

# Featured Topic: Sumitomo Electric's Efforts in Developing Its Environment & Energy Business and the Present Status of Research & Development Activities

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Confronted with global warming and other environmental issues that have become tangible as a result of rapidly growing energy demand, mainly in developing countries, expectations are raising for stable and safe supply of environmentally friendly electric power and other energy sources. Under such circumstances, the environment surrounding electric power and energy is changing dynamically. In particular, expansion of power generation/transmission/distribution networks is being promoted on a global basis, use of renewable energy is increasing, and enhancement of the reliability of electric power systems is required in response to an increase in renewable energy consumption.

The Sumitomo Electric Group provides customers with electric power infrastructure and various other technologies and products used in telecommunication systems, automobiles, electronic equipment, and other systems. Thus the Group can offer solutions to the various new social needs for electric power and energy. The Group has been developing the products and technologies to realize three values: “reduction of environmental load,” “maintenance and improvement of electric power quality,” and “assurance of energy security.”

This feature article describes the Group's efforts in expanding its environment and energy business and the present status of technology development. The article begins with the history of the Group's electric wire and cable business and technological trends in the field.

### History of Sumitomo Electric Group's Electric Wire and Cable Business and Technical Trends in This Field

The history of Sumitomo Electric's electric wire and cable business dates back to 1897 when Sumitomo Copper Rolling Works was founded to produce copper plates, rods, and wires from copper ingots produced in Besshi and sell them to the world. In 1911, Sumitomo Electric Wire & Cable Works split off from the parent

company. In the same year, the new company put into practical use the Japan's first 11 kV high-voltage underground power transmission cable. In 1922, the company designed and produced the world's then longest submarine cable (11 kV paper-insulated lead-sheathed steel wire-armored cable), and laid it on the seabed between Niihama and Shisakajima in Ehime Prefecture. The 5th circuit of the submarine cable, which was laid in 1957, is still in operation. Even before the Second World War, our senior colleagues exerted their enthusiastic efforts at all times to introduce the world's most advanced technologies and begin their in-house commercialization as early as possible. A typical example was the introduction of OF cable (oil-filled, pressurized oil-impregnated paper-insulated cable) technology in 1928 from Pirelli & C., an Italian firm.

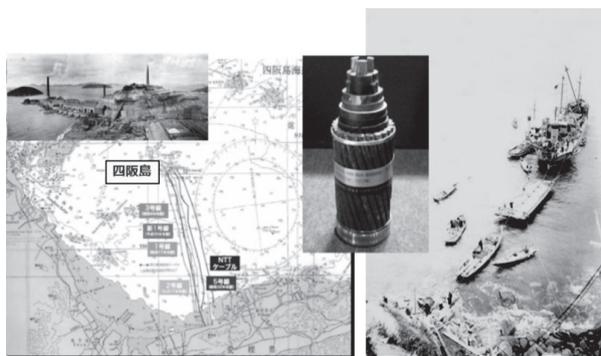


Photo 1. 11 kV submarine cable installed between Niihama and Shisakajima

An electric power business is supported by various technologies, including mainly (1) conductor technology for enhancing the overall conductivity of conductors, (2) insulation technology for enabling electric wires and

cables to withstand various voltages and operating conditions, and (3) technology for installing overhead lines, underground cables, submarine cables, and movable cables.

### (1) Conductor technology

Our Electric Conductor Div. has been consistently engaged in the development of copper conductors. In particular, the division introduced an own-developed continuous casting and rolling system for copper wire rods into the Yokohama Works in 1971. To effectively use recycled power cables and other products, the division also introduced a contirod continuous casting and rolling system with a tilting reverberatory furnace into the Osaka Works in 1981. Using these two systems installed in the eastern and western parts of Japan, the division met an increase in demand for electric wires and cables that existed at that time in Japan. Later, in response to a decline in domestic demand and accelerated expansion of our business overseas, we closed the conductive product factory at the Yokohama Works in 2001 to scrap aged facilities and built one of Southeast Asia's largest continuous casting and rolling system in Indonesia. In addition to the machine installed in Indonesia, we installed a similar continuous copper cast-rolling system in Thailand in 2014. In parallel with improvements described above, the division has advanced conductor technology, including the development and subsequent mass production of an up-cast material suitable for producing highly functional magnet wire, the development of a copper alloy wire for high-strength wiring harness applications, and the design and production of segmental conductors for submarine cable applications. For aluminum conductors, Sumitomo Electric Toyama Co., Ltd. took over the aluminum ingot smelting process and its downstream process, the aluminum wire rod production process, which had been operated by Sumitomo Chemical Co., Ltd.'s Toyama Plant until the 1970s. Since then, Sumitomo Electric Toyama has been fully devoted to operating the aluminum electric wire and cable business. In particular, this company developed and mass produced a high-strength, high-conductivity aluminum alloy wire for overhead power transmission applications in Japan. In 2016, this company also started an aluminum cast-rolling business overseas (Thailand) for the first time in the Japanese electric wire industry and went into mass production of aluminum wire conductors for high-quality wiring harness applications. Although aluminum conductors are inferior to copper conductors in terms of conductivity, the former are superior to the latter in weight and cost. This company is enjoying superior development capability and market competitiveness in the field of raw materials to products.

From a viewpoint different from that of technology, the cost of raw materials accounts for a relatively large percentage of the production cost of conductors. Both copper and aluminum are international commodities, and their demand/supply and prices fluctuate widely.

Sumitomo Electric devised a risk management system that is linked to the selling price of electric wire and introduced currency hedging, LME, and other risk-hedging techniques to maintain stable operation of its conductor business.

### (2) Insulation technology

Sumitomo Electric's Power Cable Div. has maintained and advanced this technology in a consistent manner. During the period from immediately after the Second World War to the first half of the 1950s, paper-insulated solid cables were the mainstream of power cables. However, this type of cable had a shortcoming: the formation of voids in the insulation due to heat cycling during the operation. In place of paper-insulated solid cables, OF cables became the mainstream in the second half of the 1950s and maintained their position for a long while after that, since this type of cable could withstand higher voltages owing to its improved insulation performance. To meet the demand of Japanese and overseas electric power companies for higher-voltage, larger-capacity power transmission cables, the division has installed extra manufacturing equipment. An example of such equipment was the world's then largest class submarine cable shipping turntable installed at the Osaka Works. In addition, the division originally developed a PPLP-insulated OF cable in which a semisynthetic paper (polypropylene laminated paper) was used in place of the kraft paper as the insulation material. Using this new cable technology, the division supplied the 500 kV AC (alternative current) Honshu-Shikoku interconnecting line

Historic milestones of Sumitomo Electric's power cable business	
1908	Started production of power cables
1911	Supplied the first paper-insulated lead-sheathed high-voltage (11 kV) power cables in Japan
1922	Manufactured the world's longest (21 km) submarine cable (Connecting Niihama and Shisakajima)
1928	Introduced OF cable technology from Pirelli Cables, an Italian firm
1939	Introduced ACSR (aluminium conductor steel-reinforced) technology from Aluminum Company of America (now Alcoa)
1959	Started production of CV cables
1974	Completed Toyama Electric Wire production plant nearby Nihon Senzai Co. (for producing ACSR)
1995	Additionally installed VCV (vertical continuous vulcanizer) at the Osaka Works
2001	Established J-Power Systems Corp. jointly with Hitachi Cable, Ltd.
April 2014	Acquired 100% ownership of J-Power Systems Corp.
August 2014	Incorporated the sales and construction departments of J-Power Systems Corp. into Sumitomo Electric
January 2016	Incorporated the engineering/development and quality assurance departments of J-Power Systems Corp. into Sumitomo Electric

Fig. 1. Historic milestones of Sumitomo Electric's power cable business

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in 1991, participated in the world's then highest voltage Hydro-Quebec 800 kV AC Cable Development Project in 1993, and the 500 kV DC (direct current) Anan-Kihoku interconnecting line (submarine cable across Kii Channel) in 2000. In terms of employing insulation oil, the OF cable technology has a great technical similarity to the MI (mass-impregnated) cables that have been used for the long-distance international interconnection lines having been constructed mainly in Europe. Therefore, we developed a PPLP-insulated MI cable and, in 2014, Sumitomo Electric and Prysmian Cables and Systems (the former Pirelli Cables) were jointly awarded the contract to supply 500 kV DC MI cables that are used for the Montenegro-Italy power link. Thus we became Japan's first power cable manufacturer to enter the large-capacity, long-distance DC power transmission market in Europe.

In the field of insulated wires, on the other hand, rubber was mainly used as the insulation material until the first half of the 1950s. In collaboration with Sumitomo Chemical Co., Ltd., we promoted joint research on the use of polyethylene as an insulation material. In the beginning of the second half of the 1950s, the division developed a cross-linked polyethylene insulated cable that was superior in heat resistance. The division also developed and installed catenary type (CCV) and vertical type (VCV) continuous cross-linking systems to develop a CV cable (cross-linked polyethylene insulated vinyl-sheathed cable). Using CV cables and other cables, the division met increased demand for higher voltage power cables during the high economic growth period after 1965, while participating in many big projects launched overseas. After 1975, oil-less CV cables became the mainstream of power transmission cables in place of OF cables, in response to growing concerns about environmental protection and fire accident prevention in case of cable failure. Recently, the Company developed an original cross-linked polyethylene insulation material having superior DC characteristics. Using this newly developed insulation material, the division developed and commercialized a DC-CV (direct-current transmission cross-linked polyethylene insulated) cable that can be used for offshore wind power generation systems and middle-distance international interconnecting lines. Following the first supply of DC-CV cables to the Hokkaido-Honshu HVDC Link in Japan in 2012, Sumitomo Electric was awarded the United Kingdom-Belgium interconnecting line (NEMO Link) on a full turnkey basis in 2015. The cables for this interconnecting line are under manufacturing at Hidaka/Minato Works.

### (3) Cable installation technology

In 1977, Sumitomo Electric merged Overhead Transmission Line Construction Div. and Underground Transmission Line Construction Div. into Power Transmission Line Construction Div. Until the end of 1984, the new division undertook many projects that were launched by overseas countries to improve their infrastructure. These projects included a large scale over-

head power transmission line in Iran, a composite system in Saudi Arabia consisting of an overhead transmission line and an OF underground transmission line, and a 500 kV overhead power transmission line in Thailand. Specifically, in developing countries, the division experienced many troubles in collapse of steel towers for the construction of overhead lines and hard rock excavation for the construction of underground and submarine cables. Regarding technology, the division developed and put into practical use many new techniques, namely a technique for embedding the submarine cable simultaneously after laying, a technique for laying and embedding three submarine cables at the same time, and so on.

In addition to the conductor technology, insulation technology, and cable installation technology discussed above, Sumitomo Electric's electric power-related businesses cover many other technological fields. In the field of renewable energy, we collaborate with Nissin Electric Co., Ltd. and Sumitomo Densetsu Co., Ltd. to propose and offer system solutions to customers ranging from transmission route selection to system design. We are responding to the demand for the replacement of aged transmission and distribution networks in Japan with new insulated wires, cables, and their accessories and are also developing a network maintenance and monitoring system. Customer demand is rapidly increasing in various new fields, including power generation systems represented by concentrator photovoltaic systems, electricity storage systems represented by redox flow batteries, and energy management systems. Our important challenge is to comprehensively expand our business in these fields.

In conclusion, the environment and energy business deals mainly with infrastructure, and therefore requires a long period of time to win a contract and complete it. While we manage our activities with foresight and flexibility in order to cope effectively with the changing times under any circumstances,\*1 we will run our business with a "sense of gratitude for society,\*2" engraving in our thoughts "attaching importance to technology,\*2" "respect for human resources,\*2" and "long-range planning.\*2"

• PPLP is a trademark or registered trademark of Sumitomo Electric Industries, Ltd.

\*1 An idea stated in Sumitomo's Business Principles.

\*2 Theosophy stated in the Sumitomo Spirit.