SUMITOMO ELECTRIC
Connect with Innovation

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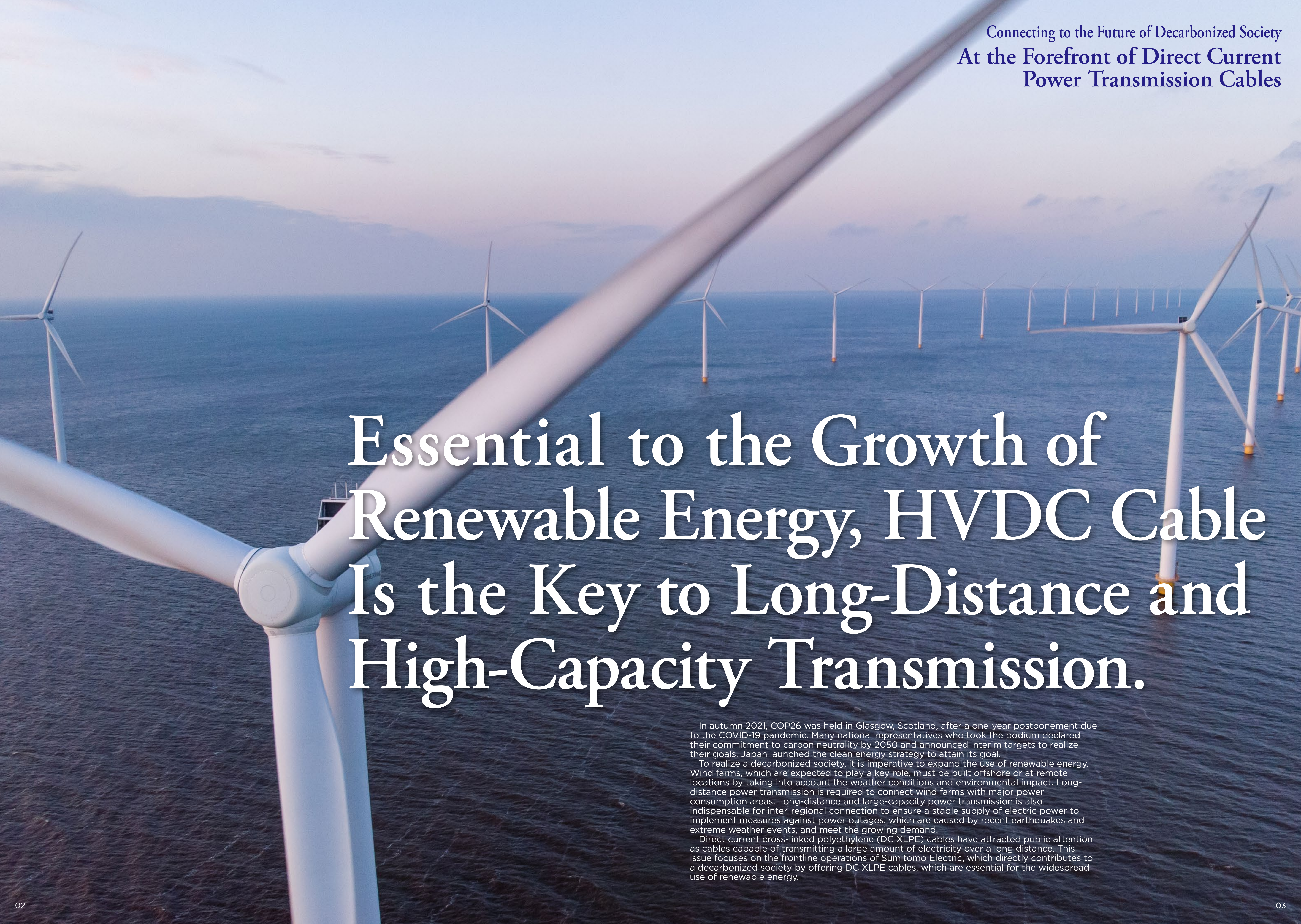
**Innovative Development,
Imagination for the Dream,
Identity & Diversity**

Feature

Connecting to the Future of Decarbonized Society

At the Forefront of Direct Current Power Transmission Cables

SUMITOMO ELECTRIC GROUP

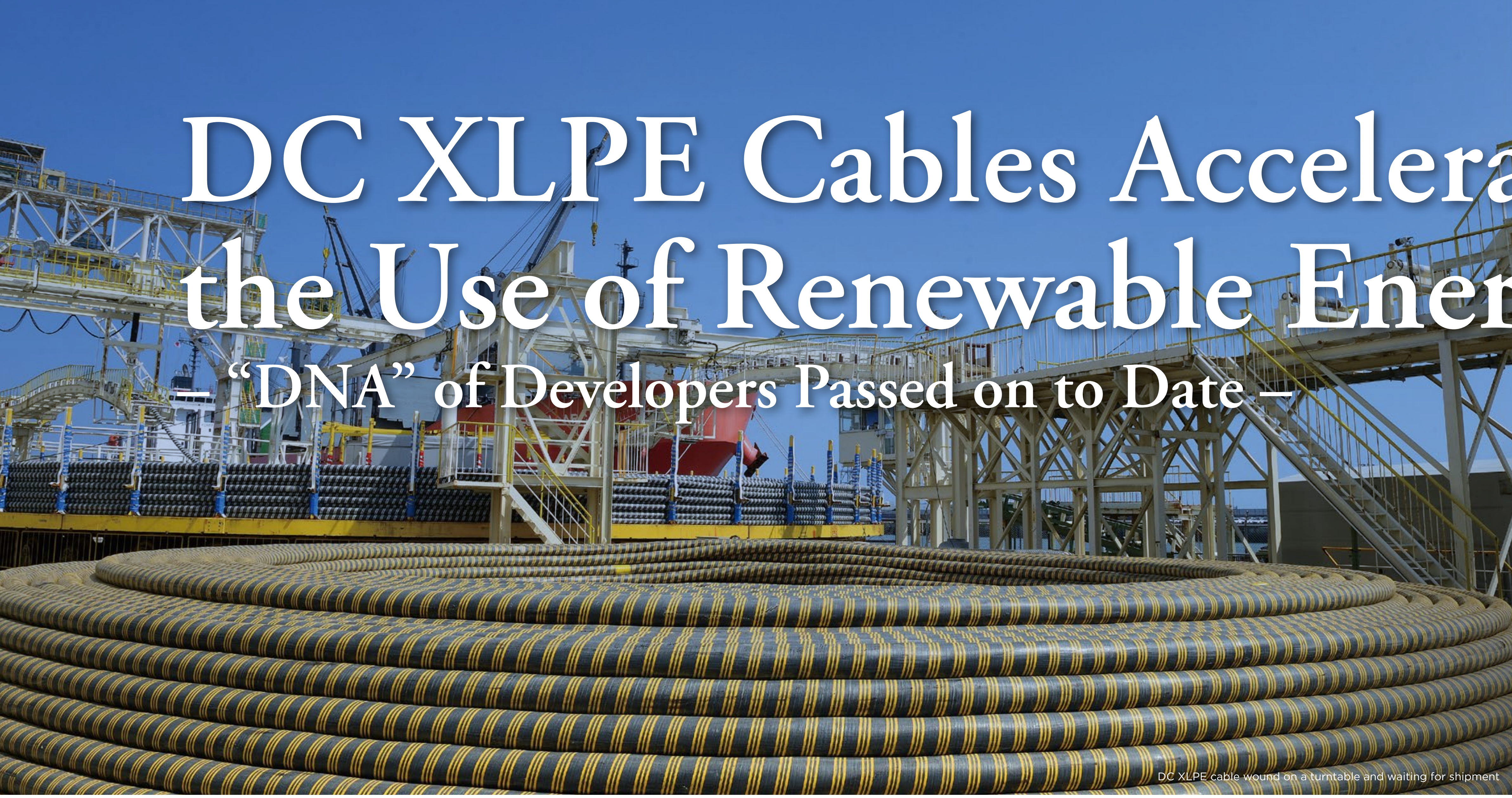


Essential to the Growth of Renewable Energy, HVDC Cable Is the Key to Long-Distance and High-Capacity Transmission.

In autumn 2021, COP26 was held in Glasgow, Scotland, after a one-year postponement due to the COVID-19 pandemic. Many national representatives who took the podium declared their commitment to carbon neutrality by 2050 and announced interim targets to realize their goals. Japan launched the clean energy strategy to attain its goal.

To realize a decarbonized society, it is imperative to expand the use of renewable energy. Wind farms, which are expected to play a key role, must be built offshore or at remote locations by taking into account the weather conditions and environmental impact. Long-distance power transmission is required to connect wind farms with major power consumption areas. Long-distance and large-capacity power transmission is also indispensable for inter-regional connection to ensure a stable supply of electric power to implement measures against power outages, which are caused by recent earthquakes and extreme weather events, and meet the growing demand.

Direct current cross-linked polyethylene (DC XLPE) cables have attracted public attention as cables capable of transmitting a large amount of electricity over a long distance. This issue focuses on the frontline operations of Sumitomo Electric, which directly contributes to a decarbonized society by offering DC XLPE cables, which are essential for the widespread use of renewable energy.



DC XLPE Cables Accelerate the Use of Renewable Energy

– "DNA" of Developers Passed on to Date –

DC XLPE cable wound on a turntable and waiting for shipment

DC XLPE cable during shipment

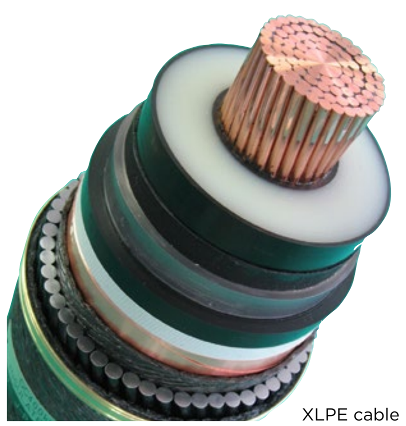
Long-cherished DC XLPE cables

Power transmission equipment for sending and receiving electricity between countries or regions is called an interconnector. The global community, which has been moving toward a decarbonized society, aims to create a future where electricity is interchanged in a large area by using international and interregional grids consisting of interconnector networks. In line with these developments in the energy market, Sumitomo Electric has been awarded contracts for interconnector projects to manufacture and install DC XLPE cables.

DC power transmission cables offer advantages in long-distance and large-capacity power transmission. DC XLPE cables, which use cross-linked polyethylene as an insulating material, have less environmental impact compared to that of oil-impregnated insulation cables. As a front runner, Sumitomo Electric became the first company in the world to achieve normal operation with the conductor temperature at 90°C, which is 20°C higher than that of conventional cables, and polarity reversal of power transmission voltage. This has achieved large-capacity power transmission, leading to the development of an innovative high-voltage DC (HVDC) cable capable of changing the voltage direction depending on the operation status of a DC interconnector (i.e., changing the direction of sending electric power by reversing the polarity of the positive and negative terminals).

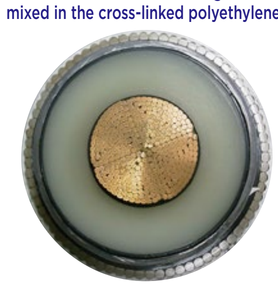
Electric power companies around the world awaited the development of this power transmission cable. However, even after the advent of the 21st century, there were no reports that XLPE cables, which went into practical application and widespread use in the 1960s for alternating current (AC), were developed for direct current (DC). Against this backdrop, the Hokkaido-Honshu HVDC Link, a submarine cable installed by Sumitomo Electric in 2012, became the first HVDC power transmission line using XLPE cables.

How did Sumitomo Electric develop DC XLPE cables? Let's take a look at the history of the development to fulfill the long-cherished dream.



XLPE cable

Types of cables

Types of insulation	Oil-impregnated insulation		Solid insulation
	OF cable	MI cable	XLPE cable
Structure	Low-viscosity oil is pressurized into insulation paper and sealed. 	High-viscosity oil is impregnated into insulation paper and sealed. 	An additive for preventing accumulation of electric charge is mixed in the cross-linked polyethylene. 
Long distance	△	◎	◎
Large capacity	◎	○	◎

Challenging spirit passed on to date

The history of Sumitomo Electric dates back to 1897, when Sumitomo Copper Rolling Works was founded to manufacture and sell copper sheets, rods, and wires using copper produced in the Besshi copper mine as the raw material. In 1905, the refinery was relocated to Shisakajima, an uninhabited island in the Seto Inland Sea. In 1922, the longest submarine cable in the world at that time (spanning 21 km) was completed between Niihama and Shisakajima to achieve stable supply of electric power. The persevering commitment to in-house manufacturing, no matter how much time it takes, is considered as the identity of Sumitomo Electric, underpinned by the challenging spirit, which has been passed on to date from Shisakajima. Sumitomo Electric has always taken the lead in the development of various power transmission cables.

The first DC power transmission cable in the world went into commercial operation in 1954 between Sweden and Gotland. Since then, oil-filled (OF) cables as well as mass impregnated (MI) cables, both of which consisted of wrapped and impregnated paper as an insulation material, were used as DC power transmission cables for many years. However, there was growing demand for insulation cables that did not pose the risk of oil leakage from the viewpoint of environmental protection in line with the growing awareness about environmental issues around the world.

Research on DC XLPE cables started in Japan in the latter half of the 1970s. At that time, long-term electrical tests were conducted to use AC XLPE cables, which were already in practical application, as DC XLPE cables without modification. However, it was found that AC XLPE cables could not be used for DC as is, due to the negative effect of the space charges (discussed later), which accumulated in the insulating material. Based on the results, Sumitomo Electric promoted the basic development of DC XLPE insulating material in 1984 in response to the development request from Electric Power Development Co., Ltd. ("J-POWER").

Note) Sumitomo Electric established J-Power Systems Corporation ("JPS") in 2001 by consolidating Hitachi Cable, Ltd. with the High Voltage Power Cable Div. In 2014, it made JPS a wholly owned subsidiary. In 2022, it succeeded JPS's business related to manufacture of electric wires and cables.

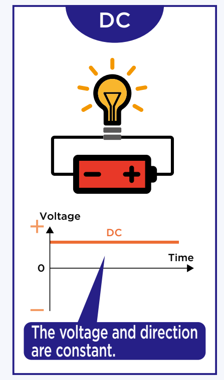
Installation of a submarine cable and Shisakajima submarine cable at that time (cross section of the cable)

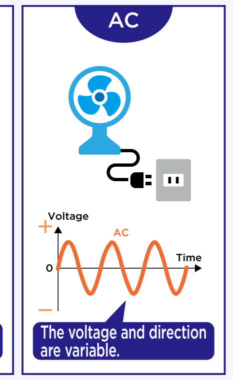
Column: Basic knowledge of DC and AC

There are two types of electricity flow: DC and AC. In DC, electricity flows in one direction from the positive terminal to the negative terminal as in the case of a dry battery. In AC, electricity flows back and forth alternatingly like waves between the positive and negative terminals. Electricity generated at a power plant is delivered to homes in AC. Thus, most electricity used at home is AC.

Why is AC used dominantly? The reason dates back to the latter half of the 1880s, when Thomas Edison and Nikola Tesla, both of whom were inventors, clashed over which should be used for future electric power systems: DC or AC. Edison started DC power transmission for lightbulbs for the first time in the world. However, he faced problems in long-distance power transmission due to difficulties in voltage conversion, which could not be achieved by the technology at that time, and costs incurred by ultra-thick copper wires required for power transmission. Meanwhile, Tesla started AC power transmission. He achieved long-distance power transmission through the process of high-voltage power transmission, step-down, and power receiving by taking full advantage of the characteristics of AC, whose voltage was easy to change, on a scale far larger than that of Edison's electric power system. In addition, AC was more suitable than DC for infrastructure because the equipment was less expensive and the maintenance cost was low. Thus, AC is used in most of the grids around the world, including Japan.

Today, electronic devices which require complicated control, such as PCs and smartphones, are operated by DC by using AC adapters, which convert AC to DC. Inverters, which are used in air conditioners and refrigerators, also convert AC to DC to achieve complicated control and energy conservation. DC is highly compatible with charging and is considered to be suitable for electric vehicles and charging equipment (i.e., suitable for renewable energy). A new era, which Edison might have ushered in, is finally beginning. DC may play a key role in the next-generation electric power system.





Devotion to the Development of DC XLPE Cables

– An Inside Story on the Development of a Special Filler Material –

Long-term electrical test site (Osaka Works)

Obstacle posed by space charge

In 1979, J-POWER completed the first-stage submarine cable for the Hokkaido-Honshu HDVC Link, which connected Hokkaido with Mainland Japan, and started operation. However, the installed cable was the oil-impregnated insulation type. Thus, the company hoped to use the DC XLPE cable for expansion or renewal from the viewpoint of environmental protection. Mitsumasa Asano of J-POWER (at that time), who worked on the development with Sumitomo Electric, looked back on the situation and said, “I felt the passion of Sumitomo Electric’s development team members, who showed extraordinary perseverance to accomplish the project whatever it might take.”

“The biggest obstacle was how to suppress the space charges. Electric charges, which are invisible, refer to the amount of electricity with which an object is charged. The electric charges that accumulate in an insulating material when DC voltage is applied are referred to as ‘space charges.’ These prevent an insulating material from fully demonstrating its performance. Electrical breakdown* may result when a power transmission system is hit by lightning. This was the biggest factor that prevented application of XLPE cables to DC. When we conducted various tests to eliminate the space charges, Sumitomo Electric made an unconventional proposal. ‘Even if the electric charges are present, electrical breakdown may not occur when the electric charges are evenly and uniformly scattered in an insulating material.’ Thus, we decided to use a method of adding a filler material to the cross-linked polyethylene,” said Asano.

The insight was right. After trial and error, the space charges were finally suppressed by adding a newly developed special filler material. R&D proceeded from Stage 1 (1988 to 1995), which aimed to attain 250 kV, to Stage 2 (1993 to 2001), which aimed to attain 500 kV. All the targets were achieved.

This coincided with the deterioration of the first cable installed for the Hokkaido-Honshu HDVC Link. In 2012, the DC XLPE cable was finally put to practical application for the first time in the world to meet the replacement needs.

“In the actual manufacturing operations, it was necessary to fabricate a long-distance cable. This posed difficulties in maintaining uniform quality compared to the prototype production. It was highly meaningful to hold discussions between the two companies about the quality control and manufacturing process,” said Asano.

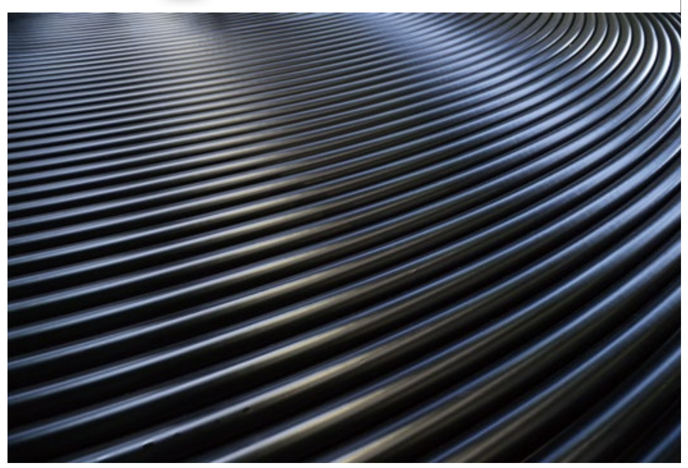
Asano also remembered what impressed him during the installation work.

“The offshore cable had to be connected with the onshore cable manually. Accidents were likely to occur at this point in the cable construction project. This process required high engineering capabilities. Sumitomo Electric’s workers were reliable in terms of both skills and construction management,” said Asano.

The project was accomplished thanks to Sumitomo Electric’s overall capabilities: development engineers who perseveringly pursued outstanding specifications, in-depth quality control at the manufacturing site, careful construction work which took full advantage of the quality, and passion to attain high levels on all aspects.

Cable installation for the Hokkaido-Honshu HDVC Link

Mitsumasa Asano
Director, Business Planning & Management Dept., J-POWER Transmission Network Co., Ltd.



Completed cable

A revolutionary idea to mix an additive

Let’s meet a legendary person who has focused on DC XLPE cables throughout his research career. Shoshi Katakai is affiliated with the Electric Wire & Cable Energy Business Unit. He has been devoted to R&D of DC XLPE cables since the 1980s, when he entered the industry.

“I spent frustrating years. However, many customers waited for the practical application of cables capable of large-capacity power transmission with minimal environmental impact, so R&D never stopped,” said Katakai.

The development of 500 kV AC XLPE cables was in full swing when Katakai started to work on research. Cross-linked polyethylene (XLPE), which is the key insulating material, significantly improved the properties of polyethylene at high temperature by cross-linking, which is a method of changing the molecular structure.

“To make XLPE an insulating material capable of coping with higher voltages, R&D members were expected to prevent defects, by entering no defects, producing no defects, and being able to prove no defects existed. The ideal was to develop the purest possible polyethylene without mixing additives,” said Katakai.

This approach was considered to be applicable to the insulating material of DC power transmission cables. However, a new problem, which did not arise in the AC power transmission cables, emerged. Conventional XLPE attained the electrical breakdown strength far below the expectations for the DC voltage due to accumulation of the space charge, which was discussed above. In other words, AC XLPE cables made from pure polyethylene could not be used as they were for DC. Thus, Katakai came up with the idea of mixing an additive and decided to use a filler material. He made steadfast efforts to carefully identify potential filler components one by one to cope with high voltages and finally determined the components and blending to resolve the problem. Efforts to achieve further miniaturization and higher purification and distribution led to a special filler material. A material with superb DC insulation characteristics was completed by uniformly distributing the components in XLPE. This is the proprietary XLPE that underpins HVDC power transmission cables currently manufactured by Sumitomo Electric. The accomplishment was derived from doubting the conventional wisdom and seeking the truth with perseverance.

“‘Seek the Truth’ – I have only followed the teaching in good faith from my teacher when I was a student,” said Katakai with deep emotion. In the 2000s, a consortium was organized with a university to publicly evaluate the results. Preparations were made toward commercialization. However, there was no project to use DC XLPE cables. It took some more time until practical application. The situation changed in the 2010s. After the Great East Japan Earthquake in 2011, there was a growing need for electric power interchange between electric power companies. Coincidentally, the DC XLPE cable went into operation in the Hokkaido-Honshu HDVC Link in 2012.

At present, Katakai focuses on training younger engineers as a fellow of Sumitomo Electric, but he remains highly motivated to work on the development.

“Interconnectors have been expanded worldwide, but more of them are needed,” said Katakai.

The Japanese government has announced a plan to construct a next-generation grid to send electric power derived from renewable energy sources, such as offshore wind power, from Hokkaido to Tohoku and Tokyo as part of its clean energy strategy. In Europe, where the electric power market has been liberalized, construction of an international grid called “super grid” is underway as the first project of its kind in the world. The development of international interconnectors has been spurred by the growing need to introduce renewable energy. Full-scale efforts have been launched by regions and countries to achieve carbon neutrality. The supply of DC XLPE cables, which were developed by Katakai and other Sumitomo Electric engineers, will be accelerated for interconnector projects in and outside Japan.

Shoshi Katakai, fellow of the Electric Wire & Cable Energy Business Unit

Electrical test

* When the strength of an electric field that applies to an insulating material exceeds a threshold, the insulating material electrically breaks down, resulting in a rapid decrease in electrical resistance and allowing a large current to flow.

Connecting Regions for Stable Supply of Electric Power

– New Hokkaido-Honshu DC Seikan Tunnel Project –

Cable drawn in and placed on a rack on the ceiling

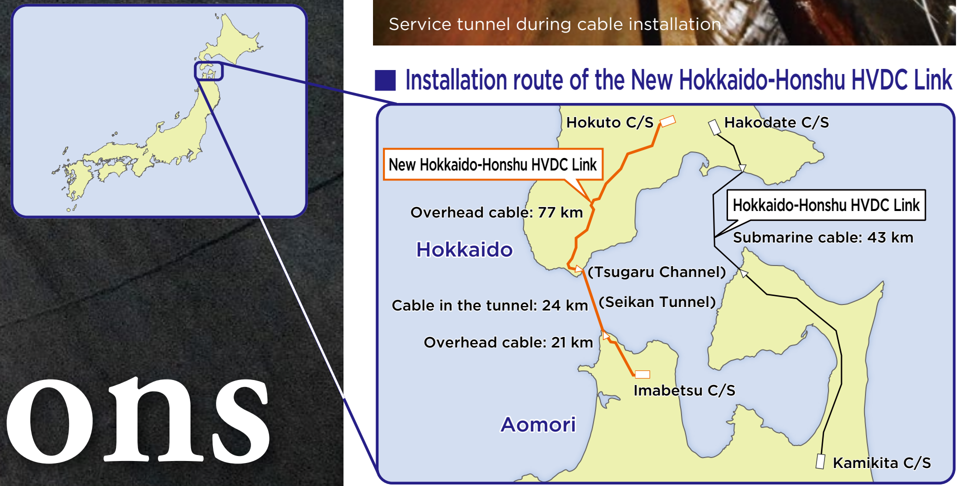
Service tunnel during cable installation

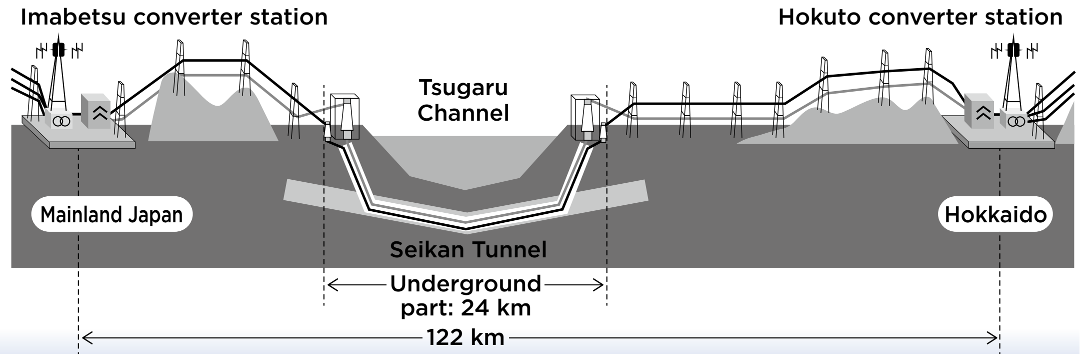
Cable connection room: Workers made efforts to implement dustproof measures in the severe environment.

Ceremony to draw in the cable (Yoshioka construction base)

Installation (on the Hokkaido side: Yoshioka cable head (draw-in port))

■ Installation route of the New Hokkaido-Honshu HVDC Link





Cross section of the New Hokkaido-Honshu HVDC Link route (courtesy of Hokkaido Electric Power Network, Inc.)
(The New Hokkaido-Honshu HVDC Link connects the Hokuto converter station on the Hokkaido side with the Imabetsu converter station on the Mainland Japan side. The New Hokkaido-Honshu DC Seikan Tunnel project aimed to construct a 24 km underground power transmission cable in the Seikan Tunnel.)

A major power outage that could have been avoided

In September 2018, the Hokkaido Eastern Iburi earthquake caused a large-scale power outage across the entire Hokkaido area.

At that time, the test operation of the New Hokkaido-Honshu HVDC Link, whose entire construction process had been completed, was about to begin toward commencement of its commercial operation in March 2019. As discussed above, the Hokkaido-Honshu HDVC Link (submarine cable) was already in place between Hokkaido and Mainland Japan. Its operation was started by J-POWER in 1979. When the demand for electric power was high in Hokkaido, a stable supply was ensured through the electric power interchange from Mainland Japan. Subsequently, the second cable was installed in 1993, and the first cable that had deteriorated was replaced by the DC XLPE cable in 2012 (total power transmission capacity: 600 MW). The New Hokkaido-Honshu HVDC Link was designed to add the 300 MW capacity to constantly stabilize the electric power supply in Hokkaido. The New Hokkaido-Honshu DC Seikan Tunnel project was initiated to construct an underground power transmission line in the Seikan Tunnel.

Tomoyuki Fukushima, who led the project as Director of the Trunk Network Work Center of Hokkaido Electric Power Co., Inc., explained how he felt at that time.

"Expansion of the interconnector had been planned previously to cope with the suspension of the Hokkaido-Honshu HDVC Link and large-scale repair in the future. Planned power outages following the Great East Japan Earthquake expedited efforts to enhance electric power interchange and expand interconnectors. The investigation and design of the New Hokkaido-Honshu HVDC Link started two months after the earthquake. The project aimed to start operation in five years after commencement of construction, which was short in terms of the construction period for an interconnector. I remember how I felt frustrated every time I was told 'the power outages across Hokkaido could have been avoided if the New Hokkaido-Honshu HVDC Link had been in place,'" said Fukushima.

Taking on a challenge to cope with the severe tunnel environment

The cable was to be installed in the Seikan Tunnel. This was an unprecedented challenge for both Hokkaido Electric Power and Sumitomo Electric. Fukushima was the responsible person who formulated the basic plan. He admitted that he sometimes felt anxious about whether the project would be successful.

"We decided to install the cable in the Seikan Tunnel because the space in the tunnel was accessible to workers to visually check the cable after commencement of the operation. It was easy to conduct inspection and maintenance. It should be noted that the cable was to be installed in the service tunnel, which ran parallel with the main tunnel for the Shinkansen bullet train and was far smaller than the main tunnel. The installation space was near the ceiling, but both the installation space and work space were very small, so we had to make arrangements to adapt the design, construction method, and on-site management to the environment in the tunnel," said Fukushima.

Tomoyuki Fukushima
Northern Advancement Center for Science & Technology (NOASTEC)
(Executive Officer of Hokkaido Electric Power Co., Inc.)

One year was spent to investigate the environment in the tunnel, formulate a route plan, and determine the equipment configuration. Sumitomo Electric participated in the project from the investigation phase. The situation was identified carefully to perform the construction work safely and reliably. Nevertheless, various problems, both major and minor ones, arose every day after commencement of the construction work.

"The submarine tunnel was completely dark, and humidity in the tunnel was always over 80%. In addition, a cloud of dust blew up due to the air pressure when Shinkansen bullet trains passed in the main tunnel. Despite such a construction environment, it was almost a miracle to complete the interconnector construction project in five years as planned, which usually takes eight to 10 years. It is difficult to explain in a word, but as I look back, the success was attributable to the efforts to discuss issues, which emerged one after another, with all the members and resolve them without compromise through concerted efforts. Above all, Sumitomo Electric's engineering capabilities played a key role to deliver the 24 km-DC XLPE cable in a short period," said Fukushima.

Growing demand for DC interconnectors in Japan

The large-scale power outage in 2018 stirred up discussions about the importance of interconnectors. The New Hokkaido-Honshu HVDC Link became the first interconnector in Japan to use a voltage-sourced AC-DC converter, which was just developed for HVDC in the 1990s. "DC XLPE cables, which can be used for any DC conversion methods, are derived from the high development and engineering capabilities of Sumitomo Electric. This was a valuable project for Sumitomo Electric," said Kazutoshi Abe of the Power Cable Project Engineering Div. with confidence.

"The DC grid is like an expressway to interchange electricity in a large area, while the regional grid is a general road to send electricity to homes and companies. AC is used for the general road, so an AC-DC converter serves as an interchange of roads. There are two types of AC-DC converters: line-communicated converters and voltage-sourced converters. Sumitomo Electric's DC XLPE cables can be used for both AC-DC conversion methods. The New Hokkaido-Honshu HVDC Link is the first project in Japan to apply the DC XLPE cable to the voltage-sourced AC-DC converter. The needs for similar specifications will grow in the field of interconnectors. Sumitomo Electric built a track record befitting the self-acknowledged top brand of DC power transmission cables," said Abe.

Kazutoshi Abe
Electric Cable Project Div.

One big step forward in the interconnector scheme

Having seen the completion of the New Hokkaido-Honshu HVDC Link, Fukushima is currently engaged in industrial promotion in Hokkaido at the Northern Advancement Center for Science & Technology (NOASTEC), to which he has been temporarily transferred.

"Zero Carbon Hokkaido is part of the Basic Policy on Economic and Fiscal Management and Reform promoted by the Japanese government. Hokkaido offers the biggest potential in Japan in terms of renewable energy, including offshore wind power. It will serve as a front runner when Japan aims to achieve carbon neutrality by 2050. Since renewable energy depends on the weather conditions, it requires a robust grid capable of coping with supply fluctuations. If interconnectors further expand in the future, Hokkaido will not just receive electric power from Mainland Japan through interchange; the electric power business to transmit renewable energy generated in Hokkaido to Mainland Japan will be further accelerated," said Fukushima.

The New Hokkaido-Honshu HVDC Link is considered to have been a big step forward to achieve a scheme of connecting all of Japan through a large grid and sending electricity, which is generated at various locations and by various methods, to the consumption areas. Abe, who currently promotes an offshore wind power generation project in Japan, talked about his aspiration regarding the future of DC XLPE cables.

"To promote the widespread use of renewable energy, whose power generation amount is unstable, large-area interconnection must be ensured to stabilize the supply amount. The DC XLPE cables will increase their presence in interconnector projects in and outside Japan. I hope to gain experience and knowledge overseas and meet the growing demand in Japan," said Abe.

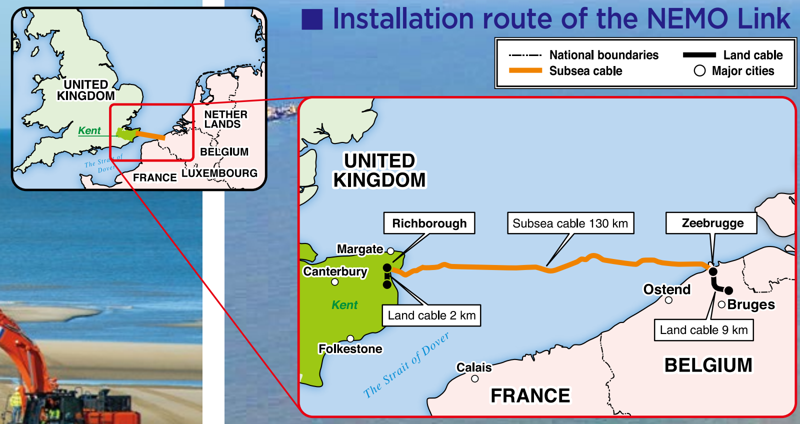
In the paradigm shift in the history of energy, Sumitomo Electric will fulfill its role as a supporter of electric power companies by offering DC XLPE cables.

An Excellent Operation Rate of 99.8% Achieved by a Multinational Team

– Nemo Link Project –

Cable laying on the Belgium beach side

■ Installation route of the NEMO Link



Landing operation of the submarine cable on the Belgium side

Construction proceeded with multinational members

The true value of DC XLPE cable proven in Europe

In Europe, which has been a global leader in tackling climate change, cross-border trade of electricity is already commonplace, and there is an international power transmission line using Sumitomo Electric high-voltage direct current (HVDC) cable.

The UK-Belgium interconnector was built to help reduce CO_2 emissions by utilizing renewable energy generated in both countries and to facilitate low-cost and stable power interconnection. In 2015, Sumitomo Electric signed a contract for this project with Nemo Link Limited, a joint venture between National Grid plc (UK) and Elia (Belgium), and took its first step into the European interconnector market. Sumitomo Electric was responsible for the manufacturing and installation of DC XLPE cable of a total length of approximately 140 km, including a submarine section of 130 km across the North Sea. The interconnector went into operation in February 2019, and its transmission voltage of 400 kV set a world record at that time. While the first issue of this e-magazine featured a story about receiving the order for this project, this issue introduces a story after that to the present.

The offshore installation started from the UK side in August 2017. The entire construction process had to be completed by the early winter of 2019 in order to start operating the facility as scheduled. To meet the tight schedule, Sumitomo Electric sent engineers with a wealth of experience. One of them is Takuya Miyazaki (Submarine Construction Group, Offshore Projects Construction Department, Power Cable Project Division), who directed the construction at the site as a member of the construction team.

"About 50% of troubles occur in the process of connecting cables. However, as long as they relate to connecting, we know how to manage them. This is our strength since we have accumulated a wealth of know-how. However, at the late stage of the construction, when it seemed to be proceeding as scheduled, an unexpected problem occurred. The cable installation work stopped 3 km before the cable landing point on the Belgium side. The planned landing point was a swimming beach. Since it was difficult for a large submarine cable laying ship to navigate the shallow sea, a special construction method and work ships that suit the terrain were necessary, but apparently the work method taken by the construction company in charge of this process was wrong," says Miyazaki.

Takuya Miyazaki
Senioir Assistant Genral Manager,
Submarine Construction Group, Offshore Projects Construction Dept., Power Cable Project Div.

Nemo Link interconnector cables to be installed between UK and Belgium (before cable burial)

"The cable cannot be landed!"—A decision made to resolve the situation

It was a different kind of problem from the ones that had been able to be resolved by patiently dealing with them. While taking time to consider countermeasures, report the situation to Nemo Link, and discuss response with related departments in Japan, the swimming season came. On-site work was not possible during the season, and the time left for the construction team was becoming shorter and shorter. The testing of the cable had to be completed by early December, when the testing of the converter station was scheduled to begin. A tense atmosphere pervaded the team. "A construction delay crossed my mind," reveals Miyazaki.

"In the end, we hastily arranged another construction company and tried landing operation several times by changing cable-laying ships. It was a tightrope walk, but the landing was finally completed in October 2018," says Miyazaki.

However, some European members of the construction team disagreed with this response.

"In Europe, if a contract is not fulfilled by a subcontractor, it seems to be common to prioritize negotiation over anything else, and people think that it is unavoidable to suspend the construction during the negotiation and delay the schedule. However, we prioritized keeping the delivery schedule promised to Nemo Link and tried to solve the problem without suspending the construction. We gave top priority to doing what we should do for our customer. This Japanese style 'customer-first principle' may have seemed strange to European members," says Miyazaki.

Miyazaki and his Japanese colleagues sincerely explained the "Sumitomo Electric way" to European members. Although they had different ideas and methods from each other, they shared professionalism and a common desire for the success of the project.

"The construction team consisted of twenty-some European members, mainly from the UK and Belgium, and three to four Japanese members. It may be more accurate to say that Japanese members acted as 'coordinators' who created an environment in which individual team members could perform their jobs at a high level, rather than 'instructors' or 'leaders.' Since we had built a relationship of trust with our European counterparts while keeping this in mind, they finally accepted the way we suggested," says Miyazaki.

Transparency that strengthened the partnership

The landing of the submarine cable on the Belgian side was the biggest challenge for the project, but it resulted in increased confidence in Sumitomo Electric, says Mr. Bert Maes, the CEO of Nemolink Ltd.

"It was a very risky decision to change the subcontractor at the late stage of the construction, but Japanese members clearly explained why the problem had occurred and how they were dealing with it," says Mr. Maes.

Mr. Bert Maes,
CEO, Nemolink Ltd.

When Nemo Link was established as a joint venture between the UK and Belgium and began discussing the selection of contractors for this project, National Grid was reluctant to appoint a company that had not had any track record in Europe, while Elia was willing to use DC XLPE cable. An opportunity to resolve the disagreement between the two companies was the enthusiastic proposal from Sumitomo Electric: "Please visit Japan to see our manufacturing site."

"We decided to leave the submarine section to Sumitomo Electric because we were convinced of its transparency in the event of a problem, not to mention its technical excellence," says Mr. Maes.

He says that the final deciding factor was that Sumitomo Electric showed things as they were without hiding or exaggerating.

"This attitude was consistent throughout all processes, from manufacture to transportation and construction. Sumitomo Electric also showed great cooperation with Siemens Energy, a German company in charge of the converter station," says Mr. Maes.

Great achievement of a 99.8% facility operation rate

While Sumitomo Electric was in charge of the HVDC cable, Siemens Energy was in charge of the converter station that converts transferred electricity from DC to AC and vice versa. The partnership between these two companies was a great contributor to the success of this project.

"The cable was not the only thing that was connected through this project," says Mr. Joergen Kroemeke, General Manager of HVDC Project Execution at Siemens Energy, referring to another aspect of the project.

"The construction team was a multinational organization with members from five countries. Not only Japan and Europe, but also individual European countries have different backgrounds. A strong partnership was essential to achieve a common goal, and it was a challenge to find how to build it. Team members actively interacted with each other even during non-work hours by going on weekend trips with their families and going out for dinner. It was an invaluable opportunity to deepen our understanding of each other's culture," says Mr. Kroemeke.

The success of this project significantly strengthened the relationship between the two companies. Since then, as reliable partners, they have jointly worked on technical development and participated in various interconnection projects around the world.

In 2022, the UK-Belgium interconnector celebrated its fourth year of operation. With the tailwind of the increasing development of offshore wind farms, it is playing an important role in power infrastructure in the EU. Due to the impact of the COVID-19 pandemic, the members of Sumitomo Electric have had to abandon visiting the site to perform regular inspections in 2020. However, this winter, they received good news from Nemo Link: "The annual facility operation rate in 2021 was 99.8%, the highest in the past three years!" Such a high average also means Nemo Link's stable earnings from the facility. Sumitomo Electric DC XLPE cable is certainly demonstrating its true value in an environmentally advanced region.

Strong partnership between Siemens and Sumitomo Electric
Left: Mr. Joergen Kroemeke, General Manager of HVDC Project Execution, Siemens Energy Global GmbH & Co. KG
Right: Teruaki Kawaguchi, Project Director, Sumitomo Electric

By Crossing Borders, HVDC XLPE Cable Brings the Future of Electricity to People Around the World.

Sumitomo Electric's track record in winning contracts and installing DC XLPE cables (as of April 2022)

U.K.-Belgium interconnector (±400 kV)

NEMO project:
Awarded a contract in 2015, completed in 2019

World's highest voltage DC XLPE cables at DC 400-kV in commercial operation

Entry into the European interconnector market as the first Asian cable manufacturer

Extra-high voltage DC power transmission cable system in Germany (±525 kV)

A-Nord project:
Awarded in 2020, to be completed in 2028

World's highest voltage DC XLPE cables under construction

Germany-Denmark interconnector (±400 kV)

KONTEK: Awarded in 2021, to be completed in 2023

World's first system adopted with the combination of Line Commutated Converters and 400-kV-class DC XLPE cables

Extra-high voltage DC power transmission system in UAE (±400 kV)

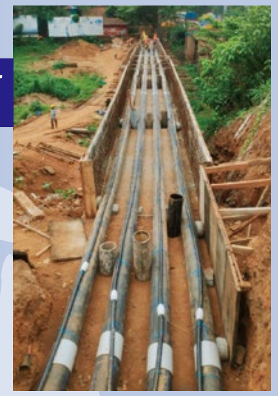
Project Lightning: Awarded in 2022, to be completed in 2025

First extra-high voltage DC XLPE cables to be used in the Middle East

Extra-high voltage DC power transmission cable system in India (±320 kV)

PK2000:
Awarded in 2017, completed in 2021

First extra-high voltage DC power transmission cables in India



U.K.-Ireland interconnector (±320 kV)

Greenlink project:
Awarded in 2021, to be completed in 2024

Load leveling through interchange of renewable energy between countries

Hokkaido-Honshu HVDC Link (±250 kV)

Awarded in 2009, completed in 2012

World's highest voltage DC XLPE cables as of 2012

New Hokkaido-Honshu HVDC Link (+250 kV)

Hokuto-Imabetsu DC Trunk Power Line:
Awarded in 2015, completed in 2019

World's longest extra-high voltage cables installed in a subsea tunnel across a strait

Renewable energy and DC power transmission cables
Just like two wheels of a cart toward decarbonization

Electricity is supplied while constantly balancing the power generation amount with consumption. Supply must not be lower than demand, but oversupply must also be avoided. Stable supply is maintained when a necessary and sufficient amount of electricity is generated. These are the unique characteristics of this energy.

This is why renewable energy, whose power generation amount depends on the weather conditions, poses difficulties. Power generation and consumption in a region inevitably results in unstable electric power supply. However, if many power generation systems are linked via an interconnected grid in a large area to secure a large supply amount, the surplus electricity in a consumption area can be delivered to a different consumption area where electricity is in short supply. In addition, renewable power plants, including offshore wind farms, are located in remote areas. For these reasons, HVDC cables that can withstand large-capacity long-distance power transmission are definitely required to realize a decarbonized society.

In Europe, a project is underway to build an offshore wind power generation facility called "energy island" in the North Sea and the Baltic Sea and share electric power with neighboring countries. Obviously, DC interconnectors will be reinforced, and the international grid will be further expanded.

Renewable energy and DC power transmission cables are just like two wheels of a cart to lead the world to carbon neutrality.

Mission as a specialist of DC power transmission cables

Such a project is not limited to Europe. In COP26, India, which had not mentioned any specific numerical target, announced that it would increase the percentage of renewable energy to 50% by 2030. In India, an interconnector for which Sumitomo Electric manufactured and installed, an HVDC XLPE cable of ±320 kV went into operation in 2021. Multiple projects are underway in various parts of the world to newly install and expand interconnectors. The number of inquiries that Sumitomo Electric receives has been increasing year after year. The advent of the era of carbon neutrality, where the global community is linked by interconnectors, is getting closer to reality.

Yasuyuki Shibata, Managing Executive Officer and General Manager of the Social Infrastructure Sales & Marketing Unit, who supervised various interconnector projects in and outside Japan, talked about the pride of a manufacturer in a growing market toward a decarbonized society.

"Realization of a decarbonized society is an imminent issue. Manufacturers, including Sumitomo Electric, can resolve issues by offering technologies and products. Notably, DC power transmission cables are indispensable to promote the widespread use of renewable energy. Our DC XLPE cables were derived from about 30 years of persevering research and in-house development based on materials technology. This is an unparalleled product that embodies our identity. It is my greatest pride to underpin our society by harnessing this technology," said Shibata.

Shibata continued to express his commitment to carbon neutrality with enthusiasm.

"We will work on carbon neutrality based on the belief that we will achieve it. We will continue to further improve the quality of products and expand production facilities. We hope to establish a reputation in the global market by taking full advantage of our expertise and contributing directly to a decarbonized society," said Shibata.

As a key player in the global arena, Sumitomo Electric has already been taking on challenges to deliver as many DC XLPE cables as possible and lead the world to a sustainable future.

Yasuyuki Shibata
Managing Executive Officer and General Manager of the Social Infrastructure Sales & Marketing Unit

Sumitomo Electric
The Professionals

“Favorable terrain is more important than good timing, Harmony among people is more important than favorable terrain” – I have been following this teaching.
“Harmony among people” to me, does not mean a group of playful good friends, but means a situation where individuals have motivation and belief and continue to improve themselves while working toward a shared vision.

id
Featured person

Makoto Katayama

Deputy General Manager of the R&D Planning & Administrative Div. and General Manager of the Planning Dept.

1993: Joined Sumitomo Electric
1993: Electromagnetic Application System Research Dept., Electric Power System Technology Laboratory
1993: Harima Laboratory
2000: Optical Communication Research Dept., Yokohama Laboratory
2005: Director of the Optical Precision Implementation Group, Optical Components R & D Dept., Optical Communications R & D Labs. and Photonics Analysis Group of the Analysis Technology Research Center
2008: R & D Planning Dept.
2009: President of Innovation Core SEI, Inc. (U.S.)
2016: Manager of the Innovation Promotion Office, R & D Planning & Administrative Div.
2019: General Manager of the Planning Dept., R & D Planning & Administrative Div.
2021: Deputy General Manager of the R&D Planning & Administrative Div. and General Manager of the Planning Dept.

Building a Shared Vision to Create “1” from “0”

“Talking with Unfamiliar People and Organizations” This is the Way to Open Up New Businesses.

What to do to overcome fear

“Sumitomo Electric will establish an organization to conduct research on industrial applications of synchrotron radiation. Would you like to join it?” If a senior researcher of my university laboratory had not invited me, I would have chosen a career as a scientist. To tell the truth, while I was conducting research on nuclear fusion in my doctoral program, I was secretly envious of former fellow students from my master’s program, who had been hired by corporations. Although they complained about their difficulties, but they talked about their work with excitement. I decided to join Sumitomo Electric because I was strongly motivated to contribute to society in a more direct way.

When I was assigned to the Harima Laboratory, I was immediately put in charge of the process from planning to design to completion of a beamline.*1 This was exactly what I heard before I joined the company: “Sumitomo Electric has a corporate culture that allows young employees to undertake projects with a sense of responsibility.” Subsequently, I undertook a project to prepare to promote the utilization of SPring-8.*2 I learned what “goal-oriented basic research” means at a company. At the Harima Laboratory, we worked on commercializing yet-to-be-publicized research results and contribute to society. Namely, we were working every day to find a way to create “1” from “0”. Researchers dedicated their effort to gathering information to come up with new ideas. I also read many business books.

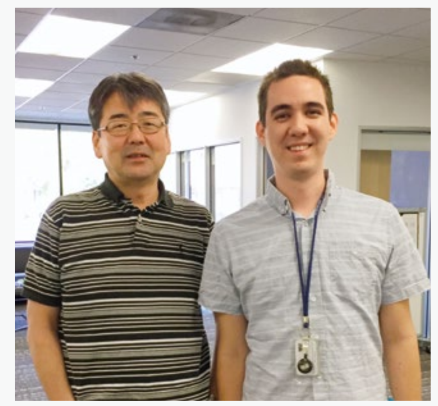
At that time, I came across the “fact, faith, and fear” theory of future insight. Here, “fear” means that one is not even aware of what he or she does not know. To start something new, it was necessary to overcome fear. By talking with unfamiliar people and organizations, I think I could overcome the fear of what I don’t know. I was convinced that this was the answer to creating something out of nothing. However, I was not expecting I would learn just how difficult it was, years later.

*1: Beamline: Equipment for using synchrotron radiation

*2: SPring-8: Large synchrotron radiation facility of the highest performance in the world capable of generating synchrotron radiation located in Harima Science Garden City in Hyogo, Japan

Melancholic Fridays in Silicon Valley

Later, I was put in charge of the development of optical parts at the Yokohama Laboratory. In 2008, I was assigned to the R&D Planning Division. In the spring of 2009, I received an offer to be transferred to Innovation Core SEI, Inc. (ICS) in the U.S. The mission was to explore new business opportunities in Silicon Valley, the test bed of the global market. This was the “business to promote PoC business,” which
I proposed in a project under direct supervision of the president, to think about the future of Sumitomo Electric 30 years later. Honestly, I had not expected to be assigned this mission myself.



One year after returning to Japan, I visited the ICS office on a business trip and met Millard, one of my colleagues, again on Casual Friday.

Immediately after I was transferred to ICS, I worked on a project to enter the development of Light Peak, the next-generation communication protocol (later renamed “Thunderbolt”), which was to be used between digital electric home appliances, such as PCs and TVs, under the initiative of Intel. At first, the Intel staff did not even remember our company name and called us “Sumimoto.” Nevertheless, I made an appointment in the afternoon every Friday and visited them with our sales team to discuss topics that we managed to come up with. We continued this routine for months. Sometimes, we could not see the Intel staff when we paid a visit because their working style was very casual on Fridays. I was only motivated to continue visiting them because I had determined to do so. I never felt so melancholic as I did on Fridays.

One day, we learned that they had a problem with a newly developed product. We proposed on the spot to study solutions. I asked for help from the Optical Communications R&D Lab, with which I was once affiliated. We were able to propose a solution in less than two weeks. In response, they introduced several Intel researchers, and we were able to build a good relationship. Our proposal to resolve the problem of twisted wires by using ultra-fine coaxial wires was also well received. Sumitomo Electric was chosen to be the first vendor for the project. This was possible because of the comprehensive capabilities of the Sumitomo Electric Group, which has various technology seeds and enables prompt collaboration among relevant departments to take action.

“Harmony among people” to achieve a shared vision

I also made it a personal rule to participate in networking events on Fridays. Silicon Valley was uniquely vibrant even after Lehman Brothers collapsed. Events were held at different locations, and engineers who just met exchanged information off-the-record over drinks. This was a common practice. I am shy around strangers, so I felt blue until I reached the venues. Once I drink, I become talkative, so I enjoyed the events.

At that time, Tech Giants, which later became known as GAFA (Google, Apple, Facebook, and Amazon), were rapidly growing by acquiring start-ups. They employed many engineers from India and China. On a public road in San Jose, I saw a company conducting an automated driving test. This was what is called proof of concept (PoC) today, which is the initial phase of a new business. This was exactly what we were trying to do to overcome “fear.” We practiced the solution to create something out of nothing in Silicon Valley without knowing it. We went out to see people, talked about our vision, and seriously asked for candid opinions. The starting point was communication with unfamiliar people and organizations.

I learned an old saying from my university professor: “Favorable terrain is more important than good timing, Harmony among people is more important than favorable terrain.”*3 I have been following this teaching.

“Harmony among people” to me, does not mean a group of playful good friends, but means a situation where individuals have motivation and belief and continue to improve themselves while working toward a shared vision.

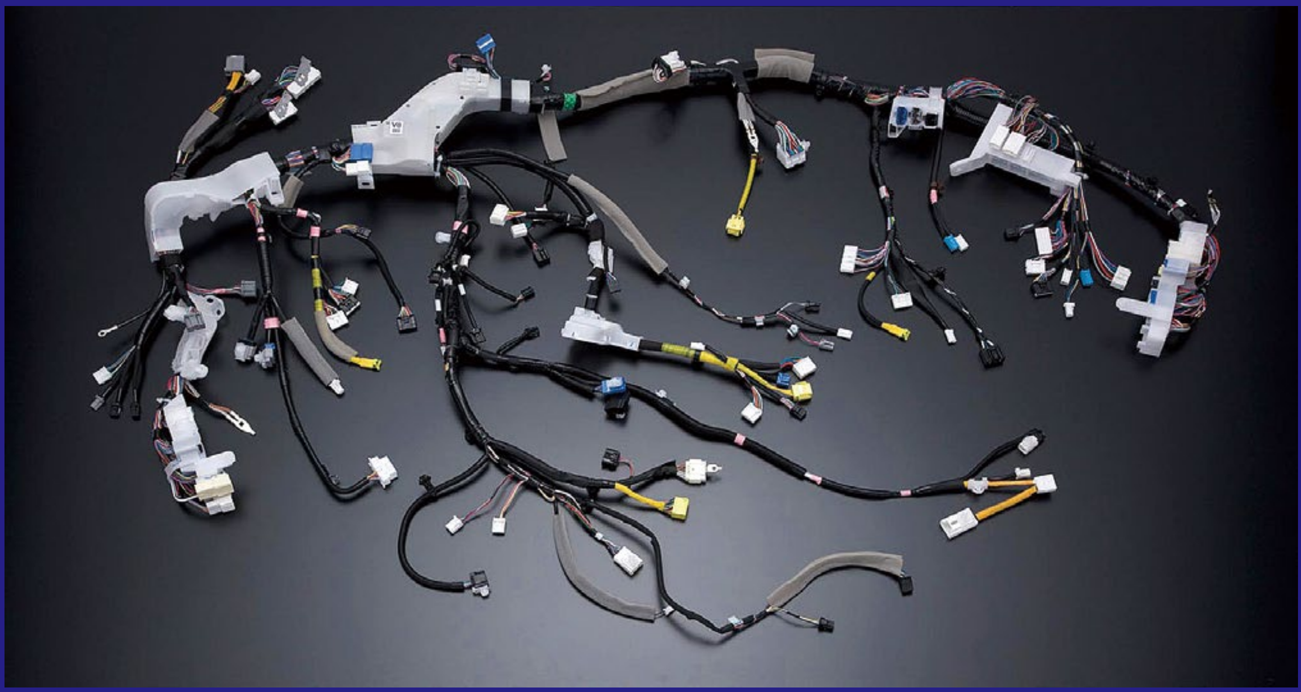
To achieve sustainable growth of Sumitomo Electric, “Harmony among people,” whereby highly capable individuals work toward a shared vision, will play a key role. Such activity will help create new businesses.

*3: A quote from Mencius. In order of worthiness of consideration when planning an operation, from least to most, are timing, terrain, and Harmony among people.

A Picture of Sumitomo Electric in Those Days

2010

Commencement of Sales of Aluminum Wiring Harnesses



Wiring harnesses that are arranged throughout a vehicle

Efforts to Resolve Social and Global Issues

In 2010, Sumitomo Electric launched sales of aluminum automotive wiring harnesses. A wiring harness refers to an assembly of electric wires for power supply and signal transmission. In line with the increasing functionality of vehicles, the number of electronic devices built into vehicles has been increasing. Wiring harnesses connect these devices to supply electricity and transmit signals throughout a vehicle.

The Sumitomo Electric Group started the development and production of wiring harnesses immediately after the end of WWII. In the 1960s, the Company rapidly expanded production due to the high economic growth period of Japan and resultant motorization.

Recently, the auto industry has been working to reduce energy consumption and improve fuel efficiency in order to cut CO_2 emissions, which has become a social and global issue. It was essential to reduce the weight of the vehicle body in line with the improvement of engine combustion efficiency. In general, copper electric wires are used for wiring harnesses due to their superb conductivity. To meet the needs of reducing the weight of the vehicle body, the Sumitomo Electric Group developed aluminum alloy electric wires exclusively for automotive use by achieving high strength and conductivity. It succeeded in halving the weight while maintaining current-carrying capacity equivalent to that of copper electric wires. When the product was released in 2010, the anti-vibration performance was inferior to that of copper electric wires. The scope of application was limited to interior wiring, such as doors, and instrument panel wiring around the driver's seat.

In 2015, the Sumitomo Electric Group succeeded in the development of high-strength aluminum alloy electric wires, whose strength was superior to that of copper electric wires, by taking full advantage of its engineering capabilities. This made it possible to use aluminum wiring harnesses in areas subject to severe vibration, including the area around the engine. Aluminum wiring harnesses contribute to weight reduction and resource conservation because the reserves of aluminum are several times larger than that of copper.

· Also read id vol. 02 feature article: "Aluminum Wiring Harness: Key Factor in Change of Automobiles and Auto Future."
https://global-sei.com/id/2017/10/pdf/sei_id002.pdf

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