent reliability.

Various optical-fiber technologies were studied by WG15 whose regular members all consisted of Japanese participants. Two TBs were issued in 2004, which were "New Optical Access Technology" and "All-Optical Backbone Technology".

ICT architecture that achieves networking in widely distributed electric-power-control devices in real time has been proposed.

As the outcome of those activities, WG and TF documents are prepared by Japanese conveners. The list of which is attached as Table 5.

Table 5 List of documents published by Japanese conveners

Year	WG & TF	Title/Convener
1988	TF38.02.07	An international survey of the present status and the perspective of expert systems on power system analysis and techniques **Prof. Yasuo Tamura (Waseda University)**
1989	TF38.04.04	Electric power transmission at voltages of 1,000kV AC or ±600kV DC and above. Network problems and solutions peculiar to UHV AC transmission **Mr. Yukinori Ichida (Tokyo Electric Power Company)**
1991	TF38.06.01	Expert system applied to voltage & VAR control FINAL REPORT **Prof. Yasuo Tamura (Waseda University)**
1992	WG21.14	Guidelines for tests on high voltage cables with extruded insulation and laminated protective coverings **Mr. Hisanori Furusawa (Furukawa Electric Company)**
1992	TF33.04.04	Artificial pollution testing of HVDC Insulators: Analysis of factors influencing performance **Prof. Katsuhiko Naito (Nagoya Institute of Technology)**
1992	TF38.02.08	An international survey of the present status and perspective of long-term dynamics in power systems **Prof. Yasuo Tamura (Waseda University)**
1993	WG37.08	Adequacy and security of power systems at planning stage **Dr. Kazuhiro Takahashi (Central Research Institute of Electric Power Industry)**
1993	TF38.02.02	Modelling and simulation of black start and restoration of electric power systems **Mr. Takashi Hayashi (Tokyo Electric Power Company)**
1994	WG21.06	Accessories for HV cable extruded insulation **Mr. Zensuke Iwata (Furukawa Electric Company)**
1994	WG37.17	Impact of technological progress on demand-side appliances **Dr. Kazuhiro Takahashi (Central Research Institute of Electric Power Industry)**
1996	TF38.06.05	Application of expert systems to education and training of power system engineers **Dr. Hiroshi Suzuki (Mitsubishi Electric Corporation)**
1998	WG11.01	Negative-phase sequence and harmonic-current capability of turbo-generators **Dr. Makoto Tari (Toshiba Corporation)**
1999	TF33.11.03	Application of metal oxide surge arresters to overhead lines **Prof. Tatsuo Kawamura (University of Tokyo)**
2002	TF15.06.02 Group A WG15.10	Interfacial phenomena affecting electrical insulating properties in composites - Proposal of test method, results and discussion of CIGRE RRT - **Dr. Toshikatsu Tanaka (Central Research Institute of Electric Power Industry)**
2002	WG34.08	Isolation and restoration policies against system collapse **Mr. Masanori Matsuura (Chubu Electric Power Company)**
2002	TF38.01.11	Impact on network structure and control by Task Force 38.01.11 **Mr. Seiji Sekine**
2004	WG37.33	Development of dispersed generation and consequence for power systems **Mr. Makoto Yagi (Kansai Electric Power Company)**
2008	WGA3.22	Technical requirements for substation equipments exceeding 800 kV **Dr. Hiroki Ito (Mitsubishi Electric Corporation)**
2008	WGB3.15	Cost reduction of air insulated substations **Mr. Koji Kawakita (Chubu Electric Power Company)**

6. Future plans

The Japanese National Committee of CIGRE has been producing a Treasurer or members for the AC, SC, and TC since 1996. As a leading country in the Asia-Oceania region it continues to contribute to the growth of the power industries of the world with outstanding technologies that have originated in Japan.

With the advent of the new century, the numbers of CIGRE members have rapidly been growing as well as with increasing attention focused on CIGRE in Japan. This was the outcome of the promotion activities related to business groups including universities, and also of the hosting of SC meetings and the colloquium that encouraged power industries to acknowledge the importance of CIGRE. JNC sent regular members of all 16 SCs on oversea activities. The number of accepted technical papers has been within the top ranking for many years. In the future, JNC will lead us to a low-carbon future apart from original XLPE-cable, ZnO-arrestor, and UHV technologies. Energy-saving devices such as heat pumps, renewable energy such as solar and wind-power systems, pumped storage, and electric vehicles will help us all in the future. To achieve this, sending conveners to WGs/TGs and continuous contributions are necessary. JNC fully supports the election of a Japanese chairman for a study committee, who will be able to contribute to an even brighter future.