ENERCON STORAGE TECHNOLOGY

First pilot projects for energy storage realised

NEW MAINTENANCE CONCEPT  ENERCON adapts cycles and content for Service

OPTIMISED LOGISTICS FOR LARGE-SCALE PROJECTS  Disused air field serves as intermediate storage area

ENERCON IN NORWAY  First repowering in the land of fjords
Rethink planned changeover to tendering system

Dear customers, business partners and employees,

Thanks to their overwhelming success and the diversity of players, renewable energies are becoming ever more important for power supply in Germany. With an aggregate installed power capacity of 93.1 GW and an over 30% share of the power supplied in the first half year, renewables have now reached a status of system-relevant power plants. The energy transition seems to be on the right course.

However, this development is currently at risk of being jeopardised by revisions to the successful EEG (Renewable Energy Sources Act) and the introduction of a tendering process. We are familiar with tendering in many international markets and have not yet found an example where this system has been able to reduce costs, attract a diversity of players and promote achieving ambitious development targets for renewable energies. Yet, exactly these targets are the decisive factor in attaining a decentralised energy transition which also meets citizens’ approval.

The Federal Government should, as announced in 2014, rethink this issue to see if the changeover is really necessary. As illustrated in the key issue paper published by the BMWi at the end of July, the uncertainty and risks triggered by the tendering model could lead to rising costs for financing and thus render electricity from renewables unnecessarily costly. With the current proposals for tendering, acceptance will disappear as small projects and community-owned wind farms will most probably no longer be possible due to increased tendering demands on “small operators”. We need far fewer exceptions for small projects – for example the de minimis regulation proposed by the sector – if we want to maintain a diversity of players in the task of achieving the energy transition. Germany-wide development of wind energy can also hardly be maintained due to the current proposals. Because of decentralization, this is however essential for added value and power future supply security.

Acceptance, jobs and the decentralised energy transition are at risk. Uncertainties and constant changes to regulatory frameworks have not yet benefited any sector. We are on the right track, are actively participating in ensuring system stability and are continuing to lower costs. We should not unnecessarily put this development at risk. A constructive dialogue concerning the final draft of the new regulation as of 2017, should be urgently resumed!

Hans-Dieter Kathwig
ENERCON Managing Director
Renewables targets

Most states now have expansion targets for renewable energies. According to a report by the International Renewable Energy Agency (IRENA), 164 countries around the world have so far adopted policies in this area. In 2005, it was only 43. In other words, the number has almost quadrupled in the last ten years.

The expansion targets for renewables relate in large part to the electricity sector. According to Federal Government guidelines, the proportion of electricity to be sourced from renewable energies in Germany should rise to 40 to 45 percent by the year 2025. Mainly thanks to the growth of onshore wind energy, Germany is well on the way to achieving this target: figures from the German Renewable Energy Federation (BEE) show that the proportion of total electricity consumption sourced from renewables was in the region of 33 percent in the first half of 2015, which is the highest it has ever been. This rise is said to be due mainly to the dramatic expansion of onshore wind energy facilities, coupled with good wind yields. The photo shows the construction site of the Emden-Borssum wind farm with two Enercon E-115/3 MW turbines (hub height 135 m).
The first voyage following class renewal stopped off in Viana do Castello, Portugal, before crossing the North Atlantic for its destination in Canada. ENERCON is making a considerable contribution to the sustainable transportation of its wind energy converters for projects all over the world with its E-Ship 1. Since entering service in 2010, the cargo vessel has become an integral part of the wind turbine manufacturer’s transport solution. The Flettner technology has proven effective and robust in commercial use. Depending on weather conditions, fuel savings of up to 15% can be achieved.

The other ENERCON innovations – a streamlined superstructure and hull and a specially coordinated rudder/variable pitch propeller combination – have proven effective and resulted in further fuel savings. This, together with the use of practically sulphur-free marine gas oil (MGO) and the use of SCR catalytic converters mean that the “E-Ship 1” sets a high benchmark in the multi-purpose freight segment.

Pilot project on balancing energy successfully completed

ENERCON and its partners have successfully completed a pilot project on supplying balancing energy from wind energy converters. The “R2 Wind” research project at Estinnes wind farm in Belgium demonstrated with eleven E-126/2.5 MW and 4 MW turbines that it was technically possible for wind energy converters to vary output to largely compensate for fluctuations in the power grid. Apart from ENERCON, the wind farm operator WindVision, the energy trader Eneco Energy Trade and the transmission system operator Elia were all involved in the pilot project. Wind, PM and Sales – Grid Integration monitored the pilot project on behalf of ENERCON. During the two-month project phase, Estinnes wind farm was part of Elia’s secondary reserve and provided the grid with up to 10 MW of negative balancing power as and when necessary. This required the wind energy converters to respond in real time to desired values transmitted by Elia and to alter their active power output continuously by adjusting their rotor blades.

The turbines responded quickly and with great precision to the grid operator’s signals, according to one of the principal findings. Furthermore, the pilot project raised concrete technical and market-related issues which will have to be resolved if wind farms are to be able to participate commercially in the balancing energy market in the future.

New building completed for Gotha training centre

ENERCON has completed the new building at its training centre for WEA service staff in Gotha. After just a nine-month construction period, the first classes in theory were already being held in the new two-storey building by the end of July. The training centre complements the existing classrooms on the premises of the ENERCON Service Center in Passauer Straße, Gotha, where advanced practical training is already being provided.

The roughly 1,800 m² building is designed for a capacity of 278 trainees per day. It comprises ten classrooms and conference rooms, as well as offices and a fully-equipped cantina catering for about 100 people.

In Gotha, employees of WEA Service companies attend classes in industrial safety, First Aid and plant technology, among other things. ENERCON expects to welcome some 5,000 trainees there this year. This translates to about 20,000 bednights at the Gotha site. Some 12,000 of these will be spent in ENERCON’s own guest house.
ENERCON apprentices begin training for the first time at the EEZ

ENERCON’s new training workshops have been unveiled at the Energy, Education and Experience Centre (EEZ) in Aurich, and the first duty of the company’s new flagship training centre was to greet this year’s apprentices as they began their vocational training at the sites in East Frisia. ENERCON saw a total of 80 young people take the first step in their working lives in Aurich this year. Another 40 youngsters are due to begin training with companies at the Magdeburg site in September. After being welcomed and having their photos taken in front of the E-115 exhibit in the inner courtyard of the EEZ, the new Aurich apprentices were shown the glazed workshops in which some of them will complete part of their training. Introductory events and tours of the workshops also featured on this programme.

ENERCON is currently providing training in 22 trades, industrial and technical fields. Electrical engineering and logistics are two of the key areas of specialisation. As well as traditional training programmes, ENERCON also offers the option of dual study in a number of fields. Currently in Aurich, 160 apprentices are in training and in Magdeburg there are 136 apprentices.

All are benefiting from high quality training and outstanding instructors proven by the excellent results of ENERCON apprentices in the final examinations. ENERCON apprentices are regularly among the Chamber of Commerce winners and best in their category. Just last July, seven electrical engineering apprentices who completed their training in record time were presented with an award for their outstanding achievements. ENERCON believes that training its own skilled workforce is important if it is to ensure the availability of a future generation of qualified and specialist employees. As a leading, versatile and constantly growing enterprise in the renewables sector, ENERCON needs personnel with all sorts of different skills. Consequently, the prospects of the youngsters being offered employment once they have completed their training remain excellent.

New project plant in Canada begins tower production

ENERCON has commenced tower production at its new plant in St. Catharines, Ontario. The temporary factory erected in a former shipyard on Lake Ontario in the Niagara Region is manufacturing concrete segments for a total of 77 hybrid towers of the E-115 series with hub heights of 135 m for the nearby NRWC wind farm in Pelham, Ontario.

The production halls on the shipyard site were leased by ENERCON, converted to comply with manufacturing specifications, and fitted out with the necessary equipment. Production commenced in an 18-month term. Experienced colleagues from WEC Turmbau sites in Germany and from the Canadian concrete tower works in Matane, Quebec assisted their colleagues in St. Catharines during the installation and start-up phase. The project plant in St. Catharines has ambitious targets to meet, as the aim is to produce all of the tower segments required for the project within six months, since ENERCON must vacate the production halls at the end of this brief period.

At the end of August, Austria’s Chancellor, Werner Faymann, visited ENERCON’s Austrian concrete tower factory in Zurndorf and in Burgenland were essentially only approved projects are benefiting from the remuneration which means that projects are being held up with long waiting periods.

In Austria, the prospects of the enterprise in the renewables sector, ENERCON needs personnel who are being offered employment once they have completed their vocational training remain excellent.

Austria’s chancellor visits ENERCON’s concrete tower factory in Zurndorf

After being welcomed and having their photos taken in front of the E-115 exhibit in the inner courtyard of the EEZ, the new Aurich apprentices were shown the glazed workshops in which some of them will complete part of their training. Introductory events and tours of the workshops also featured on this programme.

ENERCON is currently providing training in 22 trades, industrial and technical fields. Electrical engineering and logistics are two of the key areas of specialisation. As well as traditional training programmes, ENERCON also offers the option of dual study in a number of fields. Currently in Aurich, 160 apprentices are in training and in Magdeburg there are 136 apprentices.

All are benefiting from high quality training and outstanding instructors proven by the excellent results of ENERCON apprentices in the final examinations. ENERCON apprentices are regularly among the Chamber of Commerce winners and best in their category. Just last July, seven electrical engineering apprentices who completed their training in record time were presented with an award for their outstanding achievements. ENERCON believes that training its own skilled workforce is important if it is to ensure the availability of a future generation of qualified and specialist employees. As a leading, versatile and constantly growing enterprise in the renewables sector, ENERCON needs personnel with all sorts of different skills. Consequently, the prospects of the youngsters being offered employment once they have completed their training remain excellent.

New project plant in Canada begins tower production

ENERCON has commenced tower production at its new plant in St. Catharines, Ontario. The temporary factory erected in a former shipyard on Lake Ontario in the Niagara Region is manufacturing concrete segments for a total of 77 hybrid towers of the E-115 series with hub heights of 135 m for the nearby NRWC wind farm in Pelham, Ontario.

The production halls on the shipyard site were leased by ENERCON, converted to comply with manufacturing specifications, and fitted out with the necessary equipment. Production commenced in an 18-month term. Experienced colleagues from WEC Turmbau sites in Germany and from the Canadian concrete tower works in Matane, Quebec assisted their colleagues in St. Catharines during the installation and start-up phase. The project plant in St. Catharines has ambitious targets to meet, as the aim is to produce all of the tower segments required for the project within six months, since ENERCON must vacate the production halls at the end of this brief period.
Energy storage systems are key technologies which are essential if the energy turnaround is to become a reality. They provide an independent guarantee of greater grid stability and supply security despite fluctuating levels of renewables. A pioneering large storage pilot project by Enercon and its project partner Energiequelle has now been officially launched in Feldheim (Brandenburg). Other pilot projects are currently being designed by Enercon or are at the planning stage.
The importance of renewables to our energy supply is growing in step with their continuing success. Accounting as they do for more than 25% of energy consumption in Germany, the relevance to the system of power plants operating with renewable energies such as wind, sunlight and biogas has now become clear in relevance to the system of power plants operating with renewable energies. The regional back-up power plant at Feldheim (RRKW) was constructed right next door to Feldheim wind farm with its 42 wind energy converters – the majority supplied by ENERCON. It comprises a battery storage system with 10 MW installed power and a capacity of 10.79 MWh. It stores energy from the grid which is used as primary balancing power to stabilise any frequency fluctuations in the control zone of network operator 50Hertz. Any discrepancy between the demand for and production of energy is balanced out in seconds, thanks to the energy stored in the RRKW batteries. The energy is stored in a total of 3,360 lithium-ion storage modules, which are housed inside the 17 x 30 m storage building. The rechargeable cells come from the Korean battery manufacturer LG. ENERCON supplied the complex power electronics for the pilot project, including the controls for the inverter used for charging and discharging and for the connection to the grid. The project partner Energiequelle is responsible for the overall planning and commercial management of the project. A total of 42,300 kW power cabinets are used at the RRKW. These are based on ENERCON’s tried and tested inverter technology – core ENERCON technology which is installed in every ENERCON wind energy converter and can be relied upon to ensure that the energy which is produced is converted to a grid-compliant voltage. To date, ENERCON has manufactured about 142,000 of these 300 kW power cabinets. They are in operation in more than 24,600 wind energy converters around the world.

To ENERCON and Energiequelle, the RRKW represents an important milestone on the road to the energy turnaround. It is the largest battery storage system in Germany so far, and will serve as an important role model in the future restructuring of the energy system. "Flexible battery storage systems such as the one in use at the RRKW are enabling renewables to assume greater responsibility for the system as a whole despite their fluctuating availability, and they are doing this independently of fossil-based back-up solutions," explains Jens Winkler, who is responsible for the power industry and energy management division at ENERCON. At present, gas and coal-fired power stations still have to be kept on standby to ensure that the same high levels of energy demand can be met even when there is little wind or sun. These environmentally-harmful reserve power stations will be put out of business by storage systems, which will make it possible to produce 100% of our balancing energy from renewables. Energiequelle’s managing director Michael Raschemann is therefore optimistic that it will be possible even in the medium-term to secure our energy supply from renewable sources alone, with the help of storage systems like the one in Feldheim.

The RRKW Feldheim

The RRKW Feldheim is situated directly next to a wind farm with ENERCON WECs.

Largest battery storage system to date

Other benefits of storage technologies in the restructuring of the energy system can be found in the fact that they promote the decentralised expansion of onshore wind energy and obviate, at least in part, the need for grid expansion. "This is consistent with the cellular approach to a future energy market which we believe to be beneficial, with the possibility of different regions meeting their own energy needs from renewables," says Jens Winkler. Decentralised storage power stations distributed across the country would also increase citizen participation, which in turn would promote the acceptance of the energy turnaround. And – not least – they would have a positive impact on local value creation in the regions concerned. For wind farm operators, storage systems could also let them tap into additional sources of revenue – for instance, at times when the grid operator takes less output from their wind farms or the trading price of electricity is set at a low or even negative level, making it financially unattractive to feed energy into the grid. "In situations like that, operators could store the energy and market it elsewhere", says Jens Winkler. For instance, power-to-gas applications might be considered. This is a process whereby energy from the storage system is converted into hydrogen by an electrolyser upstream of the grid connection point. This could then be sold directly or fed into the natural gas network. Thus CO2-free "wind gas" could be made available to consumers, for instance as fuel, or supplied as a raw material to the mineral oil or chemical industry. "Legally speaking, this would not constitute a multiple sale, which is prohibited, as the energy is not fed into the power grid," explains Jens Winkler.
Stabilization of feed-in performance

While storage solutions combined with power-to-gas applications are still at the verification stage at ENERCON, other alternatives to power frequency regulation such as the one found in Feldheim have already been successfully implemented. “The storage of renewable electricity can also consolidate the feed-in capacity of wind energy converters”, explains Bettina Lenz, head of the storage system and energy management department of ENERCON’s research and development company WRD, and WRD project leader for RRKW Feldheim. The possibilities of this are currently being studied as part of another storage pilot project being conducted by ENERCON in partnership with the energy supplier SEV at Húsahagi wind farm on the Faroe Islands. The 2.3 MW battery storage system is designed in the first instance to even out rises and falls in the power supply obtained from wind energy converters. By balancing out abrupt fluctuations, a more constant feed-in capacity is achieved, which in turn improves the stability of the island grid on the Faroes. This also prevents situations from arising whereby the grid operator restricts feed-in capacity when a high-wind phase coincides with low energy demand.

The battery storage system of the wind farm with its 13 ENERCON E-44/900 kW turbines comprises two battery containers from the French manufacturer Saft combined with a 2.3 MW smart container for power conversion and control developed by ENERCON. The lithium-ion batteries have a nominal power of 2.3 MW and a capacity of 720 kWh. The smart container houses ENERCON’s inverter technology and the components for controlling the power electronics.

“ENERCON’s expertise in the field of energy storage lies in the provision and control of interface features for connecting the storage system to the grid.”

Joachim Stilla, Division Manager of Innovation Strategies and System Architecture and Program Manager for storage systems, WRD GmbH

While storage solutions combined with power-to-gas applications are still at the verification stage at ENERCON, other alternatives to power frequency regulation such as the one found in Feldheim have already been successfully implemented. “The storage of renewable electricity can also consolidate the feed-in capacity of wind energy converters”, explains Bettina Lenz, head of the storage system and energy management department of ENERCON’s research and development company WRD, and WRD project leader for RRKW Feldheim. The possibilities of this are currently being studied as part of another storage pilot project being conducted by ENERCON in partnership with the energy supplier SEV at Húsahagi wind farm on the Faroe Islands. The 2.3 MW battery storage system is designed in the first instance to even out rises and falls in the power supply obtained from wind energy converters. By balancing out abrupt fluctuations, a more constant feed-in capacity is achieved, which in turn improves the stability of the island grid on the Faroes. This also prevents situations from arising whereby the grid operator restricts feed-in capacity when a high-wind phase coincides with low energy demand.

The battery storage system of the wind farm with its 13 ENERCON E-44/900 kW turbines comprises two battery containers from the French manufacturer Saft combined with a 2.3 MW smart container for power conversion and control developed by ENERCON. The lithium-ion batteries have a nominal power of 2.3 MW and a capacity of 720 kWh. The smart container houses ENERCON’s inverter technology and the components for controlling the power electronics.

“ENERCON’s expertise in the field of energy storage lies in the provision and control of interface features for connecting the storage system to the grid.”

Joachim Stilla, Division Manager of Innovation Strategies and System Architecture and Program Manager for storage systems, WRD GmbH
Feeding bees at our site

IN ORDER TO PROVIDE FOOD FOR BEES AND BENEFICIAL INSECTS, ENERCON HAS CREATED A ROUGHLY FIVE HECTARE WILDFLOWER MEADOW AT ITS SITE IN AURICH-SANDHORST. THIS IS IN ADDITION TO THE EXISTING FLOWER AND ORCHARD MEADOWS WITH WHICH ENERCON IS MAKING A VOLUNTARY CONTRIBUTION TO ENVIRONMENTAL PROTECTION AND NATURE CONSERVATION.

The land to the south of the ENERCON innovation centre in Aurich-Sandhorst is a colourful sea of flowers. Sunflowers, camomile, poppies, heliotropes, campion, yarrow, vetch, mustard and clover as well as numerous other cruciferous and papilionaceous plants and their cousins from the forget-me-not family create a vibrant contrast to the glazed façade of ENERCON’s company headquarters. ENERCON planted some five hectares of wildflower meadow in its grounds in the early summer. Now the wild flowers are providing bees and beneficial insects with vital food, which is proving ever harder for them to find because of the intensive agriculture which is widely practised.

The grounds in Sandhorst are not being used at present, so instead of sowing them with grass seed, ENERCON came up with the idea of turning them over to bee-friendly flower pastures. Ten different seed mixtures containing between 5 and 39 individual varieties – including annuals and perennials – were sown. A tractor and drill were used on the more extensive areas. Youngsters who tend ENERCON’s “KITA Wirbelwind” kindergarten enthusiastically scattered the seed mixtures in the less accessible corners.

Flower meadows offer all flower-visiting insects a rich source of food throughout the growing season and into October. Conversely, there is barely sufficient nourishment to be found by honey bees, wild bees, bumblebees, butterflies, moths, wasps and the like on agricultural land, which is farmed intensively in many places today. A search for a classically grazed cow meadow, where not only grass but also wild flowers and grasses grow, will usually be in vain. That is why many beekeepers are already sounding the alarm.

Another benefit of keeping flower meadows in a near-natural state is that they also attract spiders, ants, grasshoppers, beetles, earwigs and other insects which, along with the flower-visiting insects, provide food in turn for pheasants, partridges, swallows, robins, tits and other bird species. Furthermore, wild flowers can also feed small game animals with a vegetarian diet, such as hares and roe deer.

“We regard our wildflower meadows as a voluntary contribution to environmental protection and nature conservation”, says Helmut Gerken, the technical plant manager of the innovation centre, who himself keeps bees for a hobby. “As a company engaged in the renewables sector, it is only natural that we should be committed to the environment in other areas too.” This commitment is anchored in the company’s guiding principles, which accord a high status to environmental protection.

There are, accordingly, several other examples to be found at the Aurich site of ENERCON’s commitment to the environment: the new flower meadows take their place alongside the existing 4,400 m² of wildflower meadows created by ENERCON and some 70,000 m² of orchard meadows, where indigenous shrubs such as rowan, sloe, wild rose and hawthorn are among the species introduced in order to develop these natural areas. Nesting sites for bats, birds and insects have also been created there with the help of the children and young people who are members of Sandhorst fire brigade. //

IN ORDER TO PROVIDE FOOD FOR BEES AND BENEFICIAL INSECTS, ENERCON HAS CREATED A ROUGHLY FIVE HECTARE WILDFLOWER MEADOW AT ITS SITE IN AURICH-SANDHORST. THIS IS IN ADDITION TO THE EXISTING FLOWER AND ORCHARD MEADOWS WITH WHICH ENERCON IS MAKING A VOLUNTARY CONTRIBUTION TO ENVIRONMENTAL PROTECTION AND NATURE CONSERVATION.

Youngsters from ENERCON’s “KITA Wirbelwind” kindergarten helped with the sowing – accompanied by KiTa leader Yvonne Schäfer (left) and technical plant manager Helmut Gerken (right).

“We regard our wildflower meadows as a voluntary contribution to environmental protection and nature conservation”, says Helmut Gerken, the technical plant manager of the innovation centre, who himself keeps bees for a hobby. “As a company engaged in the renewables sector, it is only natural that we should be committed to the environment in other areas too.” This commitment is anchored in the company’s guiding principles, which accord a high status to environmental protection.

There are, accordingly, several other examples to be found at the Aurich site of ENERCON’s commitment to the environment: the new flower meadows take their place alongside the existing 4,400 m² of wildflower meadows created by ENERCON and some 70,000 m² of orchard meadows, where indigenous shrubs such as rowan, sloe, wild rose and hawthorn are among the species introduced in order to develop these natural areas. Nesting sites for bats, birds and insects have also been created there with the help of the children and young people who are members of Sandhorst fire brigade. //
White Paper in favour of flexibility in all electricity markets

As well as aiming to increase the flexibility of the Energy-Only Market (EOM), the Federal Government’s White Paper is also seeking to increase flexibility in the Electricity Balancing Market. Batteries, but also Wind Energy Converters (WECs), should be the beneficiaries.

The Federal Government has presented its White Paper on the design of the electricity market, which will form the basis for a new energy market bill next year. As well as rejecting capacity markets, its core message is that the electricity market must become more flexible. This applies not only to the EOM, where surplus amounts of energy are traded on the stock exchange, but also to the electricity balancing market, which is essential for ensuring a stable electricity system.

ENERCON has long been involved in the provision of ancillary services by WECs, as meeting all our needs from renewable energies also requires us to guarantee system stability. That is why ENERCON is represented on a number of research projects and involved in some actual pilot projects (cf. the report on p. 10 about storage technologies). Supplying balancing energy is technically feasible, but the prevailing conditions are often not conducive to this. In terms of storage solutions, the Federal Government should consider promoting the potential use of storage systems in practice. This support must go further than mere research projects; instead, support should be given to concrete applications in the marketplace, for instance by providing exemptions from the tax on electricity and the EEG levy, and it should extend further than just electricity storage applications per se.

The regulations governing the secondary control reserve and the minutes reserve, i.e. with positive and negative balancing power being dealt with separately.

The periods for which offers are tendered must also be reduced. It is difficult for volatile power generators to make a firm offer extending over several hours. While competition increases as offer periods are reduced, which should mean lower costs in the long term. ENERCON believes that the tendering of one-hour time slots is both possible and necessary.

The lead time between submitting a tender and supplying electricity must be reduced dramatically in order to make a significant improvement in forecast quality. This will make more options available in terms of supplying electricity from renewables, whose levels can fluctuate. ENERCON considers a lead time of 24 hours to be sufficient in the case of secondary control reserves and minutes reserves.

Verification procedures vis-à-vis the amount of balancing energy actually delivered are also important. In the past, grid operators have issued a road map for power stations on whose basis the balancing energy was supplied. A predefined roadmap does not make economic sense, as the WECs would have to operate at less than full capacity, thus wasting valuable CO2-free electricity. Consequently, a verification procedure is urgently required for potential feed-ins. Such a procedure has already been tested successfully in Belgium with the transmission system operator ELIA at the Estinnes wind farm.

The quantity of balancing energy required should not be determined months in advance, but using an adaptive technique. In other words, the required quantity should be determined the day before it will actually be needed on the basis of forecasts.

As a partner in dena’s Ancillary Services Platform, ENERCON is also helping to shape the future development of framework conditions, and is committed to ensuring that politicians put their pronouncements in favour of flexible markets into action and create the necessary adjustments to the regulatory framework for storage systems and renewable energies, because in the past markets have been designed to meet the needs of conventional power stations. Since it is our intention to replace these framework conditions must be adapted to suit the new power generators, and as we all know, that means renewable energies.

Not only are ENERCON wind turbines equipped with a WEC control system, but also with an intelligent grid management function. With this WEC concept, the variable frequency AC current is fed into the grid by means of a full-scale power converter. In order to guarantee reliable power feed, voltage and current are recorded in cycles at a reference point of the wind energy converter and other values such as e.g. the frequency are determined. These are transmitted to the control system and regulate, among other things, the turbine’s feed-in behaviour.

Due to ever rising loads and the increasing number of volatile power feed sources in distribution and transmission networks, connection requirements for renewable energy generators are becoming ever more stringent. These requirements are also reflected in the standards and directives. For a number of years now, wind energy converters have been equipped with grid stabilizing features.

ENERCON’s feed-in concept allows for highly dynamic reactive power injection regardless of the operating point defined by the wind. The essential thing here is that the WEC indexes through a grid fault without disconnecting from the grid. During the grid fault, the control system in ENERCON wind energy converters supports the grid by feeding in the appropriate reactive current. This dynamic grid support contributes to stabilizing the grid. The new 4-MW-platform will be equipped with the FACTS power feed feature which includes the provision of asymmetrical reactive current in the event of asymmetrical grid faults. FACTS stands for Flexible AC Transmission System. By means of the respective factors, the input can be adjusted to the prevailing grid conditions. Likewise, all current wind energy converters in the ENERCON product range will be provided with a FACTS update. All ENERCON wind energy converters therefore meet the most recent technical requirements for connection to high voltage networks. This grid technology again adds to increasing turbine reliability and security.

The WEC control system monitors and records the wind energy converter’s current operating data – an efficient control system which ensures secure, profit-yielding operation.

White Paper in favour of flexibility in all electricity markets

As well as aiming to increase the flexibility of the Energy-Only Market (EOM), the Federal Government’s White Paper is also seeking to increase flexibility in the Electricity Balancing Market. Batteries, but also Wind Energy Converters (WECs), should be the beneficiaries.

The Federal Government has presented its White Paper on the design of the electricity market, which will form the basis for a new energy market bill next year. As well as rejecting capacity markets, its core message is that the electricity market must become more flexible. This applies not only to the EOM, where surplus amounts of energy are traded on the stock exchange, but also to the electricity balancing market, which is essential for ensuring a stable electricity system.

ENERCON has long been involved in the provision of ancillary services by WECs, as meeting all our needs from renewable energies also requires us to guarantee system stability. That is why ENERCON is represented on a number of research projects and involved in some actual pilot projects (cf. the report on p. 10 about storage technologies). Supplying balancing energy is technically feasible, but the prevailing conditions are often not conducive to this. In terms of storage solutions, the Federal Government should consider promoting the potential use of storage systems in practice. This support must go further than mere research projects; instead, support should be given to concrete applications in the marketplace, for instance by providing exemptions from the tax on electricity and the EEG levy, and it should extend further than just electricity storage applications per se.

The regulations governing the secondary control reserve and the minutes reserve, i.e. with positive and negative balancing power being dealt with separately.

The periods for which offers are tendered must also be reduced. It is difficult for volatile power generators to make a firm offer extending over several hours. While competition increases as offer periods are reduced, which should mean lower costs in the long term. ENERCON believes that the tendering of one-hour time slots is both possible and necessary.

The lead time between submitting a tender and supplying electricity must be reduced dramatically in order to make a significant improvement in forecast quality. This will make more options available in terms of supplying electricity from renewables, whose levels can fluctuate. ENERCON considers a lead time of 24 hours to be sufficient in the case of secondary control reserves and minutes reserves.

Verification procedures vis-à-vis the amount of balancing energy actually delivered are also important. In the past, grid operators have issued a road map for power stations on whose basis the balancing energy was supplied. A predefined roadmap does not make economic sense, as the WECs would have to operate at less than full capacity, thus wasting valuable CO2-free electricity. Consequently, a verification procedure is urgently required for potential feed-ins. Such a procedure has already been tested successfully in Belgium with the transmission system operator ELIA at the Estinnes wind farm.

The quantity of balancing energy required should not be determined months in advance, but using an adaptive technique. In other words, the required quantity should be determined the day before it will actually be needed on the basis of forecasts.

As a partner in dena’s Ancillary Services Platform, ENERCON is also helping to shape the future development of framework conditions, and is committed to ensuring that politicians put their pronouncements in favour of flexible markets into action and create the necessary adjustments to the regulatory framework for storage systems and renewable energies, because in the past markets have been designed to meet the needs of conventional power stations. Since it is our intention to replace these framework conditions must be adapted to suit the new power generators, and as we all know, that means renewable energies.

Not only are ENERCON wind turbines equipped with a WEC control system, but also with an intelligent grid management function. With this WEC concept, the variable frequency AC current is fed into the grid by means of a full-scale power converter. In order to guarantee reliable power feed, voltage and current are recorded in cycles at a reference point of the wind energy converter and other values such as e.g. the frequency are determined. These are transmitted to the control system and regulate, among other things, the turbine’s feed-in behaviour.

Due to ever rising loads and the increasing number of volatile power feed sources in distribution and transmission networks, connection requirements for renewable energy generators are becoming ever more stringent. These requirements are also reflected in the standards and directives. For a number of years now, wind energy converters have been equipped with grid stabilizing features.

ENERCON’s feed-in concept allows for highly dynamic reactive power injection regardless of the operating point defined by the wind. The essential thing here is that the WEC indexes through a grid fault without disconnecting from the grid. During the grid fault, the control system in ENERCON wind energy converters supports the grid by feeding in the appropriate reactive current. This dynamic grid support contributes to stabilizing the grid. The new 4-MW-platform will be equipped with the FACTS power feed feature which includes the provision of asymmetrical reactive current in the event of asymmetrical grid faults. FACTS stands for Flexible AC Transmission System. By means of the respective factors, the input can be adjusted to the prevailing grid conditions. Likewise, all current wind energy converters in the ENERCON product range will be provided with a FACTS update. All ENERCON wind energy converters therefore meet the most recent technical requirements for connection to high voltage networks. This grid technology again adds to increasing turbine reliability and security.

The WEC control system monitors and records the wind energy converter’s current operating data – an efficient control system which ensures secure, profit-yielding operation.
ENERCON introduces new maintenance concept

INCREASED REGULATION IN THE FORM OF STANDARDS AND DIRECTIVES MEANS THAT THE MAINTENANCE OF WIND ENERGY CONVERTERS REQUIRES A MORE WIDE-RANGING INSPECTION THAN IN THE PAST. IN ORDER TO ENSURE THAT IT CONTINUES TO PROVIDE AN EFFICIENT, CUSTOMER-ORIENTED SERVICE UNDER THESE NEW CONDITIONS, ENERCON IS ADJUSTING ITS MAINTENANCE CYCLES AND PACKAGES.

ENERCON is preparing a comprehensive restructuring of its maintenance concept in Germany. Tasks which were previously performed separately will in future be aggregated and carried out on the same dates. Moreover, additional inspections will be carried out every four years, and there will be improved documentation of the maintenance work carried out; this will include the certificates and reports required by the relevant supervisory authorities. This restructuring is in response to increased regulation in the form of standards and directives, which means that the maintenance of wind energy converters requires a more wide-ranging inspection than in the past.

“In order to ensure that our customers are provided with an efficient, customer-oriented service, we are adjusting our maintenance cycles and packages,” explains Volker Kendziorra, commercial head of ENERCON Service Center. A new maintenance concept has been developed over the past 12 months in response to the steady rise in statutory regulation. This enables operators to comply with all plant and personal protection requirements, because they are ultimately responsible for the operational safety of their wind energy converters.

Responsibility for the changes lies primarily with the increase in statutory requirements such as the so-called DGUV3 inspection (previously the BGV A3) for electric components of wind energy converters and the periodic grid protection test. In future, customers will be able to read and download the proof-of-compliance documents at the Service Info Portal (SIP).

Inspections which used to be conducted separately will be aggregated, enabling ENERCON to extend its standard maintenance interval from every three to every six months. This means that in future the so-called master maintenance which combines electrical and mechanical maintenance, and the grease maintenance included in the present maintenance concept will be carried out at half-yearly intervals. The service teams will be restructured for the master maintenance, and their vehicles equipped with new measuring instruments. Maintenance operations which can only be completed in certain weather conditions – such as overspeed switch and transmission tests – will in future be carried out during the wind-based maintenance, which will form part of master maintenance. Additional modules will also be available which will be scheduled every four years. Apart from the 4-yearly maintenance, these will include WIC-relay and grid protection tests.

“In order to ensure that our customers are provided with an efficient, customer-oriented service, we are adjusting our maintenance cycles and packages.”

Volker Kendziorra, Commercial Head ENERCON Service Center.

New maintenance cycle
The maintenance process is an integral part of the type test, so it goes without saying that the process of transition from a three-monthly to a six-monthly maintenance interval will be accompanied by our major certification partners. We have already received positive feedback from them. The existing service contracts need not be adjusted,” adds Hermann Bohlen, head of customer service at ENERCON.

The new maintenance concept will be introduced in Germany in the first quarter of 2016, and international implementation will follow later during that year. //

Table: The new maintenance concept provides for the annual master maintenance (including wind based maintenance) and grease maintenance. Every four years the comprehensive 4-yearly maintenance and the WIC-relay and grid protection test are performed.

<table>
<thead>
<tr>
<th>Maintenance type</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master maintenance1</td>
<td>During the maintenance WEC components as well as mechanic and electric</td>
</tr>
<tr>
<td></td>
<td>points, safety equipment and power and control cabinets are inspected and</td>
</tr>
<tr>
<td></td>
<td>evaluated. Lubricants are topped up.</td>
</tr>
<tr>
<td>Wind based maintenance2</td>
<td>The maintenance operations performed require a certain wind force. These</td>
</tr>
<tr>
<td></td>
<td>operations include, in particular, over-speed switch tests, transmission</td>
</tr>
<tr>
<td></td>
<td>tests and chopper resistor tests.</td>
</tr>
<tr>
<td>Disease maintenance</td>
<td>WEC components are inspected visually and lubricants are topped up.</td>
</tr>
<tr>
<td>4-yearly maintenance3</td>
<td>Additional sections are checked, components are inspected in detail, and the</td>
</tr>
<tr>
<td></td>
<td>pitch and yaw gear oils are filtered.</td>
</tr>
<tr>
<td></td>
<td>In addition, all checks are carried out which ensure comprehensive protection</td>
</tr>
<tr>
<td></td>
<td>of man when working on the WEC. Continuity of protective conductor systems</td>
</tr>
<tr>
<td></td>
<td>and protection equipment is checked and insulation resistances are measured</td>
</tr>
<tr>
<td></td>
<td>(required by DGUV Regulation 3 amongst others).</td>
</tr>
<tr>
<td>WIC-relay and grid protection test4</td>
<td>During the WIC-relay test medium-voltage circuit breakers are checked by a</td>
</tr>
<tr>
<td></td>
<td>special test device for proper protection function (requirement of DGUV</td>
</tr>
<tr>
<td></td>
<td>Regulation 3 amongst others).</td>
</tr>
</tbody>
</table>

New EPK package for converters in service for 20 or more years

Operators of ENERCON wind energy converters which have been in service for 20 or more years will in future be able to benefit from the company’s tried-and-tested full-maintenance programme. ENERCON is offering them a special version of its ENERCON PartnerKonzept (EPK) with immediate effect. Called the EPK III, this service product will be based on the standard EPK, although there will be certain exclusions because of the greater risk of failure associated with older converters.

As with all EPK contracts, the scope of services included in the EPK III encompasses scheduled maintenance and remote monitoring of the converter. The repair and replacement of standard spare parts and troubleshooting during servicing are also included. In the above circumstances, ENERCON guarantees a continued 97% technical availability of the converter.

Excluded from the EPK III on the other hand are the repair and replacement of large components, including labour costs, the logistics costs associated with large components, and crane hire to replace them. Such work will only be carried out upon the tendering of an offer by ENERCON and its acceptance by the customer.

This is because of the increased risk of failure associated with converters which have exceeded their anticipated service life: 20 years in the case of earlier ENERCON series as opposed to the 30 years expected of the newest series introduced in the spring, the E-126 EP4. Moreover, it is not always economically viable to replace large components in old converters because of the lower feed-in tariff which is paid. Under the Renewable Energy Sources Act (EEG), converters which have been operating for twenty or more years only receive the much lower basic tariff.

Before an EPK III contract can be concluded, a stability analysis must be submitted by the customer. Once the converter is more than 20 years old, this evidence must be supplied by an independent inspector; otherwise the licensing authorities may threaten to decommision it. A fresh document must be submitted every two years, or every year if the servicing of the converter is not performed by an independent service team. ENERCON recommends that affected customers apply to an accredited inspector for their stability analysis well in advance, and contact ENERCON Service so that a solution can be found with regard to the future maintenance of the converter by ENERCON Service.

ENERCON developed the EPK III so that we could offer the customers concerned an upgraded alternative to a pure maintenance contract,” explains Hermann Bohlen, head of customer service at ENERCON. “We aim to provide every one of our customers with the best possible service at all times.” //
PRACTISE

Intermediate storage site on a disused airfield

ENERCON IS INSTALLING TWENTY E-82/2.3 MW TURBINES AT THE MAHLWINKEL WIND FARM IN SAXONY-ANHALT. THE CONSTRUCTION SITE ON THE GROUNDS OF A FORMER MILITARY AIR BASE IS A TEXTBOOK EXAMPLE OF HOW LOGISTICS CAN BE OPTIMISED FOR A MAJOR PROJECT.

The concrete tower segments stand in two rows each nearly 600 m long. The intermediate storage area for the Mahlewinkel wind farm construction site in Saxony-Anhalt is almost at full capacity - providing reinforcements for the assembly teams who are installing a total of 20 E-82/2.3 MW turbines with a hub height of 138 m on the former military air base once used by the Soviet armed forces in Germany.

Low-loaders arrive with more components all the time. The mobile crane whose job it is to unload the heavy haulage vehicles is in almost continuous use. It also leads the HGVs which transport the components from intermediate storage to the respective assembly site in the wind farm as they are required. "The central logistics point enables us to ensure optimum control of the material flow during assembly", explains ENERCON project leader Hardy Mickoleit. "The intermediate storage area ensures that our works can continue to deliver their components at all times, regardless of how construction work is progressing on site. We also take some of the pressure off the building site, as we no longer have to store any components on the crane hardstand. They are all now kept at the logistics point."

Assembly and project logistics present particular challenges in the case of large-scale projects such as Mahlewinkel. Where hybrid towers and machinery are involved, hundreds of heavy loads bringing fresh supplies of materials must be scheduled to arrive “just in time”. If the transport chain is disrupted at any point - for instance, because there are no police escorts available and the heavy haulage vehicles are unable to leave the works - then construction activities can fall behind schedule. That is why when ENERCON is engaged in a large-scale project, it investigates the possibility of identifying logistics points which can provide temporary storage either in the wind farm itself or in the immediate vicinity of the project. This provides a buffer in case supplies ever fail to arrive. With some major projects, the intermediate storage sites are also used for the pre-assembly of machine components.

But it is unusual even for ENERCON to have at its disposal such an enormous intermediate storage area actually on the wind farm site as the one to be found in Mahlewinkel. The concreted area measures 600 m long and 55 m wide, and is the former apron of the Soviet military air base. Until the Wall came down in 1989, Soviet military helicopters used to be parked on the spot now used by ENERCON project management to provide temporary storage for tower segments. "These were ideal conditions for us", reports Hardy Mickoleit. "The surface could be used for storage without the need for any other preparatory work. And access to the site is very generously proportioned."

Progress on completing the wind farm has proceeded space, not least thanks to the optimisation of logistics for the major project on the spacious site at the forest’s edge. Indeed, all of the towers were finished ahead of schedule. The wind farm has now been commissioned, and the project will soon be handed over to the project planner UMAAG and the eventual operator, the insurance group Talanx. Mahlewinkel wind farm is forecast to produce an annual energy yield of some 94.5 million kWh, making it one of the largest wind farms in Saxony-Anhalt.

An impressive temporary storage area: concrete tower segments deposited on the former apron of the airfield in Mahlewinkel.

Mahlwinkel wind farm with its twenty E-82/3 MW turbines.
First residents’ wind energy converter erected in Saxony

ENERCON HAS INSTALLED AN E-101/3 MW TURBINE IN STREUMEN [SAXONY] FOR THE ENERGY COOPERATIVE EGNEOS. THIS IS THE FIRST WIND ENERGY PROJECT IN THE FREE STATE TO OFFER LOCAL PEOPLE AN OPPORTUNITY TO PARTICIPATE.

Participation models for local residents offer many advantages in relation to the expansion of onshore wind energy. After all, wind farms with local participation and energy cooperatives give the neighbours of the wind farm and people from the surrounding regions a real opportunity to get involved from the planning stage and later to benefit financially from the operation of the wind energy converters. This makes wind energy projects more likely to be accepted, which is essential if the energy turnaround is to continue to be implemented successfully. Moreover, such participation enhances value creation in the local area.

Another advantage of energy cooperatives is that people can own a stake in them even if they make only a relatively small contribution. A recent survey by Leuphana University in Lüneburg revealed that at the end of 2014, a total of 973 energy cooperatives were registered in Germany – with a considerable proportion operating their own wind energy converters. In Saxony too, an energy cooperative is for the first time using wind power to generate its own electricity. ENERCON recently erected an E-101/3 MW turbine for egNEOS (Energiegenossenschaft Neue Energien Ostsachsen eG) in Streumen wind farm.

This first wind energy converter to be owned by a Saxon cooperative was installed during the repowering of a wind farm in the municipality of Wülknitz near Riesa in the district of Riesa Grossenhain, which was connected to the grid in 1999. Two E-101/3 MW turbines with hub heights of 135 m – one of which is owned by egNEOS – were erected to replace two antiquated DeWind 48 machines. egNEOS expects the converter to produce an annual energy yield of some 6 million kWh, enough to supply 2,500 households in Saxony.

egNEOS would like the cooperative project to serve as a model for the entire federal state. “We want to demonstrate with this pilot project for Saxony that residents’ wind projects are feasible here too”, says board member Jan Stoye. “We hope that as many as possible of the people of Saxony will feel emboldened by our project, and that other wind generators will get involved. It would be fantastic if there was at least one windmill in each wind farm owned by the local people, so that the largest possible number of people can get involved.”
First repowering
in the land of the fjords

ENERCON HAS INSTALLED THREE E-70/2.3 MW TURBINES TO REPLACE FIVE OLD VESTAS AT MEHUKEN WIND FARM IN THE FAR WEST OF NORWAY.

Jagged rock faces rise from the sea and tower up to form ragged cliffs on which, over thousands of years, the forces of nature have left their distinctive marks. Patches of sparse vegetation sprout on the mountain slopes, while the surf of the European North Sea foams at the foot of the cliffs, driven there by the brisk, unrelenting wind. On the island of Vågsøy off Norway’s west coast, nature reveals herself in spectacular fashion.

Vågsøy lies at the mouth of Nordfjord, some 300 km north of Bergen and immediately south of Stadlandet, the “West Cape” of Norway. Because of its harsh climate and strong, often-gale-force winds, the coast has a notorious reputation with sailors. For the operators of wind energy converters, on the other hand, the island is a perfect location, which is why Mehuken wind farm has been producing electricity there since back in 2001. For its first large-scale repowering project in Norway, ENERCON recently replaced five old Vestas at this wind farm (V52s with nominal power of 850 kW each) with three E-70/2.3 MW turbines.

The customer for the three E-70s is the operator Kvalheim Kraft DA, a joint venture of the East Norwegian energy suppliers Vardar and Østfold Energi. Both companies are longstanding clients of ENERCON. The tried and tested ENERCON strong-wind turbines were installed on tubular steel towers with hub heights of 64 m. This has expanded the Mehuken site to eleven E-70s altogether, with a total output of 25.3 MW. Eight turbines of the same ENERCON type were installed back in 2010 when the wind farm was first extended.

Repowering has reduced the footprint of the wind farm. However, its production capacity has increased significantly: the operator reckons that the three E-70s will produce an annual energy yield of 21 million kWh. Compared with the old Vestas machines, that will mean an increase in production of 9.5 million kWh. Together with the eight existing E-70s at the wind farm, the total output of the extended facility will be restricted to ca. 22 MW by bottlenecks in the grid. Annual energy yield should be between 74 and 75 million kWh. As soon as the bottlenecks have been removed, Olav Rommetveit (Managing Director of Kvalheim Kraft) expects to see a marked rise in this figure.

“Mehuken is a challenging location”, says Eike Gentsch, ENERCON Sales Manager for Norway. “The terrain has steep inclines, and there are narrow access routes to the site. Moreover, the wind farm is adjacent to a nature reserve.” That is why the existing infrastructure of the wind farm had to be used during erection work, resulting in restricted space on the construction site during this phase.

Nonetheless, the experienced erection team managed to transport and assemble the turbines using standard equipment. Eike Gentsch is delighted that ENERCON has been able to complete a greatly admired reference project with its revamp of Mehuken wind farm. Repowering wind farms tends to be rather difficult in Norway because of the low feed-in tariff and a complicated certification system. “Mehuken demonstrates that repowering is commercially feasible for operators, even under these sorts of conditions”, according to Gentsch. //
ENERCON has now completed its expansion of Steinriegel wind farm. Eleven E-70 E4/2.3 MW turbines have been erected on behalf of the experienced project developer ECOwind for the wind energy project in the municipality of Ratten in Styria. They now stand alongside the original turbines erected at the wind farm at Rattener Alm ten years ago. This means that there are now a total of 21 wind energy converters producing ca. 75.6 million kWh per annum of renewable energy at the Alpine site 1,600 m above sea level. The annual energy yield has increased almost 2.5-fold to ca. 75.6 million kWh – enough energy to power some 24,000 homes.

The construction work at Rattener Alm took place between May and November 2014. Because of its challenging mountain location – Steinriegel is one of the highest wind farms in Europe – special transport solutions were required. A temporary transhipment point was set up in the small town of Ratten for the delivery of the tower sections and machine components. The converter parts were brought there by heavy haulage vehicles before being transferred onto special self-propelled transporters for the last stage up to the wind farm construction site. These remote-controlled units have ten steerable axles and are equipped in such a way that the rotor blades can be transported almost vertically. These so-called Alpine transport chassis, which have already been used successfully by ENERCON for earlier projects in high and medium mountain ranges, allow the transporters to negotiate narrow sections such as hairpin bends without the need to widen them considerably or fell trees. Around eighty journeys had to be made with the special transporters over the 15 km stretch from the transhipment point to the construction site, some of which was along steep and narrow forest tracks.

The E-70 E4s were installed on tubular steel towers with a hub height of 85 m. Because of the prevailing meteorological conditions at the site, they are equipped with ENERCON’s rotor blade de-icing system.

The wind farm contributes to the total of 107.9 MW of wind energy fed into the grid in Styria. There are other projects at the planning stage in the region.

The Steinriegel II wind farm threw open its doors for its official opening in early June. Some 3,000 visitors seized the opportunity to view the facility, which has since been sold to the energy supplier Wien Energie. They were able to explore the interior of a wind energy converter, look down at the wind farm from the man basket of a mobile crane or during a helicopter ride around the site, and take an electric mountain bike tour of the facility. As a matter of principle, some of the visitors and operators drove to the wind farm in their electric cars, and were delighted to find they could charge their batteries directly from the wind energy converter. The great interest shown by the local population and the positive attitude to wind power in the region were reflected in the high number of visitors, and this, together with the colourful programme of activities on offer, was responsible for bringing the expansion project to a successful conclusion.
Innovative ideas are the hallmark of our success moving us forward. We are passionate about realizing wind energy projects across the globe and meeting tomorrow’s energy technology challenges. Make your contribution of ideas to enforce the development of progressive and innovative technologies in our company.

For our R&D company, Innovation for ENERCON GmbH in Bremen, we are seeking to hire an expert in the field of civil engineering (m/f).

**Key Expert**  
Civil Engineering (m/f)

**Responsibilities**
- Develop innovative ideas and concepts for improving and enhancing ENERCON’s wind turbine technology in the field of towers, tower erection and foundations
- Generate ideas to fill the innovation and technology roadmaps
- Develop technology to ensure technical feasibility
- Manage technology and innovation projects
- Assume responsibility of incorporating promising ideas and/or concepts in the product range up to realization of the prototype
- Advise management regarding strategic technical issues for towers, erection and foundations
- Generate ideas for active, systematic development of the patent portfolio and analysis of competitors’ patent portfolios

**Qualifications**
- Degree in civil engineering
- At least five years experience in wind energy technology or similar dynamically loaded structures
- Proven success in technical materialisation of innovation
- Experience in project management
- Managerial experience
- Goal-oriented; able to make decisions, to take criticism, and to deal with conflict management

Submit your applications online through our Careers portal  
Reference code: DE105565  
Place: Bremen

Contact  
Ms Christoffers  
Phone +49 (0) 49 41 - 927 248

[karriere.enercon.de]