

# connect

---

4 String expertise for  
the ultimate challenge

16 With high voltage  
through the Gulf of Patras



## Legal Notice

### Publisher

PFISTERER Holding AG  
Rosenstrasse 44  
73650 Winterbach  
Germany  
Tel: +49 7181 7005 0  
Fax: +49 7181 7005 565  
info@pfisterer.com  
www.pfisterer.com

### Editorial Team

PFISTERER Kontaktsysteme GmbH  
Rosenstrasse 44, 73650 Winterbach

Thomas Bachmann, Christiane Bär,  
Katrín Brecht, Alejandro Escobin,  
Natalie Fischer, Valentino Magnano,  
Ivan von Meister, Peter Müller,  
Lambros Papadias, Dr. Frank Schmuck,  
Frank Straßner, Gregor Vollbach

### Text Concept and Text Editor

Karolina Kos  
www.xyzeiler.de

Sympra GmbH  
Agency for Public Relations  
Stuttgart

### Art Direction

BERNETBRANDS  
BERNET COMMUNICATION GmbH  
Stuttgart

© Copyright by  
PFISTERER Holding AG

## PFISTERER Customer Magazine Issue 1 2020

- 4 String expertise for the ultimate challenge
- 10 Short News
- 12 Kadaň – From Vision to High-Performance Production
- 16 With high voltage through the Gulf of Patras
- 20 Short News
- 22 One solution for all types of cable damage – the Universal Repair Kit from PFISTERER
- 24 SEANEX optimises 66 kV connection technology for offshore wind turbines
- 26 Global trends in offshore wind power

## Editorial

Dear reader,

Reliability and security are key requirements for people. This is particularly applicable to energy infrastructure because we all depend on a reliable energy supply at the end of the day. Therefore, reliability and security have always been the core principles behind PFISTERER's solutions. This is evident in lots of aspects of our day-to-day work.

Therefore, the French network operator RTE has confirmed that we provide long-term security by qualifying our expertise in the integration of maintenance-free silicone rubber composite insulators into existing chain designs for overhead lines (Page 4). These silicone rubber composite insulators are also manufactured in a state-of-the-art production environment at our new plant in Kadaň in the Czech Republic. This plant has already been qualified by numerous energy companies too (Page 12).

We also ensure supply reliability in an entirely different way: working as a team with Hellenic Cables, we are responsible for the realisation of a new undersea cable connection through the Greek Gulf of Patras with high-voltage joints and outdoor terminations (Page 16). And, with SEANEX, we are also ensuring reliability in the field of renewable energy production in the 66 kV offshore field (Page 24). We would



Stephan Götschel



Dr. Konstantin Kurfiss

like to draw our expert interview with Karin Ohlenforst from the Global Wind Energy Council (GWEC) to your attention. This forecast gives us an exclusive insight into the global trends in the field of offshore wind energy (Page 26).

And, should there be any cable damage despite all the care and attention, we ensure reliability in an emergency with our Universal Repair Kit, which is suitable for all cable sections (Page 22).

Have a read and be inspired! We hope you find this information interesting and look forward to being able to provide you with reliable support in your upcoming projects.

Best regards,

Stephan Götschel

Dr. Konstantin Kurfiss

PFISTERER Holding AG Board of Directors

# String expertise for the ultimate challenge

**PFISTERER was successfully qualified by the French transmission system operator Réseau de Transport d'Électricité (RTE) as a supplier of overhead line insulator string solutions for the 225 kV and 400 kV extra high voltage levels. Qualification centred on the precise integration of silicone composite insulators including protective fittings into existing string designs as an alternative to glass cap insulators for special applications. It was a challenging process that required extensive expertise. This story illustrates why, in addition to material quality and modern manufacturing processes, the application-specific design of string components with full consideration of their interactions is crucial to ensure the reliable, safe and economical use of insulator strings for decades.**

»This is where silicone composite insulators really show their strengths.«

Ivan von Meister  
Project Manager at PFISTERER

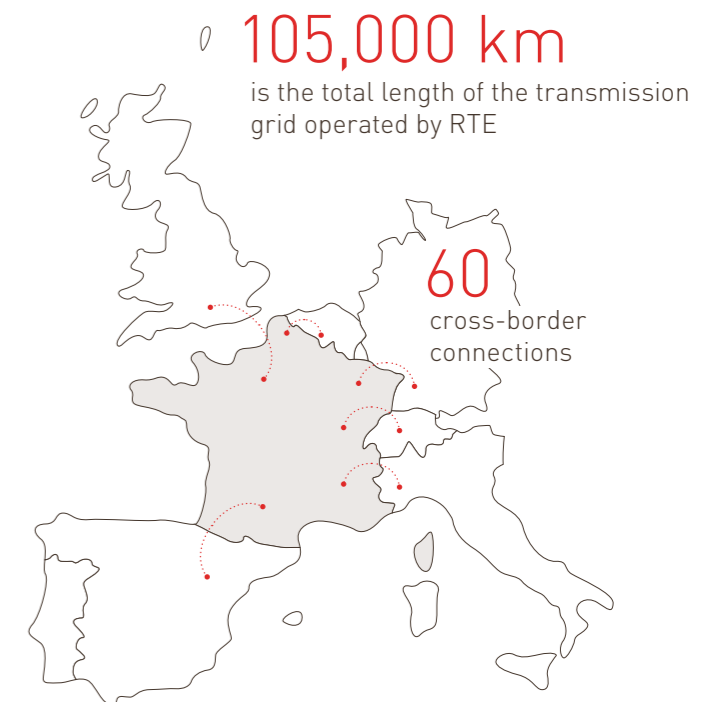
With nearly 105,000 km of lines, RTE operates the largest transmission grid in Europe. Almost half of its 400 kV and 225 kV overhead lines transmit electricity over long distances and to 60 cross-border connections with the United Kingdom, the Benelux countries, Germany, Switzerland, Italy and Spain. Lines at 150 kV, 90 kV and 63 kV are used for regional sub-transmission. Mainly glass cap insulators are used in the insulator strings for the overhead lines. RTE uses silicone composite insulators where lines traverse industrial zones, coastal areas or mountainous regions.

Ivan von Meister, a project manager at PFISTERER who played a leading role in the qualification of the new components for RTE, describes the background: "In these areas, conditions for operating overhead lines are more difficult due to increased air pollution or rough, inaccessible terrain. This is where silicone composite insulators really show their strengths."



**Technology transfer:**  
Qualification centred on the precise integration of silicone composite insulators including protective fittings into existing string designs for glass cap insulators.

Some of these strengths are due to the silicone rubber material that is used. The insulating jackets of composite insulators are made from a formulation specially developed for high-voltage outdoor use. A key property of silicone rubber is that it is hydrophobic: it causes moisture to bead and run off the insulator surface. This prevents the formation of a continuous film coating, which could become conductive due to dissolved contaminants and allow creepage currents to flow. The result is very good arcing resistance in heavily polluted environments like railway tunnels. "Silicone rubber also has the ability to recover and transfer its hydrophobicity. That means it can restore its hydrophobicity if hydrophobicity is lost or reduced, and transfer it to attached contamination layers," explains Dr.-Ing. Christiane Bär, head of composite materials development in the corporate technology department at PFISTERER. Therefore the usual maintenance activities on conventional insulators in outdoor applications – such as cleaning or surface treatments – can be eliminated. Silicone composite insulators are also breakage resistant under shock stresses. Their low weight facilitates transportation and installation, and enables sleek mast designs.



## Cost-effective durability

"These properties have led to the widespread acceptance of silicone composite insulators. PFISTERER has accompanied their continuous development with innovative solutions and practically relevant groundwork," says Dr.-Ing. Frank Schmuck, Director Corporate Technology and head of OHL (overhead lines) Composite product portfolio management at PFISTERER. He also authored the reference book "Silikon-Verbundisolatoren – Werkstoffe, Dimensionierung, Anwendungen" (Springer-Verlag). Whether used throughout the grid or selectively as at RTE, composite insulators support the operational reliability and economic efficiency of high-voltage overhead lines and hence also of electrical power transmission systems. "RTE attaches great importance to safety and economy in its commitment to high electricity availability in line with modern standards – both as a grid operator in France and as a partner to energy suppliers worldwide," states Michel Bartissol, president of PFISTERER's French subsidiary. As the local contact for RTE in Illzach, he worked closely with PFISTERER's sites at Malters in Switzerland and Kadaň in the Czech Republic for the project implementation.

Since January 2019, PFISTERER has supplied silicone composite insulators for various suspension and strain strings in accordance with RTE standards for voltages and load classes 225 kV/150 kN, 400 kV/300 kN and 400 kV/600 kN including protective fittings. Their design was the outcome of an extensive qualification process.



**Strong under strain:**  
Fitting the 1,200 kN double strain insulator strings by PFISTERER with silicone composite insulators and protective fittings. Each insulator can support mechanical loads of up to 600 kN. This is equivalent to a weight of around 61 t on the ground.

nical industry organisations such as CIGRE and IEC, for example. And thanks to customers worldwide who entrust us with challenging tasks.”

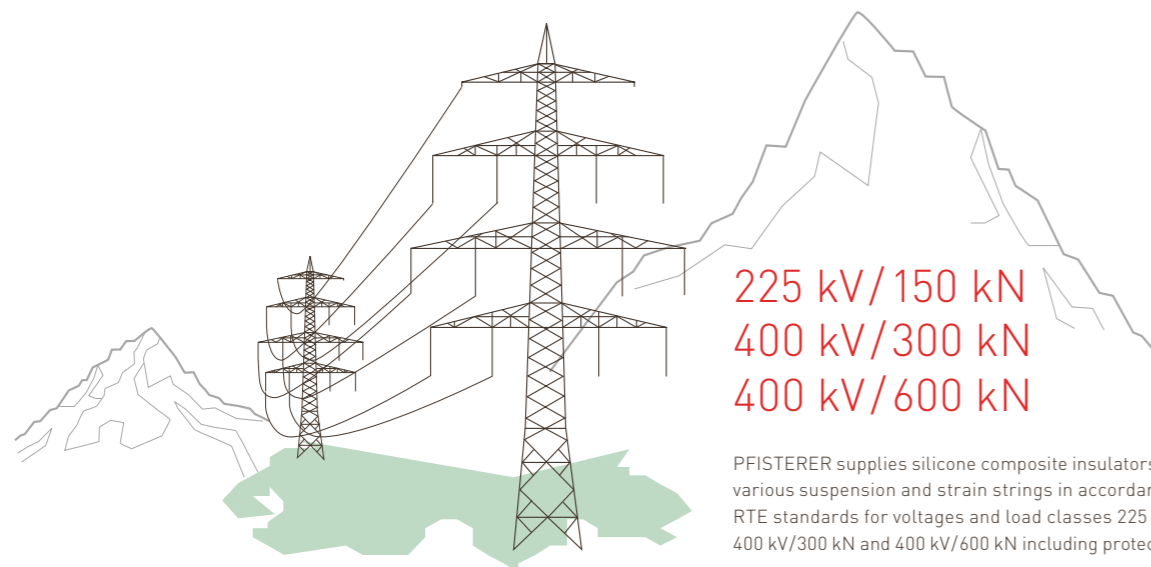
Every design is complex, whether for standard applications or a special solution. The overarching goal is always to arrive at a functional and economically optimised end product. Christophe D’Hondt, technical support engineer at PFISTERER, outlines the complexity: “Each insulator string has to fulfil numerous mechanical and electrical requirements. Sometimes they demand conflicting design characteristics, but nevertheless they all have to be implemented as a lifelong cohesive and efficient whole.” The design for RTE is a case in point – with added difficulty.

The silicone composite insulators had to be integrated with protective fittings into RTE string designs which normally use glass cap insulators. This was the ultimate challenge for PFISTERER’s string experts: the seamless implementation of a technology change within very tight design constraints and with interdependent design criteria. Insights into the design of insulators and protective fittings for 400 kV double strain insulator strings illustrate some of the requirements and the typical differences between glass cap and silicone composite insulators.

**Strong under strain. Safe in operation.**

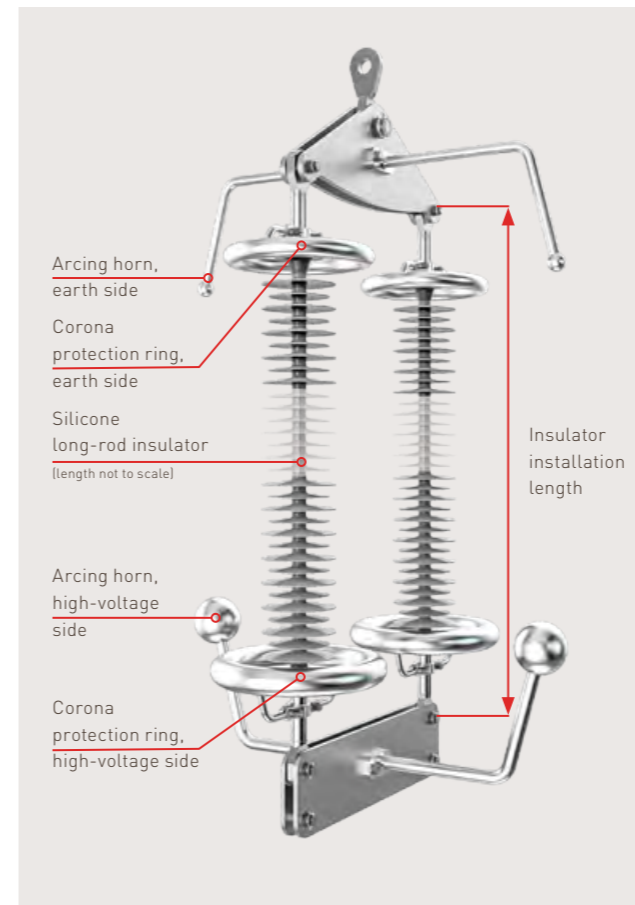
When transmission lines pass through mountainous terrain, they are sometimes routed across significant changes in elevation. This can cause increased tensile forces on the conductor cables, which also affects insulator strings and masts. In such applications, RTE uses special heavy-duty double strain insulator strings with composite insulators and a total load capacity of 1,200 kN [see figs. page 7 for an example string structure with component labels]. It follows from this as a mechanical

PFISTERER met these special challenges with knowledge drawn from experience: almost 100 years of designing overhead line systems and more than four decades with silicone composite insulators. “Our expertise develops with the latest technology and shapes it,” says Thomas Bachmann, head of the OHL Composite division at PFISTERER. “Through our extensive involvement in tech-

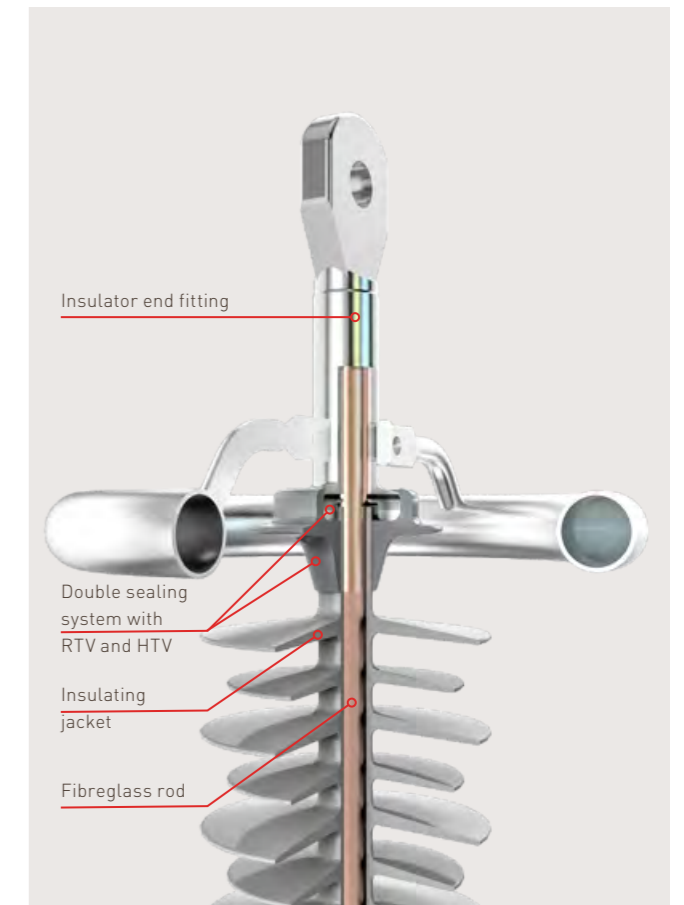


225 kV / 150 kN  
400 kV / 300 kN  
400 kV / 600 kN

PFISTERER supplies silicone composite insulators for various suspension and strain strings in accordance with RTE standards for voltages and load classes 225 kV/150 kN, 400 kV/300 kN and 400 kV/600 kN including protective fittings.



**For decades of safe and reliable operation:** The precise design of the composite insulators and protective fittings by PFISTERER for existing RTE string designs was assisted by 3-D-models. Shown on the left is a model of the double suspension string for 400 kV/600 kN with silicone composite insulators (each 300 kN). The detailed view on the right shows a cutaway of the internal structure of string components.



requirement that the 400 kV insulators used in the string each have to be able to take a load of up to 600 kN. One of the critical factors here is the design of the insulator’s metal end fittings. They are usually cast for attachment to glass cap insulators. With composite long-rod insulators, end fittings are pressed onto the fibreglass rod. In this case, the force required to break the insulator increases with the compression length of the end fitting and the diameter of the fibreglass rod. The higher the tensile forces that a silicone composite insulator has to transfer, the greater the crimp area [compression area] that has to be provided. An important design variable is the “damage limit” of the fibreglass rod, below which practically no fibre breaks occur.

The dimensioning of end fittings, in turn, can influence how electrical requirements are implemented, for example in the design of protective fittings. Arcing protective fittings are provided to protect high-voltage insulators against the damaging effects of an arc, which can be caused by overvoltages due to a lightning strike or switching operation, for example. The critical factor for this protective function is the distance or clearance between the arcing protective fittings. It significantly

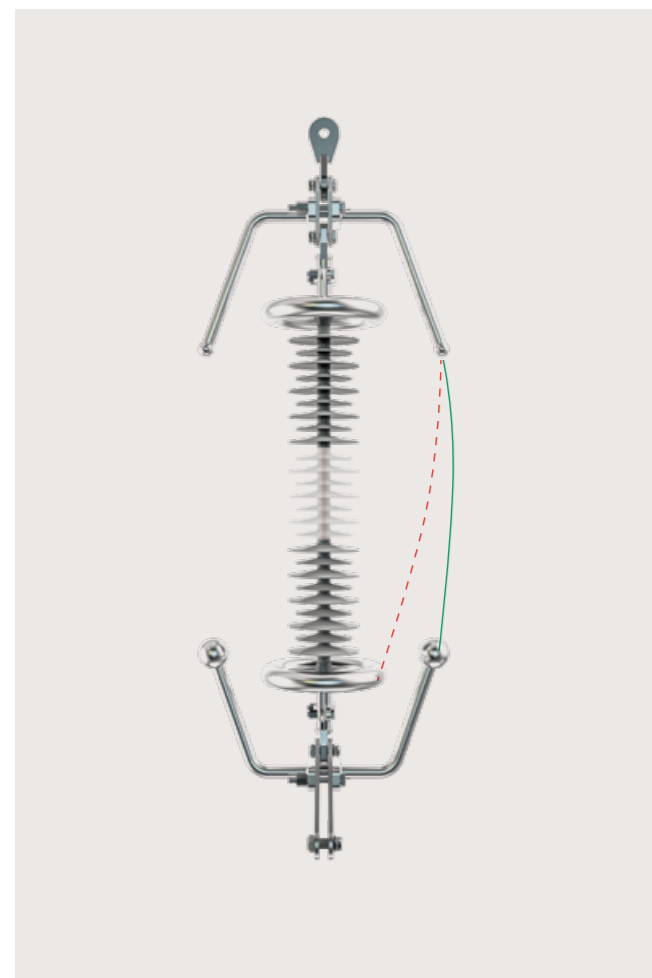
influences the withstand voltage value. This marks the limit up to which no flashover may occur on the insulator string despite an overvoltage. If this limit value is exceeded and a flashover occurs, the arcing protective fittings form a spark gap that acts as a surge arrester. Their geometry causes the arc to extinguish itself at a sufficient distance from the insulator jackets and in a controlled manner.

Based on operational experience, for lifelong reliability and the consistently advantageous use of high-voltage insulators with silicone rubber insulation, it is necessary to integrate corona protection as well. Conventional corona protection is aimed at preventing corona discharges on metallic string components with associated phenomena such as audible noise as well as radio and TV interference. Additional corona protection is usually implemented in the form of corona protection rings. These are intended to prevent corona discharges on the insulator surface in damp conditions, known as water droplet corona, and on metal string components in direct proximity to the insulator surface, thereby preventing damage to string components and the insulating jacket. Corona protection can be combined with arcing protection and implemented

in one protective fitting. Or corona and arcing protection can be provided separately in two protective fittings, as required by RTE for their own insulator strings.

**Efficiency through standards.  
Agility for individual needs.**

An effective lever for implementing requirements economically is to use standardised resources and procedures enterprise-wide. "PFISTERER has many established components and proven designs for integrated insulator strings. This enables us to directly cover many different standard applications," says Ivan von Meister. "At the same time, we are used to adapting what we have and developing individual solutions when specific applications or customer specifications require it." RTE's existing string designs result in fixed installation lengths for the respective insulators, including protective fittings. These limited PFISTERER's use of standard component designs when implementing RTE's mechanical and electrical requirements described above. But the design is a success – professional and lean.

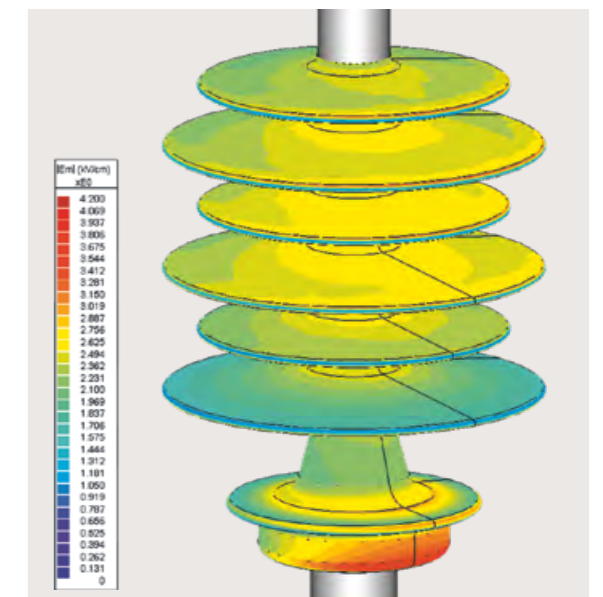
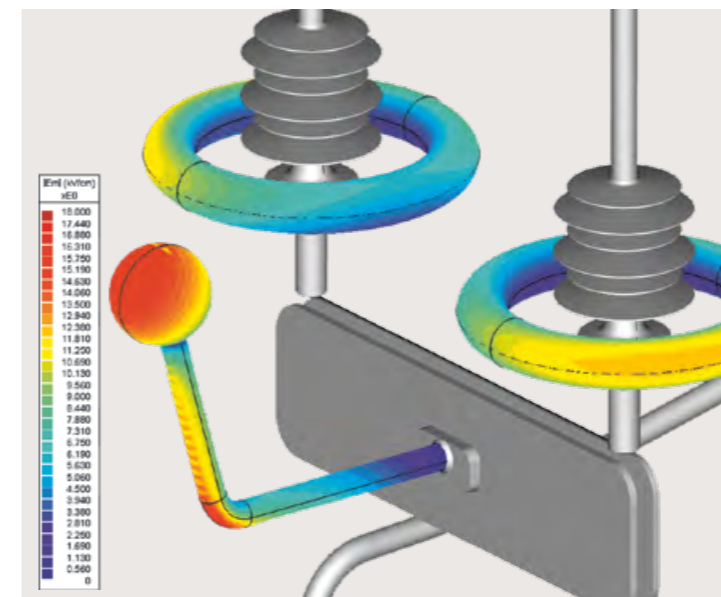
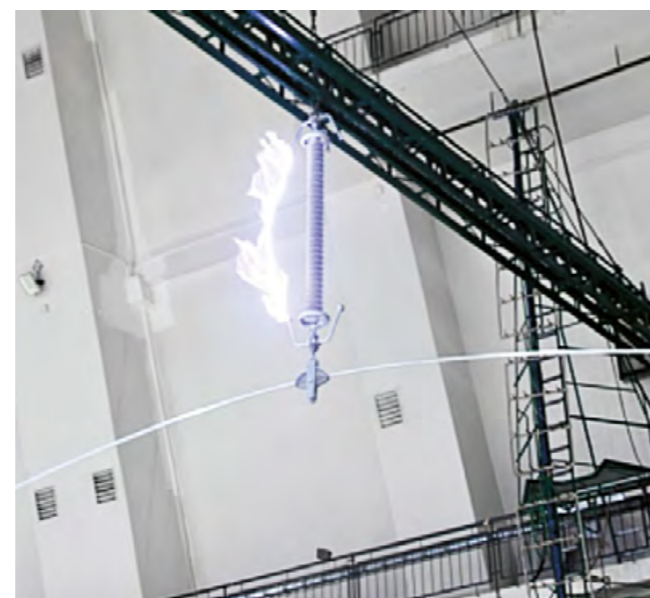


**Correct coordination:** The distance between the corona rings and arcing horns is critical for the functionality of the corona and arcing protection. If the distance is insufficient, a flashover could jump from the arcing horn to the corona ring (red dashed line) and damage string components. If the distance is correctly designed, however, a flashover can only occur in a controlled manner between the arcing horns (green line), protecting insulators and other string components. This is demonstrated in a lightning impulse test conducted for RTE on a 225 kV single suspension string in the EGU high-voltage lab (image on the right).

To achieve the predefined installation length with silicone composite insulators while taking the required load classes into account, the string specialists at PFISTERER developed an alternative design for the end fitting. This approach would only work if PFISTERER could guarantee that the insulators were manufactured with smaller installation length tolerances than usual. In parallel, the existing string designs posed another complex design challenge: there was also very little space in which to integrate the multi-part arcing protection fittings and corona rings. Within very narrow limits, both protective fittings had to be carefully coordinated with each other.

Christiane Bär explains the coordination process and why it is so important: "Protective fittings have to meet certain design criteria to function properly. Corona rings have to be precisely positioned at particular places in the insulator string, for example. With arcing protective fittings, there has to be an exactly defined clearance between their arcing horns. At the same time, these design characteristics must not interfere with each other. The critical factor here is a sufficient distance between corona rings and arcing horns. Otherwise, instead of burning safely between the arcing horns, an arc could jump to the corona, destroy it thermally, and possibly damage the insulator and insulator string." The correct coordination is illustrated in figures left.

PFISTERER used state-of-the-art simulation software to calculate the electrical field strengths and assist the electrical design of the insulators and protective fittings



**Efficient development:** PFISTERER uses simulation software that calculates electric field strengths to assist the design of protective fittings and insulators. The images above show electric field strength simulations on the high-voltage side protective fittings (left) and on the high-voltage side silicone rubber surface of the insulator (right). The colours indicate that the specified field strength limit values in each case of 18 kV/cm (left) and 4.2 kV/cm (right) are not exceeded.

for RTE (see figs. top). "In conjunction with values from experience, the calculations confirm whether a string design is suitable from the point of view of corona protection, or still needs some adjustments. This speeds up the design process and provides certainty for the subsequent dielectric testing of insulator strings," explains Jaka Strumbelj, development engineer and specialist in electric field simulations at PFISTERER. "It requires experience in applying numerical computer models and interpreting the results." PFISTERER has summarised its 15 years of involvement in this field in an in-house specification for performing the calculations, based on global project experience and independent studies.

**Top in tests**

Insulators and protective fittings by PFISTERER have proven their quality and faultless operation as part of a string assembly in numerous mechanical and electrical tests. PFISTERER had these tests conducted on behalf of RTE by independent test institutes. The correct coordination of the protective fittings was confirmed by dielectric testing at EGU, including lightning impulse testing (see fig. page 8). Extensive arcing tests on the strings were carried out at KEMA – in some cases with increased requirements according to RTE standards: the 400 kV strings, for example, withstood a maximum short-circuit current of 63 kA for 0.25 sec., and thus demonstrated their excellent short-circuit strength.

PFISTERER ensures the consistently high quality of its products for RTE and all customers worldwide in compliance with international norms and by following continuously optimised internal standards for materials and

production. These include the material formulation for manufacturing the insulating jacket for composite insulators. High temperature vulcanising (HTV) silicone rubber, highly filled with aluminium trihydrate (ATH) is preferred. It wins out over low-viscosity silicone rubber types that are not filled with ATH, such as room temperature vulcanising (RTV) or liquid silicones (LSR), with its outstanding erosion and leakage track resistance as well as very good dynamic hydrophobic characteristics: rapid hydrophobicity recovery and short transfer times. The youngest plant in the PFISTERER Group, in the Czech city of Kadaň, is now the largest site for silicone-related production (more on page 12). In June 2019, it too was successfully audited for cooperation with RTE.

**Proven resilience:**

Example of a silicone composite insulator clamped into a tensile testing machine to test the maximum tensile strength. PFISTERER insulators for RTE were designed for load classes 150 kN, 300 kN and 600 kN. All were successfully tested.



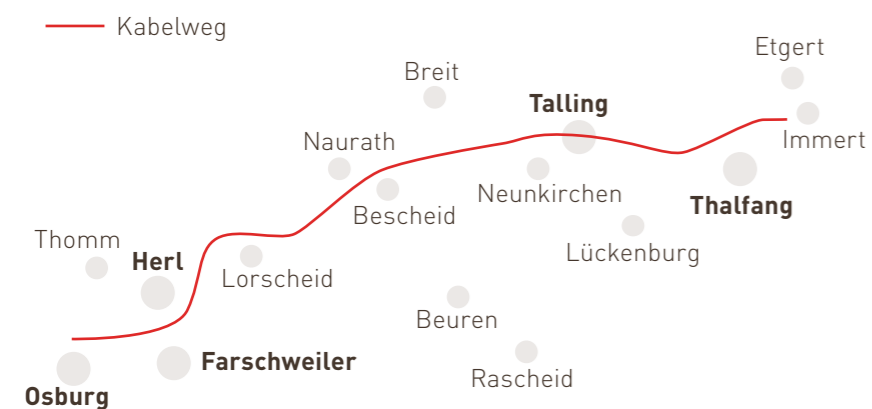
## Cables for wind energy

One of the longest 110 kV underground cable lines in Germany will be built in 2020 near Trier. Soon, electricity from the wind turbines in the Hunsrück region will flow 17.3 kilometres to the Osburg substation. Distribution network operator Westnetz considers this measure an investment into the energy revolution. The existing grid is reaching its limits due to increasing quantities of wind energy.

PFISTERER is supplying the complete 110 kV cable system including cable accessories as a turnkey solution. In early 2020, a total of 52 km of underground cables (in 3 phases

of 17.30 km each) with integrated fibre optic cables in the cable screen and with two conductor cross sections (1,200 mm<sup>2</sup> and 1,800 mm<sup>2</sup>) will begin to be laid in order to achieve the required transmission power. 60 connecting elements (in the form of IXOSIL 110 kV crossbonding joints and transition joints from 1,200 mm<sup>2</sup> to 1,800 mm<sup>2</sup>) will be used.

In total, Westnetz is investing approximately 19 million euros in the cable route, which will mainly run along public roads. Completion is projected for autumn 2020.

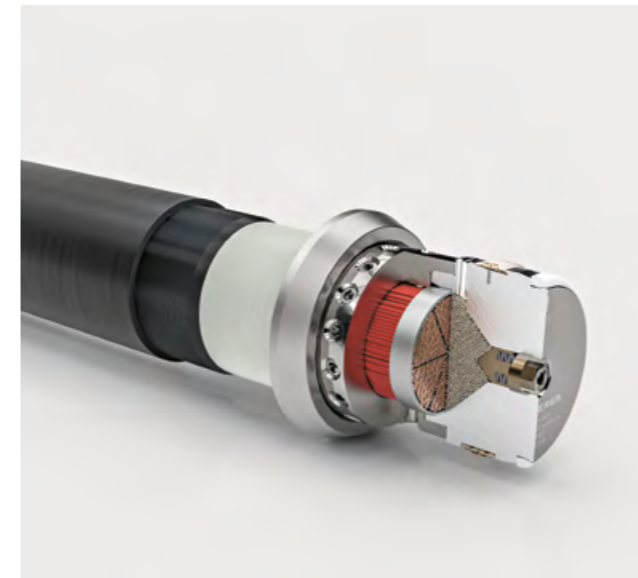


## Dr. Konstantin Kurfiss returns to PFISTERER

As of 1 January 2020, PFISTERER Holding AG has appointed Dr. Konstantin Kurfiss as a new member of the Executive Board alongside Stephan Götschel. Dr. Kurfiss has more than 15 years of experience in electrical power transmission and distribution technology and assumes overall responsibility for sales and technology at PFISTERER. He already worked for PFISTERER between 2005 and 2013, where he was most recently responsible for international sales. By mutual agreement between PFISTERER Holding AG and its former CEO Martin Billhardt, he retired from the Management Board at the end of 2019.



## FrontCon – Rethinking the connection principle



This enables a very short and compact contact system for all voltage levels and large conductor crosssections up to 2,500 mm<sup>2</sup>. The time required is reduced by up to 80%. Installation takes only around 2 hours – not longer than for conventional cables with standard connections. At the same time, possible damage when stripping the individual strands is prevented. That significantly reduces the risk of installation errors.

FrontCon is available as a connection technology for CONNEX cable connectors and IXOSIL terminations, as well as for cable connections in MSA joints and type-tested with specific cables. The first cable projects have now been in operation for several years. The contact system can be adapted for any fittings, enabling reliable and cost-effective solutions in cable systems. It can be installed vertically or horizontally.

High-voltage power cables increasingly utilise single-strand insulated conductor designs that significantly reduce skin and proximity effects, enabling more power transmission with the same cross-section. But this conductor structure complicates the cable connection process. PFISTERER has developed FrontCon, which uses a completely new connector principle to significantly simplify and shorten installation.

Conventional connecting of single-strand insulated cable conductors is a time-consuming process: separate the individual strands, strip them one by one, then rearrange them as far as possible in the original form without damaging any of the strands – A challenge and despite best efforts, the original conductor structure is usually not achieved.

### Faster, better connections for single-strand insulated cables.

With FrontCon, PFISTERER is therefore pursuing a new frontal approach: In contrast to the conventional solution, FrontCon is installed directly on the end of the cable – no work is required on the individual strands. Specially developed contact balls make contact with the front faces of the individual strands. Together, these contact balls behave like a liquid. They compensate for slight unevenness at the conductor end, and ensure that the same contact forces are applied across the whole conductor cross-section.

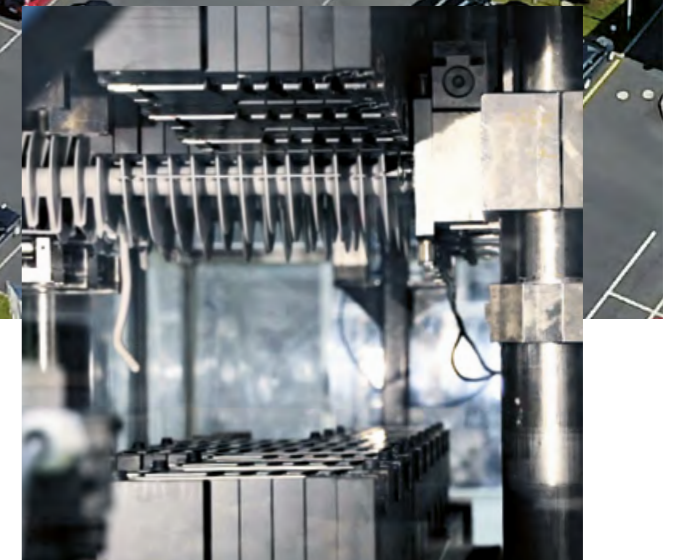


### PFISTERER receives the Golden Amper Award 2019

At Amper 2019, the international electrotechnics and electronics trade fair in Brno, Czech Republic, PFISTERER was awarded the Golden Amper for FrontCon in the electrotechnics category. This innovative approach convinced an expert jury of leading scientists. Exhibits are judged on their global competitiveness, technical and technological level, originality of the used solution, safety and user comfort, and service and spares availability. This is the second time that PFISTERER has won the Golden Amper award.

# Kadaň – From Vision to High-Performance Production

Manufacturing at the highest level, using state-of-the-art technology and building on the extensive expertise of our innovation centres in Germany and Switzerland – this was our vision when we were planning our new branch in Kadaň, Czech Republic. The new plant brings together the production knowledge of our experts we have acquired over many years at the other branches and combines it with optimum manufacturing conditions for silicone rubber processing.



Silicone composite insulators for overhead lines are one of the products manufactured at Kadaň.

In Kadaň, decades of experience from Germany and Switzerland meet state-of-the-art production technology.



An ambitious project that we were only able to tackle with the help of many participants. With their active support, we managed to build one of the most advanced and efficient plants in the PFISTERER Group, allowing us to produce highest-quality energy infrastructure products for our customers in an outstanding manufacturing environment.

## Continuous optimisation of know-how and processes

A key area of silicone rubber processing in Kadaň is the production of silicone composite insulators for overhead lines and control units for cable accessories, such as cable terminations, connection parts and cable joints, which are also manufactured in Kadaň. The insulators made of silicone rubber are used on high-voltage overhead lines to prevent voltage arcing between mast and power line. Control units use geometrical field control to reduce the electric field strengths at the settling edges of the outer conductive layer of the high voltage cables.



This combines decades of experience from Germany and Switzerland with the latest production technology. With the goal in mind to continuously optimise quality and efficiency, we use internally trained auditors to monitor the procedures non-stop. This allows us not only to synchronize processes but to permanently test and refine them as well.

A concise plant layout, cleanly defined procedures and a multitude of identical machines facilitate fast and flexible high-volume production. Operating data can be recorded, analysed and evaluated in real time. Using cutting-edge test conditions, our products are tested for functionality and resilience in application situations – highly automated, traceable and compliant with standards.

**Testing institutes and customers put their trust into the new location**

The Kadaň site is frequently inspected by a certification authority. It meets the ISO 9001, ISO 14001 and OHSAS 18001 international standards for quality management, environmental management and occupational health and safety.

Although the location is still relatively new, 90% of our customers have already qualified the plant in a short time, including companies such as Amprion, RTE France, Enel, E.ON, GE Power Grid Solutions EMEA, Innogy, Siemens, TenneT TSO and the Saudi Electricity Company. To meet the high demand, we have created a full-time position, which is solely responsible for coordinating customer audits that take place almost every week in Kadaň.



The use of high-grade transparent silicone makes it possible to detect even the smallest irregularities in the material.

**A film is worth a thousand words**

If you want to get a better feel of what it actually looks like, we invite you to watch our branch video:



Under state-of-the-art test conditions, our products are tested for our customers in application situations in accordance with all relevant standards. Test procedures are highly automated and traceable.





A new land-sea cable connection in the Strait of Rio-Antirrio near Patras will in future link the Peloponnese to the 400 kV grid in central Greece. Together with Hellenic Cables SA, PFISTERER is ensuring safe and punctual connection with IXOSIL high-voltage joints and outdoor terminations. The two partners have been working together successfully in joint MV, HV and EHV projects for around 15 years, mainly in Europe, but also internationally.



The spectacular Rio-Antirrio Bridge has linked mainland Greece to the Peloponnese peninsula since 2004.

## With high voltage through the Gulf of Patras

The view over the Strait of Rio-Antirrio is stunning: at this point, only two and a half kilometres of blue sea separate the Peloponnese in southern Greece from the central mainland. Since 2004, a spectacular bridge has spanned the entrance to the Gulf of Patras, providing a permanent road link. But the idyll is deceptive. As in the whole of Greece, the area is considered seismically active, especially since the 65 metre deep strait lies on a tectonic fault zone. A challenge for all infrastructural facilities, which must be built to withstand earthquakes.

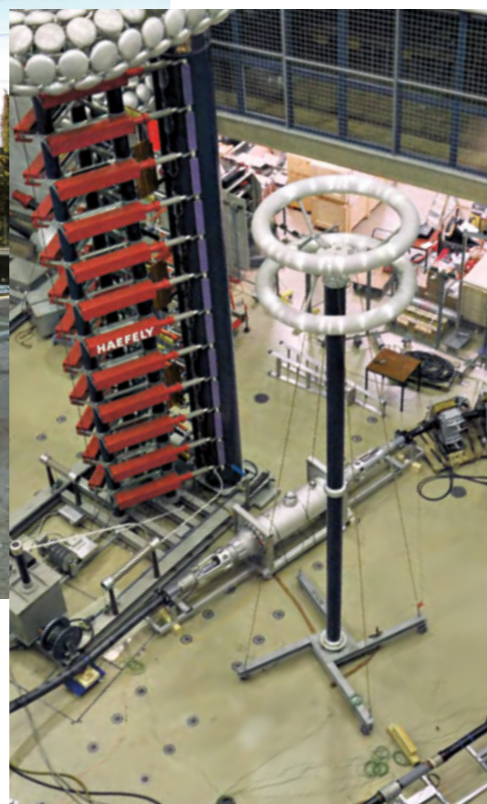
### **Preliminary tests successfully completed in 2016**

The client for the current project to expand the 400 kV grid further is the energy supplier IPTO, a subsidiary of PPC, the largest energy supplier in Greece. While the eastern connection of the Peloponnese through the Corinth Canal is already well developed, the western

connection of southern Greece to the power plants in the east is now being improved. Planning for the land-sea cable connection began around five years ago, and a year ago Hellenic Cables and PFISTERER were awarded the contract against competitors. The two companies are linked by a long-standing partnership, as Eduardo Santana, Director of PFISTERER's PTS Cable business unit, emphasises: "Hellenic Cables as a manufacturer of power cables and PFISTERER as an independent expert in cable fittings have always shared the same philosophy of implementing the maximum technical for our clients and making a decisive contribution as a team to the overall success of such projects." Starting with initial projects in the MV and HV sectors, the 420 kV fittings from PFISTERER underwent cable-specific system testing with Hellenic Cables in accordance with IEC 62067 in 2016. "For qualification purposes, the CONNEX and



For qualification purposes, PFISTERER's CONNEX and IXOSIL fittings were tested with higher requirements.



IXOSIL fittings were also tested at 230 kV instead of the usual phase-to-earth voltage of 220 kV in accordance with the higher requirements of the Greek network operator. The lightning impulse tests were increased from 1,425 kV to 1,550 kV. The PFISTERER systems passed all the tests with flying colours – an important prerequisite for the current EHV project,” reports Lambros Papadias, PFISTERER Delegate for Greece and neighbouring Balkan countries. PFISTERER is currently one of the few suppliers of fittings worldwide that can show it has passed this test successfully. In order to respond optimally to individual market requirements, PFISTERER maintains a strong local presence. At the same time, the PFISTERER plants in Germany and Switzerland are developing technical solutions with an international vision.

#### 400 kV under the sea

The new EHV connection on the west coast of the Peloponnese is based on two three-phase submarine cables. These are connected to the land cables on both shores

by IXOSIL slip-on joints (land/sea cable) from PFISTERER, followed by further joints at intervals of 300 to 800 m, depending on the length of the land cable sections. For connection between the sea and land cables, the IXOSIL transition joints and SICON connectors also ensure a safe transition between the different cable diameters of 1,200 mm<sup>2</sup> for the sea cable and 2,500 mm<sup>2</sup> for the land cable. For monitoring purposes, one phase of the sea cable and one phase of the land cable are equipped with a fibre optic conductor.

While the EHV connection in the Strait of Rio-Antirrio uses XLPE cables of the same kind, the PFISTERER fittings are generally universally applicable and compatible with XLPE cables from all suppliers. In addition to the planning, manufacture and delivery of the IXOSIL joints and outdoor terminations, PFISTERER is also responsible for their installation by its own EHV-trained installers. The joints are placed on land in ducts and then buried.

#### Close cooperation boosts projects

“Hellenic Cables and PFISTERER are a prime example of a successful partnership,” stresses Lambros Papadias. “In close exchange, we face the technical challenges in the projects together and benefit from each other’s many years of experience.” Following earlier projects in Greece, Romania and the Balkans, numerous joint contracts have since followed throughout Europe, such as the connection of TENNET’s Dolwin Alpha offshore converter platform in the North Sea. Another project involving PFISTERER in Greece was the 150 kV connection to the Cyclades Islands; in March 2019, a further 400 kV EHV project was completed successfully in western Greece with Hellenic Cables.

And the next projects are already in the pipeline: in addition to the current installation of the EHV connection at Patras, preparations are underway for a new 170 kV submarine cable connection between the Peloponnese and the island of Crete. Here, too, Hellenic Cables and PFISTERER won the joint contract.



Two three-phase EHV submarine cables are connected to the land cables on both shores using PFISTERER connection joints.

»Hellenic Cables and PFISTERER are a prime example of a successful partnership.«

Lambros Papadias,  
PFISTERER delegate, Greece



The installation of IXOSIL joints and outdoor terminations for the new 400 kV land-sea cable link near Patras is in full swing.

# News

## True dedication – customer service in the eye of the storm



Hurricane Dorian's path of devastation.

On Friday 6 September, having left a wake of devastation in the Bahamas, Hurricane Dorian made landfall in Cape Hatteras, North Carolina, as a Category 1 storm. Tim McLaughlin, PFISTERER NAM Sales Director, played a part in the relief effort, providing rapid assistance after 190,000 people in the local area were stuck without power.

Dorian was the first major hurricane of the 2019 Atlantic hurricane season, and is regarded as the worst ever natural disaster to hit the Bahamas. On 1 September, the Category 5 hurricane slammed into the Abaco Islands with wind speeds of 295 km/h. The damage was catastrophic.

Preparing for the worst, the U.S. states of Florida, Georgia, South Carolina, North Carolina and Virginia declared a state of emergency and issued evacuation orders. On September 6, Dorian finally reached Cape Hatteras – only 60 miles away from our North America Sales Director Tim McLaughlin – and caused a power outage affecting 190,000 people.

### Rapid delivery of SICON screw connectors

Two days later, McLaughlin received a call requesting an urgent delivery of SICON screw connectors. These are ideally suited to connecting all kinds of copper or aluminium cables, solid or stranded, for voltages up to 245 kV and conductor cross-sections of 16–400 mm<sup>2</sup> – so they are also ideal for quick repairs to storm-damaged power lines.

Although the worst was over, Tim had to drive the whole way through flooded streets, dodging debris and toppled trees, to deliver the connectors as fast as he could. Simple handling and reliable installation then enabled the customer to restore service swiftly to the local community by replacing failed cables with pre-made cables connected with SICON 2-hole NEMA lugs. This is one more reason why the energy supplier uses proven SICON screw connectors by PFISTERER in all conceivable application scenarios.



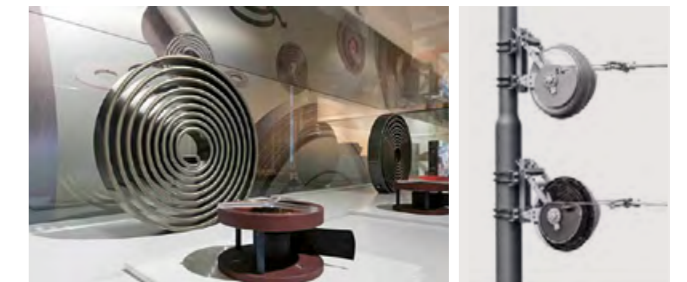
Tim McLaughlin [right] on arrival at Cape Hatteras.

## Peak excitement: TENSOREX C+ at the Junghans Terrassenbau Museum

A technical masterpiece: the creation of energy for small mechanical clockwork using tightly-wound metal springs. But craftsmanship has mastered that too ... all over the world and in the Black Forest in particular. You can marvel at this technical masterpiece in the new **Junghans Terrassenbau Museum** in Schramberg.

The principle of spring tension is in no way limited to clockwork. An outstanding example of its application in industrial technology is provided by our **TENSOREX C+ spring retensioning system** which is used for overhead lines for electric trains in both local and long-distance rail transport.

Therefore, it is no coincidence that PFISTERER has been asked by the management of the Terrassenbau Museum to illustrate this sophisticated application by creating an image of the TENSOREX C+.



## PFISTERER has been named a Global Market Leader Champion again

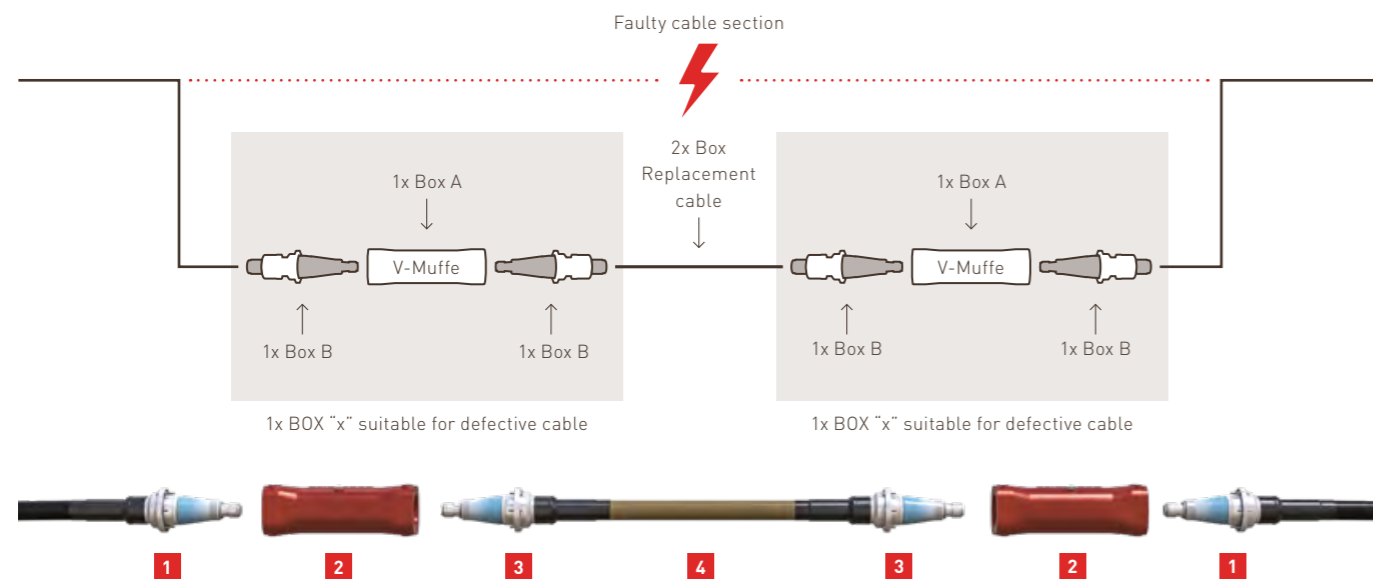


The magazine "Wirtschaftswoche" (Economic Weekly) has dedicated its October 2019 special edition entitled "Deutschlands Weltmarktführer 2020" [Germany's World Market Leader 2020] to global technology leaders that are mostly family-owned companies. Following appearances in 2017 and 2018, PFISTERER has now made the list for the third time in a row. Global companies that are especially successful in their market segment are given the title of global market leader, which demonstrates the outstanding quality of their products

and services. PFISTERER once again met all the necessary criteria and was listed as a Global Market Leader Champion in the "high voltage cable accessories and power grids" segment. This award is simultaneously praise and motivation.

The basis for the ranking is the Global Market Leader Index for Germany, Switzerland and Austria, which was developed by the HBM Unternehmenschule (School for Entrepreneurs) at the University of St. Gallen in cooperation with the Akademie Deutscher Weltmarktführer (Academy of German Global Market Leaders) and a media partner "WirtschaftsWoche". It includes German companies that have a leading position in their respective markets. The Global Market Leader Index uses an objective and transparent selection process where the selection criteria and the calculations are made public when the complete Index is published.

# One solution for all types of cable damage – the Universal Repair Kit from PFISTERER



[1] CONNEX plug connector for existing cable ends, [2] CONNEX connection joint, [3] CONNEX plug connector for replacement cable, [4] replacement cable.

**One wrong move with an excavator shovel and you have a problem. The cable is cut, and hundreds of households and businesses are left in the dark. A quick solution is then necessary: with its Universal Repair Kit, PFISTERER offers the first universal cable repair system – suitable for all XLPE cables, regardless of type, age or diameter.**

Trouble-free grid operation is a must for energy suppliers. Continuous supply must be ensured as far as possible, not only with a view to customer satisfaction, but also regarding high downtime costs. However, with thousands of civil engineering works every day, cable damage cannot be avoided completely. On top of this, there are cable faults caused by weather conditions, ageing and water ingress. The problem: in view of historically grown grids and the corresponding large number of different cable types, materials and cable diameters used, preventive preparation for possible emergency operations is a logistical challenge for grid operators. In the event of a broken cable or a line fault, there is no time to procure replacement solutions with long delivery chains. The

effort and costs for preventive storage are correspondingly high. Faced with this challenge, PFISTERER, as a cable-independent manufacturer, looked for a cost-effective, quickly deployable repair solution that minimises both downtimes and storage costs and thus the costs for operators.

## Replace – plug in – finished

The solution is based on the universal plug-in principle of the PFISTERER fittings. They can be used to connect all types, materials and diameters of different cables, because as a cable-independent manufacturer, PFISTERER offers suitable connector configurations for all cable types. A pluggable cast resin joint in turn serves as a universal connecting piece between the different cables. In combination with a defined XLPE replacement cable, universal and reliable repair sets for defective cable sections can be assembled very quickly. At the same time, the modular design of the joints and connectors reduces the range of parts that need to be held in stock. Once the defective cable section has been located and exposed, the affected section is simply cut out and the two remaining ends are fitted with connectors. Then a replacement cable, also equipped with plugs, is placed between the cable ends and finally all plugs are plugged into the joints – done.

In order to make the installation and storage of the Universal Repair Kit as easy as possible, PFISTERER developed a universal cast resin joint from its existing range for voltage levels up to 170 kV, which is also suitable for underground applications. It can connect any cable conductors such as copper or aluminium, as well as different diameters and insulation materials. At the same time, the new universal joint fulfils all necessary shielding requirements up to cross-bonding or fibre optic conductor monitoring and is therefore ideally suited for replacing defective joints or cable sections. PFISTERER will soon also be offering pluggable terminations for cable damage near a termination.

## Less stock and less outlay

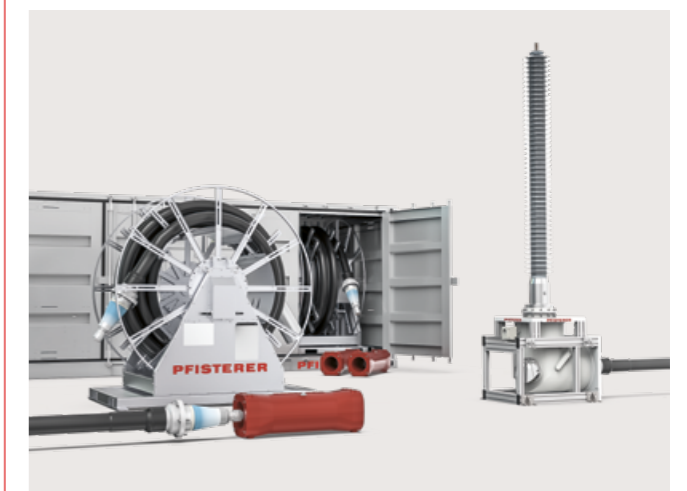
“The special feature of our solution lies in the universality of the joints used and the configured replacement cable. This can correspond, for example to the cable with the largest cross-section installed in the operator’s grid – and then acts as a new connection, suitable for all applications. This means that it does not matter what type of XLPE cable or cross-section is affected in the event of damage. Thanks to the connection fittings, the pluggable spare part fits all XLPE cable types in the network,” explains Alejandro Escobin, Senior Product Manager HV-CONNEX at PFISTERER. This means that grid operators do not have to spend a lot of time and effort on maintaining all cable types, as far as this is possible at all. At the same time, installation is simplified for the fitters, as only one universal system needs to be used.

## Coherent overall concept – ready-to-use

“The Universal Repair Kit is a cable repair system with real added value for our customers, because it offers the highest flexibility with the lowest inventory costs. In the overall concept, however, we go one step further, because we also want to make the provision of all components as simple as possible when needed,” explains Alejandro Escobin. This is why PFISTERER designed a systematically pre-sorted container box that contains all the components required and can be transported safely and quickly to the point of use. This box is individually adapted to the cable systems installed in the customer’s grid, so that the plugs and joints can be used universally for all conceivable applications. This completely eliminates the previous extensive storage for every eventuality. “Our fittings are dry systems. They are thus oil and gas-free and therefore immediately ready for use – simply ready-to-use. They are also easy to store and have a long shelf life,” Escobin adds.

## Quick Deploy Solutions

In order to be optimally equipped at all times, preventive preparation and planning for all possible scenarios in an energy grid is necessary. The new Universal Repair Kit is therefore part of a whole series of quickly deployable solutions – the Quick Deploy Solutions – with which PFISTERER provides its customers with preventive support for rapid deployment, necessary repairs, installation work, maintenance or revisions. These include connection solutions for easily transportable emergency transformers, as well as construction cable systems and a universal kit based on just a few components for bridging and bypassing plant components in substations. In addition, PFISTERER provides training for the customer’s employees and fitters and also ensures continuous service for the components.



# SEANEX optimises 66 kV connection technology for offshore wind turbines

**SEANEX by PFISTERER is an offshore variant of the successful CONNEX HV connection system that is specially adapted for 66 kV inter-array cabling. With SEANEX, too, PFISTERER exploits the advantages of the robust inner cone system. At the same time, the fitting is the most compact and most lightweight offshore connection solution for 66 kV.**

Offshore wind power will become more and more important in the energy mix of the future. Numerous projects worldwide are in the planning stage – not only in Europe, which has long been a pioneer, but especially in Asia and the United States. Countries such as China and Taiwan, where PFISTERER is also active, are focusing heavily on offshore wind farms and thinking big. In view of the high total output from such large-scale farms, the inter-array cabling, which connects the wind turbines to the offshore substation, is an important factor. As the nominal power of wind turbines increases, it is a greater challenge to transport the electricity reliably, safely and as loss-free as possible. Cables become thicker, heavier and less flexible, connection and assembly take more time, and the overall infrastructure installation costs rise. For this reason, recent years have seen a step change in the voltage level for connecting modern offshore wind farms, from 33 kV to 66 kV – i.e. from medium to high voltage. By operating at a higher voltage, 66 kV cables can transmit more power, with a smaller cross-section and lower current than conventional 33 kV cables. That means reduced costs together with improved supply reliability and more power.

PFISTERER developed the SEANEX offshore solution specifically for these market requirements. As the inventor of the inner cone technology that has always formed part of the proven CONNEX HV connection system, PFISTERER has decades of operational experience on offshore platforms. Now SEANEX optimises this tried-and-tested system for connecting wind turbines. "The inner cone system is optimal for offshore wind turbine cabling,



**Proven high-voltage technology:** dry pluggable inner cone solutions for offshore inter-array cabling as well as transformer and GIS connections – GNV GL certified.

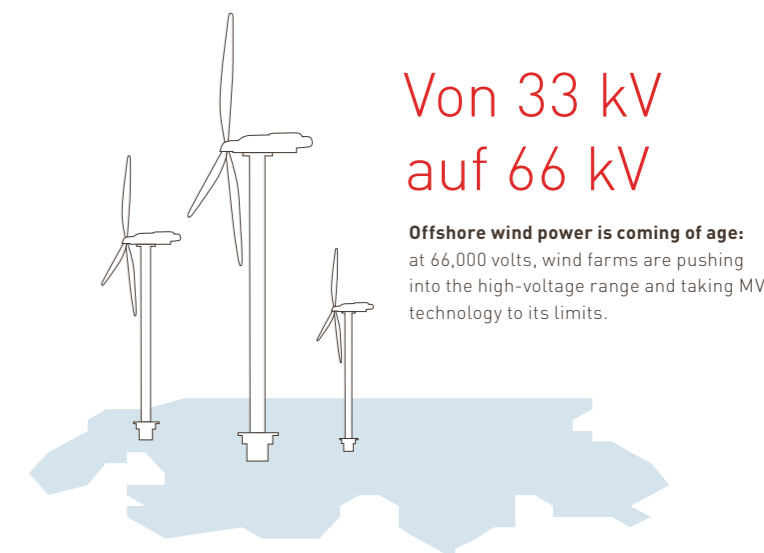
as it offers many installation and handling advantages," explains Dr. Peter Müller, Head of Renewables at PFISTERER. Compared to an outer cone design, the maintenance-free inner cone fittings are much more robust because of their separate mechanical and electrical contacts. As a result, they cope better with sudden load changes. In addition, the fittings are touch-safe at all times, which makes working in tight spaces much safer and simpler. As for durability, the inner cone system guarantees reliability far beyond the projected operational life of a wind farm.

## **SEANEX – lightweight, robust and easy to install**

Specially developed for the requirements of interconnecting wind turbines, the SEANEX connector in conjunction with the associated cast resin joint represents a unique

fitting. During the development process, HV specialists at PFISTERER always kept the design-to-cost principle in mind. The new fitting combines all the proven performance features – salt water resistance, solid insulation, pluggable and touch-safe – yet it is much more compact, lighter in weight, and lower in cost. The cast resin joint measures a mere 39 cm long and weighs just 28 kg. SEANEX plugs also have a rotatable bell flange so that they can be easily plugged in from any position, without having to twist the cable. "Aside from the lower costs, these advantages give our customers greater flexibility for handling and installing the HV fittings," Dr. Peter Müller points out.

Thanks to the pluggable connection between the sea and



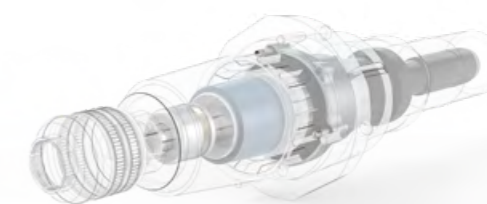
Von 33 kV  
auf 66 kV

**Offshore wind power is coming of age:** at 66,000 volts, wind farms are pushing into the high-voltage range and taking MV technology to its limits.

tower cable, the tower segment construction phases can be clearly separated. The joints can be preinstalled on-shore in the tower segment or base element, resulting in shorter offshore installation times. Then, at sea, the tower wiring is connected by simply plugging in. What's more, in contrast to outer-cone plugs there is no need to build a transition box.

## **One connection technology for the whole offshore wind farm**

Since the beginnings of offshore wind power, PFISTERER has been involved in developing numerous platform projects for offshore grid connections. With its CONNEX fittings, PFISTERER is the only manufacturer offering an offshore-certified solution that has been tried and tested for 20 years. "On the platforms, we have always worked with HV, so it was an obvious and logical step to use proven HV concepts for the inter-array cabling," Dr. Peter Müller notes. "Now with HV CONNEX fittings and the new SEANEX plug, all connections in the whole offshore wind farm can be uniformly implemented with inner-cone technology – from the wind turbines and platform to the on-shore substation. PFISTERER is currently providing inter-array cabling equipment for 102 Siemens turbines in the new East Anglia One (EA1) wind farm. With a total output of 714 MW, this is the first large-scale wind farm at the 66 kV voltage level.



The most compact inner cone connection system for 66 kV: SEANEX is around 30% smaller than conventional size 4 components.



Interview  
**Karin Ohlenforst**  
 Director of Market Intelligence

The Global Wind Energy Council (GWEC) is an international trade association for the wind energy industry and comprises manufacturers, developers, suppliers and trade organisations. The association advises partner organisations and governments on local energy market development, with the aim of promoting the worldwide expansion of wind energy. The annual Global Wind Report provides detailed insight and analysis for the wind industry and is the most widely used data source in this energy sector. [www.gwec.net](http://www.gwec.net)

# Global trends in offshore wind power

The Global Wind Energy Council (GWEC) publishes an annual report analysing global trends in the wind power industry. In this interview, Karin Ohlenforst, Director of Market Intelligence, discusses the future of global offshore wind power.

## Karin, where do you see the largest future growth in the offshore wind market?

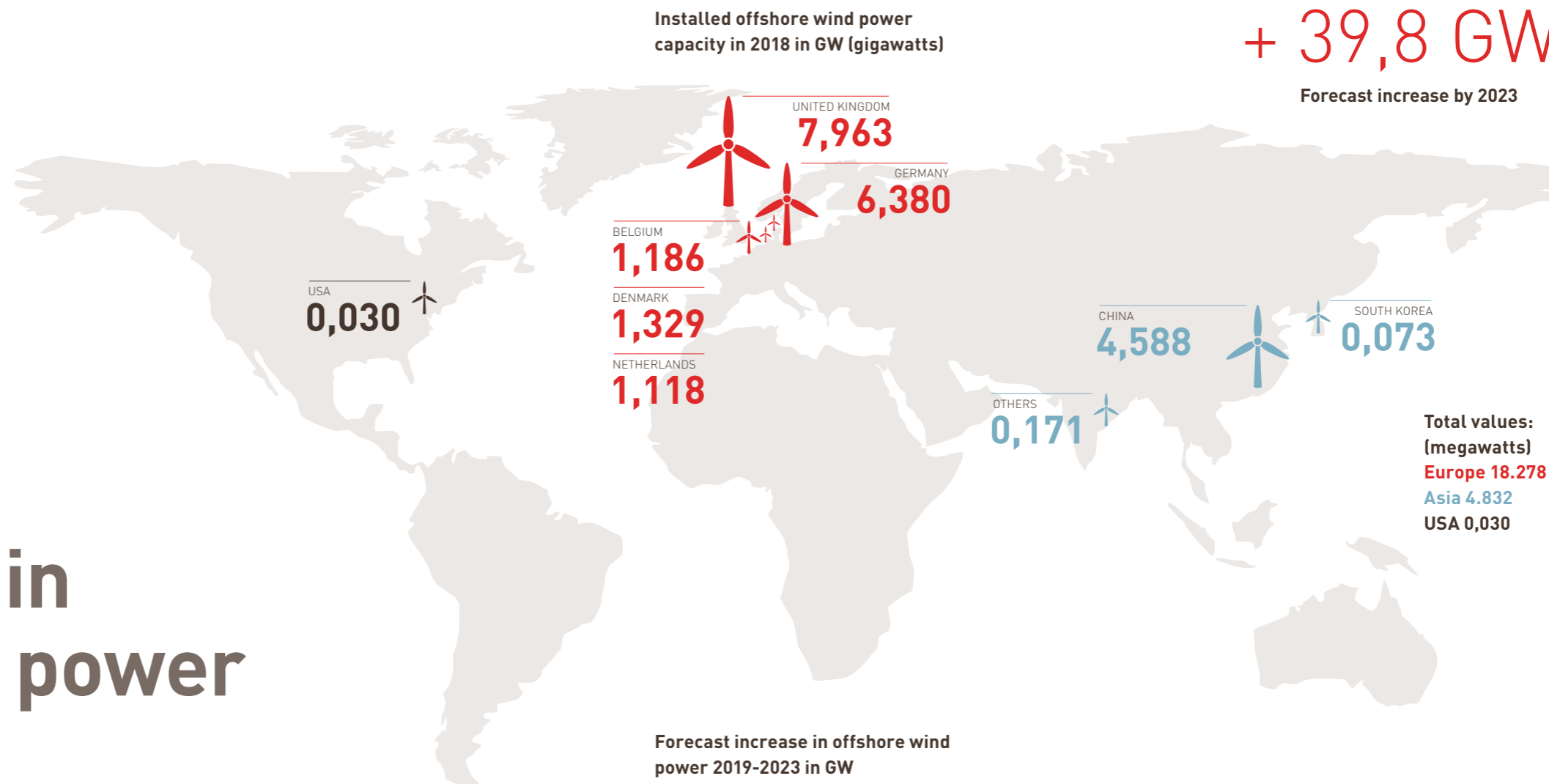
According to our research, offshore wind currently has the largest growth potential in the wind power sector. We expect to see a total volume of 190 gigawatts (GW) by 2030 – currently there are 23 GW worldwide. Europe has the largest share at the moment, with 18 GW, but future growth will happen outside Europe. First in Asia, then in the U.S. too. China's offshore capacity is likely to reach around 60 GW by 2030, and total capacity in Asia will be about 100 GW. Countries like Japan and South Korea will play an important role, but so will Vietnam and Thailand. America's East Coast has grand ambitions at the moment. Here we are expecting to see growth of 1015 GW in offshore capacity over the next ten years. But there is generally still a lot of potential in the United States, for

example in California, so the U.S. as a whole could see a significantly larger increase. That will depend on the development of floating technology, among other things.

## What are the biggest drivers of development potential in offshore wind power?

There are two main factors. First, wind power is easily competitive today in terms of electricity generation costs, and in many countries it is already cheaper than coal, gas or nuclear power. Countries that continue to rely on these conventional energies can also expect high socio-economic costs. Second – and this is new – offshore wind power is now able to replace entire nuclear power plants, based on size alone. Japan for example is looking at large-scale offshore projects as a possibility for replacing nuclear power generation. And that will mean really big offshore projects.

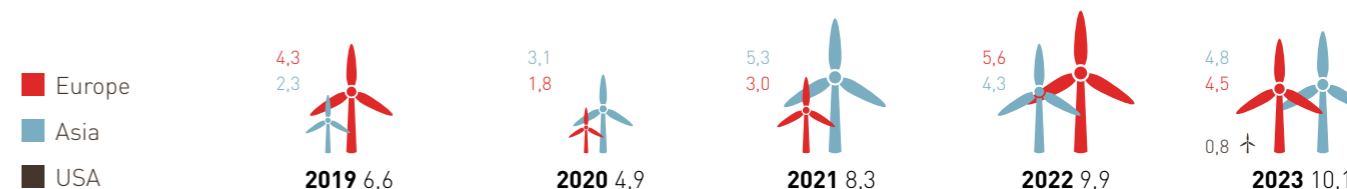
## Installed offshore wind power capacity in 2018 in GW (gigawatts)



**+ 39,8 GW**  
 Forecast increase by 2023

Total values:  
 (megawatts)  
**Europe 18.278**  
 Asia 4.832  
 USA 0,030

## Forecast increase in offshore wind power 2019-2023 in GW



## What role do inter-array cabling and transmission play in such large-scale projects – also with regard to increasingly powerful turbines?

I think we are not at the limit yet in terms of turbine size – capacities of over 15 MW are conceivable in the future. But even with current technology, we are still a long way from exploiting wind power's global potential. With regard to costs, however, inter-array cabling plays an important role, especially the required cable lengths. So there will be further advances in cabling/transmission – more so than in tower design, for example. The change-over from 33 kV to 66 kV is a hugely significant step. We can also see the growing importance of this area in the ever greater weighting given to transmission in tenders and auctions. And with floating technology, even larger offshore projects in the order of 1-2 GW are conceivable.

For this reason, too, transmission is becoming increasingly important.

## Is floating technology coming? Is it the future trend?

Floating wind turbines will certainly be a bigger phenomenon in the future. In our outlook to 2030, we have included a potential of around 10 GW. Development is currently still in its early stages, but many offshore markets cannot be exploited without floating technology – South Africa and the U.S. West Coast for example – because of the deep water and steeply shelving coastlines. Floating technology may help to develop these offshore markets, but the necessary cable lengths drive the price up, and at the end of the day, it has to be worthwhile.



**ALL CABLES LOVE PFISTERER.** As an independent cable accessories specialist, we have everything that cables need. Connection systems, joints and cable terminations from PFISTERER can make any XLPE cable – regardless of the cable manufacturer or cable diameter – a voltage-proof connection up to 550 kV.