

connect

4 CONNEX on the transformer:
Calculating with vision

12 Made in Dubai: Converter station
for North Sea wind farm



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- 4 Calculating with vision:
Considering the life-cycle
costs of transformer
connections
- 10 News: Innovative solutions
from the energy supply
industry
- 12 From Dubai to the North Sea:
Building a converter platform
in the Persian Gulf
- 16 Clearing up after Hurricane
Harvey: SICON restores
power to Houston
- 18 Taking the train to Budapest:
TENSOREX keeps catenary
wires correctly tensioned



Martin Billhardt

Editorial

Dear Readers,

These are exciting times for the PFISTERER group, and as Chairman of the Executive Board, I am pleased to play a part in shaping them. For nearly 100 years, the PFISTERER name has stood for innovation and reliability in energy transmission and distribution. That is how it will remain in the future.

Developing new markets, for example in the United States, along with a strong role for PFISTERER in the offshore wind sector, are just two future projects that are particularly close to my heart. You can read about them in this issue of connect.

Meanwhile, the construction of our central production and logistics facility in Kadaň continues. Not everything is running optimally here, and this may have affected you over the past few months. I would like to take this opportunity to apologise for these circumstances. We are doing everything in our power to solve the problems.

But please be assured that as our customer, you are central to all we do. Every day, we work hard to deliver the reliability and service that you expect from PFISTERER.

Sincerest regards,

A stylized, handwritten signature in black ink, consisting of several loops and a long horizontal stroke at the end.

Martin Billhardt

Chairman of the Executive Board
PFISTERER Holding AG

Calculating with vision

The building and operation of energy infrastructures in the high-voltage sector can be costly. In comparison, only a tiny amount is paid for connectors for grid facilities such as power transformers. And yet not all connectors are the same. So it is worth comparing various solutions with a view to their lifelong cost impact. After all, the decision to purchase a pioneering connection system can open up cost-effective options for demand-based system design and usage. And it can also provide added safety – as it does with CONNEX. No matter how it's worked out – with factors, imponderables, possibilities. Practical approaches to costing can be seen in operations throughout the world.

The overall cost consideration in the decision to buy capital goods has become more important in recent years, compared with a narrow focus on the purchase price. Even with grid facilities, and not without reason.

Savings pay off.

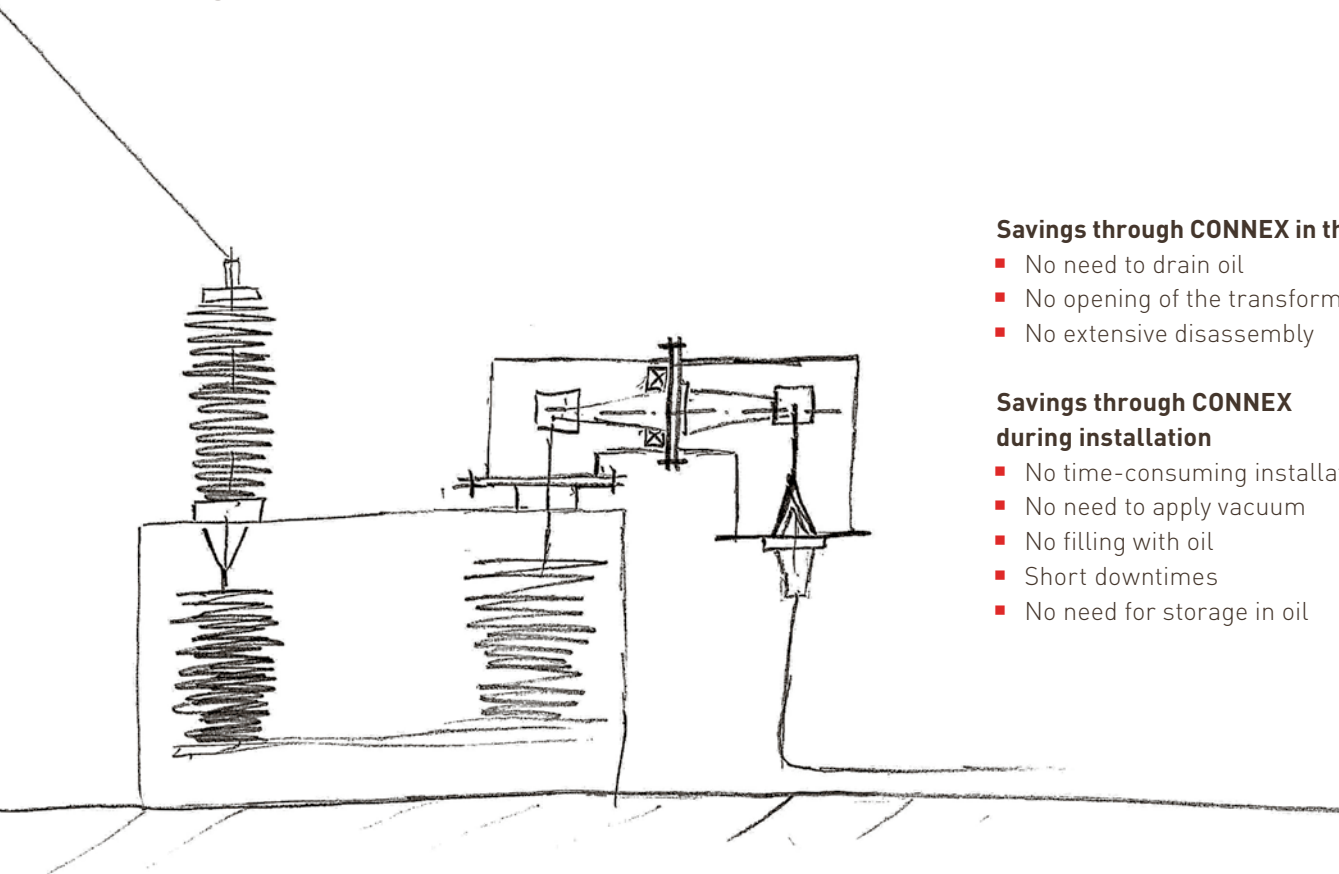
A cost estimate for 145 kV bushings in use on an AC transformer: the purchase price for three conventional bushings is approx. 60% of the price of three pluggable CONNEX bushings. And yet: CONNEX costs appreciably less across quite a few life-cycle stages. Valuable time, for example: max. 1 hour assembly time per HV CONNEX bushing, approx. 3 hours for each conventional high-voltage bushing – according to the rule of thumb based on the experiences of fitters worldwide. In addition, there are other specific expenses for classic bushings. These are all costs which inevitably accumulate, since bushings have to be installed and/or removed several times – including time-consuming oil works such as filling and applying vacuum – during a transformer's working life: before dispatch of the transformer during its factory testing with connection components. Then for dispatch and transport. Then assembly and start-up testing at the place of use. And after 25 years at most, for maintenance when the transformer reaches half its service life, when the bushings are checked and need to be disassembled.

Savings through CONNEX in the factory

- No need to drain oil
- No opening of the transformer
- No extensive disassembly

Savings through CONNEX during installation

- No time-consuming installation
- No need to apply vacuum
- No filling with oil
- Short downtimes
- No need for storage in oil





Pluggable HV CONNEX connectors simply plug in during assembly on site. The socket is fitted in the transformer at the factory.



CONNEX: Faster installation and design advantages have a positive impact on life-cycle costs.

By this stage, the savings made thanks to the easy assembly of CONNEX bushings almost completely offset the extra cost. This is partly thanks to the plug-connector technology: the interface for every bushing is a CONNEX socket, permanently installed in the equipment. When the system is connected, the bushing is plugged in – and there you are. CONNEX bushings are just as easy to remove – simply unplug them. Both steps can be carried out without time-consuming oiling. And that's good for the equipment, the nerves and the budget.

Taking into account these standard costs, the decision to choose pluggable CONNEX bushings compared with conventional bushings remains a small residual sum – and that pays off several times over as a specific investment in the prevention of system damage, downtimes and supply failures. “The CONNEX plug-connector system eliminates the real risks that arise with classic connectors by their very nature”, explains Eduardo Santana, Director Business Unit Power Transmission Solutions Cable at PFISTERER. “The CONNEX socket forms an enclosed unit with the transformer that is tested at the factory and which can be left untouched for its working life. Traditional solutions, on the other hand, can only be connected and removed if the transformer is open. If a nut or screw accidentally falls into the active part, they have to be removed to prevent damage to the transformer. Additional costs running into six digits can be incurred until a proper operating state is restored.”

The loss of small parts during bushing assembly is a relatively clearly defined danger to the integrity of the system.

In operating practice, many more risks can be expected. They can occur at any time, and their impact is difficult to assess. Lightning strikes, short circuits caused by animals, vandalism, storms and so on. Whatever may disrupt the flow of current, one thing is certain: system faults often cost more than just the cost of repair. With CONNEX connectors that can be removed and assembled quickly, valuable time can be gained in serious situations.

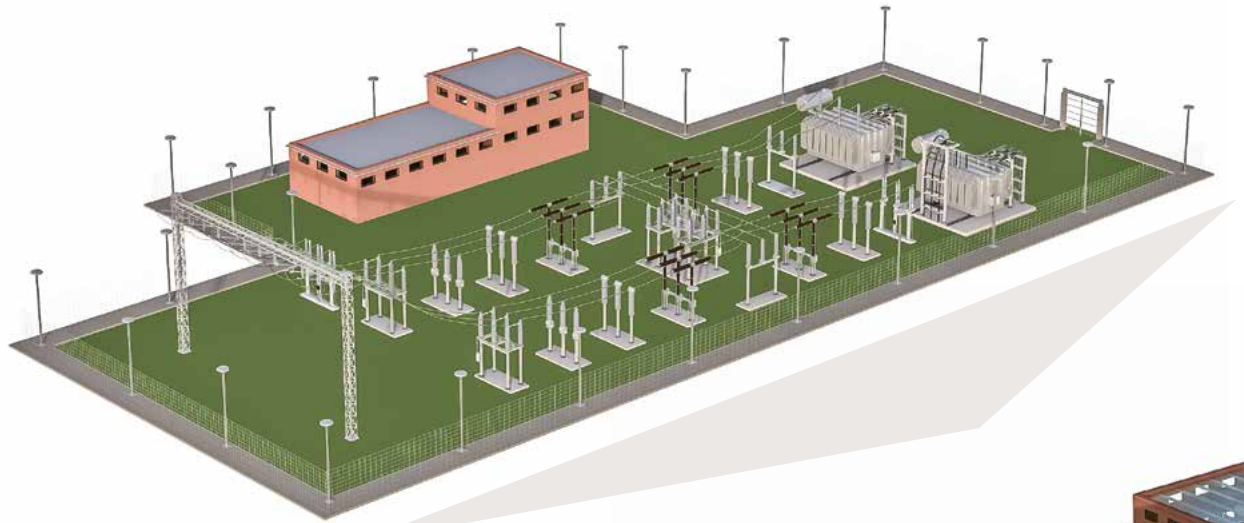
No calculation process can ignore the costs. Ultimately, the results must be right.

“Overall cost effects cannot be precisely determined on a generalised basis, as they depend on many factors such as the calculation model, meaning total cost of ownership or life-cycle costing, general cost conditions, environmental factors, the operator philosophy, system specification and so on”, explains Eduardo Santana. “But no matter how you work things out in detail, potential savings with CONNEX can be determined more specifically for individually determined cost sources.”

Take the case of transformer design with 145 kV cable connectors: connecting traditional cable terminations on systems requires a cable connection box with an insulating system. This is a bulky element that can be either reduced or abandoned completely if CONNEX cable connectors are used. They are connected in the same way as CONNEX bushings, by plugging into CONNEX sockets. These can be compactly installed directly into the system housing. This means that an AC transformer can be made up to 5-10% more cheaply. And CONNEX also helps save space that may be tight and which is often expensive.

In-house substation replaces outdoor switchgear:

CONNEX enables a fully encapsulated, compact system. This means that valuable land in urban centres can be reclaimed. PFISTERER surge arresters provide space-saving and reliable surge protection indoors.



Room to manoeuvre where space is precious and important for safety.

Substations in residential and industrial districts are a side-effect of increasing urbanisation. According to the UN, 55% of the world’s population lives in urban districts today, and this is expected to increase to an estimated 68% by 2050. At the moment, cities use two-thirds of the global energy demand. “Urban substations combine a number of requirements that considerably affect costs. They need to be streamlined and unobtrusive, as we see in Europe, the USA and the Middle East, for example”, says Eduardo Santana. “In addition, locations near consumers regularly call for grid facilities to meet increased performance and safety standards.”

Just the subject of space for substations is a potential challenge in urban areas. Power transformers are designed to operate for around 40 years – a long time, during which their environment can change dramatically. Where there is still space for air-insulated systems today, they must give way in the foreseeable future to in-house solutions because new living and working spaces are being created or changing structurally. The faster and more comprehensively urban structures grow and the more densely they have already grown, the more rising land prices will generally have to be taken into consideration. In contrast to the use of traditional connectors, with CONNEX it is possible to overcome these challenges in a way that offers technical and financial advantages, with added safety for



both facilities and people. In addition, an indoor solution offers better noise protection, an important factor in urban areas.

Take the case of the city of Zurich: here, the new Oerlikon substation, which is largely underground, operated by the City of Zurich (ewz), only takes up 30% of the space needed for the original open-air grid facility, releasing 5,200 m² of valuable building land when decommissioned. The sale of this land covers the extra costs of building underground. A major lever here is the consistent use of space-saving technologies, including CONNEX for all high and medium-voltage connectors for the two GIS and three transformers.

PFISTERER has developed its own pluggable CONNEX surge arresters combining minimum space requirements



Compact transformer cell where only limited space is available



with maximum safety. They are solidly insulated, which makes them uniquely compact and ideal for space-saving direct installation at the transformer to provide outstanding surge protection. The use of CONNEX throughout the system provides cost-effective protection of systems and people. Enclosed CONNEX cable connectors reduce susceptibility to failure. All system interfaces are touch-safe, which means that maintenance personnel can work safely at greater speed, as in the Klus substation in Switzerland.

What counts in cities is twice as important on the ocean.

The 2018 Renewables Global Status Report states that there was a 30% increase in offshore wind power capacity installed worldwide to over 18,000 MW in 2017. Bloomberg New Energy Finance is expecting that figure to rise to more than 100,000 MW by 2030. Offshore development over the next few years is to be driven forward by the UK,

Germany, the Netherlands, Taiwan and China. The USA is also set to become an important market in the next ten years. Some factors are certain here: extreme environmental conditions, high risks, massive cost pressure. The application's fitness for the future depends on the technical progress made.

The increase in inter-array voltage from 33 to 66 kV is regarded as very promising. It is thought that this will lower the overall costs for connecting an offshore wind park to the grid by up to 15%. This was the estimate for East Anglia ONE, the first large-scale wind park operated by Scottish-Power Renewables in the North Sea, working at 66 kV. It links 102 Siemens turbines, each with a capacity of 7 MW, with two converter stations. The inter-array sea and tower cables are connected using CONNEX cast resin joints for voltages up to 72.5 kV.

Their properties offer some cost-effective advantages: the joints can be installed very quickly and safely, since they are dry insulated, touch-safe and pluggable. Sheath fault tests can be carried out easily with an insulated contact bar for the cable shield. They are fully submersible, and also resistant to UV radiation, salt water and salty air. Their integrated longitudinal water barrier prevents any water that enters because of a cable fault from getting into the other connected cables.

The same applies to the CONNEX 170 kV joints for the DolWin offshore project. The installation of the converter platform in the North Sea is an important milestone within the DolWin gamma project, with General Electric, acting on behalf of TenneT, connecting two wind parks to the German transmission network via HVDC cabling. With DolWin, a standard process was developed for the series construction of converter stations – a pioneering step in the direction of viable DC cables for low-loss power transmission across long distances.

The PFISTERER installation team had to overcome some challenging hurdles: alongside 170 kV cast resin joints and cable fittings from the CONNEX range, it laid 16 kg/m heavy, highly flexible 155 kV cables across several platform levels and through preallocated, extremely low spaces that were sometimes only 1 m high. "Our installation specialists show their experience in working with complex cable pulling on construction sites as well as in training courses – whatever the type of cable", says Vukasin Basara, Project Manager at PFISTERER. "CONNEX connects all standard cables regardless of size, which means that they can be selected on a cost-effective basis, and has been developed for profitable power generation at sea. The system reduces installation time, space requirements, risks to the system, people and the environment, and has been certified by the classification company DNV GL for offshore use, where it has been proved successful."

Flexibility is the deciding factor.

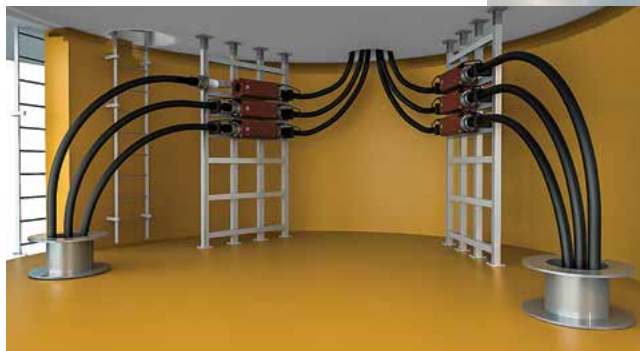
There are challenges for system operators everywhere. Sooner or later, every grid has to be modernised, repaired, extended, decommissioned, enhanced. Things start to move more dynamically when the supply of power takes a new direction, as a result of the increasing use of renewable energy sources, for example. It is not always clear how grids will look in 5, 10 or 20 years. This is all offset by a number of constants: transformers and switchgear will need to operate as efficiently as possible over decades. And power will need to flow reliably. How can flexibility and stability be reduced to a common denominator? The combination of financial product benefits and solution skills available from PFISTERER makes CONNEX a key technology in the realisation of cost-effective innovations for supply reliability. Three examples:

Siemens emergency transformers for two major US power supply companies are intended to prevent blackouts and massive consequential damages. Here they can do in 96 hours what normally takes months: replace a failed power transformer. Peter Müller, Regional Sales Manager at PFISTERER, describes a crucial factor, alongside transportation and easy installation: "To be suitable for use across the grid, the transformers need to serve various voltage levels and connectors. And that's also possible with CONNEX. The system covers voltages up to 550 kV. At its heart, the socket on the device can be equipped as required with bushing, cable plugs, surge arresters, test adapters or dummy plugs."

For the modernisation of a ring-shaped 115 kV transmission cable in the US state of Virginia, Dominion Energy scored a first in North America. Instead of setting up a temporary overhead power line as a bypass, the power

supply company invested in a mobile 230/115 kV substation. PFISTERER supplied CONNEX cable connectors and IXOSIL terminations for connecting the mobile GIS and transformer units. They completed their first operation perfectly. The substation took the full line load for four months without faults. The operator sums it up: at least six months of construction time was avoided, and the one-off costs for the substation were about 30% of the total costs of a temporary overhead power line. These savings cover almost 40% of the cost of purchasing all the mobile units. Just one more use on this scale will cover the rest.

AVU Netz GmbH is relying on versatile station systems for a grid undergoing change. For the purchase of its new 110/10 kV transformers, the German grid operator specified an interface concept with CONNEX at all phases and star points. The result: a design form for three connection layouts – bushing, cable, wall bushing – integratable throughout the grid without modifications. Not forgetting the reduced procurement and storage expenditure.



66 kV inter-array cabling: PFISTERER solutions lower the overall costs for connecting an offshore wind farm to the grid.





Turnkey cable systems for DolWin gamma. Extremely flexible Feltflex cables run over several platform levels and connect to the gasinsulated switchgear with CONNEX.

Offshore platform DolWin gamma leaving Warnemünde in June 2017. Highly flexible 155 kV cables with pluggable CONNEX connection fittings were installed here for the first time.



Mobile substation instead of a temporary overhead power line: Dominion Energy breaks new ground in grid renewal with PFISTERER.



Fast. Streamlined. Safe. Systematically flexible.

The bottom line? The effects of connection components on the overall costs of transformers and switchgear are undeniable and should not be underestimated. With traditional connections, the expenditure has to be accepted. With an innovative solution, it can be reduced or even eliminated. With the former, the connection options are limited. A system with an universal interface and many different pluggable components, on the other hand, multiplies the possible uses of the system. And is safer too. The crucial factor is whether the connection solutions are evaluated with these options in mind and which solution is finally chosen. "CONNEX only costs a fraction of a grid system, and at the same time it rationalises its operation, protects it and makes its use more flexible for decades – for standard and exceptional situations, and under normal and difficult operating conditions", concludes Santana. "All in all: CONNEX pays off."

CrossPower supplies electricity to school in Tanzania



St. Aquinas Secondary School in Mtwara (Tanzania) will soon get its electricity from a 35 kW CrossPower system including a 20 kW photovoltaic installation. The project is being financed by private donations. The school complex of six buildings currently has an unreliable power supply consisting of a connection to the local electricity provider and an old solar installation. The new CrossPower system will provide a reliable and independent round-the-clock power supply. Comprising an energy management system, a 35 kWh battery bank and a 25 kW system inverter, the system is installed in a 20-foot container. The new PV array is mounted on the roof of a building. Individual system parts are connected together using PFISTERER plug & operate components. St. Aquinas Secondary School is situated about four kilometres from the centre of the port city of Mtwara, on the Indian Ocean. The school for girls and boys is run by the Missionary Benedictine Sisters of Tutzing (Germany).

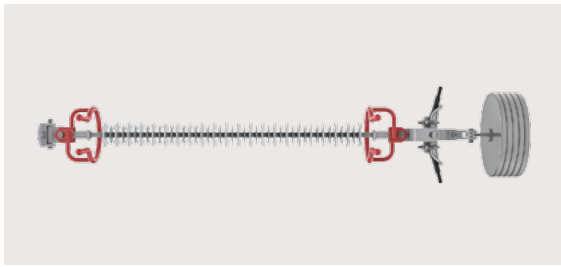
SERVICE

Safety in overhead power line construction



Safety at work is a top priority, including for high-voltage overhead power line engineers. PFISTERER offers free safety training for this work. One part of the course focuses on the correct installation and maintenance of wedge-type pulling clamps. These clamps are used to pull the overhead conductors – often weighing several tons – onto the towers. If the clamps are not fitted correctly, or if they are damaged, there is an increased risk of accidents. “Tools like this are not standardised or subject to continuous checks,” explains Werner Medwed of PFISTERER OHL Team Deutschland. At the same time, he emphasises the safety relevance of these devices. “We have noticed that damaged or broken wedge-type pulling clamps are increasingly being used,” Medwed says. Often the clamps are 20 or 30 years old. That is not a problem if they are handled and maintained correctly. But not infrequently, they are not cleaned and greased after each use as they should be. Or the clamps are hit with steel hammers during removal. “This can break the clamps and it is becoming a risk factor in overhead line installation,” Medwed warns. As part of the safety training courses, PFISTERER also offers a visual check of the wedge-type pulling clamps.

Silicone replaces porcelain on high-voltage transmission tower



Previously, replacing outdated ceramic insulators with composite insulators involved considerable work and expense. In partnership with Swiss grid operator BKW Energie AG, PFISTERER has developed a 145 kV short chain that substantially reduces the costs and work involved in updating power lines. It is now possible to change from porcelain to silicone insulators without any tower design modifications, which means no new approval procedures are required. A key feature of the short chain is an innovative way of attaching the protective fittings to the insulator. This means they can be mounted on the fork, and a double eyelet is not required. Fewer chain components are needed, and the overall length can be reduced by as much as 240 mm. The complete chain has been successfully tested in the laboratory at 40 kA / 1 s, and it is patented. Currently, BKW is fitting the new short chains in a pilot project.

Secure mounting for weather stations on overhead power line towers

The weather is playing an increasingly important part in energy transmission via overhead power lines. Firstly, damage caused by bad weather has increased in recent years. And secondly, Europe-wide research projects are in progress on dynamic thermal rating (DTR) and dynamic capacity utilisation. The aim is to adjust electricity transmission in overhead power lines depending on the weather. This would allow conductors cooled by wind and low temperatures to temporarily transmit more power. To record accurate weather data to enable precise predictions, weather stations are being installed on overhead power line towers. PFISTERER offers a special mounting bracket for this purpose. It consists of three parts, and is compatible with any tower for 110 kV and upwards. Now, for a pilot project, 50 brackets have been produced and supplied to German transmission system operator Amprion.



New insulators for the Deutsches Museum

The Deutsches Museum in Munich (Germany) is sourcing new silicone insulators from PFISTERER for its Faraday cage. Every day, the museum stages an impressive demonstration of how a Faraday cage shields against electric fields. A visitor sits inside a wire sphere that is suspended above ground and insulated from earth. Then the electric potential of the sphere is brought up to a high voltage level. Sparkover occurs at around 270 kV across a 70 cm spark gap – making the high voltage visible to all. The sphere is insulated from its horizontal support beam by two adjacent long-rod insulators arranged in parallel. Now, after 66 years of fault-free operation, the insulators had to be tested. With ceramic insulators, there is no non-destructive way of doing this. So, on the advice of PFISTERER, the ceramic insulators have been replaced with new Rodurflex composite insulators. The old ceramic insulators were made in late 1952 at the former Stemag works in Wunsiedel (Germany). Following several changes of ownership, this factory now belongs to LAPP Insulators, and so is part of the PFISTERER group. The new composite insulators were produced in Wunsiedel this time round too.

One round trip to Dubai

The BorWin gamma converter platform had an unusually long journey to its final destination: the offshore platform was built in Dubai, before beginning its trip to the North Sea. With its local team on site, PFISTERER delivered and installed the complete 155 kV cabling beforehand and ensured seaworthy terminations during the passage.

Around 130 km north of the German North Sea coast, the operator TenneT is busy building the BorWin gamma converter station to connect the two offshore wind parks Global Tech I and EnBW Hohe See to the grid. The three-phase current generated at sea is converted to direct current and then transmitted to the grid connection point in Emden/Ost along the approximately 160 km long and 900 MW strong high voltage direct current line BorWin3. The converter platform was built by Drydocks World in Dubai on behalf of the manufacturer consortium Petrofac/Siemens. "That is a special feature of this project," says Hans-Ulrich Lengler, Senior Project Manager at PFISTERER, "because after construction in Dubai, the converter platform had a long sea voyage to the North Sea before it was firmly anchored there." Petrofac, which specialises in oil, gas and offshore projects, contracted PFISTERER in 2016 to deliver and install the complete 155 kV offshore part of the platform including 155 kV cables, link boxes and cable clamps as well as 71 HV Connex terminations for connection of the gas-insulated switchgear (GIS), sea cables and transformer connections.

Seasoned team on site in Dubai

Two things were paramount for the customer's benefit and trouble-free implementation. Firstly, PFISTERER, with its system group, offers a central contact point for procurement of fittings, cables and services. Secondly, PFISTERER has the possibility to despatch an experienced local installation team to the site to assume supervision and installation roles flexibly and inexpensively – in other words, a complete package of technology, installation, local support and expertise in engineering and design. PFISTERER is thus able to support its customers efficiently



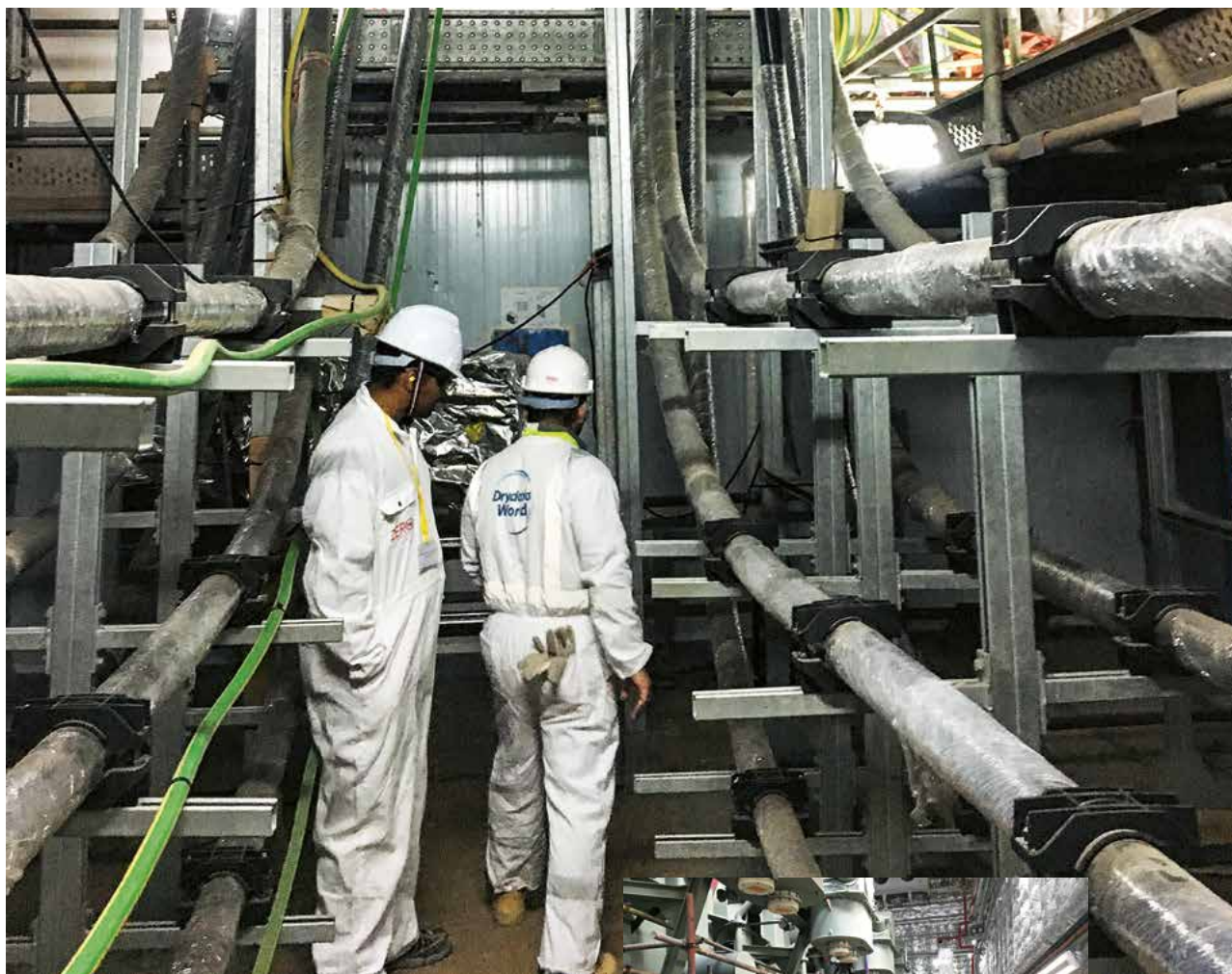
Drydocks Dubai: This shipyard is one of the largest of its kind in the Middle East, and is a preferred location for shipbuilding and ship conversion as well as offshore construction. Around 350 ships are built here every year. Most are big tankers (VLCC) and container ships (ULCC). An increasing number of converter platforms for global offshore wind energy generation are set to be produced here too.



The platform in the port at Dubai: Working at over 40 °C.



HV cable systems inside the platform. The cables are covered to protect them from heat and dust.



For five months, the PFISTERER team worked on installing the 155 kV fittings and the GIS connection. This was also the first time that copper cables with a cross-section of 2,500 mm² were used on a platform – with a weight of 32 kg/m and a bending radius of 3 m.



in their projects worldwide. “We have been working in Dubai actively with our own team for 11 years and have taken over material deliveries and installation projects in the whole Middle East, e.g. substations, or delivering cable lines with joints including their installation,” says Thorsten Ludwig, Regional Sales Manager in PFISTERER Dubai branch. He, himself, has been working in Dubai for six years. “Local experience plays an important role in our region. We are au fait with the local circumstances, mentality and climatic conditions.” And the contractor, Petrofac, had also already made good experiences in its collaboration with PFISTERER in MV projects in Abu Dhabi. Nevertheless, the team had to overcome very special challenges in the BorWin gamma project. Although the

technicians in Dubai are used to working in substations, installation on an offshore platform still under construction is a completely different matter. Various different disciplines work simultaneously in a confined space and need to be coordinated, and a lot of time and bureaucracy is needed for the safety checks for the employees and registration of the tools before entering the docks.

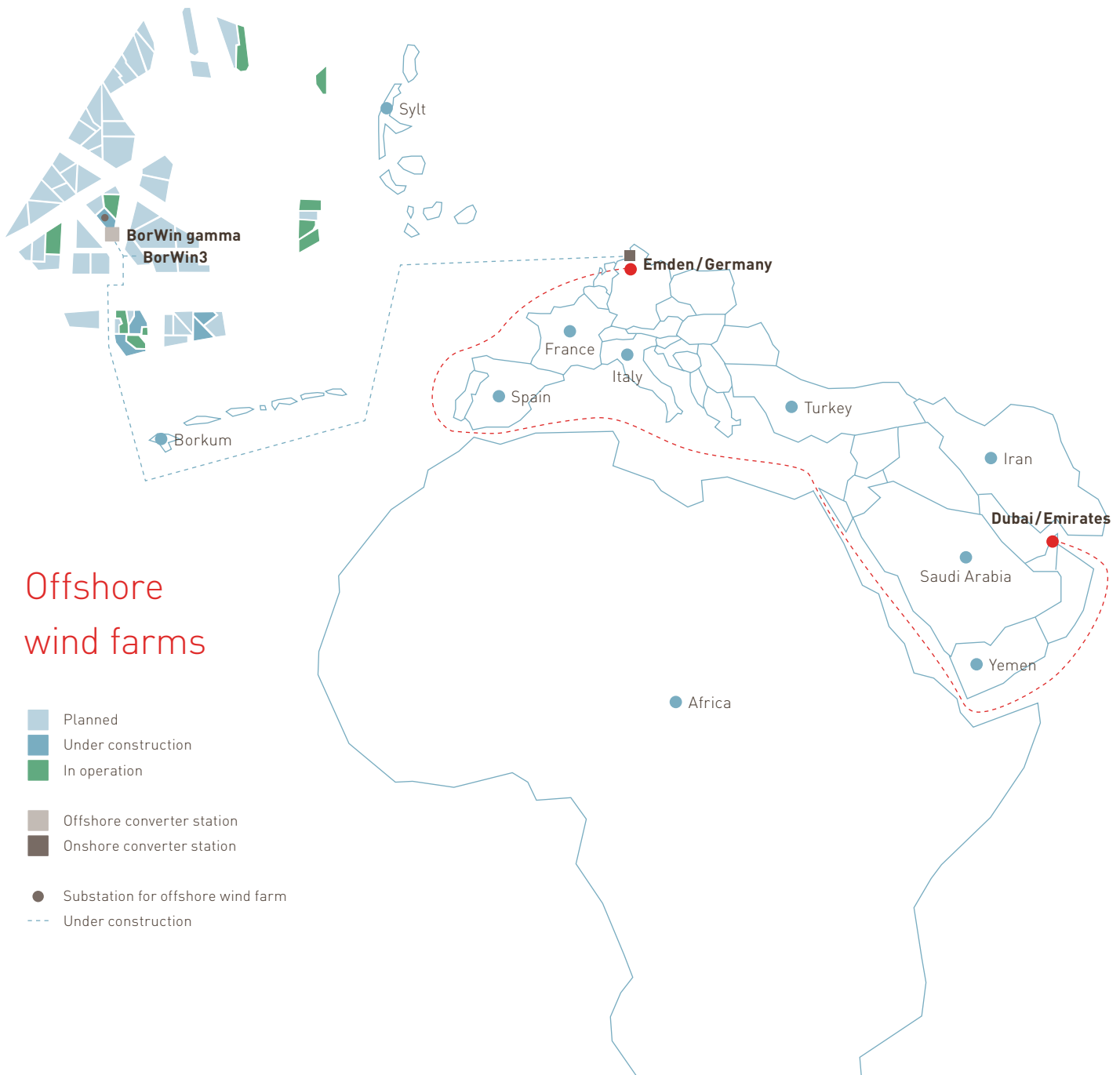
Five months at full steam

On top of this, there were only two possible time slots available for shipping the converter platform, adding to the time pressure on the team. Everything, therefore, had to proceed according to schedule. For five months, the team worked on installing the 155 kV fittings. In addition

to cables with a cross-section of 800 mm², copper cables with a cross-section of 2,500 mm² were used on a platform for the first time – with a weight of 32 kg/m and a bending radius of 3 m. A total of 15 sections, each with a length of 30-40 m, will connect the GIS with the submarine cable as soon as the converter platform is firmly anchored. Around 3 km of cable with a cross-section of 800 mm² connect the gas-insulated switchgear on the upper level with the transformers on the level underneath on the platform. “Overall, the team installed 45 Connex terminations (size 6s) for the GIS/transformer connection and 26 Connex terminations for connection of the submarine cables,” says Thorsten Ludwig. “Without our experienced team it would not have been possible to finish installation in this time with the necessary quality.” The Siemens switchgear had already been equipped in the factory with the Connex device connectors as specified by TenneT. The Connex system from PFISTERER is the only offshore-certified system for a voltage level of 155 kV.

Safe and ready for the high seas

The last engineering challenge, according to Hans-Ulrich Lengler, now lies in the long sea voyage to the North Sea: “Everything needs to be installed very firmly for shipment because the mechanical stresses at sea are very high, and vibrations and oscillations could cause the plug connections to loosen or come undone altogether – unlike in platforms that have already been anchored properly.” For this reason, PFISTERER recommended and installed compensation clamps for strain relief. They ensure that the movements of the cables are balanced out and mechanical stresses are not transmitted to the termination and socket. The team on site was also able to advise on the design of the cable support system for the 2,500 mm² cables because they need a special support system due to their high weight. Following successful installation of all components, nothing technical now stands in the way of the BorWin gamma converter platform’s voyage to the North Sea. The platform is due to be commissioned next year.



Flooded streets, ruined homes: Hurricane Harvey was one of the costliest natural disasters to hit the USA, and also a huge challenge for energy suppliers. To repair damage to the municipal grid in Houston as quickly as possible, CenterPoint Energy opted to use the SICON cable connection system from PFISTERER for the first time. The Texas electricity and gas network operator now plans to make the easy-to-install screw connector its standard choice, thereby following the current trend. More and more companies in the USA and Canada are now also using SICON in the low-voltage sector as it works safely, quickly and reliably.



SICON connection technology has long been widespread in the USA and Canada for medium-voltage cables with 15 kV to 35 kV and transmission cables with 45 kV to 170 kV. The core of all SICON connectors is the patented, stepless shear bolt without a predetermined shear-off point in the thread. The bolt always breaks off automatically at the right point during installation, at the height of the top edge of the connector body, thereby avoiding sharp edges. The second special component of the SICON connector is the friction disc integrated at the end of the bolt. It prevents scraping on the conductor when tightening, so that



Connecting cables – the easy way: SICON connectors connect all cables, regardless of the conductor material and type.

“Houston, problem solved” – USA uses SICON successfully in LV applications



Flooded streets in Houston in the aftermath of Hurricane Harvey. Once the water subsided, the power grid was repaired – with the help of SICON screw connectors.



The right SICON connector for every application. Here as a contact element in the outer-cone plug.

Back to normal again in just 48 hours

CenterPoint Energy (CNP) originally became aware of SICON while looking for an alternative to soldering conductors. Due to heat and smoke, this process is risky for workers. But CNP did not want to compromise on the reliability of the cable connections. So it contracted an independent cable laboratory to investigate the screw connector. The results were so convincing that CNP immediately ordered 50 screw and branch connectors from the SICON family. "We planned to use SICON not only for our previously mainly hand-made solder joints, but also to connect our 400 mm copper conductors in our shaft system," says David Mathes, Operation Manager in CNP's Major Underground department. But before that happened, Hurricane Harvey flooded the northern part of Houston. It was only with considerable effort that the energy supply could be maintained in the city centre. When the water subsided, CNP noticed a loss in voltage, caused by damage to the low-voltage cables. At first the cables were cut off and replaced in the conventional way. "To accelerate this time-consuming process, we decided to use SICON connectors. We repaired the faults in five blocks and returned all services to the normal voltage range in just 48 hours. Since then the power grid has been working without a hitch and we are working on making SICON our standard solution," says David Mathes. SICON has thus proven its technical concept for the low-voltage sector successfully not only in numerous tests, but also in practical use.

even the finest single strands remain undamaged during installation. Both functional elements together guarantee optimum electrical contact regardless of the type and quality of the conductor. Further, SICON is designed such that it can be installed in a single step.

Number one in North America

More and more energy suppliers are recognising the technical and practical superiority of screw connectors over compression joints in the low-voltage sector as well, where cables are connected with low voltage but high currents. Demand for SICON grew in the USA and Canada in this market segment by 60 percent last year. A similar growth in sales seems likely in 2018. SICON is now the most used screw connector in North America. PFISTERER offers it in cooperation with the leading accessory manufacturers 3M, Richards, Eaton and Prysmian. Among the customers that use SICON in various applications are, for example, the transmission system operators AEP in Ohio and National Grid with its gas and electricity network in New York, as well as Toronto Hydro, the second-largest electricity supplier in Canada.

SICON branch connectors: The patented shear bolts break away burr-free and can be covered in heat shrink immediately after installation.



Make way for the train to Budapest

The Budapest-Esztergom route is the second-busiest railway line in Hungary and the main transport axis for the Budapest metropolitan area. Over the past two years it has been modernised, extended and electrified over a length of 51 km. PFISTERER delivered its patented TENSOREX C+ spring-tensioning system for the catenary wires and track cables. There they have proven their worth particularly in the redesigned stations and in Hungary's longest tunnel. Investor and supervisor is Nemzeti Infrastruktúra Fejlesztő Zrt. (NIF Zrt.), the Hungarian National Infrastructure Development Company.

The new regional trains of the type FLIRT have been running independently on the electrified route between Budapest and Esztergom since April. The extension and modernisation of the route is an important project for Hungary's MAV Zrt. railway operator and an infrastructure project of central importance to the Hungarian Ministry for Development, supported with funds from the European Union. All partners involved are focussed on integrating the latest technical solutions into the Hungarian railway network, which is undergoing continuous development. Apart from the electrification of the complete line, the project also involves new two-track construction of the RakosrendezőÚjpest section. In addition, the Esztergom station is being redesigned and Újpest station converted into an intermodal transport hub. "The Budapest-Esztergom axis is an important transport artery with high train frequency. Thanks to the modernisation and extension, it will play its important role in the future," says István Kovács, Sales Manager at PFISTERER. Together with his team, he supports the planning for the construction of the catenary wires and track cables and also trains the local fitters. "Since installation of TENSOREX is not

complicated and can be done without special tools, installation proceeded without problems. That is one big advantage of the system."

Fits, even when things get tight

For NIF Zrt., the company responsible for planning the project, the patented, spring-actuated catenary wire tensioning system TENSOREX C+ from PFISTERER offers numerous advantages. Firstly, it creates a constant tensile force on the catenary wire, so that changes in length due to temperature fluctuations during the day and night, and from season to season, are equalised optimally and



the catenary wire remains at a constant height at all times. Secondly, thanks to its compact construction, it is highly suitable for installation in confined spaces such as in stations, bridges and tunnels. "TENSOREX C+ is delivered ready for installation and can be installed on all existing types of masts or directly on tunnel walls or ceilings," says project manager Ilona Kovácsné Marczis from NIF Zrt. The line includes the "Kopár-hágó", Hungary's longest tunnel at 780 metres. "In addition to this, we installed TENSOREX at a few inaccessible points where delivery of heavy concrete weights would not have been possible."

Better safety for passengers and the operator

The system enhances passenger safety at the new stations: thanks to the combination of a spiral spring with eccentric disc, it is possible to dispense with the normal concrete or steel weights completely, and all moving parts are installed in such a way as to be inaccessible so that people are not endangered by falling weights or parts should a cable break. "The future operator MAV also benefits in the



The compact TENSOREX C+ spring-tensioning system is the modern alternative to conventional wheel tensioning systems.



The Budapest-Esztergom route is the second-busiest railway line in Hungary, and the main transport axis for the Budapest metropolitan area. 18 TENSOREX C+ were installed over a distance of 51 km.

Benefits

- More compact and lighter than wheel tensioning systems
- High precision of response
- High level of safety
- Easy installation – lower installation costs
- Practically maintenance-free
- Virtually immune to vandalism

case of operational damage to the catenary wire or necessary repairs from short downtimes on the busy route because the spring-tensioning system is maintenance-free and can still be used in its entirety in the event of a broken cable," says Ilona Kovácsné Marczis. A total of 18 TENSOREX C+ tensioning systems and 2,500 connection clamps from PFISTERER were delivered. Normal train operations are already under way and the two stations are due to be finished by autumn.



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.