

Wind Industry in Germany

ECONOMIC REPORT: An overview of the German wind industry

COMPANIES: Leading companies in the sector present their products and services

INDUSTRY DIRECTORY: Easy access to the right contact

2018



INTERNATIONAL

Wind Industry in Germany 2018

BWE INDUSTRY REPORT



Editorial



Dear Reader,

Success requires a willingness to tackle new challenges every day with enthusiasm and optimism. Success also requires the setting of demanding targets and a serious and determined approach from those tasked with achieving them. In the wind energy sector we are proving, at every company and across the entire value creation chain, how despite complex political conditions, the foundation for success is being laid both at the level of commerce and in terms of employment and climate policy. Our sector continues to grow, both in Germany and in the rest of the world. Investment in renewable energies is growing strongly. Wind energy is establishing itself as the top-performer of a future energy industry.

Germany remains the leading market for wind energy in Europe, still a considerable margin ahead of Spain and the United Kingdom. Germany can also hold its own at international level, with an expansion of 5,333 megawatts offshore and 1,279 megawatts onshore. In terms of technology, Germany remains the driver of innovations when it comes to turbine availability, producible quantities of electricity, forecast reliability, new maintenance concepts or questions of grid integration, as well as management of fluctuating generation and digital concepts such as virtual power stations.

The country's technological leadership is based on a strong and dynamic home market that relies on committed and engaged employees in the respective companies. To safeguard this position, we need regional governments that are willing to support and positively shape the energy transition at local level. And we need a national government which holds its course, which is capable of identifying and exploiting opportunities, and which above all believes in the capabilities of the industry.

The foundations are being laid as we speak. Wind energy already accounts for 15 percent of net electricity generation in Germany. If we include all renewable energies, this figure increases to more than 35 percent. By 2030, the share of renewable energies will have increased to 65%. This is why we want to take on more and more system responsibility. We want to be able to supply commercial and industrial customers directly and make our contribution towards mobility and heating energy. We would like to see access to all infrastructures in the energy sector in a bid to manage the challenge of seasonal shifts. In recent years we have successfully integrated the major growth of onshore and offshore wind generation into the grid, but we still support the optimisation of the existing grid and the expansion of the transmission grids.

The German Wind Energy Association (BWE), comprising more than 3,000 companies and over 20,000 members, represents the expertise and experience of the entire industry. In addition to the supplier and manufacturer industry anchored in German engineering, project developers, specialist lawyers, experts and appraisers, the financial industry, and companies from the fields of logistics, construction, service, maintenance, and storage technologies, the BWE now also includes electricity traders, grid operators and energy providers. This makes us one of the largest associations for renewable energy in the world, allowing us to represent the entire value chain in the sector. We are driving technological development forward in our advisory committees, task forces and forums. Together, we will work towards a successful energy transition!

Yours,

H. Albers

Hermann Albers, President of the German Wind Energy Association

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Wind energy has become a driver for the economy and employment. In 2016, more people were employed in the industry than ever before. In the course of the EEG reforms, however, there were also plant closures and job losses for the first time in 2017.

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Despite the increasing proportion of green electricity, Germany’s carbon dioxide emissions are rising. This is due to the fact that the number of lignite-fired power stations has remained high, and that climate protection measures in the heating and transport sectors have stagnated.

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In order to achieve climate protection targets, green electricity must also reach the heat, transport and industrial sectors. The pressure to act is particularly great in the steel industry. For decarbonisation it would require a great deal of hydrogen generated using green electricity.



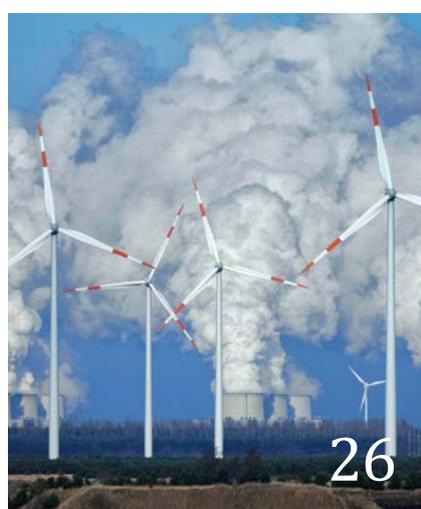
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The innovative power of the companies operating in Germany has given them the edge in terms of technology. Manufacturers are exporting and expanding into foreign markets in Europe, North America and Asia.		Planning, finance, transport, construction and marketing. The fields of planning and operation of wind turbines are a continuous growth market in Germany.		Around 430 addresses of leading companies in the wind industry.	
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Manufacturers of wind turbines from all over the world buy systems and components in Germany. Years of experience of the operational side together with specific research and development projects to reduce manufacturing and operating costs and prolong service life are much in demand everywhere.		Working closely with its cooperation partners, the German Wind Energy Association (BWE) publishes a comprehensive overview of the industry in a publication entitled "Wind Industry in Germany".		Picture credits	224
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Economic report:

The German Wind Industry

The wind energy sector in Germany is a worldwide leader. Already today, its manufacturers, suppliers and service providers employ over 160,000 people.

Christinendorf wind farm, Luedersdorf near Trebbin.



Wind power becoming increasingly affordable

Record installations in Europe, slight fall in new installations in the USA and China. Wind power is attracting investment worldwide – and becoming increasingly affordable. This is good news for the expansion of climate-friendly energy production, but it puts the sector under considerable cost pressure.

2017 was a record year for the German wind sector. The fact that the share of renewable energies in Germany's gross electricity consumption rose to 36 percent at the end of the year was largely down to wind turbines. Europe-wide, wind power is replacing coal as the third most important form of production.

The background to this strong growth, in addition to the political initiatives aimed at climate protection, are the greatly reduced electricity production costs of wind energy. On a global average, these are now only 5 euro cents per kilowatt hour (ct/kWh) and on a par with – or even below hydropower and new coal and oil-fired power stations. This is the result of the study "Renewable Power Generation Costs in 2017" by the Renewable Energies Agency IRENA with data from thousands of power station projects.

The trend is clear: costs are falling worldwide. In Europe, 2017 saw the first tenders for offshore wind turbines to be built after 2020 without state-guaranteed feed-in tariffs. For the first time, these turbines will be financed solely from electricity sales on the stock exchange and direct deliveries to industrial electricity customers. According to Bloomberg New Energy Finance (BNEF), the volume of such purchase agreements increased by around 20 percent to 5,500 MW worldwide in 2017 compared to the previous year. The wind industry is responding to this: the new onshore wind power models presented by manufacturers in 2017 show that the size and efficiency of the turbines will soon increase significantly.

In 2017, the global installed capacity of onshore and offshore wind power reached 52,500 MW. While there were record installations in Europe, numbers in the USA and China fell. Although the number of newly installed facilities continued to be high in both markets, the figure dropped for the second time in a row after strong growth in 2015 and 2016.



Erecting an ENO 126 with 3.5 MW at Kölsa wind farm.



Beach sailing in front of Teesside wind farm near Redcar on the English North Sea coast.



According to market players, the delay on some projects in the USA can be attributed to continued uncertainty under President Trump. In contrast, the high growth rates in Germany and other European countries are down to preemptive effects: project developers have used the time before national governments convert their subsidy systems to tenders and thus further increase cost pressures.

Positive outlook for 2020

2017 was also marked by job losses at some manufacturers: Siemens Gamesa, Senvion and Nordex announced some major job cuts. Companies such as Adwen and Lagerwey were bought up or sought out strong partners. Even if the reasons are different in each case, it is clear that cost pressures are rising and that companies have to gear up for increasing competition.

Not least to prevent job losses in Germany, the discussion has begun on increasing the planned onshore wind power expansion from 2,800 to 4,000 MW in 2018 and 2019. Offshore expansion targets are also expected to be increased. At the same time, the number of wind farms across Europe for which there are investment decisions has increased. Countries such as Spain, Sweden or Russia are again planning substantial investments. Overall, the outlook for the global wind energy market is positive. Analysts expect annual installations to increase to 62,000 (VDMA) -70,000 MW (GWEC) by 2020, up from 52,500 MW in 2017.

Record growth in Europe stabilises world market

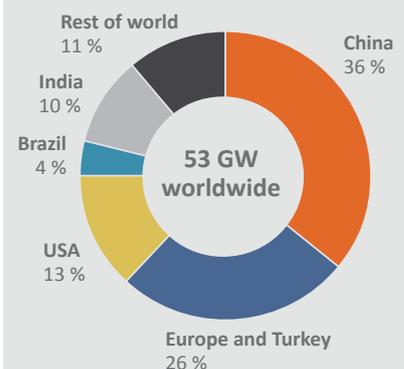
High figures in the USA and China, record installations in Europe. Almost as many wind turbines were built around the world in 2017 as in the previous year. In Europe, wind energy has grown more quickly than ever before, replacing coal as the third largest source of electricity. The average cost of wind power is falling rapidly and is now almost on the same level as fossil fuels.

According to the global wind energy agency GWEC, the onshore and offshore wind turbines newly installed worldwide last year reached a combined total rated capacity of around 52,500 MW. This is only 2,000 MW less than the previous year, although significantly less than the record year in 2015, which saw a new capacity of almost 64,000 MW. However, 2015 benefited from an unusually large expansion in China – just under 33,000 MW – which has remained a one-off positive outlier even for China. The installation volume in the People’s Republic in 2017 came to a good 19,500 MW. The US, with 7,017 MW, came slightly below the figures of previous years. Both countries are therefore characterised by a high level of consistency when it comes to installations, which is an important signal after the turbulences of the past.



Happy faces at AIOS wind farm, Kemi.

World market of wind energy 2017



The fact that the global market dropped only slightly in 2017 was helped by Europe, especially Germany and the United Kingdom, India, and the offshore sector. All of these grew more strongly in 2017 than ever before. In Europe, wind energy accounted for 11.2 percent of electricity generation, overtaking coal as the third largest form of production, as determined by the Agora Energiewende foundation. This makes renewables as a whole the largest source of electricity for the first time, even above coal. Almost all of the power plants newly installed in Europe in 2017 use renewable energy sources – more than half of them are wind turbines, followed by solar power stations. By contrast, the balance of construction and dismantling is negative for all fossil fuels except gas-fired power plants.

EU 2020 goals are driving installations

According to the World Wind Energy Association (WWEA), however, the record year in Germany and the significant growth in other European countries are partly due to pre-emptive effects. Under pressure from the EU, state governments are converting their subsidy systems from fixed feed-in tariffs to tenders. This leads to high expansion still under the familiar, safe conditions of the fixed feed-in tariffs.

It should also be noted that some countries, particularly in Eastern and Southern Europe, are failing to keep pace. The fewest new installations in 2017 were recorded in Spain, with just 96 MW. According to the EWEA, however, this is set to change before long: in 2017, “final investment decisions” were made in Spain for wind farms amounting to 1 billion euros in cost, corresponding to around 1,200 MW of onshore wind power.

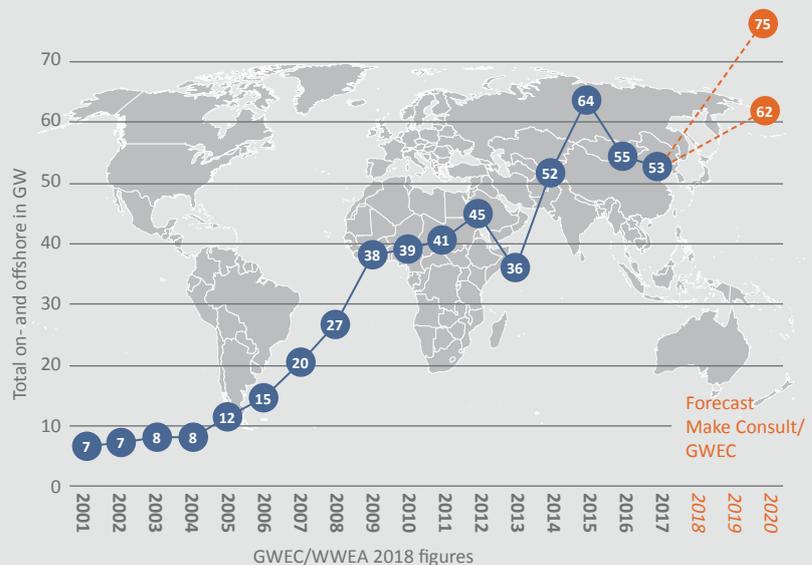
Thanks to significant cost reductions, renewable energies, in particular onshore wind energy, are priced at a level that can mostly compete with new fossil fuel plants. On a worldwide weighted average, one kilowatt hour of electricity from onshore wind energy today costs about 5 euro cents (6 US cents), as calculated by the IRENA agency, based on data from thousands of power plant projects. Good locations may even produce significantly better values. Onshore wind thus represents the second most cost-effective green energy behind hydroelectric power (5 US cents), ahead of bioenergy and geothermal energy (7 US cents each). According to IRENA, current auction results show that in 2020, onshore wind power will be available for 3 US cents per kilowatt hour on average. Electricity from fossil fuels already costs 5 US cents on average – and this figure is rising. This does not even include external costs such as damage incurred by CO₂ emissions.



Wind farm in Andalusia.

For 2018, GWEC expects a significantly higher global expansion of around 61,000 MW. By 2021, the annual installation volume is expected to increase to 75,000 MW. The figures from Make Consult, quoted by major manufacturers like Siemens Gamesa, are a little more modest: the experts from Denmark expect 62,000 MW in 2020.

World wide wind energy installations (in GW/year)



Source: WWEA 2018; GWEC 2018, Make Consult 2018 quoted by Siemens Gamesa; diagram by Ahnen&Enkel

Wind power is driving the German energy transition

More wind turbines were installed in Germany in 2017 than ever before. The good weather conditions also set new records for power generation. As a result, the German green power target for 2020 is expected to be reached by 2017.

The record increase of 1,792 onshore wind turbines with a total rated capacity of 5,333 MW stood out – amounting to 15 percent more than in the previous year and 12 percent more than in the previous record year of 2014. This is because all plants that were approved by the end of 2016 are able to go live with fixed feed-in tariffs by the end of 2018 in accordance with the old 2014 version of the German Renewable Energy Sources Act (EEG). This affects around 8,600 MW. The remaining 3,300 MW of approved

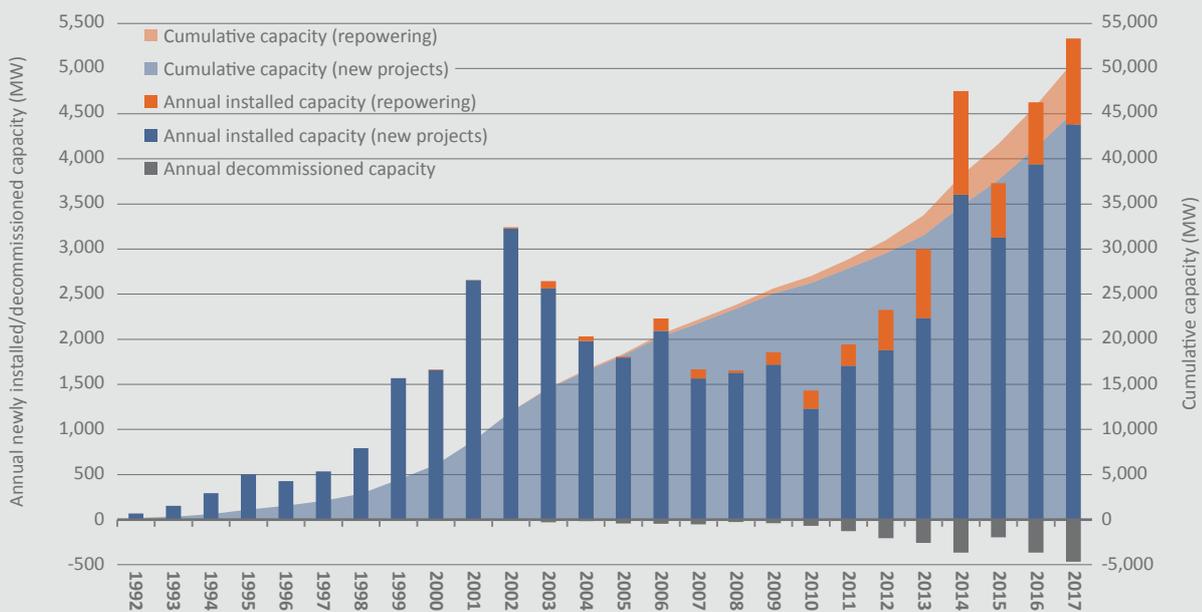
plants that are not yet supplying the grid will most likely follow in 2018. At the turn of the year, a total of 28,675 onshore wind farms, supplying 50,777 MW of power, were connected to the grid. The total number of turbines may become slightly less as a result of decommissioning older turbines (repowering).

A similar “final sprint” is currently taking place for offshore wind turbines, which can still claim fixed-price compensation until the deadline of 31 December 2019.

In the offshore sector, 222 new turbines with a total capacity of 1,250 MW were connected to the grid last year – an increase of 55 percent compared to the previous year and the second largest expansion so far. This means that, by the turn of the year, 1,169 plants with an installed capacity of around 5,387 MW were connected to the grid. By the end of 2019, just under 2,300 MW will have been added under the 2014 EEG.

EXPANSION OF WIND ENERGY IN GERMANY

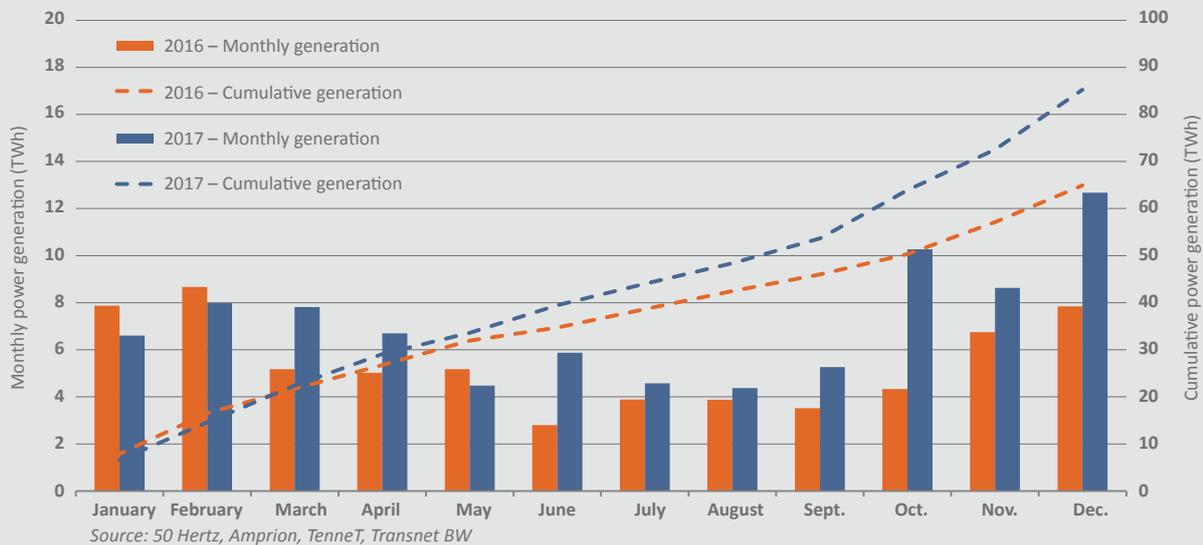
Wind power is growing fast



Source: Deutsche WindGuard 2018

ONSHORE AND OFFSHORE POWER GENERATION

Strong increase in production



Source: Deutsche WindGuard 2018

Very high growth in power generation

The figures determined by Deutsche WindGuard also show new record values for the amount of wind power generated. Onshore production in 2017 rose by almost a third to 85 billion kWh. Offshore wind turbines provided a combined total of 18.3 billion kWh of power, an increase of almost 50 percent compared to 2016. This was due not only to the high level of newly installed capacity, but also to favourable weather conditions in the so-called 'wind year'.

Wind energy thus remains the workhorse of the energy transition in the electricity sector. According to preliminary figures compiled by the working group AGEE-Stat for the German Federal Ministry of Economics, electricity generation from renewables in Germany increased by about 15 percent in 2017, to 216 billion kWh. The share of renewable energies in gross electricity consumption is therefore around 36 percent, compared to 31.5 percent in the previous year. This ratio has more than doubled since 2010

(16.9 percent). The German government's goal of at least 35 percent by the year 2020 has thus already been achieved.

The new installation statistics for 2017 also show a regional distribution of wind energy that is important for the cohesion of the German electricity market. While in the early years of wind energy, around 90 percent of turbines were installed in coastal regions, under the old EEG they increasingly reached Germany's southern regions. "The fact that the southern German states now account for 44 percent of the additional construction demonstrates that, from a technical perspective, the use of wind energy is economical throughout Germany," says Hermann Albers, President of the German Wind Energy Association (BWE).

North Rhine-Westphalia ranked second with a gross new installation volume of 307 wind turbines (870 MW), behind Lower Saxony (485 wind turbines, 1,436 MW), but ahead of Schleswig-Holstein (180 wind turbines, 552 MW) and Brandenburg (171 wind turbines, 535 MW).

Baden-Württemberg made it to fifth place with 128 wind turbines, supplying 401 MW. On average, this was where the largest turbine facilities were built. Politicians now face the challenge of maintaining this regional balance despite the switch to a tender system.

For 2018, an additional onshore capacity of about 3,500 MW is to be expected, of which about 3,300 MW will be under the transitional system, with a small proportion representing the first new installations under the tender system. From 2019, annual new capacity will be capped at 2,800 to 2,900 MW. It is uncertain how much expansion can be expected, given that in the first tender procedures it was mainly community wind projects without approval that won the bids, and these will not be put into operation until 2021 at the earliest.

More and more direct electricity contracts with industry customers

The cost of producing electricity from renewable energies is falling and could in future be increasingly financed through higher electricity prices and long-term supply contracts with major electricity consumers. However, “corporate PPAs” such as these are still unusual in Germany.

According to the International Renewable Energy Agency (IRENA), all mainstream technologies in renewable energies such as wind power and solar energy will generate electricity at a cost “at the lower end of the range of fossil energies” by as early as 2020. In particular, wind and solar energy systems at favourable locations are set to produce the “cheapest electricity of all possible forms of generation”. Today, 4 US cent/kWh is already a “routine” cost for producing electricity from onshore wind turbines and will continue to fall.

Globally, we are getting closer and closer to the point at which renewable energies will be financed entirely by direct sales of the electricity generated, and no longer through state-guaranteed tariffs.

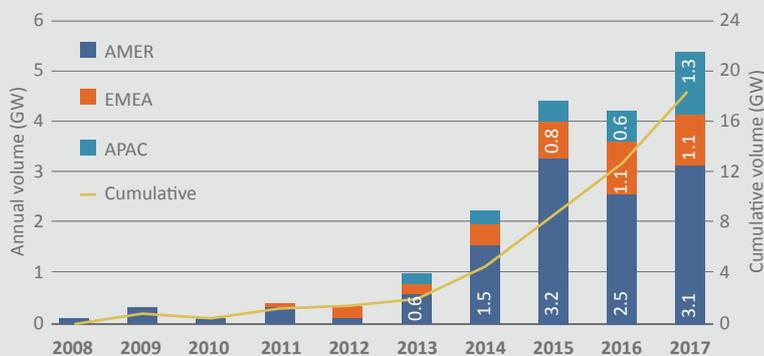
In this context, attention will turn increasingly to long-term supply contracts known as power purchase agreements (PPAs) between system operators and energy providers or large consumers (corporate PPAs). In a PPA, both sides agree on a given supply quantity over a specific period and at a defined price.



The importance of PPAs of this kind is increasing worldwide. According to Bloomberg New Energy Finance, contracts for a total of 5.4 gigawatts were concluded in 2017, an increase of 25% over the previous year.

Windpower Europe is already predicting a “PPA Revolution”. The main countries so far are the USA and United Kingdom, where the law requires that a given percentage of electricity be generated from renewable sources, and they ensure this by means of PPAs.

Growing electricity sales to companies



Volumes of electricity usage contracts between renewable energy producers and companies (corporate PPAs) relating to installed power in GW. EMER: Europe, Middle and Far East, Africa; AMER: America; APAC: Asia, Pacific
Source: BNEF 2018

Virtually no PPAs in Germany

According to Energy Brainpool, the fixed tariffs, low energy prices and procurement horizons of around three years on the current market in Germany mean that demand for PPAs is very limited. Existing contracts are characterised by extremely favourable plant locations and customers with a green image and long planning horizons, such as the frequently mentioned internet giants Google, Microsoft and Amazon. A mass market will not develop until the decade after 2020 when, after 20 years of operation, many wind energy plants will also lose their EEG subsidies.



According to Energy Brainpool, the question will then turn to the way contractual conditions will be agreed in individual cases and whether one of the two parties will benefit more than the other. This depends on whether the price of electricity increases at more than or less than the rate calculated in the contract. For an example plant, Energy Brainpool calculated a “fair value” by which the opportunities and risks arising from the change in price are split equally between generator and consumer. German analysts calculate this price as being 3.2 ct/KWh.

The International Energy Agency believes that by 2022, around half of the then-newly installed wind turbines worldwide will be financed via PPAs. Some businesses have shown an interest in PPA. For example, the initiative RE100 brings together 125 major corporations, ranging from Kellogg’s to Tata Motors, that wish to switch to 100% renewable energy sources. However, only four German companies figure among them, namely SAP, BMW, real estate company alstria, and Sky.

In Germany, experts are not expecting to see any corporate PPAs in the near future, given that various legal taxation and usage rules and lower energy prices on the stock exchange stand against this.



Nordex N117 at the wind farm CC4E of HAW technology centre, in Curslack/Hamburg.

Contested tender design has to be adjusted yet again

The 2017 tenders were dominated by legally defined community wind farms without BImSchG approval. This jeopardised the expansion targets and unsettled the supply industry. In the meantime, politicians have “repaired” the EEG and increased the onshore tender quantity.

In 2017, the system for promoting wind energy in Germany was converted from fixed feed-in tariffs to remuneration, the amount of which is determined in the tenders. In the first three tender rounds in 2017, 2,730 out of 2,820 MW of the tendered amount went to legally defined community energy companies, which are able to plan projects without approval in accordance with the Federal Immission Control Act (Bundesimmissionsschutz-Gesetz – BImSchG). The community energy companies had also received significantly more time from legislators for implementation, with four and a half years instead of two.

This framework for community energy companies was an attempt to give small, local initiatives a chance in the tenders. The intention was to preserve the variety of players and ensure the acceptance of new local wind farms. However, established medium-sized project developers seized the opportunity to secure wind farm projects under the legal definition of community energy companies.

Due to the exemption from BImSchG approval and the implementation period of four and a half years, however, it is not certain how high the implementation rate of these projects will be. This is why the manufacturers of wind turbines in particular have warned about an approaching “expansion dip” in onshore wind power.



Citizen's wind farm in Lübow, Mecklenburg-Vorpommern.



2018: Greater planning security and volumes

The Federal Government reacted to this and in mid-2017 suspended the exemption from the BImSchG approval for the first two tenders in 2018. This is set to make time for the tendering methods to be thoroughly reviewed under a new government.

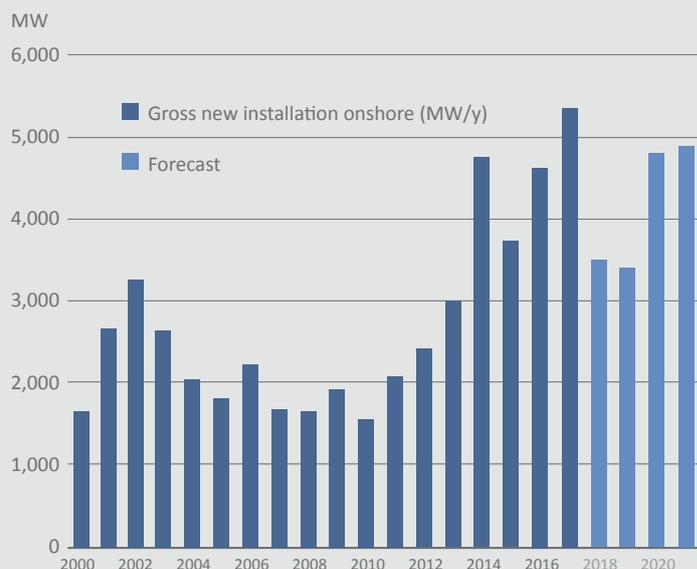
In light of the delays in forming the government, the German Bundesrat, on the initiative of the state of North Rhine-Westphalia, also introduced a draft law to the Bundestag at the beginning of February to reform the German Renewable Energy Act (EEG). The law is expected to come into force by the third auction in early August. The objective is that only approved projects can participate in the tenders and that the implementation period is reduced again to two years. In addition, the volume of tenders should be increased significantly as early as 2018, in order to counteract any potential "expansion dip". Industry associations expect that the expansion of onshore wind power in the coming years will average 4,500 MW per year (see graph).

The German Wind Energy Association (BWE) and the German Engineering Federation (VDMA) praised the initiative. However, in order to achieve the goal announced by the new Federal Government of increasing the share of green electricity to 65 percent by 2030, an effective adjustment of the tendering volume for onshore wind energy beyond 2020 would be necessary, especially since the EEG subsidy will not apply to many old turbines from 2020. The goal of the lawmakers must also be to remedy the significant north-south divide as regards the awarding of contracts. While 44 percent of all wind turbines were erected in Germany's southern states in 2017, they received only 28 percent of contracts in the auctions. Federal policy has recognised the need for action and promised a model for better regional distribution. Various models are being discussed, including a fixed quota of contracts for the south. The BWE recommends adjusting the reference yield model once again, taking into account low-wind locations as well.



ANNUAL TENDERS AND EXPANSION FORECAST

High-level onshore expansion planned



Annual expansion of onshore wind energy (in MW) from 2000 to 2017 and forecast for 2018 to 2021
Sources: Onshore: BWE "Installation figures 2018" including planned special tenders

A watershed moment for offshore wind power

2017 marked a transition for offshore wind power. For the first time, project developers announced that they would do without government remuneration. Also, the first floating wind farm went into operation. This changes some basic preconditions.

The outcome of the first tendering of offshore wind farms in Germany in April was rather surprising, even for the majority of experts. Energy providers EnBW and Ørsted (formerly Dong Energy) were awarded four projects with a total rated capacity of 1,500 MW – three of them at the market premium bid of zero cents/kWh. In anticipation of falling costs and rising electricity prices, they held out the prospect of doing without public funding altogether. These wind farms will not be connected to the grid until the middle of the next decade and the investment decision will only have to be made in a few years, in accordance with the law. The bidders therefore have time to wait for costs and prices to develop. If they retreat, they would pay a relatively small penalty compared to the amount invested.

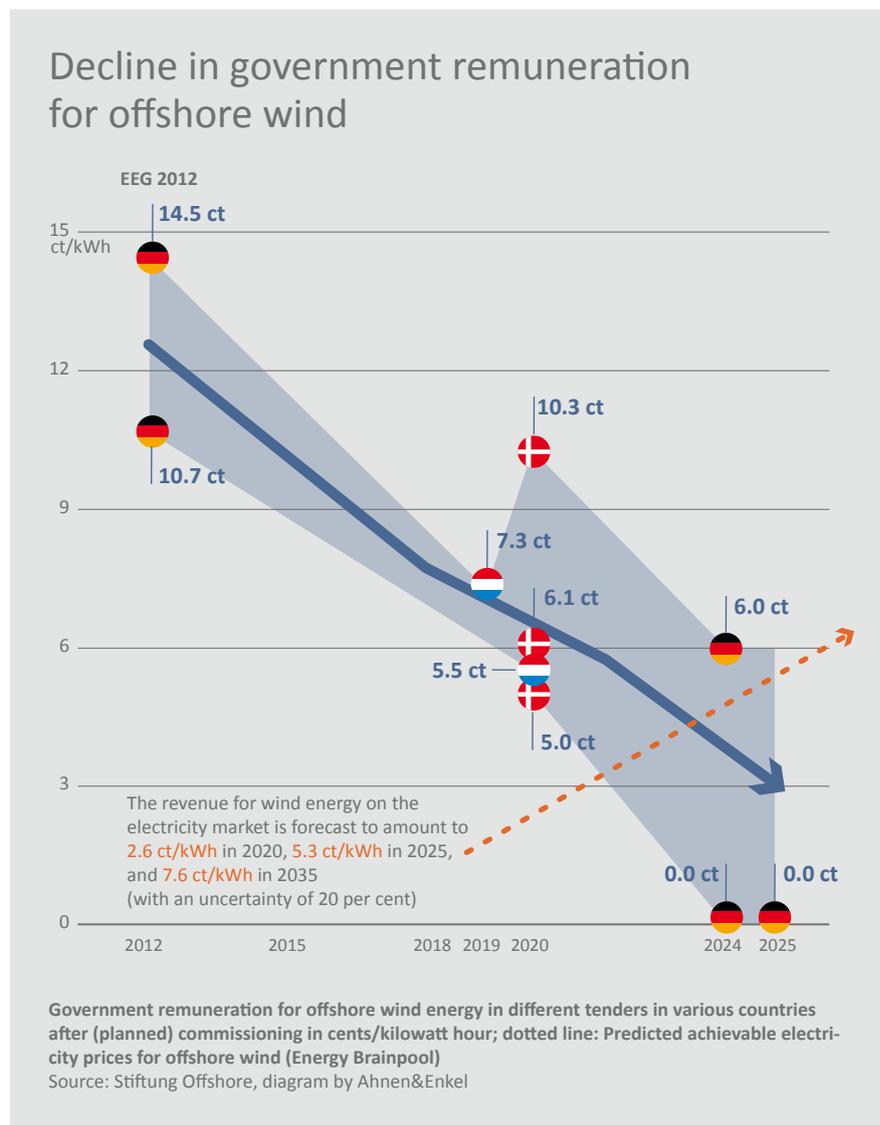
The price slump was looming. In previous tenders in the Netherlands and Denmark, the reference values fell successively, from more than 7 to less than 5 cents. Until then, the government-fixed remuneration had averaged 12 to 14 cents.



Butendiek offshore wind farm with a total output of 288 MW.

The German auction result quickly prompted the Dutch government to adapt its tender design and in the future allow only zero-cent bids. And it did so successfully: for the first project following the

new method, there were several bids at the end of 2017. The decision now falls on the basis of soft criteria such as the technical quality of the plans for the power station or tenderer experience.



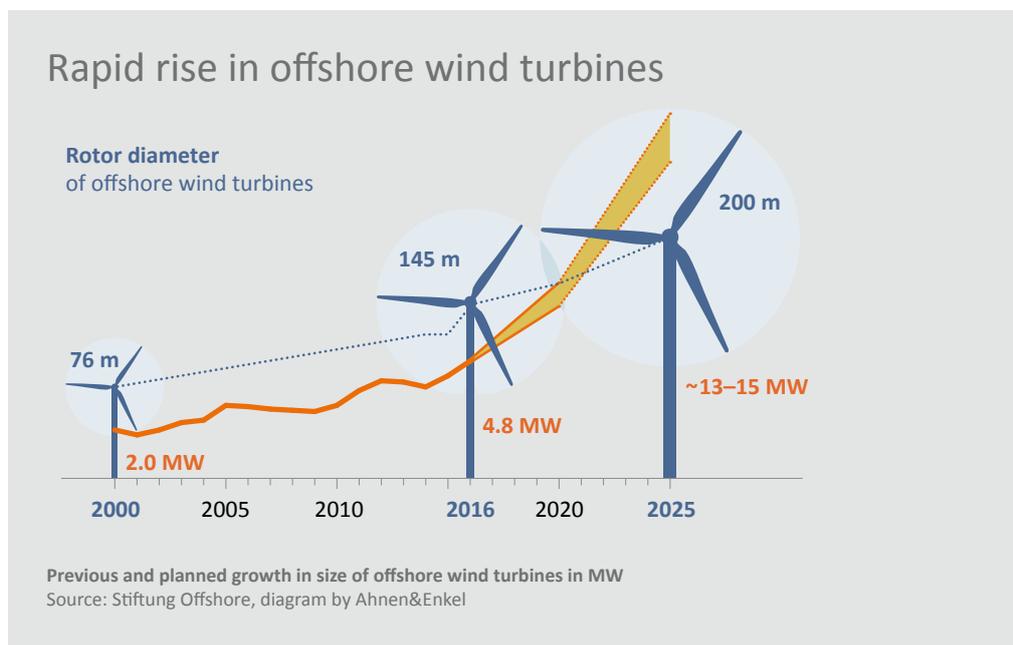


Gode Wind offshore wind farm in the German North Sea with a total output of 582 MW.

Europe remains the only major market

The only major market for offshore wind to date is Europe. In the past year, installed capacity rose by a record level of 3,100 to 15,800 MW. This is largely due to the United Kingdom (1,700 MW) and Germany (1,300 MW). The total installed capacity in Europe, and thus the world, is restricted to 98 percent to five countries: United Kingdom, Germany, Denmark, the Netherlands and Belgium. The main reason is that 95 percent of all shorelines with 50 metres and more are too deep for the foundations of the wind turbines. This also applies to France, Portugal and Norway. Floating foundations therefore offer a great deal of hope in this regard. In October, the first floating wind farm known as “Hywind” began commercial operation off the coast of Scotland. The project could now usher in a whole new stage of development.

In May, the first offshore wind farm in the USA went into operation. The Block Island project just off the Atlantic coast island of the same name also gets by without government subsidies. But this is due to the high electricity prices on the island, which diesel generators had previously supplied. It is also a small project with only six turbines and a total rated output of 30 MW. One of the next growth markets is Taiwan. The government there is currently awarding the first projects totalling 5,500 MW – with temptingly high feed-in tariffs of 16 cents.



Low remuneration, large turbines

The low prices for wind power, which have emerged as a result of the tenders in the German Renewable Energy Act (EEG), put pressure on wind turbine manufacturers. They have to construct turbines with higher yields at lower specific costs. In the off-shore sector, bidders are already calculating wind turbine capacities of 13 to 15 MW.



In the fourth onshore auction in February 2018, reference prices ranged from 3.8 to 5.28 ct/kWh, with an average of 4.73 cents. This means that the remuneration level has almost halved compared to the EEG 2014. And with a price of 4.73 cents, the German Wind Energy Association (BWE) believes that a “reliable real market value” is emerging. An analysis by Agora Energiewende in May 2017 concludes that the full costs at good sites in Germany could drop to 3 to 4.5 cents/kWh.

Competitive pressure is affecting manufacturer prices. According to information from manufacturer Vestas, the average turbine price for new orders at the end of 2017 was 740,000 euros per megawatt, i.e. 22 percent lower than a year earlier, according to an analysis by Overmöhle Consult. According to Agora, this development is made possible by further growth in installed capacity and rotor blade surfaces. The resulting additional yields would far exceed the additional costs. According to Agora, cost reductions are also possible with the lease prices and maintenance costs, which are significantly higher in Germany than the international average.

ENERCON is developing two new turbines based on its 3 megawatt platform (EP3): The E-126 EP3 and the E-138 EP3 (shown here).

Nordex N149/4.0-4.5. The Delta4000 series is the latest development of the tried and tested Delta platform.



Vestas V136-3.45 MW at Østerild test centre, Denmark (in December 2016).

Tenders generate a technology leap
According to Fachagentur Wind, the German market was firmly in the hands of five manufacturers in 2017: Enercon, Vestas and Nordex supplied three quarters of all new equipment, with GE and Senvion bringing it up to 94 percent. In response to the tenders, all these manufacturers have put more efficient equipment on the market.

For example, Enercon's new 3-MW class E-126 EP3 and E-138 EP3 models for medium and low-wind locations offer a larger rotor swept area and higher rated capacity. The yield of the E-126 was increased by 13 percent, according to manufacturer information.

Vestas's response to the tenders is a new 4-MW class turbine: the V136-4.2 MW for medium and high wind areas. Vestas promises additional yields of up to 21 percent over the year compared to the predecessor version.

Nordex enters the tenders with its new N149 / 4.0-4.5 Kraftpaket ("Powerhouse"). Its rotor swept area has increased by 62 percent and the maximum tower height is now 164 metres, having grown another 23 metres.

GE made the biggest leap with its 4.8 MW turbine. The 158-metre rotor diameters are the longest among onshore turbines. According to GE, this technical achievement was made possible by the takeover of the Danish rotor blade manufacturer LM in early 2017.

In addition to the significant increases in performance and efficiency, manufacturers also have to optimise all their processes, from production to transport and logistics, through to installation and commissioning. This is particularly significant in offshore wind power. Here, the challenges are even greater after the first zero-cent bids in April 2017. These bids are based on the assumption that the turbine capacity currently available on the market of just under 10 MW will increase to 13 to 15 MW by the planned commissioning of the projects in the middle of the next decade. The cost of generating electricity should reduce to such an extent that financing the operation of the turbines will be possible simply by selling the electricity on the stock exchange or to industrial companies.

Record employment – with a mixed outlook

Wind energy has become a driver for the economy and employment. This benefits not only the less-favoured north of Germany but also the suppliers in the south. In 2016, more people were employed in the industry than ever before. In the course of the EEG reforms, however, there were also plant closures and job losses for the first time in 2017.



At the end of 2016, the wind industry in Germany accounted for around 160,200 jobs in total, of which 133,000 were onshore and 27,200 offshore. This is specified in a report prepared for the German Federal Ministry for Economic Affairs and Energy (BMWi) in early 2017 by leading economic research institutes. With an overall increase of about 10 percent compared to 2015, the number of people employed in the wind industry was greater than ever before. As a result of the large number of new installations in 2016, the number of offshore installation workers increased by almost 25 percent, or just under 5,000. All in all, wind power now accounts for almost every second job in the field of renewable energy. By way of comparison, the aerospace industry in Germany accounts for, directly or indirectly, around 100,000 jobs.

The proportion of jobs in maintenance and turbine operation continues to increase. In the onshore sector, the value increased by two percentage points to 26 percent. In the offshore wind industry, the rate remains high at 39 percent.

According to a study commissioned by wind energy industry associations in March 2016, the employment effects are distributed throughout Germany. This also applies to states that have installed only a few plants. The final manufacturing processes of turbine manufacturers take place predominantly in the north, but the supply industry has established itself everywhere, predominantly in North Rhine-Westphalia (18,490 employees in 2015), Bavaria (11,820) and Baden-Württemberg (9,490). This puts North Rhine-Westphalia in second place behind Lower Saxony (32,300). This led to the state government in Düsseldorf, despite initial reservations against a further expansion of wind power, to organise an initiative in the German Bundesrat in support of onshore wind.

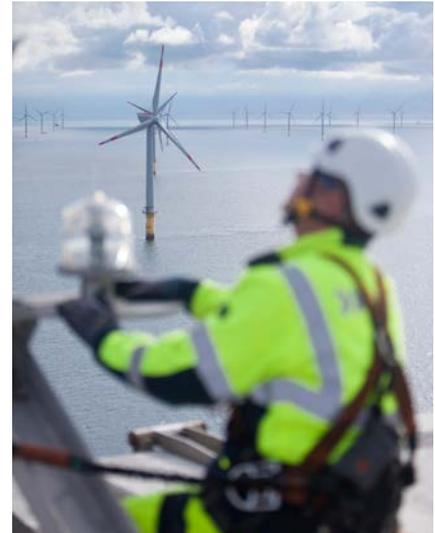
Tendering system costs jobs

According to the IG Metall union, in 2017 the employment situation throughout Germany began to look less favourable and future prospects worsened. This is primarily due to the switch from a subsidy system to a tendering system. A survey of works council members from 38 companies nationwide with 24,000 employees revealed that more than 40 percent of them expect a negative market trend, especially for manufacturers. The works councils expect job losses in just under a quarter of companies. “The situation in the wind industry is getting worse – faster and more noticeably than we had feared,” says Meinhard Geiken, District Manager at IG Metall Küste. “A year ago, there was no talk of redundancies and site closures, but now numerous companies are affected, in both the onshore and offshore sectors.” Up to 2,000 jobs are reported to have been lost in 2017.

Plant manufacturer Senvion, for example, has closed its northern German locations in Husum and Trampe as well as its subsidiary Powerblades in Bremerhaven, which specialised in turbine blades. Wind turbine blade manufacturer Carbon Rotec had to file for bankruptcy in October. The production of offshore wind turbines

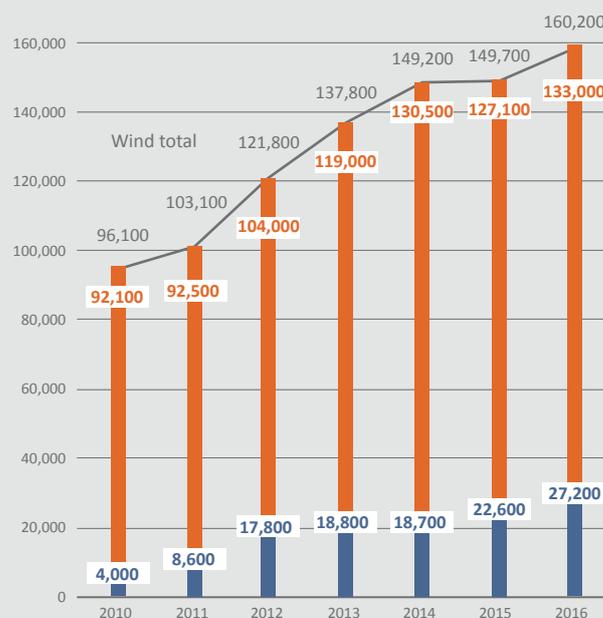
by Adwen in Bremerhaven is being discontinued by the company’s new owner, Siemens Gamesa. The group will lay off up to 6,000 of its 27,000 employees worldwide. Nordex also announced that it would be cutting up to 500 jobs.

Offshore wind power was particularly affected in 2017, and the German government reduced its expansion target in this area from 25,000 to 15,000 MW. In the “Cuxhaven appeal”, the industry, IG Metall and state governments joined forces in demanding an increase of the target to at least 20,000 MW. This, they explained, was necessary not only because of climate change, but also to safeguard jobs. Industry associations and politicians now hope to counteract job losses, especially among manufacturers, by increasing the planned expansion of onshore and offshore wind energy.



High share: With 39 percent the share of jobs in service and maintenance is constantly high in the offshore wind sector.

Significant growth in employment in 2016



Jobs directly and indirectly associated with the wind energy industry in Germany, onshore (orange) and offshore (blue). Source: BMWi 2018, “Economic Indicators of the Energy System”; graph: Ahnen&Enkel

Black on white: Germany's unfavourable climate protection figures

Despite the increasing proportion of green electricity, Germany's carbon dioxide emissions are rising. This is due to the fact that the number of lignite-fired power stations has remained high, and that climate protection measures in the heating and transport sectors have stagnated. One solution would be to increase carbon pricing.

At the end of January 2017, the German Federal Environmental Agency (UBA) sent a report on the country's current greenhouse gas balance to the European Commission. According to this report, the annual emissions of greenhouse gases such as CO₂, methane and nitrous oxide increased by 2.6 million tonnes to a total of 909.4 million in 2016. According to the UBA, this was already the second increase in a row for Germany, the pioneer of the energy transition. Since 1990, annual emissions have decreased by only 27.3 percent. What is particularly alarming is that CO₂ emissions, which make up 88 percent of greenhouse gases and dominate the public debate on climate change, have fallen by just 23.9 percent since 1990. This is significantly below the



German government's self-imposed goal of a greenhouse gas reduction of 40 percent by 2020.

The main reason for this lamentable result is that emissions from transport, building heat supplies and industry have increased. The transport sector does even worse than in 1990. In contrast, the electricity sector is performing relatively well. Emissions in this sector fell by 1.4 percent in 2016 thanks to renewable energies. The strong increase in the proportion of total energy production represented by renewables in 2017 will further accelerate this trend. Nevertheless, at the end of 2016, the electricity sector continued to account for the bulk of emissions, at 332 million tonnes. One thing is clear: if the German climate protection goals are to be reached, electricity must play a crucial role in this. "If we want to achieve something quickly in climate protection, we will have to tackle the issue of coal-fired power generation," says Maria Krautzberger, President of the UBA. This will also be critical for 2030. She recommends shutting down at least 5 gigawatts' worth of the oldest and least efficient lignite-fired power plants.

More and more CO₂ avoided thanks to renewable power



CO₂ emissions avoided in Germany thanks to renewable energy in millions of tonnes of CO₂ equivalent – due to renewable gross electricity generation (■), heating (■) and transport (■). Source: German Federal Environmental Agency (UBA), as of Dec. 2017



Open cast lignite mine in Welzow-Süd.

Wind turbines in front of Jänschwalde power station owned by Lausitz Energie AG.



When will coal be phased out?

The extent to which policymakers will follow the recommendations of environmental officials remains to be seen. The coalition agreement between the CDU/CSU and SPD is unspecific on phasing out coal. Concrete proposals will be drawn up by a commission of representatives from all sectors of society by the end of 2018. The coalition paper states that a grand coalition of CDU/CSU and SPD should increase the share of renewable energies from the current 36 percent to 65 percent by 2030. The suggested target had previously been

55 percent. According to the agreement, a special tender for 4 GW of onshore wind power within two years should help in the short term to close the foreseeable gap between actual figures and the 2020 climate goal “as soon as possible”.

The German Renewable Energy Federation (BEE) applauds the increase in the green energy target, but has pointed out the lack of incentives in the coalition agreement for the energy transition in the areas of heating and transport. In the heating sector, the coalition partners have even taken a step backwards, BEE suggests. “How the climate goals are going to be achieved in the heating sector remains an open question following the submission of the coalition agreement,” says Managing Director Dr Peter Röttgen. Above all, the industry is calling for appropriate carbon pricing in all sectors. In return, the electricity tax could be reduced, relieving the financial burden on citizens. The new edition of the Élysée Treaty, which was approved by the German Bundestag and the French National Assembly, makes a similar suggestion. In the treaty, the parliamentarians call for a joint initiative for carbon pricing.

Lignite maintains its high share in the electricity mix



Gross electricity generation in Germany by energy source in terawatt hours
Source: Arbeitsgemeinschaft Energiebilanzen, as of Dec. 2017

Green hydrogen for CO₂-free steel

In order to achieve climate protection targets, green electricity must also reach the heat, transport and industrial sectors. The pressure to act is particularly great in the steel industry. For decarbonisation it would require a great deal of hydrogen generated using green electricity.

Worldwide, industrial plants such as steel works or refineries consume about 500 billion cubic metres of hydrogen per year, 95 percent of which is currently derived from the reforming of coal and gas. Three research projects were recently launched on the decarbonisation of steel production. In February 2017, a consortium led by Austrian steel company Voestalpine was received EU funding for the “H2Future” project. The long-term objective is to replace the use of coal and coke in steel production with “green” hydrogen. An electrolyser will be erected at the plant in Linz in 2018, which will run on green electricity and split water into hydrogen and oxygen. Test operation is expected to start within a year. The Siemens plant with 6 MW of electrical input power

generates 1,200 cubic metres of hydrogen per hour, making it one of the largest in the world.

German steel company Salzgitter-Mannesmann is making similar plans at its site in Lower Saxony. In June, turbine manufacturer Sunfire installed a steam electrolysis plant with 150 kW input power and 40 cubic metres of hydrogen produced per hour. The plant has a particularly high electrical efficiency of more than 80 percent because it splits water vapour instead of water. The steam comes from the waste heat of the steel mill. The electrolyser can also be operated reversibly if necessary. This means that it does not generate hydrogen from electricity, but rather electricity from

hydrogen, like a fuel cell. Over the three years of the “GrInHy” research project, the plant is set to run for at least 7,000 operating hours per year to demonstrate its technical and economic feasibility.

Federal Government wants to strengthen integrated energy

The German “Carbon2Chem” project is taking a slightly different approach. At the ThyssenKrupp site in Duisburg, green hydrogen will be combined with carbon dioxide from the steelworks and processed into fuels, plastics and fertiliser. According to the Federal Ministry of Education and Research, the Carbon2Chem approach could save 20 million tonnes of CO₂ per year or ten percent of the annual CO₂ emissions from German industry and the manufacturing sector. This ten-year project involves 17 partners from industry and science. The Federal Government will contribute more than 60 million euros in funding by 2025, while industry will contribute more than 100 million. At commercial maturity, industry wants to invest more than one billion euros.

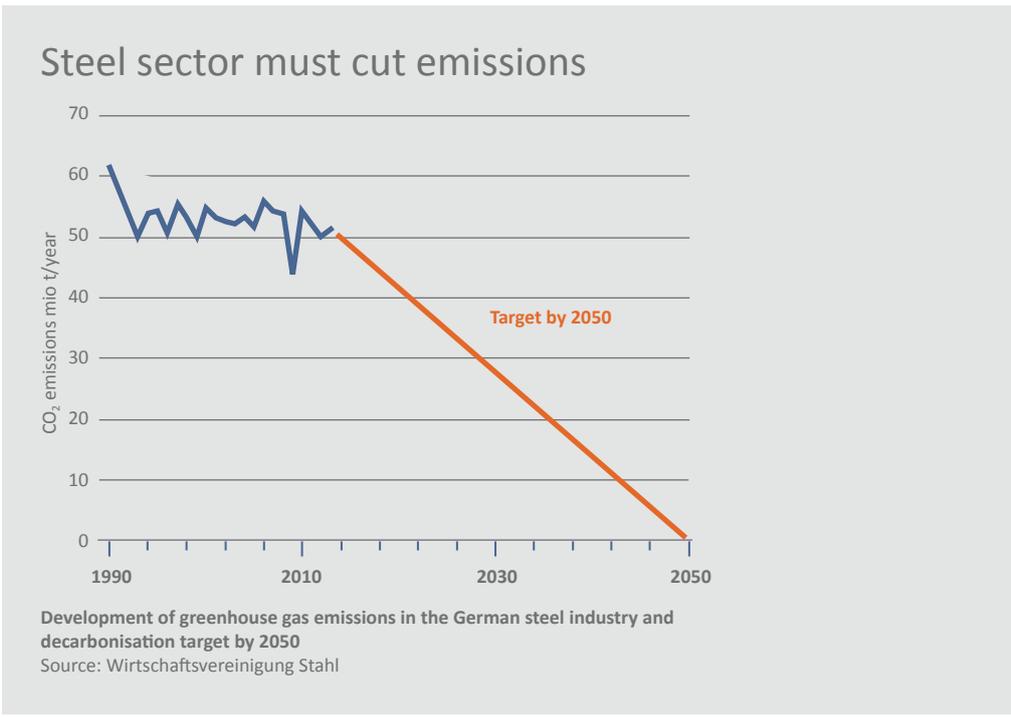


Sunfire GmbH has delivered the world's most efficient steam electrolysis module (SOEC) to Salzgitter Flachstahl GmbH as part of the Horizon 2020 project “Green Industrial Hydrogen via reversible high-temperature electrolysis” (GrInHy).



Steel production at Salzgitter AG.

Industrial use will depend on sufficient availability of affordable green electricity for electrolysis. The biggest obstacle is that electricity is weighed down with a lot more taxes, levies and surcharges compared to coal, oil and gas. The industry is therefore pushing for a relaxation of the EEG surcharge and network charges. The previous and presumably the new Federal Government is promising to redress the situation in its coalition agreement. It therefore wants to promote integrated energy and change the regulatory framework so that green hydrogen can be used as fuel or for the production of conventional fuels. The new Grid Development Plan 2030 of December 2017 takes power-to-hydrogen plants of up to 2,400 MW into account for the first time. These plants are focused on industrial sites with a corresponding demand for hydrogen.



Companies:

Manufacturers of wind turbines

The innovative power of the companies operating in Germany has given them the edge in terms of technology. Manufacturers are exporting and expanding into foreign markets in Europe, North America and Asia.





ENERCON GmbH

Innovative products and a forward-looking company

Innovative technology, high reliability and good economic viability have characterised ENERCON wind turbines for more than 30 years. The German market leader has erected more than 28,100 turbines with a total rated capacity of more than 47.6 gigawatts (as of January 2018).

ENERCON has been one of the technology leaders in the wind power sector for 30 years. As the first manufacturer of wind turbines, the company used a gearless drive concept that is a characteristic of all ENERCON wind turbines. ENERCON is also at the forefront in other areas, such as rotor blade design, control technology and grid connection technology, and, with its wide range of technological new developments, proves its innovative strength time and again.

Continual research and development guarantee the ongoing success of the company. The same applies to production and service. All the key components, such as the rotor, annular generators and

grid feeding system, are manufactured in-house. This vertical integration, which is unequalled in the wind energy industry, ensures the high quality and extreme reliability of ENERCON wind turbines. A customer-oriented service offering also

plays a part in this, guaranteeing the operator 97 per cent technical availability of the turbines. This holistic concept sets high new standards in technology, quality and safety, and consolidates ENERCON's position as the German market leader.

01



ENERCON GmbH

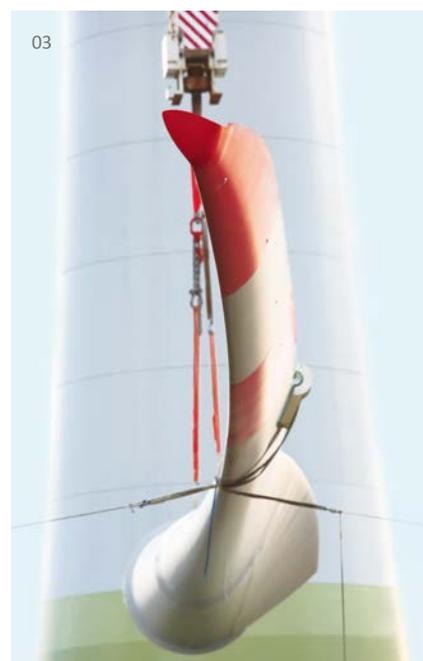
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Fax **+49 (0)4941 927 109**
E-Mail **info@enercon.de**
Web **www.enercon.de/en**
Profile **Wind turbines (> 100 kW)**
Category **Manufacturers**
Turnover **€ 5.1 billion**
Employees **18.000 (Wind energy: 18.000)**
Founding year **1984**



The product portfolio comprises wind turbines with outputs from 800 to 4200 kilowatts. The latest model is the E-138 EP3 /3.5 MW with a rotor diameter of 138 metres. The enhanced WEC design represents a more compact structure that also optimises production, logistics and installation processes. All ENERCON models boast reliable technology, low maintenance requirements and a long service life, thereby guaranteeing a high level of profitability for customers.

Thanks to the directly driven synchronous generator and innovative modular full-scale converter concept, ENERCON wind turbines have a wide range of technical options for adaptation to the grid conditions. They have a grid feeding system that is certified to the latest grid connection requirements. ENERCON wind turbines can therefore be integrated without difficulty into all supply and distribution grid structures. Furthermore, ENERCON wind turbines supply numerous features that support the grid.

True to the company's claim of „energy for the world“, ENERCON is driving forward supply with renewable energies worldwide. In doing so ENERCON is expanding its research and development, production and sales activities in line with demand. Internationally, ENERCON has a presence in the major markets with plants in Brazil, Sweden, Turkey, Portugal, Canada, France and Austria, as well as a globally decentralised service and sales network.



ENERCON's prudent, sustainable growth strategy guarantees its stability. In autumn 2012, the founding of the Aloys Wobben Foundation sealed ENERCON's independence, as well as the continuity of the company's direction. Company founder and owner, Aloys Wobben, donated his company shares to the foundation to cement the sustainable, future-oriented corporate strategy of ENERCON. The excellent financial standing of the ENERCON Group was recently confirmed again with an external rating from Euler Hermes Rating GmbH: The analysts gave ENERCON

the rating „AA-“ for its creditworthiness and sustainability. This makes ENERCON significantly above the average compared to the overall economy. ENERCON customers can therefore rely on a high level of investment security, in addition to high-quality and reliable turbine technology.

01 | E-141 in Coppanz

02 | Lifting the rotor of an E-141

03 | Single-blade installation on the E-141 in Lehe

04 | E-141 in Lehe

eno energy systems GmbH

novation for efficiency

Ever since it began manufacturing wind turbines, the name eno energy has stood for the very best in quality, flexibility and innovation.



01

engineers, institutes and universities that they demand. This focus has enabled them to create a comprehensive portfolio of turbines at a high level for almost all segments with remarkable speed.

No sooner had the first generation of turbines, in the form of the 2 MW platform, demonstrated its high quality and exceedingly high technical availability, than the massive investments in its own vertical integration were brought to bear with the 3.5 MW platform. The ambitious company is offering particularly powerful machines in the 3.5 MW class, with the eno 114, which is particularly suited to windy coastal sites, and the eno 126, designed for inland sites. The increased turbulence resistance of the machines listed in the IEC 2 wind class can result in



eno energy systems GmbH

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E-Mail **info@eno-energy.com**
Web **www.eno-energy.com**
Profile **Wind turbines (> 100 kW)**
Category **Manufacturers**
Turnover **approx. € 100 million**
Employees **Around 200**
Founding year **1999**

The eno energy group has been based in Mecklenburg-Vorpommern, Germany, since 1999. The company produces wind turbines with rated capacities from 2.05 to 4.8 MW and rotor diameters from 82 to 126 m for the onshore sector at its Rostock production site. The advances made in the area of service life by eno energy systems GmbH are only through working with renowned European suppliers. eno is also making headway internationally with subsidiaries in Sweden and France.

The company has gained a reputation from its flexibility, innovation and a high level of quality awareness. Ever since the early days, eno has always placed a high value on its own research and development and the close links with specialist



02



a more compact wind farm. In 2018 the eno 114 and eno 126 will also be launched onto the market in variants with 4.8 MW capacity in the wind class IEC II, thanks to a performance update.

Servicing and maintainability, increases in efficiency, ensuring the long-term reliability of all components and the national and international requirements for grid connections were all aspects that were focused on during development. For all issues, eno energy can turn to an excellent network of advisers, insurers and suppliers and of course, their own many years' know-how in all areas of wind energy use.

The group has positioned itself on both the national and international markets as a planner, wind farm operator and supplier of services, maintenance and management, in addition to being a manufacturer. eno energy offers both end-to-end solutions such as the complete construc-

tion of wind farms as a general contractor, and all individual services, such as separate delivery of wind turbines. This flexibility makes the company a competent partner for communal investors and project developers both in Germany and abroad.

- 01 | Plauerhagen wind farm with eno 114
- 02 | Brusow wind farm with eno 114
- 03 | Nacelle of an eno 126
- 04 | Gearbox of an eno 114



Nordex Group

The Nordex group offers powerful wind turbines for nearly all geographical regions across the globe.



The Gamma Nordex N90/2500, N100/2500 and N117/2400 multi-megawatt turbines are highly efficient wind turbines for onshore use and are produced in series. Since 2013, Nordex has been supplying the Delta Generation with N100/3300, N117/3000, N117/3600, N131/3000, N131/3300, N131/3600 and N131/3900 turbines for high, medium and low wind speeds.

The N149/4.0-4.5 is the manufacturer's latest product and the most profitable turbine for locations with low to medium wind speeds. The turbine has a 30 percent larger swept rotor and a variable output of 4.0 to 4.5 MW. Because the maximum output of the turbine is variable between 4.0 and 4.5 MW, it can be optimally adapted to the individual requirements of the grid operator, the local wind conditions and noise requirements. This also makes it possible to optimise the overall yield within a wind farm via different maximum

outputs of individual turbines. The full potential of each turbine location can therefore always be exploited, which is an advantage in large-scale projects, for example, with different wind conditions and complex topography. The N149/4.0-4.5 thus ensures that the highest possible energy yield is achieved: up to 32 per cent more compared to the low-wind turbine N131/3300, which was specially developed for Germany. Despite this increase in power, the noise emission values at rated output are a maximum of 103.6 dB(A) to 106.1 dB(A). At the request of the customer, the system can also be operated in sound-reduced modes. The sound power level at 3 MW power is then a maximum of 96.5 dB(A). The N149/4.0-4.5 is initially available with tower heights of 105, 125 and 164 meters.

In April 2016, Nordex merged with Acciona Windpower and now also offers wind turbines of the Acciona Windpower brand, which are operating successfully in various climates and markets worldwide. In the years since the first developments in 1999 to the complete product line-up of today, whose performance spectrum ranges from 1.5 MW to 3 MW and includes various combinations of rotor



Nordex Group

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Profile	Wind turbines (> 100 kW)
Category	Manufacturers
Turnover	€ 3.4 billion (2016)
Employees	5,000 (Wind energy: 5,000)
Founding year	1985





and tower, the company has gained extensive experience. This is reflected in its increasing sales and proven product developments.

Nordex SE is listed on the Frankfurt Stock Exchange under the TecDAX index (ISIN: DE000A0D6554). Nordex SE is a management holding with headquarters in Rostock. The board of directors and the operational board are based in Hamburg. The company has factories in Germany, Spain, Brazil, the US and India. The group manufactures its own nacelles, rotor blades and concrete towers.

Its products and services serve the entire value chain, from the search for suitable locations and system planning to the technical implementation of wind farms. After



the installation of the wind turbines, the company continues to offer its customers full support. For all wind turbines, its services can be tailored to the needs of the customer, ensuring smooth operation of the turbines worldwide. The average availability of all wind turbines covered by the company's service is 98%.

The group has an installed capacity of 21,000 MW worldwide and has offices and branches in 25 countries with a total of 5,000 employees.

SCHÜTZ GmbH & Co. KGaA

The SCHÜTZ GmbH & Co. KGaA that was founded by Udo Schütz in 1958 has 5,000 employees at 52 locations around the world. The broad spectrum of services offered by our group covers the areas of PACKAGING SYSTEMS, ENERGY SYSTEMS, INDUSTRIAL SERVICES and COMPOSITES.



SCHÜTZ has been producing lightweight construction materials and fibre-reinforced composite components for the aerospace industry under the brand name CORMASTER for more than 30 years. We are continuously expanding this company division with SCHÜTZ COMPOSITES, in order to successfully utilise the collective expertise and technical capabilities held by the company in the area of wind energy.

SCHÜTZ COMPOSITES, as part of the SCHÜTZ Group, develops and produces master models, moulds, prototypes, rotor blades and wind power plants at its Siershahn location in Westerwald. As an innovative manufacturer in the area of composites, the construction and production of operating materials and production facilities are an integral part of our comprehensive range of services.

SCHÜTZ

SCHÜTZ GmbH & Co. KGaA
Location Siershahn

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Profile **Wind turbines (> 100 kW)**
Category **Manufacturers**

Turnover **€ 1.7 billion**
Employees **> 5,000**
Founding year **1958**





As with all the other divisions in the SCHÜTZ Group, SCHÜTZ COMPOSITES also has the ideal infrastructure for the development and production of its products. A 32,815 m² hall complex was specially built for the wind power sector, which encompasses all of the production steps

under one roof. The continuous sharing of knowledge across the SCHÜTZ Group and direct access to the expertise of the more than 200 specialist employees in the SCHÜTZ custom machine engineering and the CORMASTER aerospace sectors provides the best all-round conditions to

ensure optimum development and production processes. SCHÜTZ COMPOSITES thus holds the full range of manufacturing capabilities – from model construction through to the finished rotor blade – all at one location. Naturally, SCHÜTZ COMPOSITES also offers all of the individual steps in the development and production processes for rotor blades – from model construction through to series production – as individual services.

SCHÜTZ COMPOSITES is ideally located from a logistical point of view directly next to the A3 motorway, just north of the Dernbach junction. Our factory in Siershahn, which covers an area of 137,000 m², can easily be spotted alongside the motorway. And thanks to the availability of a further 170,000 m² of space next to the factory, there is also sufficient space for handling even larger series production contracts.

Senvion GmbH

Having constructed over 7,700 wind turbines, Senvion is one of the world's leading manufacturers in the onshore and offshore sectors and is continuing to develop its tried-and-tested technology. With 25 years of experience, the company sets new standards in terms of quality and innovation.



The company, which is headquartered in Hamburg, has around 4,500 employees worldwide and can draw on experience gained in the manufacture and installation of over 7,700 wind turbines throughout the world.

The company's experience and expertise goes back over 25 years. Since 20 January 2014 the company has been operating as Senvion. With its wind turbines in the 2 MW class, the MM82, MM92 and MM100, the company has set new standards. More than 5,000 of these groundbreaking onshore turbines are now producing electricity safely and reliably around the world.

In order to produce high yields in the long term, Senvion continuously develops its tried-and-tested technology and optimizes the efficiency of its turbines. Since 2008, the company has been expanding its onshore portfolio with its 3.XM series. The turbines are based on the technology of the MM series and are available in different versions with a rated power of 3.7 and 3.6 or 3.2 or 3.0 MW. Depending on the specifications, the turbines are used at sites with high, average or low wind speeds.

SENVION
wind energy solutions

Senvion GmbH

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Web **www.senvion.com**
Profile **Wind turbines (> 100 kW)**
Category **Manufacturers**
Turnover **€ 2.3 billion**
Employees **4,5 (Wind energy: 4,5)**
Founding year **2001**

The international mechanical engineering company develops, produces and markets wind turbines with rated outputs of 2 to 6.3 megawatts (MW) and rotor diameters of 82 to 152 meters for almost any site. Senvion also offers its customers project-specific turnkey, service and maintenance, transport and installation as well as foundation planning and construction solutions.





Expansion of the 3 MW series

In order to offer customers the ideal turbine for every site, Senvion has expanded its 3 MW portfolio in 2017 again. The new Senvion 3.7M144 EBC is a low wind specialist with an optimized blade design with lighter efficient blades. With its bigger rotor, a rated power of 3,700 kW and new, highly efficient rotor blades it can achieve a 6.7% higher annual energy production (AEP). The new rotor blades – also used with the 3.4M140 and 3.6M140 – are based on the new Rodpack technology which replaces standard glass fibre fabric in the blade's main girder. The aerodynamically optimized blade design and the use of serrations on the

trailing edge make the 3.7M144 EBC one of the quietest turbines for low wind speeds on the market. It's celebrating its worldpremiere at the Murra Warra Wind Farm in Australia.

The 3.6M118 NES is a powerful addition to Senvion's highly successful three megawatt platform for high wind-speed sites. With its optimized rotor design the new turbine can generate very high yields while keeping LCoE to a minimum. The 3.6M118 NES is mounted on a steel tower with a standard hub height of 91 meters and suitable for sites with medium to high wind speeds. Depending on projectspecific requirements additional hub heights may also be available.

Senvion service for performance

Senvion service unlocks the full potential of your wind farm. Senvion has created a four-pillar system to ensure optimized performance and minimized Levelized Cost of Energy (LCoE). The service concept for monitoring, maintaining, regaining and enhancing performance will make sure to get the most out of the wind farm: more performance and efficiency, more output and yield, more uptime and revenue.



- 01 | 3.2M114 in Neuenkirchen
- 02 | 3.4M104 in Clauen
- 03 | MM92 Reviere au Renard Canada
- 04 | MM92 Ancora Windfarms in Portugal
- 05 | 6.2M126, Nordsee Ost, Senvion GmbH

Siemens Wind Power GmbH & Co. KG

Wind energy solutions throughout the value chain

Siemens Gamesa Renewable Energy offers onshore and offshore products as well as leading maintenance and upkeep services for making renewable energy affordable and reliable.



SIEMENS Gamesa
RENEWABLE ENERGY

**Siemens Wind Power GmbH
& Co. KG Siemens Gamesa
Renewable Energy**

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Web **www.siemensgamesa.com**
Profile **Wind turbines (> 100 kW)**
Category **Manufacturers**
Turnover **€ 11 billion**
Founding year **1976**

Siemens Gamesa Renewable Energy

Siemens Gamesa is a leading global supplier of wind energy products and solutions. Its extensive product portfolio covers both offshore and onshore technologies as well as maintenance and upkeep services. The new company's predecessors, Siemens Wind Power and Gamesa, merged in 2017. In Germany, Siemens Gamesa is represented by the Hamburg-based Siemens Wind Power GmbH & Co. KG.

Onshore technology for every location and every wind class

Cutting-edge, gearless onshore wind turbines and extremely powerful gearboxes from Siemens Gamesa provide leading solutions for any site. Flexible direct-drive wind turbines in the OptimaFlex series, with variable rated powers of 3.5 to 4.3 megawatts, were introduced in 2017. The new 4.X gearbox product platform was also released in 2017. Its SG 4.2-145 model lowers power generation costs at medium wind forces in the 4 Megawatt segment. A rotor measuring more than 150 meters in size is in preparation for low-wind sites.



Digital cost-saver in maintenance and operation

Deploying technicians to wind turbines results in production down times and logistics costs. Siemens Gamesa is taking a digital approach for most cases: Thanks to remote diagnosis and algorithm-based operation optimization, the Siemens Gamesa Wind Service significantly boosts economic efficiency both onshore and offshore.

Offshore market leader manufactures products in Cuxhaven

With the launch of its offshore nacelle manufacturing in Cuxhaven, Siemens Gamesa is expanding its leading role in offshore wind energy. The SG 8.0-167 DD system introduced in 2017 has a rotor diameter of 167 meters. Digitalized production and a cutting-edge logistics concept make offshore wind farms more economical.



01 | In 2017, Siemens Gamesa added four SWT-3.6-130 turbines to the Zerbst wind farm in Saxony-Anhalt, Germany.

02 | A new storage concept in Hamburg will begin supplying electricity from hot stones in the spring of 2019

03 | Zerbst wind farm in Saxony-Anhalt

04 | The Siemens Gamesa service technician is ready for deployment on land and sea – like at the Süderlügum wind farm in Schleswig-Holstein.

VENSYS Energy AG

More energy for our future

17,800 wind turbines using VENSYS technology worldwide with 31 GW of total rated capacity on the grid.



Customer-tailored wind turbines are developed in an individualised project development – including for small wind farms and the integration of local interests at a community scale, as well as tailor-made supply solutions for companies.

VENSYS provides municipalities and investors with comprehensive, worry-free solutions, from planning tailored to individual cases, to installation and grid connection, to an attractive service package with guaranteed availability for the entire service life.

Production in small series also gives us the flexibility for individual adaptations. Based around the manufacturing concept, our own production at our headquarters in Germany forms the basis for the permanent transfer of developments into VENSYS products. Innovative technologies go hand in hand with solid workmanship, complex quality management and needs-driven short delivery times.

Together with our subsidiaries, we offer an individually scalable complete range of services. The coordinated further development of central turbine compo-



VENSYS Energy AG

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Fax **+49 (0)6821 9517-411**
E-Mail **vertrieb@vensys.de**
Web **www.vensys.de**
Profile **Wind turbines (> 100 kW)**
Category **Manufacturers**
Turnover **€ 100 million**
Employees **164 in Neunkirchen,
90 in Diepholz**
Founding year **2000**

VENSYS ENERGY develops and manufactures gearless wind turbines with high efficiency for maximum yield. Our trademarks are powerful turbines with a permanent-magnet-excited multipole generator, a maintenance-free toothed belt drive for rotor blade adjustment, simple generator cooling and the full converter system with power generating characteristics.

Our 1.5 and 2.5 / 3 / 3.5 MW platforms consist of only a few high-quality and durable components. The simple, compact design, low maintenance costs and the advantages of wear-free systems already ensure increased yield thanks to their design.





nents guarantees seamless functionality and higher added value across the entire supply chain and the lifecycle of the turbines.

The VENSYS Group's range of services includes full-scale converters and pitch systems, electronic components and network connections as well as network planning, network integration and certification of the turbines. New to the VENSYS Group is in-house manufacturing and continued development of rotor blades.



Reliable and profitable at any location. Proven in endurance tests on four continents.

Wind turbines from our German production facilities are connected to the grid in Germany, Poland, France, Great Britain, Spain, Cyprus, USA and Canada. Further markets are being explored, supported by our subsidiary in Poland and VENSYS Inc. in the USA.

As the driving force for advanced wind power generation, VENSYS exports its technology worldwide. Our successful licensing model combines innovative technology and „made in Germany“ know-how with series production, market development and logistics in an internationally operating business network. VENSYS is therefore in a position to implement its own large-scale projects everywhere.

Our most important licensees, Goldwind and ReGen Powertech, manufacture VENSYS turbines as high-growth multipliers for India, China, Asia, USA, South America, Australia and Africa.

VENSYS wind energy technology has proven itself on four continents: under a wide variety of climatic conditions, under all network conditions, even in regions with poor infrastructure. Supported by regionally adapted service and customer-orientated support, more than 17,800 turbines with 31 GW are connected to the grid.

Building on the expertise of nearly three decades of innovative engineering, we are already working on pioneering solutions for cold-climate and hybrid turbines, as well as yield-boosting rotor blades.



01 + 02 | VENSYS production facility in Neunkirchen, Germany

03 | VENSYS headquarters in Neunkirchen, Germany

04 | One of five VENSYS 112 with a hub height of 140 m in Losheim, Germany

05 | Brake: Shipping ten VENSYS turbines to the USA

06 | VENSYS training centre in Neunkirchen, Germany



Companies:

Suppliers

Manufacturers of wind turbines from all over the world buy systems and components in Germany. Years of experience of the operational side together with specific research and development projects to reduce manufacturing and operating costs and prolong service life are much in demand everywhere.

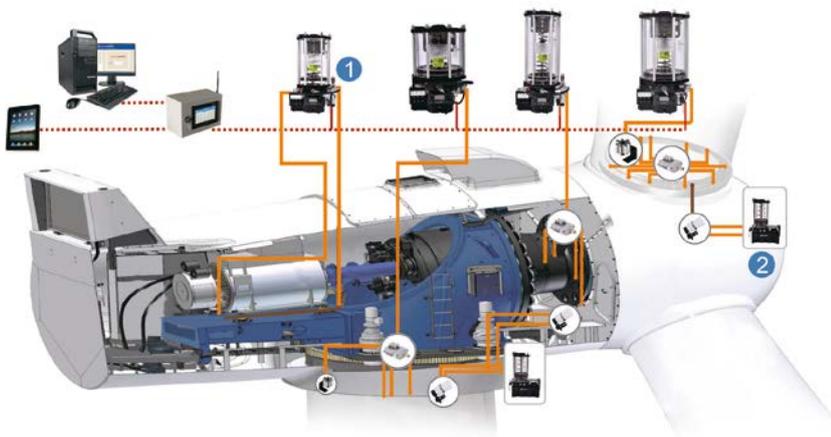


Autol Technology Co., Ltd

Centralized Lubrication Systems

Autol is committed to research, development, production and sales of centralized, competitive lubrication products and to customizing the design and development of total solutions.

Suplub-W Intelligent CLS



1. Grease pump 2. Hydraulic pump

Suplub-W Intelligent CLS

Suplub-W CLS for wind turbines provides two lubrication solutions: integrated single-line CLS and progressive CLS.

Innovations

- New-type integrated single-line distributor unit reduces blockages in the hoses and the overall fault rate of the system.
- Auxiliary unloading valve with patented technology effectively solves the unloading problem caused by the long distance of grease supply and high viscosity grease.
- Lube point amount and grease output flow rate can be adjusted as required.
- Every lube point is connected to the single-line distributor unit with separate integrated indicators, which can real-time display the lubrication state of grease points.

Our system reliably ensures the automatic supply of grease to many components of wind turbines such as main shaft bearings, generator bearings, pitch bearings and yaw bearings. We provide our customers not only with products but also the all-round equipment health management, as well as training of lubrication management, tour inspection and maintenance, technical upgrading and renovation, oil testing and analysis, lubrication test and analysis.

As a professional manufacturer in centralized lubrication system, Autol products have featured in more than 100 domestic and overseas technology patents, which have been widely used in applications like commercial vehicles, wind power generation, construction machinery, metallurgy, port machinery, etc.



AUTOL

Autol Technology Co., Ltd

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Web **www.autol.net**

Profile **Lubricants & lubrication systems**

Category **Suppliers of mechanical
components**

Employees **405**

Founding year **2005**

Lubmann GmbH

Centralized Lubrication Systems

Lubmann GmbH, which is a comprehensive supplier of centralized lubrication technology solutions, is the strategic partner of Autol in the European market.

Headquartered in Duisburg Germany, Lubmann is dedicated to innovation and reliability of centralized lubrication system. It aims to provide intelligent centralized lubrication solutions for specific customer requirements. Apart from the product we also provide total life cycle service and further application.

With a strategic partnership, Lubmann GmbH has deepened its collaboration with Autol Technology on product R & D and marketing. Conducting technological collaboration with Autol provides diversified and intelligent centralized lubrication solutions to European customers.

Suplub-W WGCS

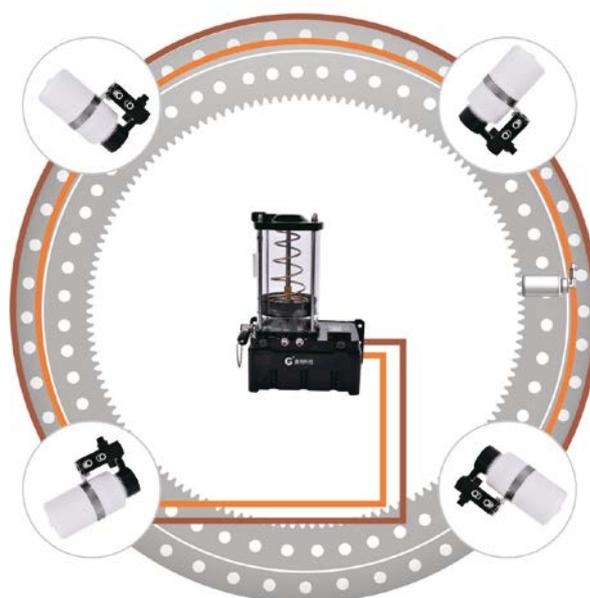
Suplub-W WGCS is a Waste Grease Collection System with high efficiency, which has been developed based on market investigation for many years and incorporated with many patented technologies. It can remove the waste grease from the bearing in wind turbines and solve the problems of pollution due to spilled grease effectively.



Innovations

- Clearing up the waste grease timely is helpful for heat dissipation from bearings and reduces bearing friction and wear.
- Relieving high grease pressure in bearings makes the bearing cavities smooth and ensures fresh grease can be easily discharged into bearings.
- Matched with a centralized lubrication system, the critical blockage problem inside bearings is effectively resolved.
- Decreasing system fault rate, saving maintenance cost and enhancing the efficiency and productivity of wind turbines.

Suplub-W WGCS

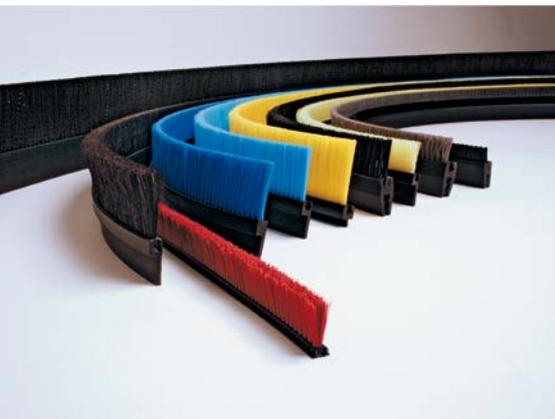


Lubmann GmbH

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Web	www.lubmann-gmbh.de
Profile	Lubricants & lubrication systems
Category	Suppliers of mechanical components
Founding year	2015

August Mink KG, Mink Bürsten

Reliable seals with flexible brush seals on wind turbines –
Know which way the wind is blowing!



Mink Bürsten develops sealing concepts with brushes in close collaboration with leading companies in the wind energy industry.

With its flexibility and numerous fibres that work at localised points, the brush has crucial advantages over comparable materials in terms of reliable protection from the effects of weather conditions, nesting insects, sand ingress or cold temperatures. At the same time, condensation can be allowed to escape, which cannot be done, or not to optimal effect, with rubber or foam. The inner or outer toothed pitch bearings are sealed with brush seals against corrosive media from the outside and against escaping grease from the inside. Because the fibres can be adapted for a very wide range of situations, use in any gap size is not a problem – gaps with high dimensional tolerances are reliably closed. Localised contact of the fibres prevents the colour from wearing off on the contacted components,

as well as preventing the fibre bundles from freezing solid. Profiles for inserting, screwing or riveting ensure very good durability. The manufacturing technology brings other advantages for sealing rotating components. Fibre slanting in the direction the component rotates significantly reduces wear and tear.

Our fibre solutions can be used for far more than just sealing!

Mink brushes reduce the noise level of your turbine:

- Robust fibres on the tips of the rotor blades reduce air turbulence
- Using a cleaning brush prevents operating noises from the azimuth brake

Conductive brushes absorb voltage:

- Lightning voltages are transferred from the brushes to the spark gap
- Brushes used for equipotential bonding offer an affordable alternative and are easy to install



August Mink KG, Mink Bürsten

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Web **www.mink-buersten.com**

Profile **Seals & vibration control**

Category **Suppliers of mechanical components**

Turnover **€ 51 million**

Employees **430**

Founding year **1845**



Flexible solutions with Mink brushes

1 | **Rotor** Mink brushes for sealing the gap on the electric pitch control of the rotor blades.

2 | **Nacelle** Mink brushes provide sealing concepts for all construction and assembly gaps in the nacelle's design.

3 | **Tower** Mink brushes as a flexible seal in the area between nacelle and tower. Mink brushes are highly resistant to UV radiation and ozone, as well as temperature fluctuations.

Balluff GmbH

Sensor and automation solutions for wind turbines and their manufacture

Over 20 years' experience in the wind energy sector and continuous innovation are the distinguishing features of sensor manufacturer Balluff.



01 | Balluff stands for 20 years of experience in the wind industrie

02 | All sensors used are HALT tested and provide optimal and safe control of wind turbines.

Wind farms are a major investment and require high levels of availability. So every component has to be extremely reliable and fail-safe. In addition, pressure on costs and prices is enormous, which forces manufacturers to constantly optimise their production and logistics processes.

As a long-term partner of the wind energy sector, Balluff and its global workforce of 3,600 employees understand these challenges. Balluff sensors have been providing optimal and safe control of wind turbines for over two decades. Their exceptional reliability and robustness are the result of optimised development processes with integrated HALT tests (**H**igh **A**ccelerated **L**ifetime **T**ests).

Identifying damage before a breakdown can occur is a must for costly wind turbines. This is why Industry 4.0/Internet

of Things and Big Data are also on the rise in the wind energy sector. Intelligent sensors, network technology and power supply units with Heartbeat technology, which not only record various parameters but also provide information about themselves and their condition, enable the gathering of detailed information on the state of a turbine.

Balluff is just the place when it comes to future-proofing your equipment. Track and trace procedures, as used in all large-scale automotive plants, are the optimum solution by Balluff.

Solutions (selection) for:

- Angle and rotational speed detection
- Pitch adjustment
- Fill level measurement
- Network technology

BALLUFF

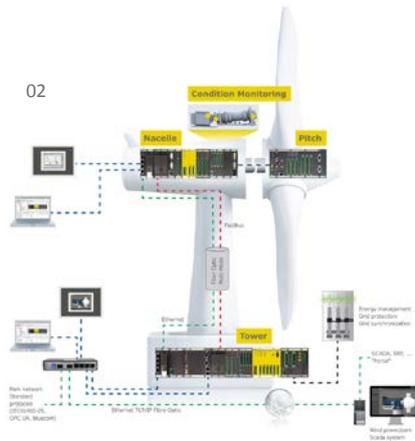
Balluff GmbH

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 E-Mail **bernd.schneider@balluff.de**
 Web **www.balluff.com**
 Profile **Sensors**
 Category **Suppliers of electrical and electronic components**
 Turnover **€ 376 million (2016)**
 Employees **3,600**
 Founding year **1921**

Bachmann electronic GmbH

We automate wind energy: safely, flexibly and in a modular system

A secure future for your wind farm: Bachmann offers its customers around the world the most sophisticated automation solutions for the on- and offshore wind sector.



Bachmann speeds up progress throughout the world in automation technology. The Bachmann Group was established in 1970 in Feldkirch, Austria, and employs over 450 people around the world. As a high-tech company our approach to development is systematic and our solutions are fully thought through. This makes us one of the leading automation partners in renewable energies, machine tools and marine sectors, and the number 1 automation specialist for the wind sector.

To date, 100,000 wind turbines – worldwide one in three – are equipped with Bachmann control technology or condition monitoring systems. Our system solutions are open, safe, flexible and modular. Customers confirm our system availability of over 99.96 percent. Integrated condition monitoring and wind farm networking are just two product highlights of Bachmann. Our innovative solutions ensure efficient engineering for your wind turbines:

01 | Bachmann headquarters in Feldkirch, Austria.

02 | Bachmann automation system for wind turbines.

Operational control

- Turbines – Control/simulation
- SCADA wind farm
- Scalable from a single turbine to a wind farm
- Data models in accordance with IEC61400
- Communication based on standards such as OPC-UA

Power quality

- Grid measurement and protection
- Analysis with integrated data recorder
- Static and dynamic grid support
- Grid monitoring in accordance with international grid codes

Wind library/template

- Complete toolbox for turbine development
- Configurable software modules
- Object structure in accordance with IEC61400-25
- Event system and statistical evaluation

Wind farm networking

- Open communication interfaces
- Real-time networking via Ethernet-bluecom
- Standards in accordance with IEC61400-25, IEC61850, IEC60870-xx, DNP3 (and more)
- OPC UA to SCADA & operational control

Condition Monitoring Systems (CMS)

- CMS experience since 1998
- Over 9,000 WTG equipped with CM technology
- The world's first GL certification of a control-integrated CMS
- Customised retrofit solutions



bachmann.

Bachmann electronic GmbH

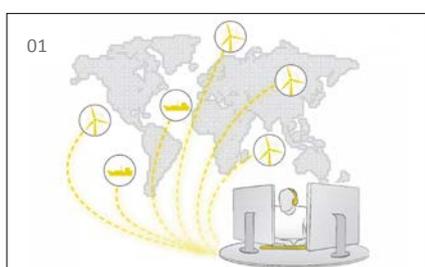
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Phone **+43 (0) 5522 3497-0**
Fax **+43 (0) 5522 3497-1102**
E-Mail **info@bachmann.info**
Web **www.bachmann.info**
Profile **Controls, cables
& switchgear cabinets**
Category **Suppliers of electrical and
electronic components**
Turnover **€ 67 million (2017)**
Employees **more than 450**
Founding year **1970**

Bachmann Monitoring GmbH

Condition monitoring systems for all manufacturers and types

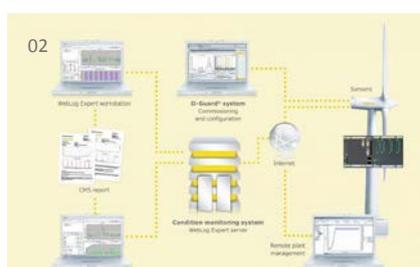
Bachmann develops, produces and sells measurement systems for the condition-based maintenance of on- and offshore wind turbines.

These systems guarantee a high level of availability and a secure investment.



Bachmann Monitoring GmbH's **core expertise** is measuring and analysing vibrations, enabling it to closely monitor onshore and offshore wind turbines. The monitoring specialist – certified by Germanischer Lloyd and based at the technology hub of Jena/Rudolstadt in Germany since 1998 – has been a subsidiary of Austrian company Bachmann electronic GmbH based in Feldkirch since 2011.

Intelligent solutions – The certified web-based CM teleservice (remote monitoring) is the key to efficiently monitoring decentralised turbines. Early identification and pinpointing of weak points ensures the reliable operation of turbines and increases yields on a sustainable basis. Condition-based maintenance based on structure-borne sound can be complemented by diagnostic functions, such as rotor blade and structural monitoring, as well as the drafting of expert vibration reports for the wind industry.



In addition to condition monitoring solutions (CMS) integrated into control systems, Bachmann also offers standalone CMS. These CM systems also enable reliable monitoring of main bearings, for example.

The "Omega Guard" was additionally certified by Germanischer Lloyd in 2012 as a fully control-integrated CMS – a **world first**. This certification is unique in the market to date. All Bachmann CMS meet international standards such as IEC 61400-25-6. The compatibility of the information models and information exchange is always guaranteed and it is possible to incorporate CMS extensively into existing network structures and control systems.

International – Among approx. 9,000 equipped wind turbines, Bachmann currently monitors 6,000 onshore and offshore turbines worldwide. Its portfolio encompasses 25 different wind turbine manufacturers of approx. 79 different types ranging from 600 kW to 8 MW.



02 | Bachmann currently monitors 5,000 onshore and offshore turbines around the world.

03 | The Bachmann online CMS ?-Guard® offers access to the condition monitoring data of every turbine from any online workplace worldwide.

04 | Top all-round care: Bachmann Condition Monitoring – the healthcare professionals for wind turbines.

bachmann.

Bachmann Monitoring GmbH

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Web **www.bachmann.info**

Profile **Service, maintenance & repair**

Category **Operation & service**

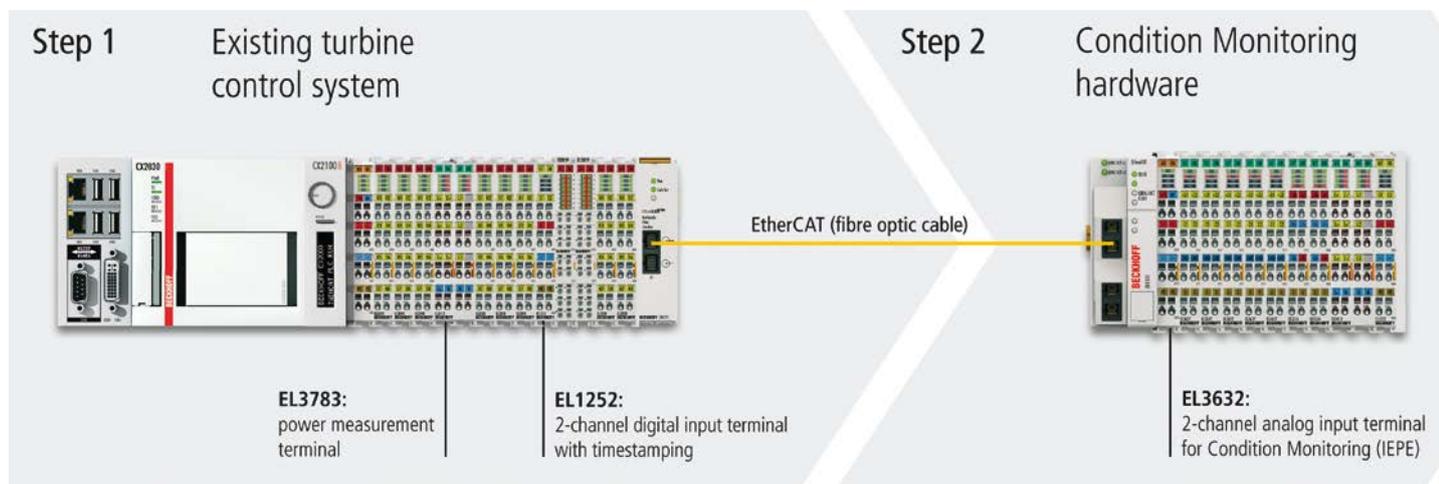
Employees **53 (Bachmann electronic GmbH:
more than 450)**

Founding year **1998**

Beckhoff Automation GmbH & Co. KG

PC-based control: The universal control platform for wind turbines

With PC- and EtherCAT-based control technology, Beckhoff implements system solutions that have been tried and tested worldwide: more than 50,000 wind turbines all over the world have been automated using Beckhoff technology, each providing up to 8 MW capacity.



Reliable Condition Monitoring: easily integrated in three steps

An Embedded PC with line-connected I/O modules, EtherCAT as universal communication system and TwinCAT automation software functions serve as the central control system. The modularity of the hardware and software portfolio enables users to configure a controller that exactly matches the performance requirements of their system and allows subsequent extensions and modifications – such as for example a retrofit of Condition Monitoring functions, without great expense.

The operation and maintenance of modern wind turbines incurs considerable costs. To maintain competitiveness, operators must minimise failure risks, reduce maintenance costs and increase the availability and energy efficiency of the system. This is where Condition Monitoring enters the game: seamless monitoring of gear units and

System-integrated Condition Monitoring

- Time-synchronous data logging in $\ll 1 \mu\text{s}$
- Reliable data analysis
- Enhanced diagnostics
- Increased system availability
- Longer service life of wind turbines
- Reduced maintenance costs
- Reduced system costs
- Enhanced competitiveness

BECKHOFF

Beckhoff Automation
GmbH & Co. KG
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E-Mail **wind@beckhoff.com**

Web **www.beckhoff.com/wind**

Profile **Controls, cables**

& switchgear cabinets

Category **Suppliers of electrical and
electronic components**

Turnover **€ 679 million (2016)**

Employees **3,350**

Founding year **1980**

Step 3

Condition Monitoring software



generators is generally recommended, not just for offshore wind turbines or systems in remote regions, but for all.

Beckhoff marries the powerful processors of modern PC technology together with EtherCAT as fast communication system, integrating Condition Monitoring functionality seamlessly into the controller. The vibrations of bearings or electrical machines are picked up by standard measurement terminals from Beckhoff and transmitted to the controller via EtherCAT. Configuration, programming and diagnostics are carried out within one system using TwinCAT.

System-integrated Condition Monitoring

With improved error detection and holistic system analysis capabilities, the control system-integrated Condition Monitoring from Beckhoff is superior to conventional hardware-based Condition Monitoring solutions.

High-frequency data acquisition via EtherCAT Terminals

For grid voltage monitoring, two EtherCAT Terminals are available from Beckhoff: the EL3783 power measurement terminal with oversampling function for status monitoring in a 3-phase AC network, and the EL1252 digital input terminal with timestamp function for the chronologically precise detection of binary control signals.

The retrofit of a wind turbine with Condition Monitoring can be realised by simply adding a terminal block with the corresponding EtherCAT measurement terminals to the turbine controller. A multi-functional input for analog measurement technology is available in the EL3751 EtherCAT Terminal. The EL3632 enables the direct connection of various acceleration sensors via an IEPE interface and performs high-precision vibration measurement. Strain gauges (SG) can be evaluated via the EL3356-0010. The raw data are recorded synchronously ($\ll 1 \mu\text{s}$) with other system data, such as power and speed, which increases the reliability of the data and reduces the number of false alarms.

A modular tool kit of mathematical algorithms for the analysis of measured values is available in the TwinCAT Conditioning Monitoring library. The library provides all essential functions for analysis, statistics and classification. Combining these algorithms with limit value monitoring is for instance, ideally suited to monitoring roller bearings.

We also recommend the utilisation of special solutions established third-party vendors, which can be directly integrated into the Beckhoff control platform, giving users access to extended diagnostics capabilities, reports, and long years of experience of these providers in consulting regarding monitoring.

If component-related threshold values are exceeded, the Condition Monitoring system triggers alarms to inform about wear, imbalances or impermissible operating states. In addition, the continuous machine monitoring can be carried out online. Trends in the characteristic values are analysed and translated into recommendations for action, for example in the planning of maintenance intervals.

Baumer GmbH

Baumer has acquired decades of expertise in the development of innovative technologies and is a single-source provider of robust and accurate sensors for wind turbines.



Baumer offers robust and reliable rotary encoders for use in wind turbines.

The HDmag flex magnetic belt tensioner was developed for large shaft diameters. It measures the precise speed and position on the load and is mounted directly on the shaft.

The PLD-certified GAM900S acceleration sensor records precise tower vibrations and shocks. At the same time, it monitors them safely, triggering redundant relay outputs when a defined limit value is exceeded. With this 2-in-1 function, it replaces dedicated acceleration sensors for measuring vibrations and mechanical limit switches. Not only does this reduce the costs for components, but also those for cabling and logistics.



Using advanced technologies along with an innovative and pioneering approach, Baumer engineers develop robust and reliable solutions for increased efficiency and availability of wind turbines through the intelligent use of rotary encoders and sensors.

Decades of close collaboration with engineering companies and equipment manufacturers have produced rotary encoders and sensors with specific advantages for the wind industry. These include rotary encoders for speed control and positioning of the pitch motor, as well as robust rotary encoders for precise position detection of the rotor blade position with no gear backlash.

Baumer also has decades of expertise in the development of durable HeavyDuty rotary encoders for offshore applications. HeavyDuty rotary encoders are extremely robust and designed to last for up to 25 years in wind turbines.

Today, manufacturers of offshore wind turbines trust in the reliability and longevity of our HeavyDuty rotary encoders.

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 E-Mail **sales.de@baumer.com**
 Web **www.baumer.com**
 Profile **Sensors**
 Category **Suppliers of electrical and electronic components**

DAFA Deutschland GmbH

75 years experience in the development, production and sale of foam, rubber and plastic products. DAFA Wind solutions are developed using our experience within every field of business to your advantage in wind power.



Foam, rubber and plastic solutions – seal, absorb and protect

DAFA is a Danish family company with more than 75 years of experience in the development, production and sale of special foam, rubber and plastic solutions.

DAFA Wind

Our objective is to combine innovative sector-specific solutions.

DAFA Wind includes products that have been developed using our experience from every field of business for your advantage in wind power.

Nacelle

DAFA's nacelle solutions help structures and electronic components in the nacelle to withstand stress, to perform better and thus to last longer. Optimise your products using our solutions within sealing, mounting and acoustics.

Rotor blades

Our foam and rubber solutions help from the very beginning; enhancing the blade design so it lasts longer and assuring safe transportation from the factory to the construction site. DAFA's solutions are on hand for de-icing solutions and maintenance tasks as well.

DAFA CargoPro®

CargoPro is a range of innovative and protective solutions for transport and storage of blades, towers and equipment for wind turbines.

CargoPro is particularly suitable for transport and storage of wind turbine blades and consist of a range of tested and proven rubber mats and foam solutions.

DAFA RotaSeal®

Your best choice in protecting rotating components in the turbine against penetration of salt, sand, water or dust. Use RotaSeal to meet demanding requirements for the hub or tower.

DAFA Tower Foundation System

Formwork elements matching requirements guarantee low tolerances and safe processes on the construction site. By using the Tower Foundation System you achieve a noticeable increase in the efficiency of the formwork.

- 01 | DAFA RotaSeal®
- 02 | DAFA CargoPro® Strap Pad
- 03 | DAFA Tip Protector



DAFA Deutschland GmbH

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E-Mail **info@dafa-germany.de**
Web **www.dafa-germany.de**
Profile **Seals & vibration control**
Category **Suppliers of mechanical components**
Turnover **€ 60 million**
Employees **310 worldwide**
Founding year **1939**



DEUBLIN GmbH

The hydraulic and electrical power to your pitch system

DEUBLIN rotating unions and electrical slip rings allow reliable media flow between stationary and rotating systems. Approved technology combined with global availability makes it a preferred solution for many leading wind turbine manufacturers.



01 For more than 60 years DEUBLIN have been internationally renowned for supplying high quality rotating unions worldwide. Manufacturing sites are located on four continents, North America, South America, Europe and Asia where 550 employees are dedicated to satisfying customer demands with fully developed and customized solutions. Highly qualified engineers located in 17 subsidiaries and 50 distributors facilitate projects worldwide from enquiry through to delivery. Superb products, high quality standards and the worldwide organisation enable DEUBLIN to be a preferred first tier supplier to the wind industry.

The Rotating Union is a precision mechanical component which allows the transfer of pressurized fluids from stationary systems to rotating machinery. Rotating unions must be designed considering a wide range of media, viscosities, temperatures and pressure ranges as well as velocities.



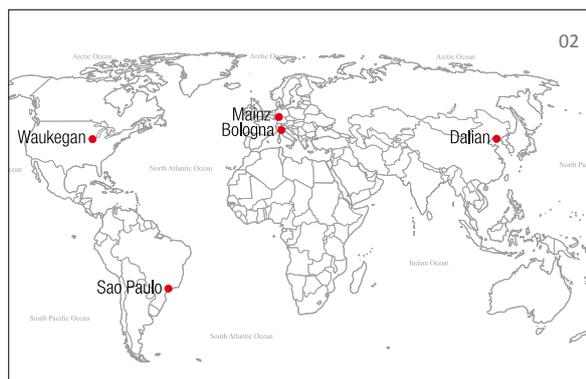
To DEUBLIN, being a partner in the wind industry means utilizing only specialized solutions that can meet highest expectations in terms of reliability and longevity. The rotating union is a critical component in the wind turbine hydraulic pitch control system.

Quality environmental standards according to ISO 9001 and ISO EN 14001 are a cornerstone of our corporate culture. Deublin is an Authorized Economic Operator (AEO) offering lean global logistic operation and secured customs clearance.



DEUBLIN GmbH

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Profile **Hydraulic components**
Category **Suppliers of mechanical components**
Founding year **1969**



01 | DEUBLIN high precision rotating union dedicated to wind power installations
02 | Deublin global production foot print

Filtration Group GmbH

Systems and components for wind power

In on- and offshore wind power systems and service platforms around the world, filtration and separation solutions from Filtration Group do an excellent job. All components and systems undergo continuous development and are characterised by highest levels of efficiency and reliability.



Filtration Group is one of the largest supplier for filtration solution and offshore wind energy systems. Typical applications for Filtration Group filters include hydraulic systems for rotor blade adjustment, for azimuth control and for the drive train brake-generally as flange-mounted filters and air breathers.

With its extensive application expertise, in-house research and development, technical center, laboratory and design development, the Filtration Group offers its customers tailor-made filter components and process engineering solutions.



Filtration Group GmbH

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Phone **+49 (0)7941 6466-0**
Fax **+49 (0)7941 6466-429**
E-Mail **fm.de.sales@
filtrationgroup.com**
Web **www.FiltrationGroup.com/
mahle**
Profile **Hydraulic components**
Category **Suppliers of mechanical
components**

For oil filtration in transmissions, e.g. an innovative oil filter module, spin-on cartridges as well as filter elements and filter housings are employed. The compact, ready-to-connect filter was developed for the specific requirements of lubrication systems in wind power plants. Integrated drainage on the dirty and clean sides, ventilation in the filter cover, an easily accessible maintenance indicator, and the high-performance two-stage filter elements provide maximum cleaning performance and long-term reliability.

01 | Oil filter module Pi 8300
02 | EcoParts elements
03 | Tower climate control system

Gram & Juhl A/S

TCM® – NUMBER 1 IN THE WIND INDUSTRY

For more than 20 years, Gram & Juhl has been developing and marketing innovative solutions for condition monitoring of wind turbines under the TCM® (Turbine Condition Monitoring) product family.

Gram & Juhl is the leading supplier of CMS by means of vibration analysis in the wind industry. More than 22,000 wind turbines and 80% of all offshore wind turbines worldwide are already equipped with TCM®.

TCM® Monitoring

TCM® monitoring gives you a deep insight into the condition of your wind turbine. Analyse vibration data early on to find out if damage to components such as gear mechanisms, bearings and generators is developing.

Identify deviations such as alignment or pitch errors that will permanently affect the optimum operating condition of the wind turbine. Thanks to full-spectrum monitoring combined with an intelligent and sophisticated alerting process, TCM® monitoring offers highly reliable and efficient monitoring of the system components.

TCM® Retrofit

With the TCM® retrofit kit, CMS can now be economically feasible by means of vibration analysis, even for older wind turbines. A retrofit kit specific to the wind turbine is assembled based on your requirements and installed by the operator of the wind turbine or a service team at low investment and installation costs.



With TCM® retrofit, you can monitor your wind turbines on an ongoing basis, replacing time-consuming and cost-intensive recurring individual measurements. Once the kit has been fitted, you will always have the current vibration data of your wind turbine at your disposal independently of any external conditions.

TCM® – The Benefits:

- Open and transparent service, included through the TCM® Customer Portal
- Vibration data can be always accessed by our customers – the data is yours!
- Early damage detection, as well as optimisation of work processes in management
- Immediate access to wind turbine information, condition indicators and recommended actions
- Reduction of operating and maintenance costs

TCM®
G · GRAM & JUHL

Gram & Juhl A/S
Gram & Juhl GmbH

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E-Mail **sales@gramjuhl.com**

Web **www.gramjuhl.com**

Profile **Condition monitoring systems**

Category **Suppliers of electrical and electronic components**

Employees **30 (Wind energy: 30)**

Founding year **1997**

HEICO Befestigungstechnik GmbH

Quality. Innovation. Service.

Your expert for the most demanding bolt connections. Over 100 years of experience and expertise in fastening technologies make HEICO a competent partner for the wind industry.



This family company, now in its fourth generation, produces high-quality products – Made in Germany. From its two production sites in Ense, North Rhine-Westphalia, the company supplies more than 1,000 customers in 68 countries around the world.

The 14 HEICO subsidiaries with their own warehousing facilities and a global distribution network with national and international trading partners ensure short delivery routes and optimal customer service.

In addition to professional technical support, the HEICO Group's own testing laboratory offers a wide range of tests for individual customer applications.

Safety is a matter of trust

Bolt connections tend to loosen under dynamic loads and extreme vibrations. This can lead to downtimes for the wind turbines. Regular checking and tightening of unsecured screw connections is costly and time-consuming. Added to this are the costs for repair and maintenance.

HEICO-LOCK® Wedge Locking Systems

HEICO-LOCK® provides reliable protection against self-loosening of bolt connections. In addition to the approved HEICO-LOCK® wedge lock washers, innovative product variants and easy-to-assemble combination products, such as the new HEICO-LOCK® combi washers, are part of the product portfolio. HEICO-LOCK® offers optimal products for an effective bolt securing in every application field.

HEICO-TEC® Tension Nut

Tightening large bolt connections in wind turbines usually require expensive electrical, hydraulic and pneumatic tools. HEICO-TEC® tension nuts in classes 8 and 10 can be delivered directly from stock and can be simply, quickly and reliably pre-tensioned by using a conventional torque wrench.



HEICO Befestigungstechnik GmbH

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Web **www.HEICO-GROUP.com**
Profile **Bolts & fasteners**
Category **Suppliers of mechanical components**
Employees **430**
Founding year **1900**

01 | HEICO Fastening Systems

02 | Wind farm

HELUKABEL GmbH

The professional cable solution for the wind energy sector

HELUKABEL GmbH is one of the leading international suppliers and manufacturers of cables, wires and accessories. We provide optimised and individualised solutions for every application in wind turbine installation.

We will advise you on:

Nacelle: Cables with increased oil- and heat-resistance, special solutions for the slip ring.

Loop: All torsion cables are tested for 18,000 cycles in our test tower.

Tower: Copper and aluminium cables, multi-wired and fine-wired, special lift cables, fibre optic cables and fastening systems.

All requirements regarding climatic conditions from -55 °C to +145 °C, offshore applications, high fire-testing parameters as well as international approvals according to UL, CSA, FT4, CE, VDE and WTTC standards can be met. These also include requirements regulating the North American market in compliance with the new UL 6141/UL 6142 standards. The Traycontrol cable series and an extensive portfolio of UL-listed products are available in stock.

Our top of the line model in the area of wind power is the WK 137-Torsion FT4 cable. It satisfies all the requirements of wind turbine manufacturers such as, increased nominal voltage of 1000 V, UL/CSA approval over a large temperature range without the use of halogen, and the



demanding FT4 fire test of the CSA. With its WK POWERLINE ALU cable, HELUKABEL is continually increasing its lead as a supplier of innovative products for the wind power industry. Thanks to its low weight and highly flexible design, aluminium conductors are closing a critical gap in power cabling. The specially developed connection equipment completes the product range.

01 | HELUKABEL WK series



HELUKABEL GmbH

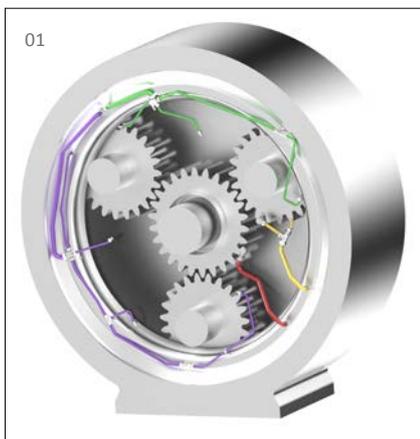
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Phone **+49 (0)7150 92090**
Fax **+49 (0)7150 81786**
E-Mail **info@helukabel.de**
Web **www.helukabel.de**
Profile **Controls, cables
& switchgear cabinets**
Category **Suppliers of electrical and
electronic components**
Turnover **€ 460 million (2016)**
Employees **1,200**
Founding year **1978**



Interhydraulik company for hydraulic components with limited liability

Development – Production – Service: Expertise under one roof

As a specialist in hydraulic connecting technology, Interhydraulik offers a diverse range of pipelines, hose assemblies and screw connections for use in wind turbines.



01 | Example of a pipe plan in the gearbox housing to lubricate the gearbox bearings

02 | Construction of the entire hydraulic connecting technology in your 3D model

We have been developing, manufacturing and distributing components for hydraulic connecting technology since 1984. As an owner-operated family business with over 190 employees around the world, today we are one of the leading system providers for hydraulic components in the fields of **mobile hydraulics** and **wind energy**.

Our passion for our customers' technical problems sets us apart. Our application technology means we can quickly develop **individual and intelligent product solutions** to a problem. Every project is supported from the development of the prototype to series production.

Our quality, experience and passion is not limited to mobile hydraulics. Our customers also include reputable companies in the field of wind energy, which have been using our products for many years all over the world.

Our products are also used on the **inside** and **outside** of gearboxes.

Inside the gearbox: Pipelines, lubrication lines, nozzles, oil reservoirs, distributors, holders.

Outside the gearbox: Hose assemblies and pipelines, intake manifolds, distributors, compensators, special components, pre-assembled components.

Due to increasing power density and ever-decreasing gap dimensions, technical cleanliness should not be underestimated for the long-term reliability of hydraulic systems. We meet the requirements of various OEMs regarding the **technical cleanliness** of hydraulic components. This is why we have our products and manufacturing processes audited by independent institutes.



Interhydraulik company for hydraulic components with limited liability

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59379 Selm**

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Web **www.interhydraulik.com**

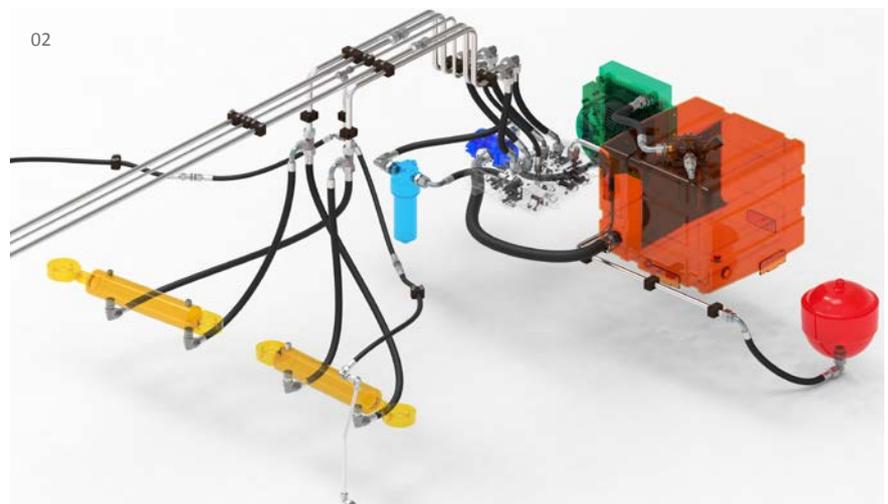
Profile **Hydraulic components**

Category **Suppliers of mechanical components**

Turnover **€ 21 million**

Employees **190**

Founding year **1984**



KTR Systems GmbH

Systems for Wind Power Technology

For more than 25 years KTR has been involved in the wind power industry and is a global market leader in the field of power transmission in wind energy plants. Customised systems consisting of couplings and torque limiters, but also brake and cooling systems are ready for deployment in wind power plants operating in the mega-Watt range.

As far back as 1988 KTR had already developed the first coupling for use in the wind power industry. With the RADEX®-N steel disc coupling we have had a coupling system on the market for over 15 years, that was specifically built for use in wind power plants and which has undergone continuous development since its inception. Currently more than 70,000 KTR couplings are used in wind turbines with a nominal capacity of up to 8MW, with thousands more added every year.

Our high-performance braking systems are used on the rotors and in the nacelle, to which end we provide products for three different applications: rotor brakes, yaw brakes and rotor lock. The systems are available in both hydraulic and electromagnetic versions.



Our large cooling units comprise of electric motors, fans and bypass systems. The cooling elements are made of weight-saving aluminium, whilst the fan cowling and frame are constructed in robust high-grade steel. In spite of their high performance, all cooling units are extremely compact. Cooling systems and motors intended for use in off-shore applications are treated with a special coating for off-shore environments, in order to protect them against the corrosive saline atmosphere.

Made for Motion – KTR

- 01 | Hydraulic and electromechanical braking systems: KTR-STOP and EMB-STOP
- 02 | Steel lamina coupling: RADEX-N wind
- 03 | Combined cooling systems: MMC eco



KTR Systems GmbH

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E-Mail **mail@ktr.com**

Web **www.ktr.com**

Profile **Brakes**

Category **Suppliers of mechanical components**

Employees **More than 1,100**

Founding year **1959**

Max Bögl Wind AG

The Hybrid Tower System and the Water Battery

Max Bögl Wind AG is manufacturer of the highest Hybrid Towers for wind turbines and with the Water Battery sets new standards in storing renewable energies.



Using renewable energies efficiently and driving forward the energy revolution: Max Bögl Wind AG is market leader in Germany for the manufacturing and erection of Hybrid Towers and holds the record for the highest wind turbine tower worldwide.

With the Water Battery, Max Bögl also setso new standards in the energy storage industry – a new type of pumped-storage power plant combines renewable energies with large-scale storage facilities. Max Bögl Wind AG is part of the corporate group Max Bögl. Founded 1929, the family-owned firm is now one of the ten largest German companies in the construction industry.



- 01 | Solutions for renewable energies.
- 02 | The Hybrid Tower System of Max Bögl – Top Performance.
- 03 | The mobile fabrication for international use.
- 04 | The Water Battery - Natural. Flexible. Unique.



Max Bögl Wind AG

Adress **PO Box 11 20
92301 Neumarkt i. d. Opf.**
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 E-Mail **wind@max-boegl.de**
 Web **www.mbrenewables.com**
 Profile **Towers**
 Category **Suppliers of large components**
 Turnover **more than € 1.7 billion**
 Employees **about 6,500**
 Founding year **1929**

Moog

Moog is your proven partner for reliable pitch systems – significantly increased reliability and our modular system architecture with optimized hardware design help to significantly reduce unplanned turbine downtime.

Over the past decade, the substantial increase in installed renewable capacity has drastically transformed the global energy landscape. Renewables such as wind have become increasingly competitive. Worldwide wind power is being harnessed to produce electric power. Ever larger and better performing wind turbines are being used to meet the increasing energy demand. Innovative technologies and mature products for onshore and offshore applications are highly sought after to ensure efficient output.

When it comes to reliability, we help you get the most out of your wind turbines. Our high reliable and low maintenance pitch system reduces turbine downtime and enables your wind turbine to generate more power, which reduces the Levelized Cost of Energy.



With Moog's latest hardware design, pitch system related failures and unplanned downtime can be reduced by up to 50%. Moog's modular system architecture helps turbine manufacturers to optimize assembly time in the hub and minimizes the engineering effort in adopting our pitch system design for new turbines. Our high reliable modular components help asset owners to optimize their spare parts inventory and reduce downtime due to reduced scheduled maintenance.

Moog Services provides staff training worldwide and guarantees spare parts delivery and reliable, specialized service. All Moog technology solutions are designed for on- and offshore installations: Each pitch system, blade sensing system and slip ring solution meets the highest quality demands and stands for superior reliability at the highest level.

The Moog Industrial Group is a division of Moog Inc. and designs and manufactures high performance pitch solutions for wind turbines. Find out more about Moog at www.moog.com/wind.

MOOG

	Moog
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Fax	+49 (0)2303 5937 199
E-Mail	wind.germany@moog.com
Web	www.moog.com
Profile	Controls, cables & switchgear cabinets
Category	Suppliers of electrical and electronic components
Turnover	USD 843 million (Moog Industrial)
Employees	almost 10,600 worldwide
Founding year	1951

01 | Moog Pitch Solutions for Wind Turbines

02 | Cutaway Moog Pitch System

M-PT Matjeschk PowerTools

Bolted connections can be checked without manipulation!

Due to environmental influences, bolts might become loose or break. Therefore, the torque of bolts is checked as part of the maintenance of wind turbines.



01 | Assembly of blade bolts with MED 70-90

02 | Felix Hebestreit, Certified Fastener Engineer (DSV)* Michael Matjeschk, Managing Director



**M-PT Matjeschk-PowerTools
GmbH & Co. KG**

Address **Am Saegewerk 11
01920 Ralbitz-Rosenthal**
Phone **+49 (0)35796 9760**
E-Mail **mail@m-pt.de**
Web **www.m-pt.de**

Profile **Tools & machine tools**
Category **Suppliers of mechanical
components**

Founding year **1994**

Practicable test methods

Often the methods for testing a bolted connection are difficult. An established method is turning the bolt with a mechanical or hydraulic torque wrench. In this case one can only determine if the bolt could be turned further. The terms for testing are defined in DIN EN 1090-2, which states that the bolt must not turn further by more than 15°. The initial testing torque must comply exactly with 1.05 times the tightening torque.

Highly sensitive test program of M-PT

For several years the development department has been addressing the difficulties of bolt maintenance. M-PT has succeeded in developing a unique test program, which allows bolted connections to be tested without turning the bolt further. To inspect a bolted connection, the electric MED torque wrench is placed on the bolt. Based on a highly complex

algorithm in the electronics, the MED continually measures the bolt's torque and incrementally becomes aligned with the testing torque. Conventional torquing tools, without this special test program, are not suitable for maintenance, because of the risk of overtightening due to the high rotational speed of such tools. In contrast, established hydraulic torque wrenches are very slow, heavy and bulky.

The MED exceeds customer demands

With the MED the maintenance of bolts becomes child's play. Every trained assembly worker can operate this test program. If several operators work on different bolting applications with the same tool, the multi-user level password protection prevents manipulation in set parameters. Together with M-PT's data logging software, the MED is the ideal tool for maintenance.



Nexans Deutschland GmbH

The Nexans Group produces cable solutions for all areas of wind power, whether onshore or offshore. The range extends from nacelle, tower and array cables to AC and DC cables for grid connection.

Hanover is home to one of the power cable factories. The site specialises in cables up to the highest voltage level and sells, among other things, single and three-phase medium voltage cables for wind farm networking. Most of them are factory-fitted with copper wires or glass fibres for communication. The cables come as sets, cut to length, assembled and electrically tested on the construction site. Matching sets and tools for easy and quick installation are also available. Nexans recently introduced 72.5 kV solutions for lower power losses.

Long-standing partner of the wind power industry

Nexans medium voltage cables are used in many wind farms. Recent references include the Hornsea Project One offshore wind farm off the coast of Yorkshire, UK. Nexans is manufacturing and installing 139 km of three-phase submarine cables for its first construction phase.

For the Westerengel onshore wind farm in Thuringia, Germany, Nexans has supplied a medium voltage cable with a record cross section. The project engineer ordered three single-phase 20 kV aluminium cables with a conductor cross-section of 1,600 mm² each, so that up to 23.1 MW of wind power can be supplied to the grid connection point with low losses over 15 km. The medium-voltage connection proved to be more economical than a high-voltage solution that would have required the construction of a new substation.



Nexans
BRINGS ENERGY TO LIFE



Nexans Deutschland GmbH

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Fax **+49 (0)511 676-2544**

E-Mail **info.nd@nexans.com**

Web **www.nexans.de**

Profile **Controls, cables
& switchgear cabinets**

Category **Suppliers of electrical and
electronic components**

Turnover **€ 1 billion**

Employees **11,000**

Founding year **2000**

NGC Transmission Europe GmbH

Expert in excellent gearbox solutions

NGC is one of the market leaders in wind turbine gearboxes and one of the world's leading suppliers of drive technology.



Quality products for any application

NGC develops, produces and distributes main gearboxes and pitch and yaw drives for multi-megawatt wind turbines. Our products meet the highest quality standards and are designed for both onshore and offshore applications, as well as for use in temperature ranges of -40 °C to +50 °C.



NGC Transmission Europe GmbH

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E-Mail **EURegion@
NGCtransmission.com**
Web **www.NGCtransmission.com**
Profile **Gears**
Category **Suppliers of mechanical
components**
Founding year **2014**

NGC standard series – the economically viable alternative

Minimise costs, reduce risks, shorten development times, simplify service and maintenance – you can achieve all this with our StanGear series, which we offer as an alternative to our customer-specific solutions.

Service without the “ifs and buts”

We provide customised servicing and maintenance concepts for your specific needs in order to guarantee high quality and sustained efficiency of our gearboxes during operation. If, for whatever reason, we cannot support you actively on-site by ourselves, we work with selected partners to bring you optimal support at all times, wherever you are.



High availability through global presence

Engineering, sales and service are available right around the world. In addition to our headquarters in Nanjing, China, NGC is also present in Singapore, the USA, Europe, Vietnam and India.

Experience and expertise – the key to our success

NGC has been providing gearbox solutions for around 50 years and, in this time, has successfully installed over 55,000 main gearboxes and more than 300,000 pitch and yaw drives in over 30 countries. Experience and expertise, in addition to state-of-the-art technology, are the essentials of our gearbox technology.

NSK Deutschland GmbH

Partnership based on Trust – Trust based on Quality

For over 15 years NSK has been a partner of the wind industry and one of the main suppliers of roller bearings for wind energy gearboxes and bearings for main rotor shafts and generators.

Combined know-how

Skills from sales and application technology are combined in the wind energy team – and also include the latest research results from our technology centres. Bearings are specifically designed using highly developed calculation and simulation tools. Our experienced engineers take account of load cycles, lubrication, deformation, thermal response and also extreme and maximum conditions. This is the only way to produce a construction with cost-optimised components that also reliably function under maximum loads and have a long service life.

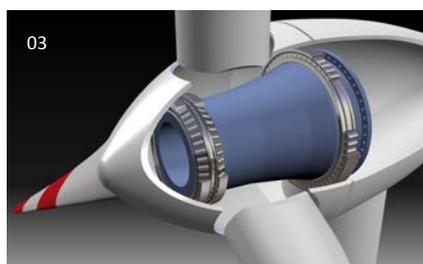
NSK wind standard

As the first manufacturer, NSK defined the pioneering wind standard U303 for roller bearings back in 2008 – including a one hundred percent traceability of the components of every single bearing and all essential processes. NDT methods (non destructive testing) are also available to avoid grinding burn, fractures in material and structural breakdowns.



Long service life with BOC (black oxide coating) and patented materials

BOC treatment of bearings prevents untimely bearing failures caused by white etching cracks (WEC). The patented special material AWS-TF (anti white structure-tough) is also available for high-level requirements and reliably prevents damage caused by WEC. Our STF material (super-tough) has proved ideal when it comes to increasing the load rating and service life, especially for contaminated lubricants. Certification by DNV GL confirms: Using Super-TF material means that the basic dynamic load rating can be improved by 23% in roller bearings, and 26% in ball bearings. This is equivalent to a doubling of bearing fatigue life.



- 01 | Main gearbox for wind turbines
- 02 | Planet wheel gear and bearing
- 03 | Main rotor shaft bearing

MOTION & CONTROL™
NSK

NSK Deutschland GmbH

Address	Harkortstrasse 15 40880 Ratingen
Phone	+49 (0)2102 481-0
E-Mail	info-de@nsk.com
Web	www.nskeurope.com
Profile	Bearings
Category	Suppliers of mechanical components
Turnover	Global: about € 7 billion
Employees	Global: about 31,500
Founding year	1916

PHOENIX CONTACT Deutschland GmbH

... more than just a terminal.

Phoenix Contact is a strong partner for the wind power industry thanks to an array of high-performance automation solutions, high-quality electronic components and innovative systems.



Phoenix Contact is the worldwide market leader of components, systems and solutions in the area electrical engineering, electronics and automation. The family-owned company employs 16,500 people worldwide and had a turnover of 2.20 billion euros in 2017. The corporate headquarters is located in Blomberg in central Germany. The Phoenix Contact Group has nine companies as well as 50 sales subsidiaries. In addition, the worldwide presence is consolidated by 40 representations in Europe and overseas. Worldwide production is occurring in nine countries with a high level of vertical integration.

Phoenix Contact is a veteran of wind energy with over 20 years experience in the field and one of the world's largest suppliers to the wind power industry. Both our electronic components and industry-specific systems and solutions are highly respected. Interface products, power supplies, monitoring systems and our wide range of surge protection components are well-established products in the industry, in addition to electro-mechanic components such as plug-in connectors and terminal blocks.

01 | We round off our hardware range with comprehensive consulting and related services.

02 | Our secret to success with our partners is our service team with its many years of experience, pooled knowledge and skills, and tremendous flexibility.

We offer hardware safety solutions and comprehensive service and consulting competence in the area of safety technology. In addition to our high-performance control systems, we offer a software library tailored to the wind power industry in the area of automation technology. It allows you to create a cost-effective automation solution for your wind turbine.

Our understanding of being close to the customer is to be at home no matter where we are in the world and speak the language of the user. It also exemplifies our contribution to a business relationship on par with our partners.



PHOENIX CONTACT Deutschland GmbH

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E-Mail **windenergy@phoenixcontact.com**
Web **www.phoenixcontact.com**

Profile **Controls, cables
& switchgear cabinets**
Category **Suppliers of electrical and
electronic components**

Turnover **€ 1.97 billion (2016)**
Employees **15,000 (2016)**
Founding year **1923**

Prysmian Kabel und Systeme GmbH

The Prysmian Group is the world's leading manufacturer for cables for the segments energy, telecom, data and industrial.

Its certified quality management with a worldwide focus ensures that product quality is always at the highest level, from the procurement and production processes, right through to the delivery process. With a focus on sustainable and environmentally friendly production processes, the Prysmian Group ensures that the fundamental principles of sustainable energy concepts are also implemented in its own company.

Our integrated management system complies with DIN EN ISO 9001, IRIS, ISO/TS 16949, KTA 1401, DIN EN ISO 14001, DIN EN ISO 50001 and OHSAS 18001. These are regularly monitored by independent experts.

As a world leader in special cables for wind turbines, we are able to manufacture products for the wind industry for all voltages or, if required, fully assembled cable sets in our German and international production sites:

Nacelle / Loop: Special cables (optional halogen-free / flame retardant) with increased oil, heat and ozone resistance, as well as optimized torsion properties.



Tower: Special cables (optional halogen free / flame retardant) for fixed installation with copper or aluminium conductors with excellent installation properties.

Wind farm cabling: From the low- and medium-voltage cables for the wind farm infrastructure, through to the high-voltage grid, we supply all cables for onshore and offshore applications.

In addition, we are able to supply cables as pre-assembled cable sets, as well as a service for fitting / commissioning or maintenance / turbine monitoring.



01 | As the world's leading manufacturer we can offer you a full product range of cables

02 | Pre-assembled cable sets

03 | Our service for fitting / commissioning or maintenance / turbine monitoring

Prysmian Group

Prysmian Kabel und Systeme GmbH

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prysmiangroup.com**

Web **www.prysmiangroup.com**

Profile **Energy & data transmission**

Category **Suppliers of electrical and
electronic components**

Turnover **€ 7.5 billion**

Employees **21,000**

Founding year **1879**

Ringspann GmbH

On-site worldwide as a premium partner for the international wind power industry



01 | Rotor brake

02 | Shrink Disc

RINGSPANN®

Ringspann GmbH

Address **Schaberweg 30–34
61348 Bad Homburg**

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E-Mail **info@ringspann.com**

Web **www.ringspann.com**

Profile **Hydraulic components**

Category **Suppliers of mechanical
components**

Turnover **€ 65 million**

Employees **Group 450**

Founding year **1944**

Whether the requirement is for high-quality drive components and mechanical overload protection, play-free connection of shafts or innovative brake systems, RINGSPANN is a premium partner to the machine and plant manufacturers of the wind power industry in these and many other areas. Seven production sites, 14 subsidiaries and a comprehensive service and consulting network worldwide ensure the customer-oriented on-site presence and high availability of all products in the entire portfolio.

RINGSPANN is a manufacturer of heavy-duty and ready-to-install wind power components, which are indispensable for the efficient and safe operation of modern onshore and offshore installations:

Freewheels as freewheeling clutches in generators

Hydraulic, pneumatic and electric brakes for decelerating, holding and stopping rotors, azimuth movement and rotor blades

Control systems for the controlled braking of the rotors

Hydraulic power units to supply hydraulic brakes

Shrink discs for the connection of gearbox hollow shafts with rotor shafts

Cone clamping elements for play-free mounting of brake discs on gear shafts

High-end clamping systems for the precision machining of gear components

As a component manufacturer, RINGSPANN stands for more than 70 years of technological expertise in the development and implementation of innovative drive and safety solutions for sectors of the energy-generating industry. The current product range of the company covers all components, types and variants that are currently market-relevant. In the field of freewheels, RINGSPANN is the world's market-leader.

Rittal GmbH & Co. KG

From rotor to tower: Rittal products are employed in all parts of a wind turbine. Rittal has supplied leading global system integrators and turbine manufacturers for many years.

Rittal GmbH & Co. KG, headquartered in Herborn, Germany, is a leading global provider of solutions for industrial enclosures, power distribution, climate control and IT infrastructure – as well as software and services. Systems made by Rittal are deployed across a variety of industrial and IT applications, including vertical sectors such as the transport industry, power generation, mechanical and plant engineering, IT and telecommunications.

Housings and enclosures from the “Rittal – The System.” portfolio are ideal for all on-shore and off-shore wind power applications.

Highly robust AE compact enclosures protect pitch-control systems in turbine **hubs** to prevent malfunction. The AE range delivers exceptional resistance to corrosion, shock and vibration, helping wind power plants to operate reliably. Rittal’s TS 8 baying enclosure system and SE 8 freestanding enclosures protect the controllers installed in **nacelles**. Efficient heaters and filter fan units condition the air. TS 8 enclosures provide effective protection for the inverters installed in wind turbine **towers**.



Customer-specific configurations can be implemented quickly and easily with standardised, modular components. Furthermore, all TS 8 models are rated IP 55 and Nema 12, and are UL certified.

The new Rittal Blue e+ units maintain optimum conditions inside the enclosures. Leveraging a hybrid cooling method, they can cut energy costs by as much as 75 percent. Rittal’s modular Ri4Power system supports the configuration of low-voltage switchgear in compliance with relevant standards. Stainless steel and aluminium outdoor enclosures keep grid feed-in and monitoring components safe from harm. Rittal housings are highly corrosion-resistant and can withstand extreme weather conditions.

01 | Its “Rittal – The System.” range covers housing and enclosure solutions, power distribution components, climate control systems, software and services.

02 | Due to their high quality standards, solutions from Rittal can be employed in every on-shore and off-shore application.



Rittal GmbH & Co. KG

Address **Auf dem Stützelberg
35745 Herborn
Mathias Heun
Vertical Market Manager –
Renewable Energies**

Phone **+49 (0)2772 505-1344**

Fax **+49 (0)2772 505-17344**

E-Mail **heun.m@rittal.de**

Web **www.rittal.com**

Profile **Controls, cables
& switchgear cabinets**

Category **Suppliers of electrical and
electronic components**

Turnover **€ 2.2 billion in 2016 (F.L.G.)**

Employees **9,300 worldwide (Rittal)
11,300 (F.L.G.)**

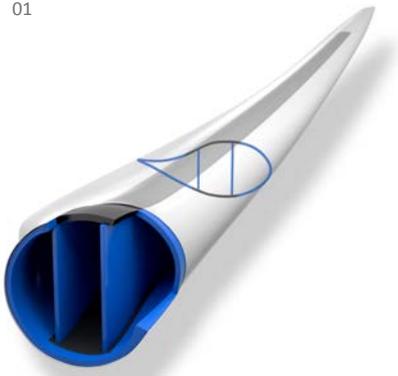
Founding year **1961**

Röchling Engineering Plastics SE & Co. KG

Increased efficiency with plastic!

For the development of wind turbines, Röchling offers a broad range of composites and thermoplastics used onshore and offshore by well-known manufacturers worldwide.

01



01 | Pultruded spar caps from Röchling, made of carbon fibre-reinforced or glass fibre-reinforced Durostone®, make the rotor blades of wind turbines stable and safe.

02 | Sliding sheets made of tribologically optimised materials developed jointly with OEMs align the nacelle in the azimuth system quickly and precisely in the wind direction.

With strong wind, blade tip speeds of up to 300 km/h and strong UV radiation, wind turbines are permanently exposed to high loads. Designers are faced with the question of how a turbine can be efficient, reliable and safe to operate even under heavy loads. The potential of wind energy is enormous, but only turbines in operation make money. High efficiencies and reduced downtimes are required.

Röchling Industrial offers a comprehensive range of composites and thermoplastics. The high-performance materials help to **develop efficient and reliable systems**. Röchling products are used worldwide by well-known manufacturers in the rotor blade, tower and nacelle, and as electrical insulation parts. The goal is always to provide the designer with the ideal material for the task at hand.

For example, pultruded **spar caps** made of carbon fibre-reinforced or glass fibre-reinforced Durostone® support development of high-performance rotor blades thanks to their strength and structure. **Sliding sheets** made of tribologically optimised materials developed jointly with OEMs enable a fast, precise alignment of the nacelle in the azimuth system. Durostone® **trailing edge serrations** support noise optimisation and efficiency thanks to their high mechanical strength and UV resistance. The range also includes machined components for gear wheels, fasteners, cable fixings and labyrinth seals.

Get advice now!

The specialists from Röchling provide advice during development. With 88 locations worldwide, the Röchling Group offers a comprehensive range of materials and manufacturing know-how close to customers everywhere.



**Röchling Engineering Plastics
SE & Co. KG
Industrial Division**

Address **Röchlingstr. 1
49733 Haren**
Phone **+49 (0)5934 701-0**
Fax **+49 (0)5934 701-299**
E-Mail **info@roechling-plastics.com**
Web **www.roechling.com**
Profile **Suppliers of mechanical
components**

Category **Plastic components**
Turnover **€ 684 million**
Employees **3,158**
Founding year **1916**

02



Schraubenwerk Zerbst GmbH

Fasteners for wind turbines

We fasten your wind turbine components safely and reliably. Wind turbine and component manufacturers around the world rely on Zerbst screws and fasteners.

The Zerbst plant has been manufacturing high-quality screws and fasteners for 100 years.

Schraubenwerk Zerbst has been supplying screws made of high-quality steel to the automotive industry as early as the 1920s. At that time, 30 % of overall production was exported to the US, UK, India and the Netherlands.

Nowadays the plant in Zerbst is a highly sophisticated production plant for fasteners. In addition to an extensive product range for rail track technology, Zerbst supplies industrial screws and screw fasteners to many industries. Customers around the world from the crane industry, automotive engineering, mechanical and plant engineering, and chemical plant construction trust the Zerbst brand.

Sustainable production and sustainable business management are among the corporate principles of Schraubenwerk Zerbst GmbH. Products in the field of renewable energy and wind turbines are ideally suited to this philosophy and are a dynamically growing business segment for the company.

Tower construction: HV sets up to M72, ready for installation with preset friction coefficient.

Offshore: Screw fasteners joining wind turbines to the sea bed.



Rotor blade: Combination of cross bolts and specially designed thermo bolts, from smaller rotor blades to over 80m long rotor blades for offshore wind turbines.

Nacelle and components: Standard screws, specially designed screws and bolts in strength categories 8.8, 10.9 and 12.9.

Services and logistics: From the warehouse to punctual delivery to building sites around the world.

Coatings: Galvanised and lamellar zinc coated fasteners can be supplied as standard. In addition, customers can order whatever type of coating they require.

**SCHRAUBENWERK
ZERBST GMBH** 

Schraubenwerk Zerbst GmbH

Address **Altbuchsland 22
39261 Zerbst**
Phone **+49 (0)3923 713-0**
Fax **+49 (0)3923 713-200**
E-Mail **info@schraubenwerk.com**
Web **www.schraubenwerk.de/
index_en.html**
Profile **Bolts & fasteners**
Category **Suppliers of mechanical
components**
Turnover **€ 50 million**
Employees **240**
Founding year **1919**

Schaeffler Technologies AG & Co. KG

Reliability made by Schaeffler

Schaeffler ranks among the world's leading manufacturers of rolling bearings. As a development partner for the sector we have been producing bearing supports for wind turbines for over 30 years. We offer the right bearing solution for every wind turbine and an integrated concept for safety.



SCHAEFFLER

Schaeffler Technologies
AG & Co. KG

Address **Georg-Schäfer-Str. 30
97421 Schweinfurt**
Phone **+49 (0)9721 91-0**
Fax **+49 (0)9721 91-3435**
E-Mail **info@schaeffler.com**
Web **www.schaeffler.de/windpower**
Profile **Bearings**
Category **Suppliers of mechanical
components**
Turnover **€ 14 billion**
Employees **more than 90,000**
Founding year **1883**

The right bearing solution for every wind turbine

With our INA and FAG brands, we offer the right bearing solution for rotor shafts, gearboxes, generators, and nacelle and blade adjustment. Special greases, services and products for all aspects of maintenance and condition monitoring round out our program.

Reliability made by Schaeffler

Cost-effective wind turbines require reliable components. We offer an integrated concept for safety.

Schaeffler Wind Power Standard

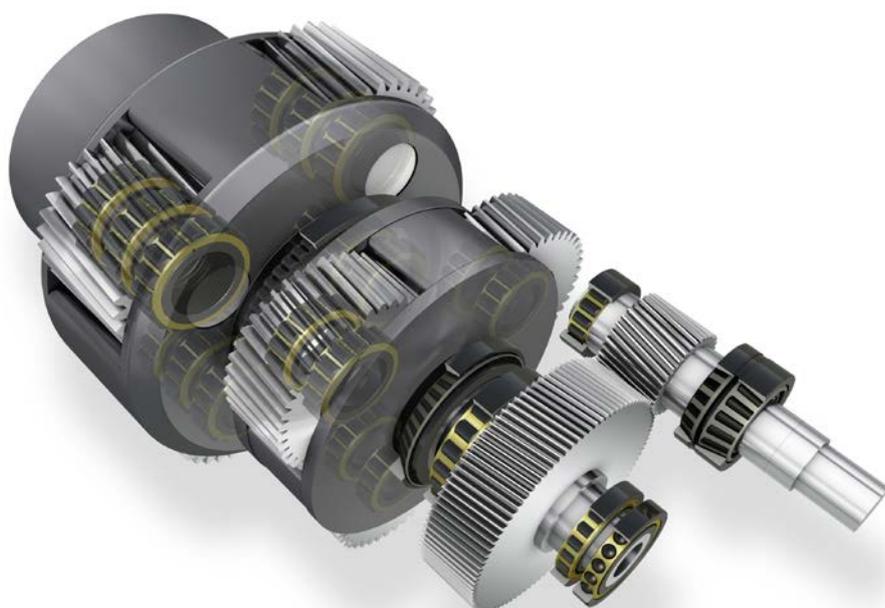
This standard for products and processes means Schaeffler is ensuring outstanding quality and reliability and is offering the same high standards of quality as it is already successfully offering in the automotive and aerospace industries.

Optimal design with advanced calculation and simulation programs

Our specialists work closely with designers, manufacturers and operators of wind turbines. State-of-the-art calculation and simulation programs ensure optimal designs for bearings for wind power applications are produced. The entire system is considered starting from a single rolling bearing and its components, the adjacent construction up to the entire power transmission system, which is displayed and optimized using multi-body simulation programs developed in-house.

Realistic tests on Schaeffler's "Astraios"

One of the most modern, largest, and highest performing large-size bearing test rigs in the world, enables bearings of up to 15 tons and measuring up to 3.5 meters to be tested. Astraios simulates the real loads and moments that occur in a wind turbine. This means we are making a major contribution to shortening development times for wind turbines as well as making the design process more reliable and increasing the cost-effectiveness and safety of these turbines.



Prevent White Etching Cracks with Durotect B

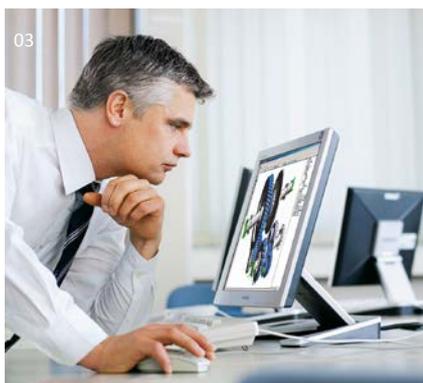
Prevent WEC with Durotect B

Schaeffler has comprehensive testing facilities for creating white etching cracks (WEC), analyzing the causes and developing solution concepts for reducing the risk of WEC.

The solution that Schaeffler recommends is to use black oxide coated rolling bearings. The advantages that our Durotect B coating system offers include increased protection against WEC, which has been statistically verified by extensive experience in the field.

High plant availability due to condition monitoring

We offer products and services for all aspects of condition monitoring, e.g. remote monitoring and diagnosis, offline measurements, endoscopy, thermography and speed measurement. Thus maintenance operation costs can be reduced and the availability of wind turbines can be increased. Digitalization makes entirely new solutions possible in the field of maintenance services. With predictive maintenance, we are expanding conventional condition monitoring approaches by allowing users to look into the “turbine’s future” and thus opening up new possibilities for increasing efficiency and reducing the total cost of ownership (TCO).



- 01 | Increased reliability and cost-effectiveness for wind turbines. AstraioS – one of the most modern, largest, and highest performing large size bearing test rigs in the world
- 02 | State-of-the-art calculation and simulation programs ensure optimal designs for bearings.
- 03 | Bearings, condition monitoring and services – the right solution for every wind turbine <http://windpower.schaeffler.com>
- 04 | Online condition monitoring – increased profitability due to permanent monitoring

Siemens AG

Creating the most from wind

With wind equipment by Siemens, you can rely on products and systems designed for maximum performance and tried-and-tested under harshest operating conditions a thousand times. All components support seamless communication among each other throughout all levels – for your wind energy plants' maximum availability.

Creating the most from wind

As experienced partner in the wind industry, we offer optimally matched products and systems for the electrical engineering equipment of wind energy plants. Your advantage: Maximum availability and efficiency, low production and maintenance costs, time savings in terms of engineering and commissioning as well as minimized time-to-market. This facilitates rapid return on investment and allows for a long-term reduction of your cost of energy.

Minimized time-to-market

Using our intelligent software solutions for virtual prototyping and virtual testing, you can develop new wind turbines with optimized cost efficiency and rapidity – right down to market maturity. Practical tools support planning and ease and accelerate the engineering process. Also commissioning is sped up – thanks to matched components and ease of handling.

Maximum efficiency

Our standardized components and matched systems can be optimally combined with each other. This allows for your specification's easy and accurate implementation. Our components' efficient interaction is already ensured in advance by means of comprehensive system tests.

Maximum availability

Our components and systems support seamless communication among each other, throughout all levels. This facilitates the wind energy plant's intelligent optimization as well as self-protection with extreme weather conditions. Furthermore, all plant parts can be consistently monitored and controlled for damage prevention – also remotely. Preventive maintenance allows for the minimization of downtimes due to repair and for the targeted planning of maintenance works.

Investment protection throughout the entire lifecycle

Standardized product ranges, high connection compatibility and comprehensive system tests as well as the proven industrial quality of all components ensure high investment protection. As global market leader in the field of automation technology, our experience enables us to ensure maximum product and production quality and to prove our excellence through the industry's customary certificates. As regards spare parts, high downward-compatibility as well as long-term, global spare parts availability support rapid replacement and restart.

SIEMENS

Siemens AG

Address **Gleiwitzer Str. 555
90475 Nuremberg**

E-Mail **wind-equipment.industry@
siemens.com**

Web **www.siemens.com/
wind-equipment**

Profile **Safety features & equipment**
Category **Suppliers of electrical and
electronic components**

Employees **377,000**

Founding year **1847**

SIEMENS
Ingenuity for life



Wind Equipment
Sustainable Market Specific Solutions

[siemens.com/wind-equipment](https://www.siemens.com/wind-equipment)



Our portfolio

- SIMATIC Wind Automation automation and turbine control systems, incl. wind-specific software, for efficient automatic wind energy plant operation.
- Industrial communication facilitates the control and monitoring of wind energy plants and the coordination of entire wind parks; it ensures the safe and reliable interaction of all system components also under harsh operating conditions; the SCALANCE and RUGGEDCOM network components form the basis of the required data networks.
- SIMATIC WinCC OA both represents a state-of-the-art SCADA solution for optimized operations control of (multiple) wind parks as well as a central service portal for wind energy plants (Multi-level Wind SCADA Center).
- Generators for turbines with and without gear ensure optimum energy output coupled with maximum reliability.
- The SIPLUS CMS condition monitoring system supports condition monitoring of wind energy plants and preventive maintenance.
- The products of the SIPLUS extreme range offer extreme ruggedness for applications in harshest environments.
- Matched components for rotor blade adjustment and nacelle tracking facilitate the realization of intelligent pitch and yaw systems; SIMATIC automation systems, SIRIUS industrial controls and SINAMICS frequency converters form the basis for such application.
- Industrial controls from the SIRIUS range ensure reliable switching, protection, starting and monitoring of motors as well as communication connection via IO-Link.
- The products of the SENTRON range for low-voltage energy distribution offer perfectly matched protection, switching, measuring and monitoring devices.
- SIVACON 8PS busbar trunking systems ensure optimum energy transport; NXPLUS C Wind and 8DJH 36 medium-voltage switchgear as well as our highly efficient GEAFOL cast-resin transformers and liquid-immersed distribution transformers facilitate reliable connection between wind energy plant and power grid.

SpanSet GmbH & Co. KG

Safety and quality „Made by SpanSet“

SpanSet supports international customers in the wind industry and offers a global service through its international network. In our own production plants we can rapidly implement individual requests.



01 | Magnum-X



02 | ClimaTech harness



SpanSet GmbH & Co. KG

Address **Juelicher Str. 49-51
52532 Uebach-Palenberg**

Phone **+49 (0)2451 4831 0**

Fax **+49 (0)2451 4831 8191**

E-Mail **info@spanset.de**

Web **www.spanset.de**

Profile **Tools & machine tools**

Category **Suppliers of mechanical
components**

Turnover **€ 26 million**

Employees **150**

Founding year **1967**

Lifting, load control, height safety and safety management are the cornerstones of our business at SpanSet, an international group of companies. Our production plants and sales organisations in Europe, the USA, Asia and Australia employ around 800 people. 22 companies in 19 countries offer our customers a global service and generate annual sales of 110 million euros. Our German companies include SpanSet GmbH & Co. KG in Übach-Palenberg, SpanSet secutex GmbH in Geilenkirchen, and AXZION GKS Stahl- und Maschinenbau GmbH in Langenfeld. The holding company of the group is based in Wollerau, Switzerland, near Lake Zurich.

The weaving, dyeing and production plant of SpanSet GmbH & Co. KG develops round slings and lifting straps ready for series production in close partnership with customers, universities and research institutions. In addition, SpanSet offers many other services including seminars, testing and repair services, consulting, expert reports and certifications.

SpanSet meets the growing demands of the wind industry with tailor-made products:

Magnum-X: Extremely robust and compact

The heavy-duty round sling Magnum-X has a maximum load capacity of 450 tonnes. An outstanding feature is its very compact design. Thanks to a fibre blend of high-performance fibres and a compact tubular casing, it is up to 50 percent narrower and lighter than comparable conventional round slings. This reduces the formation of wrinkles at the deflection point of the load and ensures a long service life.

ClimaTech: Preventing falls

This harness combines a seat and body harness and is designed for people working on wind turbines and measuring masts. Complies with EN 361, 358, 813.

Axzion GKS Stahl- und Maschinenbau GmbH

Intelligent lifting equipment for the wind industry

At home with wind: Axzion GKS specialises in lifting equipment for both on- and offshore wind turbines. The company representatives of the SpanSet Group guarantee a global and comprehensive service.

Axzion GKS, Langenfeld, is a German company of the international SpanSet Group. The company supplies customised products and special solutions for the complex requirements of transporting and assembling wind turbines and other large components.

Quality 7 – a one-stop solution

From construction to service, all product stages at Axzion are closely integrated. The QUALITY SEVEN 7-point programme involves the closely monitored development of products within in-house development and production, from steel to the finished lifting equipment. Approx. 84% of all delivered products are modifications and custom solutions, with only one in six items of lifting equipment being a standard product. The processing of high-quality materials ensures that our products function optimally. New developments are tested on our own test benches and all finished products undergo tests at independent testing institutions. Testing by Germanischer Lloyd, Lloyds Register or Norske Veritas is mandatory for offshore deployment. Customers then receive full documentation. Experienced engineers and technicians provide service, maintenance and repairs, training, and demonstrate correct product use.



VarioTAP: A perfect fit

The Vario Tower Attachment Point (TAP) was developed for tower segments with a dead weight of up to 240,000 kg and diameters of 2.5 to 6.5 m. The TAPs are available in load capacities of 17,000, 27,500, 40,000 and 60,000 kg.

Upending Tool: Everything under control
The Axzion Upending Tool, with a dead weight of 90,000 kg and a load bearing capacity of 1,500,000 kg, was developed for lifting and erecting the piles and is operated by Axzion Rental Services GmbH.



01 | Upending Tool

02 | VarioTAP



Axzion GKS Stahl- und Maschinenbau GmbH

Adress	Winkelsweg 172 40764 Langenfeld
Phone	+49 (0)2173 208920
E-Mail	wind@axzion.de
Web	www.axzion.de
Profile	Service, maintenance & repair
Category	Operation & service
Turnover	€ 25 million
Employees	130
Founding year	1991

SSB Wind Systems GmbH & Co. KG

Be consistent. SSB Wind Systems is your system supplier for all pitch systems. Thousands of pitch systems worldwide, self-developed switch and control cabinets or on-and offshore solutions for WTGs: Just a few highlights from over 25 years of experience in the wind energy sector.



01

01 | All systems go! SSB Wind Systems is your system supplier for all pitch systems.

02 | New converter for electrical pitch systems have to be designed as well as for onshore and offshore wind turbines.

03 | In connection with PerfectPitch, SSB Wind Systems developed the first App for electrical pitch systems.



02

Perfect solutions for new generations

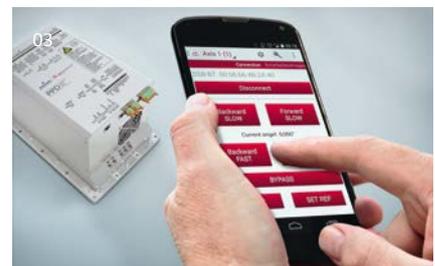
Since 1990, we have offered our technologies and know-how for onshore and offshore:

- Pitch systems (750 KW to 10 MW)
- Switch and control cabinets
- Service (upgrades & solutions, spare parts, training, support)

On this basis, we develop solutions so outstanding that, even over the long term, you won't ever have to worry about if and how they work. The fact that an entire generation will also benefit from your clean solution is not a side effect. It is rather the main objective driving all our actions.

Perfectly in tune: Our pitch systems.

From pitch drives to PerfectPitch Drive, our range of products is as comprehensive as a pitch system. A perfect combination of components, harmonized to deliver a complete solution: our Perfect Pitch System. Designed to fulfill your individual requirements and your wishes for WTGs up to 3.X MW and rotor sizes of up to 140 meters, a large part of our



03

system is comprised of the Perfect Pitch Drive as well as the Perfect Pitch Interface applications module. The integration of numerous functions within the Perfect Pitch Drive halves the total area of the pitch drive in the nacelle.

Not only do we consider pitch systems as a whole but we also develop and build them. This level of hands-on knowledge guarantees the highest quality and availability of your pitch systems.

Highest quality service: at eye-level

We don't just develop and build pitch systems. We maintain them too. Our service teams support you with commissioning, on-site services and spare parts procurement for all systems we deliver. Additionally our service offer includes the training of your service technicians and installers.



SSB Wind Systems GmbH & Co. KG

Address **Neuenkirchener Strasse 13
48499 Salzbergen**
Phone **+49 (0)5976 946-0**
Fax **+49 (0)5976 946-139**
E-Mail **info.ssb@mail.nidec.com**
Web **www.ssbwindsystems.com**
Profile **Controls, cables
& switchgear cabinets**
Category **Suppliers of electrical and
electronic components**
Employees **300 worldwide**
Founding year **1970**

STEGO Elektrotechnik GmbH

STEGO heating elements, regulators, fans, lamps and accessories protect your sensitive electronic components from harmful climatic influences.

STEGO products are used in all places where sensitive electronic components must be protected from humidity and other climatic influences. Heating elements, regulators, fans and STEGO accessories help you to optimise operating conditions and to reach maximum protection for your installations. So that you can be sure of lasting success!

Perfect thermal management. Since it was founded in 1980, STEGO Elektrotechnik in Schwäbisch Hall, Germany, has been developing, producing and selling an ever-growing range of products for the protection of electric and electronic components. All STEGO products are aimed at reaching optimum climatic conditions in the most varied environments, ensuring that all sensitive components work reliably at all times.

Tried and tested temperature and humidity control systems ensure these optimised climatic conditions. If temperature and/or humidity are too low or too high, the necessary countermeasure is immediately initiated, for example a heater is



turned on or a filter fan circulates cool air. A diversity of conditions such as the change from day to night, or particularly warm or cold regions, make climatisation an ever-increasing and challenging task. To meet this challenge, STEGO offers everything that is needed to protect sensitive components from corrosion and malfunction. Worldwide service supporting quality worldwide. STEGO's thermal management solutions are exported internationally and find use in the most diverse areas of application and climatic conditions.

- 01 | STEGO Headquarters in Schwäbisch Hall
- 02 | Semiconductor Fan Heater CSL 028
- 03 | Electronic Hygrotherm ETF 012



STEGO Elektrotechnik GmbH

Address **Kolpingstrasse 21
74523 Schwäbisch Hall**

Phone **+49 (0)791 95058 0**

Fax **+49 (0)791 95058 45**

E-Mail **info@stego.de**

Web **www.stego.de**

Profile **Cooling & climatisation**

Category **Suppliers of electrical and electronic components**

Founding year **1980**

TECHNO-PARTS GmbH

Innovative sealing systems and moulded parts for modern technology

In sealing technology, the smallest details are critical for reliable functioning. Our products have been doing their job reliably for years, from the tried-and-tested to the innovative component.



01 | Shaft seals for wind turbines and for heavy machine construction

02 | Most modern storage technology and more than 20,000 different articles in stock

03 | Headquarter in Essen



Dichtungs- und Kunststofftechnik
Sealing and Plastics Technology

TECHNO-PARTS GmbH
Sealing and Plastics Technology

Address **Alte Bottroper Straße 81**
45356 Essen

Phone **+49 201 86606-0**

Fax **+49 201 86606-68**

E-Mail **vk@techno-parts.de**

Web **www.techno-parts.de**

Profile **Seals & vibration control**

Category **Suppliers of mechanical components**

Founding year **1981**

Over 50 years of experience in the sealing field for hydraulics, pneumatics, chemicals and plant engineering have made us a high-performance company. We cover almost all applications – from miniature pneumatics to heavy-duty hydraulics, from chemicals and plant construction to offshore wind turbines. We continuously put our experience to work in the development and optimisation of our growing product range.

Our staff's wide-ranging expertise ensures a comprehensive service – from technical advice to our customers on-site to flexible order handling and on-time delivery.

A warehouse with well over 20,000 different items and flexible production for machined and injection-moulded products, combined with in-house tool-making, enable us to meet most customer requests in the shortest possible time.

A well-equipped laboratory for physical and chemical testing, comprehensive experiments and certification in accordance with DIN EN ISO 9001 make a significant contribution to our high quality standards and the further development of our products.

Individual packaging is just as much a part of our services as our own eKanban system and a quick service for urgent repairs and prototypes.

For the special requirements of wind turbines, we also supply radial shaft seals with high-strength, fabric-reinforced elastomer backs and excellent sliding properties. The shaft seals are available for internal and external sealing, also in split design with diameters up to 4,000 mm. This facilitates repairs and alleviates difficult installation conditions.

thyssenkrupp Rothe Erde GmbH

Our products ensure perfect turning in the wind

With production facilities in 10 countries and an associated sales network, we and our subsidiaries have been a reliable partner for all turbine manufacturers for decades.

Put to the test in our own R&D centre

When it comes to bearing and connecting elements of wind turbines, we develop individual solutions that are used worldwide thanks to intensive R&D work in onshore and offshore turbines. We define the special requirements together with our customers and then implement them in close cooperation. State-of-the-art test methods and efficient analysis tools provide valuable information on durability, service life, performance capability and utilisation limits. The test series are carried out, among other things, using our customers' companion structure under real conditions in our own, newly built and enlarged R&D centre, and all individual components are thoroughly tested. This enables us to design our products according to customer-specific requirements and optimal cost considerations in terms of the levelised cost of energy (LCOE).

Our product spectrum ranges from blade, tower and rotor bearings to rings for the tower and gearbox manufacturing.



The rotor bearing

Whether single-row or multi-row design, clamped or bolted installation, caseless or induction hardened raceways without soft spot, we develop and manufacture suitable solutions for diameters of up to 6,500 mm.

The tower bearing

Single-row or double-row four-point bearings, but also three-row roller bearings are particularly suitable for this purpose.

The blade bearings

We recommend single and double row four-point bearings as well as three-row roller bearings.

With the perfect combination of manufacturing possibilities (for tower and blade bearings up to 8,000 mm), our own R&D centre and our experienced employees worldwide, we are able to meet all future challenges together with our customers in the onshore and offshore field.



thyssenkrupp Rothe Erde GmbH

Address **Tremoniastr. 5-11
44137 Dortmund**
Phone **+49 (0)231 186-0**
Fax **+49 (0)231 186-2500**
E-Mail **rotheerde@thyssenkrupp.com**
Web **www.thyssenkrupp-rotheerde.com/GB/index.htm**
Profile **Bearings**
Category **Suppliers of mechanical components**
Employees **about 7,000**
Founding year **1861**

TOTAL Deutschland GmbH

More efficiency for your wind turbine

TOTAL offers high-performance lubricants for on- and offshore wind power plants. Due to the special formulation, they enable an extended oil change interval, lighter cold starts and increased plant efficiency.



TOTAL Deutschland GmbH
Vetriebsdirektion Schmierstoffe

Adress **Jean-Monnet-Str. 2**
10557 Berlin

Phone **+49 (0)30 202 76 787**

Fax **+49 (0)30 202 77 96 634**

E-Mail **rm.industrie@total.de**

Web **www.total.de/industrie**

Profile **Lubricants & lubrication systems**

Category **Suppliers of mechanical components**

Turnover **€ 15 billion**

Employees **3,100**

Founding year **1955**

TOTAL – a multinational energy company

TOTAL is one of the world's leading mineral oil companies. As an international oil and gas producer and supplier, TOTAL employs approximately 100,000 employees in more than 130 countries. TOTAL Germany GmbH is part of the group and operates around 1,200 service stations, making it Germany's third largest service station network. The company's extensive activities include the sale of lubricants, heating oil, aviation fuel, liquid gas, bitumen and special products. Furthermore, TOTAL also operates Europe's most modern refinery, the TOTAL Raffinerie Mitteldeutschland GmbH.

Applied high-performance lubricants

TOTAL is one of the world's leading suppliers in the industrial sector and covers almost all areas of application for highly specialised lubricants, grease and speciality products – from metal processing and food production to the operation of paper factories and even turbines. TOTAL works closely with well-known OEMs during the product development phase, and has already received OEM approvals for numerous products. TOTAL primarily operates in the chemical industry, the iron and steel industry, energy production, metal processing and plant construction, as well as the automotive and food industries.

Strong for the wind energy industry

TOTAL offers high-performance greases and oils for the wind power industry. You profit from extended oil exchange intervals and excellent protection of your plants.

With TOTAL as a partner you minimize your maintenance costs and avoid downtimes thanks to professional oil monitoring. The Carter SH 320 transmission oil from TOTAL is approved by the leading plant manufacturers such as Bosch Rexroth, ZF Wind Power, Winergy and Eickhoff.



Operational reliability and cost efficiency

The performance of industrial lubricants is crucial influence for the efficiency, reliability and resilience of machines and facilities. This in turn also has a significant impact on the company's productivity. With its TCO approach (Total Cost of Ownership), TOTAL sets high standards to optimise machine running time and reduce production and maintenance costs.

With the slogan "Committed to better Energy", TOTAL pledges itself to safety, health and environmental protection. Right from the beginning of new product development, the TOTAL research and development teams pay close attention to important parameters such as toxicity, emissions, biological degradability and product recycling.

Expert advice and service with additional benefits

The engineers at TOTAL have expert knowledge of the machines and plants – be it corrosion protection, heat resistance or protection against wear and tear. Our customers benefit from professional advice, expert application engineers and value-added services – from the rationalisation and organisation of lubrication activities, maintenance and laboratory analyses of your operating materials, to lubricant training for employees. With the help of the diagnostic system TOTAL ANAC Indus, the systems and lubricants are monitored when in use by customers, which also aids the optimisation of operational costs.

TOTAL not only provides specialised lubricants, it also offers comprehensive concepts for system optimisation. Our customers benefit from international know-how and individual and personal consultation at the local level.



U.I. Lapp GmbH

From tower to nacelle: Quality across the board

Fully integrated solutions: with Lapp Group, the wind power industry can fulfil all its cabling needs from a single provider.



In the Lapp Group's unique test facility cables up to 12 metres in length are tested under realistic conditions



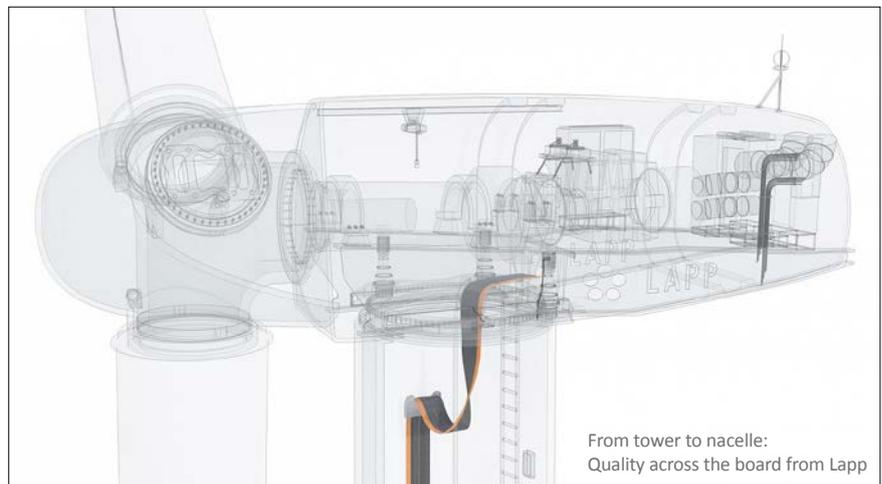
The Stuttgart-based Lapp Group is a leading supplier of integrated solutions and branded products for cable and connection technology. With brands such as ÖLFLEX® (connection and control cables), SKINTOP® (cable glands) and EPIC® (industry connectors), we offer absolute quality products and complete system solutions which meet the highly demanding requirements of wind turbine manufacturers. Ready-to-connect systems are manufactured in-house by Lapp Systems.

With its own, state-of-the-art test centre, the Lapp Group assures that its products are of the highest quality. Thus Lapp customers can be sure that systems function reliably with minimum downtimes. For this purpose, the Lapp Group operates a unique 16-metres-high test facility, in which cables up to 12 metres in length can be tested under realistic conditions as found in the loop of a wind turbine.

This type of test facility where all fastening points for cables and conductors exactly match real-life conditions only exists in one other location in Europe.

Specifically for the wind energy sector we have developed and tested cables which are flame-retardant, halogen-free and torsionable and which cover a wide range of temperatures. In combination with the SKINTOP® cable glands, which provide unrivalled vibration protection, we offer a product portfolio that perfectly meets the industry's highly demanding requirements. Many of our products comply with common international standards.

With our own production sites in Europe, Asia, North and South America and a network of sales offices and logistics centres on all continents, we are always available to our customers wherever they are in the world – always working fast and to the same high quality standards.



From tower to nacelle:
Quality across the board from Lapp

U.I. Lapp GmbH

Address	Schulze-Delitzsch-Strasse 25 70565 Stuttgart
Phone	+49 (0)711 7838-3175
Fax	+49 (0)711 7838-7330
E-Mail	andreas.mueller@lappkabel.de
Web	www.lappgroup.com www.lappkabel.com
Profile	Controls, cables & switchgear cabinets
Category	Suppliers of electrical and electronic components
Turnover	€ 1,027 million (consolidated)
Employees	3,770
Founding year	1959

Weidmüller

Your partner in Industrial Connectivity

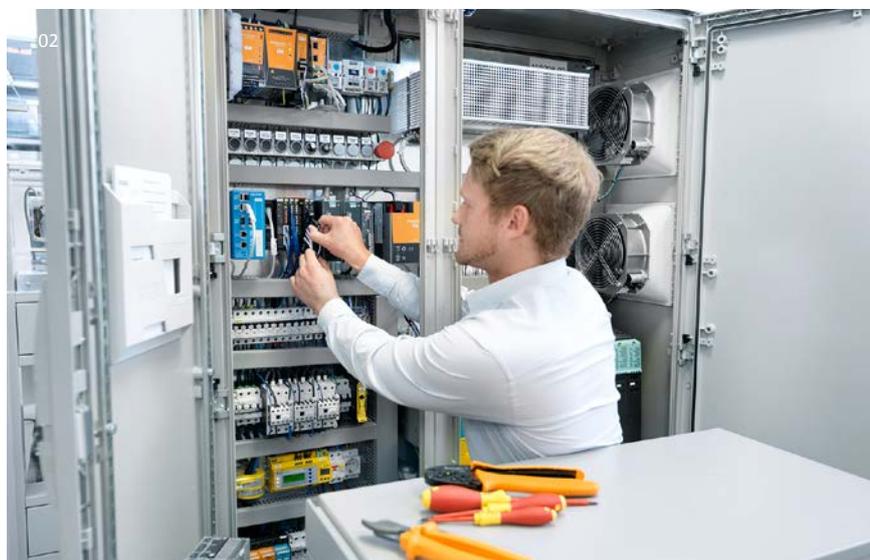
As experienced experts we support our customers and partners around the world with products, solutions and services in the industrial environment of power, signal and data. We are at home in their industries and markets and know the technological challenges of tomorrow. We are therefore continuously developing innovative, sustainable and useful solutions for their individual needs. Together we set standards in Industrial Connectivity.

The Weidmüller Group owns manufacturing plants, sales companies and representatives in more than 80 countries.



01 | Operating wind turbines efficiently –
Optimum results with our automation solutions

02 | Wind Bottom Box Installation



Weidmüller

Weidmüller

Address **Klingenbergstrasse 16
32758 Detmold**

Phone **+49 (0)5231 14-0**

Fax **49 (0)5231 14-292083**

E-Mail **info@weidmueller.com**

Web **www.weidmueller.com**

Profile **Condition monitoring systems**

Category **Suppliers of electrical and
electronic components**

Turnover **€ 696 million**

Employees **4,500**

Founding year **1850**

Winergy

Flender GmbH

With over 125GW gearbox capacity supplied Winergy is the leading component manufacturer for wind turbines. Winergy offers gearboxes in a power range of 750 kW–10 MW and more, as well as service.



- 01 | Winergy Gearboxes
- 02 | Production processes according to VDA 6.3. quality standards
- 03 | Extensive service portfolio incl. up-tower services



Winergy – Flender GmbH

Adress **Am Industriepark 2
46562 Voerde**
 Phone **+49 (0)2871 92-4**
 Fax **+49 (0)2871 92-2487**
 E-Mail **info@winergy-group.com**
 Web **www.winergy-group.com**
 Profile **Gears**
 Category **Suppliers of mechanical components**
 Founding year **1981**

Reliability is the foundation of a long-term partnership

In 1981, Winergy started to manufacture gearboxes specifically designed for wind turbines. Today, with more than 35 years of experience, Winergy offers the complete mechanical part for the drive train. To date we have supplied more than 125GW of gearbox capacity. Reliable, efficient and at low lifecycle costs Winergy gearboxes and couplings ensure that wind turbines all over the world convert windpower into electrical energy.

To support your customers globally – you must be represented locally

Since Winergy’s foundation, we have successfully implemented a globalization strategy and today operate production and service facilities in Europe, USA, China, India, Australia and Japan.

Quality is more than just a word to us – it is the essence of our products

The quality that we demand from our products is also reflected in our process-

es. Our customers all around the world benefit from our high-quality products and short delivery times. This is achieved with our comprehensive and fully integrated process management, lean operation and zero defect tolerance.

Our drive train components are as unique as your requirements

Detailed wind turbine specification is the foundation of individual drive train development. Winergy takes its long-term experience into account to develop cost-effective solutions that perfectly fulfill customer requirements. The result: mechanical components which increase energy efficiency.

Reliable service solutions

We have service concepts that are individually tailored to the requirements of our customers. The objective is to ensure high availability of your systems, resulting in reduced operating costs.



Woodward Kempen GmbH

CONCYCLE® Wind frequency converters for wind turbines with 12 MW+
Development, production and service for specific frequency converters for onshore and offshore wind turbines.

Reliable frequency converters with highest power density and maximum energy yield

For more than 20 years Woodward has been one of the leading, independent manufacturer of customized and application specific frequency converters for renewable energy generation.

An installed base of more than **16.500** frequency converters summing up to a total power larger than **36 GW**. Onshore and offshore wind turbine applications in more than 40 countries indicate Woodward's high level of expertise within the wind industry.

By adopting the aerospace processes of Woodward Inc., as well as our digitalized requirements management system, we ensure the high quality standards within Woodward Kempen GmbH.

The combination of expertise, highest quality standards, flexibility and a global service network is key to success for the trust in Woodward by its business partners and their success in the market.

Woodward CONCYCLE® frequency converters are technologically leading and set benchmarks in the renewable energy sector. In wind turbine applications, they are used as partial or full-size-converters.

Characterized by high power density, they enable a flexible arrangement inside nacelle or tower installations and ensure maximum reliability, best efficiency and high quality of the power supply.

The applied hardware and software is developed by using state-of-the-art simulation test benches, which ensures the highest possible energy yield.

Woodward is your strong partner with an excellent service and supports you during installation, commissioning and throughout the whole lifetime of your wind turbine.

We support maximum yield and cost-optimized operation by our global service network, fast spare part deliveries, upgrades, technical training as well as tailored service contracts.



01 | Woodward Kempen GmbH
02 | Concycle DFIG Frequency Converter
03 | Concycle Full Size Converter



Woodward Kempen GmbH

Address **Krefelder Weg 47
47906 Kempen**
Phone **+49 (0)2152 145-321**
Fax **+49 (0)2152 145-468**
E-Mail **Concycle@woodward.com**
Web **www.woodward.com**
Profile **Transformers, converters &
power resistors**
Category **Suppliers of electrical and
electronic components**
Employees **350 (Wind energy: 280)**
Founding year **1996**



Companies:

Service & logistics

Planning, finance, transport, construction and marketing. The fields of planning and operation of wind turbines are a continuous growth market in Germany.



ABICON GmbH

Independent – Innovative – Competent

As innovative project developers, we plan and implement sustainable concepts in the context of renewable energies – with our corporate network, we are prepared for any kind of challenge.



ABICON GmbH was founded in 2007 and is today run by managing shareholders Dr Andreas Möller and Thomas Knieling. It offers its expertise across all phases of project development, from site acquisition to commissioning, with a focus on wind energy and photovoltaics. ABICON GmbH also provides support for commercial and technical management.

Our work as project developers is based on four principles:

- Inclusion of all project participants and open communication
- Fast project implementation and individual solutions
- Absolute transparency in project development
- Contact partners throughout the project duration and beyond

By implementing the world's most sophisticated environmental management system, EMAS, we undertake to continuously improve our environmental performance, going above and beyond legal regulations. ABICON's ultimate objective is to develop concepts that are economically sustainable and improve regional value creation. Whatever the process, our team sees itself as a moderator between government authorities, landowners, energy suppliers, councils, citizens and investors. In this context, nature conservation and renewable energies are not in opposition, but go hand in hand

Since 2015, ABICON GmbH and its shareholder GP JOULE have formed a strategic partnership for the best possible implementation of existing projects and for overcoming future challenges. A steadily growing and ambitious team of agricultural engineers, geographers and environmental specialists are working together on implementing the ABICON vision: the continuous development of renewable energies for a cleaner environment.



ABICON GmbH

Address **Schönsteiner Straße 23
34630 Gilserberg-Moischeid**
Phone **+49 (0)6696 912 939 10**
Fax **+49 (0)6696 912 939 20**
E-Mail **info@abicon-gmbh.de**
Web **www.abicon-gmbh.de**
Profile **Planners & project developers**
Category **Planning**
Employees **16**
Founding year **2007**

01 | Dr Andreas Möller,
Managing Director of ABICON GmbH

02 | The team at ABICON GmbH



ABO Wind AG

Your Partner for Clean Energy

ABO Wind is one of Germany's well-established wind energy experts and offers wind farm development and construction, operational management, service, maintenance, and technical solutions.



22 Years of Wind Energy Expertise

ABO Wind has been on the map since 1996. So far, ABO Wind has developed, constructed and commissioned more than 1,300 megawatts of wind energy capacity in six countries and sold project rights of another 450 megawatts. The 450 employees realise projects with an investment sum of about 300 million euros per year. In addition, ABO Wind provides technical and commercial management of wind farms with a total capacity of 1,200 megawatts across Europe. ABO Wind also develops photovoltaic projects and hybrid energy solutions that combine wind, photovoltaics and energy storage.

01 | Installation of rotor blades during the repowering process of Framersheim wind farm

02 | The staff in the control room monitors operations of the wind farms.

03 | ABO Wind's own service teams take care of inspections, safety checks, fault clearance and repairs.



Project Development and Repowering

ABO Wind initiates wind energy projects, acquires land or existing projects, carries out all technical and commercial planning and engineering, prepares bank financing and installs turnkey wind turbines. ABO Wind also offers Engineering, Procurement and Construction (EPC) services to help third party projects succeed. Among municipalities, landowners and energy cooperatives, ABO Wind is known as a fair and reliable partner.

Operational Management and Technical Solutions

Remote monitoring, on-site service, contract management, accounting: Our flexible modules offer the perfect fit for each wind farm. In addition, experienced engineers develop smart solutions such as "ABO Lock", an access control system which allows operators to steer and log access to their wind farms conveniently and without a key.



Service, Maintenance & Technical Assessment

ABO Wind offers maintenance, repairs, safety checks, inspections and troubleshooting from a single source. Our technical experts assess all major components, from the foundation and tower to the drive train and rotor blade.

ABO WIND

ABO Wind AG

Address	Unter den Eichen 7 65195 Wiesbaden
Phone	+49 (0)611 267 65-0
Fax	+49 (0)611 267 65-599
E-Mail	kontakt@abo-wind.de
Web	www.abo-wind.de
Profile	Planners & project developers
Category	Planning
Turnover	€ 300 million (project volume)
Employees	440 (Wind energy: 420)
Founding year	1996

Agentur für Wirtschaftsförderung Cuxhaven

The Economic Development Agency Cuxhaven as a one-stop agency for the development and marketing of the German Offshore-Industry-Center Cuxhaven.



01



02

01 + 02 | German Offshore-Industry-Center Cuxhaven



The Economic Development Agency Cuxhaven initiates, accompanies and coordinates projects and measures to promote the economic location of Cuxhaven, in addition to its main areas of activity such as commercial and municipal investment promotion and consulting. A central project is the development and marketing of the German Offshore-Industry-Center Cuxhaven.

The German Offshore-Industry-Center Cuxhaven offers for offshore and heavy-duty industry optimal infrastructures and unique selling points, such as an excellent nautical location for production, installation and service as well as heavy-duty logistics areas and quay facilities, offshore-, heavy-duty- and multi-purpose terminals, heavy-duty platform, mobile and gantry cranes, free commercial and industrial areas, optimal transport connections (motorway, railway, Sea-Airport Cuxhaven/Nordholz) experienced and competent local service providers, as well as comprehensive education and qualification programmes.

Agentur für Wirtschaftsförderung Cuxhaven

Adress **Kapitän-Alexander Str. 1
27472 Cuxhaven**

Phone **+49 (0)4721 59960**

Fax **+49 (0)4721 599629**

E-Mail **info@afw-cuxhaven.de**

Web **www.afw-cuxhaven.de
www.doiz.de**

Profile **Offshore**

Category **Planning**

Employees **21 (Wind energy: 5)**

Founding year **2006**

PROJECT PRESENTATION

German Offshore-Industry-Centre in Cuxhaven

With the German Offshore Industry Centre right on the shipping lanes of the Elbe estuary, Cuxhaven offers a unique infrastructure for the offshore wind industry and is aiming to fulfil great potential for future development.



Due to its geographical location, the dynamically developing German Offshore Industry Centre in Cuxhaven provides ideal conditions for the use of wind energy in the North Sea.

At 13.5 to 15.8 metres, the deep waters of the Elbe allow sufficient draught to easily service special ships or other vessels.

At the same time, the German Offshore Industry Centre in Cuxhaven offers a special infrastructure ideal for the demands of the offshore wind industry and suitable for the production, loading and shipping of wind power components.

As early as 2006, the city of Cuxhaven built a specialised hydraulic structure for offshore projects with a surface area of 1,500 m² and a maximum load of 90 t/m² – the heavy load platform.

With two offshore terminals (another berth will be completed in 2018), a multi-purpose terminal, jack-up rigs, RORO ramps and heavy-duty storage areas, Cuxhaven occupies an outstanding position on the North Sea coast.



The German Offshore Industry Centre thus provides an entire spectrum of logistics options, ideal conditions for production, installation and service, as well as excellent nautical accessibility for the offshore industry.

Since 2006, the city of Cuxhaven, the state of Lower Saxony and the EU have invested more than 285 million euros in the portside and landside infrastructure in Cuxhaven (implemented by Niedersachsen Ports GmbH & Co. KG as a company of the state of Lower Saxony and Cuxhavener Hafen Entwicklungsgesellschaft GmbH as a municipal company) – around 390 million euros were invested in production facilities by the offshore industry.



Companies such as Siemens Gamesa Renewable Energy, AMBAU, Nordmark, Mare, Cuxport and a large number of suppliers and service providers have recognised the benefits of Cuxhaven's location and, by settling here, have steadily expanded the wide-ranging field of expertise of the German Offshore Industry Centre in Cuxhaven in terms of both quality and quantity.

Cuxhaven's German Offshore Industry Centre will continue to offer enormous development potential in the coming years and provide the best conditions for implementing the energy transition on the water.



The blue box on the left has contact information for the German Offshore-Industry-Centre Cuxhaven. For further information visit www.doiz.de

BayWa r.e. renewable energy GmbH

r.e.think energy

BayWa r.e. is one of the leading providers within the renewable energy sector in wind power, solar, bioenergy and geothermal. Our many years of experience in the wind energy sector in conjunction with a comprehensive service range benefit customers and business partners alike.



A specialist in developing, planning, financing, building, managing and maintaining wind turbines, BayWa r.e. is a solid and experienced partner. BayWa r.e. offers a diverse range of services:

Project development and turnkey construction

BayWa r.e. has developed and implemented wind farms with installed capacity of over 1,300 MW worldwide.

With the EEG 2017 creating a potential point of tension, in the future partnership models between the parties involved will become increasingly important to ensure the ongoing success of projects. For this reason, we have developed various partner models which support community wind farms, public utilities and smaller developers in all project phases, as and when required.

The range of services includes:

- Site analysis and evaluation
- Land acquisition
- Acquisition of project rights at each development stage
- Risk assumption for projects under the EEG 2017
- Planning permission/implementation
- Turnkey construction as a general contractor
- Project structuring and funding

Technical and commercial management

As a service provider for investment funds, banks, international investment companies, municipal utilities and citizens' cooperatives, BayWa r.e. manages the technical and commercial aspects of wind and solar energy projects with total rated capacity of over 3,000 MW all over Europe.

The range of services includes:

- 24/7 monitoring through the control centre with multilingual staff
- Control of maintenance and servicing
- Regional service staff for checks and immediate troubleshooting
- Full responsibility for the plant and DGUV V3 electrical equipment tests
- IT security for a reliable plant communication
- Infrared (IR) inspections with drones
- Contract and stakeholder management
- Accounting
- Budget and liquidity management
- Representation of the operator's assets



BayWa r.e. renewable energy GmbH

Address **Arabellastrasse 4
81925 Munich**
Phone **+49 (0)89 383932-0**
Fax **+49 (0)89 383932-32**
E-Mail **info@baywa-re.com**
Web **www.baywa-re.com**
Profile **Planners & project developers**
Category **Planning**
Turnover **€ 945.9 million (2016)**
Employees **1,300**
Founding year **2009**



02



Direct marketing and energy trading

BayWa r.e. also offers electricity marketing for producers of renewable electricity generated from wind, solar, biomass and geothermal sources, as part of the market bonus model and in the electricity balancing market:

- Energy trading of renewable electricity: Generation forecasts, EEG energy trading, portfolio management, accounting group management, remote control
- Assumption of marketing risks
- Optimising revenue potential: Marketing in the energy balancing market and wholesale market
- Usage of own electricity and regional marketing models for electricity producers; processing via internal accounting groups and billing systems

Rotor blade services

As a certified and manufacturer-independent service provider, BayWa r.e. provides extensive services to optimise and maintain rotor blades of all manufacturers and performance categories:

- Servicing and maintenance of rotor blades, on site and at the factory
- Assessments, warranty inspections and periodic inspections
- Cleaning and sealing of rotor blades, as well as cleaning of nacelles and towers
- Distribution of used wind turbines
- Developing add-on components to optimise rotor blades
- Heavy-duty transportation fleet
- Disposal of rotor blades
- Replacement blade sets on stock

Planning and consulting

BayWa r.e. offers comprehensive technical consulting and planning services for renewable energy.

The range of services includes:

- Due diligence reports
- LIDAR measurements
- Yield and emission reports
- Feasibility studies
- Permission planning and management
- Implementation and monitoring construction
- Grid planning
- Project management
- Optimising operation

Together with experienced employees from BayWa r.e., numerous customers and business partners have been able to realise the most appropriate solution for their business success. Moreover, backed by the financial strength of BayWa AG, BayWa r.e. is a reliable business partner for the long term.

04



- 01 | Campomaggiore wind farm (Italy)
- 02 | Gunzenhausen wind farm (Germany)
- 03 | Heavy-duty transportation with our own fleet of vehicles
- 04 | Construction of Klågerup wind farm (Sweden)

BaxEnergy GmbH

Innovative Solutions for a Greener World

BaxEnergy is dedicated to delivering innovative turnkey solutions to renewable energy players for complete visualization, data analysis and optimization of their power plants worldwide.



01 | BaxEnergy Control Room, Catania
02 | Key facts BaxEnergy

AssetStack® – Asset Management Solution

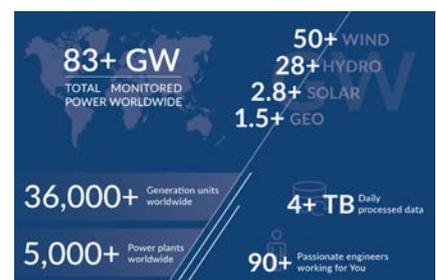
AssetStack® is the BaxEnergy Integrated Asset Management Solution for easily managing and storing all your power plant lifecycle information in one unique place. Contrary to many other systems, AssetStack® lets you keep the entire master data of all your assets with a customized approach, securing all data, tracking all changes and boosting your overall team productivity.

The solution, specifically designed to be a tailor-made experience that constantly drives your business processes, becomes a true “company memory” of everything that has occurred in your power plant, meeting your needs and securing the value of your investments.

Our Mission

The aim of the company is to make renewable energy easier, more efficient, affordable and secure, contributing to building a greener world for the benefit of present and future generations.

02



Energy Studio Pro® – The Next-Gen Asset Management Platform

Energy Studio Pro® is the industry leading platform capable of bringing together all renewable energy technologies and OEMs under one roof. It is the only independent turnkey solution for visualizing, analyzing and optimizing power plant operations all in one place, allowing our partners to digitize their entire assets and build their future strategies. As a cross-technology and cross-manufacturer system built with mobility in mind, Energy Studio Pro® becomes your open and flexible digital strategy through which your own KPIs and alarms may easily be configured and developed.

Thanks to the BaxEnergy IoT Datalogger and Store & Forward, the most suitable form of data acquisition can always be chosen. Connecting through SCADA manufacturers, as well as third party data collectors, ESP allows IoT data to flow to data centers.



BaxEnergy GmbH

Address **EUREF-Campus 10–11
10829 Berlin**
Phone **+49 (0)30 5863267 0**
Fax **+49 (0)30 5863267 99**
E-Mail **info@baxenergy.com**
Web **www.baxenergy.com**
Profile **Software solutions**
Category **Other services**
Turnover **€ 7.7 million**
Employees **78 (Wind energy: 78)**
Founding year **2010**

BDO ARBICON GmbH & Co. KG

Industry knowledge is a question of experience

Our industry team is your consulting partner for wind energy companies and projects in the fields of audit, tax consultancy, legal advice, corporate finance and IT.

As a medium-sized audit firm, BDO ARBICON has regional roots as well as a strong national presence and excellent international links. Our team currently comprises 120 highly qualified experts in Oldenburg, Germany. At BDO, almost 1900 employees at 26 locations throughout Germany are available as partners to help ensure the success of our clients. We have actively accompanied and helped shape the rise of the renewable energies sector since the early 1990s. We are a founding member of a supra-regional energy cluster and belong to the relevant industry associations within the BEE e.V. We use these strong networks to bring together knowledge streams and guarantee our clients a broad range of industry knowledge.

Our areas of expertise:

- Annual financial statements
- Audit of annual accounts in accordance with HGB, IFRS, VermAnIG, KAGB
- Design and structuring
- Preparation of sales brochures (VermAnIG, KAGB and WpPG)
- Advice on the implementation of civic energy projects
- Advice on requests for tenders
- External assessors of RE projects in accordance with KAGB (recognised by BaFin)
- Due diligence checks
- Design and implementation of financing concepts
- Yield certificates
- Transaction consulting
- Profitability of integrated energy models



By working closely with BDO's energy management business centre, we are able to meet the challenges of both the conventional energy industry and energy-intensive industry. For technology questions, we rely on the expertise of BDO Technik- und Umweltconsulting GmbH. Thanks to its international network of nearly 68,000 employees in 158 countries, BDO always has the right contact for you.



BDO ARBICON GmbH & Co. KG Wirtschaftsprüfungsgesellschaft

Adress **Moslestraße 3
26122 Oldenburg**
Phone **+49 (0)441 980 50 0**
Fax **+49 (0)441 980 50 180**
E-Mail **info@bdo-arbicon.de**
Web **www.bdo-arbicon.de**
Profile **Tax accountants**
Category **Finance & Law**
Founding year **1995**

01 | Our team of wind energy experts:
Sonja Hannover, Armin van Hoorn,
Michael Siefken, Klemens Lüke, Frank Reiners

BIL eG

Double benefit for the wind energy sector

BIL offers a 24/7 service using a fully digitised process for anyone seeking information. It is free and can be accessed from anywhere, including a smartphone or tablet.



01 | The exchange process of a building request via the BIL portal

02 | Diagram of the distances between the site of the construction project and the location of the requestor. Nearly 40% of requests are made over large distances.

In accordance with the EnWG (Section 12, Section 49), power line operators are obliged to provide information for planning and construction projects. This also applies to wind turbine operators.

Likewise, anyone carrying out construction work is obliged to gather relevant power line information to avoid damage and to maintain functional integrity. These two requirements mean that BIL – the nationwide information system for power line enquiries – provides a double benefit.

BIL eG is a cooperative organisation that provides a portal for processing building requests to planners and construction staff, and operators/managers of wind turbines. The BIL portal provides wind turbine operators with a quick and easy to use information service about power lines and therefore complies with the legal requirements for providing information. BIL also enables planners of wind turbines to gather power line information quickly and in compliance with the law. Potentially, all operators of power grids can be reached via the BIL portal with just one construction request.

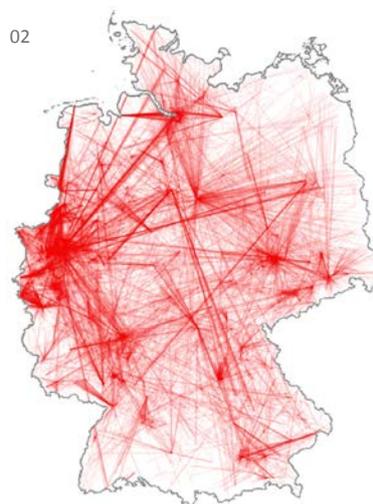
The integrated responsibility check filters all requests that are not relevant to the operator in geographical terms and significantly reduces the number of construction requests. For this purpose, the operator only provides its area of responsibility in the form of a geographic polygon.

Operating companies can therefore provide their customers with a guarantee that the process of providing power line information via the BIL portal is legally compliant. Planners can also use BIL free of charge as a helpful tool for obtaining power line information.

BIL – Twice the benefit with a completely digitised process available from any location 24/7:
<https://portal.bil-leitungsauskunft.de>



02



BIL eG Bundesweites Informationssystem zur Leitungsrecherche

Adress **Josef-Wirmer-Strasse 1-3
53123 Bonn**

Phone **+49 (0)228 92 58 52 90**

E-Mail **info@bil-leitungsauskunft.de**

Web **www.bil-leitungsauskunft.de**

Profile **Service, maintenance & repair**

Category **Operation & service**

Connected Wind Services Deutschland GmbH

Service & Maintenance – Components – Spare Parts
Connected Wind Services is Europe`s leading independent service provider for wind turbines.



We are specialized in service and maintenance, gear refurbishment and spare parts. Furthermore we help wind turbine owners or operators maximize their yield and protect their asset with our multi-brand, multi-skill approach – providing all you need from a single point of contract.



**Connected Wind Services
Deutschland GmbH**

Address **Mühlenberg 19
25873 Rantrum**
Phone **+49 (0)4848 90 128-0**
Fax **+49 (0)4848 90 128-0**
E-Mail **info.de@connectedwind.com**
Web **www.connectedwind.com**
Profile **Service, maintenance & repair**
Category **Operation & service**
Turnover **€ 6.7 million**
Employees **60+ Germany, 190+ Group**
Founding year **1987**

Deutsche Kreditbank AG

The industry expert with a local network

With almost 2,400 financed wind turbines and one of the largest renewable energies portfolios, we are your strong partner for wind energy projects in Germany.



01 | Meeting on an equal footing – even 130 m above the ground. Jörg-Uwe Fischer, Head of the Renewable Energies Competence Centre at DKB, and Jan Teut, Teut Windprojekte GmbH.

Our clients benefit from the financial expertise and high level of technical understanding of our account managers. They develop financing solutions tailored to the different technologies and locations, as well as taking fully into account project sizes and funding conditions.

Thanks to our regional network – which we expanded in 2017 by opening offices, among others, in Kiel, Münster and Oldenburg – we’re familiar with local conditions. This means we can create advantages for our customers by bringing together the stakeholders within our client groups: plant builders, regional utilities, supra-regional energy suppliers, local authorities and farmers. This includes individual models that involve citizens economically in wind and solar parks or local heating networks. Since 2004, we have implemented more than 100 citizen participation projects with our clients. Our parent company, Bayerische Landesbank, supports international projects and offshore wind farms.



The framework conditions for onshore wind energy projects have become more complex. In addition to tendering procedures and technical development of the turbines, focus has shifted to finding the right participation model for local citizens. Against this backdrop, renewable energy projects not only have to be implemented with foresight – they also need customised financing. This has been the goal of our work for more than 20 years.

“In this dynamic environment, cooperation with the German Wind Energy Association (BWE) is more important than ever in order to identify framework conditions early on and to influence how they develop,” explains Jörg-Uwe Fischer, Head of the Renewable Energies Competence Centre of DKB and a spokesman of the Wind Energy Association’s finance advisory council.

Deutsche Kreditbank AG

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10117 Berlin**

Phone **+49 (0)30 12030-9930**

Fax **+49 (0)30 12030-9902**

E-Mail **joerg-uwe.fischer@dkb.de**

Web **www.dkb.de/
erneuerbare-energien**

Profile **Banks, financial institutions &
financial service providers**

Category **Finance & Law**

Employees **about 3,200 (group)**

Founding year **1990**



Deutsche Messe AG

Energy industry meets at HANNOVER MESSE



Deutsche Messe AG will not only be presenting the subject of wind at HANNOVER MESSE, but will also be taking it to the ICCI in Istanbul, Turkey, (2 – 4 May 2018) and the CanWEA in Calgary, Alberta, Canada (23 – 25 October 2018). Both Turkey and Canada are emerging markets for wind energy and have ambitious expansion targets.

Deutsche Messe AG will continue its globalisation strategy and open up more attractive marketplaces for its customers in the energy sector through its global network of subsidiaries and representatives.

The core business of Deutsche Messe AG is the organisation of leading international trade fairs in Hanover and abroad. The international exhibition business is particularly focused on the growth markets in China, Southeast Asia, Australia, Turkey and North America. The main theme at these key fairs is on capital goods. Deutsche Messe is organising the world's most important event for the industry at the HANNOVER MESSE. The international leading trade show for integrated energy systems and mobility with more than

1,200 exhibitors is an important part of HANNOVER MESSE. Every April, the energy industry meets there to find out about new technical solutions for the energy system of the future. Integrated energy is a key area. In addition to the integration, control and intelligent networking of decentrally generated energy from renewable energy sources such as wind or PV plants, Hannover Messe also looks at storage, energy management and the energy infrastructure needed for electromobility.



Deutsche Messe AG

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E-Mail	behnaz.shabani@messe.de
Web	www.messe.de
Profile	Trade fairs & conferences for the wind energy industry
Category	Other services
Turnover	€ 360 million
Employees	more than 1,000
Founding year	1947

Deutsche Windtechnik

International service for the entire system – onshore and offshore

It's not only in Germany that there is a constant demand for independent service. Interest from operators for ISPs is growing continuously on an international scale. We are right at the center.



01 | More than 250 service teams operate for Deutsche Windtechnik internationally.

02 | Deutsche Windtechnik offers a complete, integrated service for offshore wind farms as well from foundation, to blade, to offshore substation (OSS).

03 | Special working platforms and rope-supported access methods enable safe access to the rotor blades.



Expertise, flexibility and more value for lower costs – these are what set apart the quality of our service. With our diverse range of core competencies, we are able to offer the full package of services from a single source. We now service over 3,000 wind turbines in Europe as part of permanent maintenance contracts (basic maintenance and full service). Our objective is to ensure technical systems operation and carry out our work in the most cost-efficient way possible.

Maintenance from A to Z

Whether it is the entire wind turbine, the control system, nacelle, rotor or the foundations, from large components to the smallest electronic components or even the substation, our team of experts understands your wind turbine portfolio and can provide economic benefits from a service point of view. Onshore and offshore.

Our range of services includes:

- Full maintenance and basic maintenance (Vestas, NEG-Micon, Siemens/AN Bonus, Nordex, Senvion/REpower, Fuhrländer, Gamesa)
- Expert appraisals for a range of scenarios
- QHSE
- Management services
- Offshore operations management
- Development and sale of spare parts
- Repowering

Based in Germany, at home worldwide

Our decentralised service network enables us to move swiftly between the customer, the wind turbine and spare parts warehouse. Our company's head office is based in Bremen, Germany. In addition, Deutsche Windtechnik is also active abroad: locations in Denmark, France, the Netherlands, Poland, Sweden, Spain, the United Kingdom, and the United States provide the foundation for high-quality system maintenance around the world.



Deutsche Windtechnik

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Fax **+49 (0)421 69105-499**

E-Mail **info@deutsche-windtechnik.com**

Web **www.deutsche-windtechnik.com**

Profile **Service, maintenance & repair**

Category **Operation & service**

Turnover **€ 125 million**

Employees **1,017 (Wind energy: 1,017)**

Founding year **2004**

Dunoair Windpark Planning GmbH

The energy transition comes first

As a specialist for the planning, construction and management of sites for wind turbines in Germany and abroad, DunoAir promotes climate and environmental protection.

We are a family-oriented company and safeguarding the future for the generations to come is important to us. The energy transition is an important move towards a time when access to energy is clean, inexhaustible and affordable. This goal strengthens our resolve every day to commit ourselves to wind power.

DunoAir originally began with Arjen C.F. Ploeg as a project buyer. The company developed dynamically in the years that followed and successfully established itself on the market. With the creation of its own planning department in 2009, DunoAir Windpark Planning GmbH, we have finally become a successful full-service company covering the entire value chain. From planning and construction to operation, DunoAir covers all the relevant fields for implementing projects in a serious, prompt and reliable manner.

Qualified and motivated staff are particularly important. They are the reason that DunoAir was able to grow into an international company with offices in Germany, the Netherlands and Ireland, and with projects boasting a total installed capacity of 163 MW.

Communities and local companies are closely involved in project development and are kept regularly up-to-date. Transparency like this creates trust and forms the basis for good and sustainable collaboration, with a view to adding value at a regional level.

The DunoAir team looks forward to giving investors, planners and operators the benefit of its expertise. Contact us and discover a reliable partner for the successful implementation of your projects.



01 | A relaxed glimpse of the future – wind farm festival in Weibern-Rieden

02 | DunoAir-founder Arjen C. F. Ploeg.



DUNO**AIR**

Dunoair Windpark Planning GmbH

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54290 Trier**

Phone **+49 (0)651 99 98 89-13**

E-Mail **c.wuertz@dunoair.com**

Web **www.dunoair.com/en**

Profile **Planners & project developers**

Category **Planning**

Employees **12**

Founding year **2004**

ee technik gmbh

Engineering progress can only be achieved if you keep improving your performance. At ee technik we call it “evolution engineering.” Our motivation is to revolutionize power engineering.



01 | Our team
02 | energy service portal

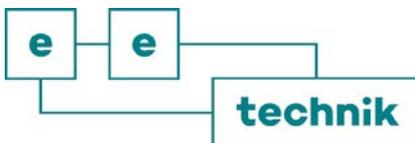


energy service portal – on this platform, all manufacturers and types of generating plants can be connected. Not only are you keeping an eye on the plants and know whether they are working the way they should, but you can also optimise processes and increase yields. Furthermore, with a reporting tool, you can easily create your monthly, quarterly or annual reports for your clients.

DEA Controller – when generating systems from various manufacturers share a common grid connection point, an EPC (energy power control) unit is required. Our certified solution, the distributed power generating system (DEA) controller, fulfils all the necessary technical requirements. Due to the modern architecture of control technology, the DEA controller can be accessed and visualized via an encrypted web-based interface.

added services – as a complementary addition to our portfolio, we offer an UPS box, an LTE box, a VOIP box and IT solutions. With the UPS box you can buffer various components in case of power failure. The LTE box brings the internet to the wind farm or substation where no broadband remote data transmission is available on site. With the VOIP box, you can create a cost-effective solution for switching off analogue telephone connections. In the area of IT solutions, we offer firewalls and routers configured according to your requirements.

managed solutions – what are „managed solutions“ – The question also reveals the answer. With the help of well thought-out and individual solutions we are able to solve complex questions and challenges. Whether this is an industry-specific topic or not – our specialists are always at your side!



ee technik gmbh

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Web **www.eetechnik.de**
Profile **Software solutions**
Category **Other services**
Founding year **2013**

egrid applications & consulting GmbH

Architects for the future of energy –

supporting you from the initial concept through to operation

We develop intelligent solutions for the decentralized integration of renewable energies in distribution grids.

Founded in 2013 as a subsidiary of the power supplier and DSO Allgäuer Überlandwerk GmbH, we are fully aware of our responsibilities in actively shaping the future of energy and we understand the needs of distribution grid, renewable energy production facilities as well as customer grids. Using our unique experience from regional and European R&D projects, we can provide you every possible perspective for the future of energy. As independent solutions provider, we guarantee cost optimization.

110 kV sub-stations

Our customized solution, optimized for integration of renewable energy production shows a modular and redundant architecture for a future-proof, expandable solution.

Call on us to build your substation with complete 110 kV grid connection for renewable power plants such as wind farms, solar farms and biogas plant – custom designed and ready on-time. By identifying your individual requirements, we can custom-tailor the sub-stations realize savings.



Local energy storage solutions for the network architecture of the future

Greater efficiency with mixed operating models.

We develop projects relating to energy storage systems that optimize internal renewable electricity consumption and perform critical tasks that benefit the overall system, such as the provision of balancing energy. Other areas: peak load capping, frequency stabilization, reactive power compensation, emergency power supply and black start capability.

Integrated energy with mobility, heating and power for the premises of tomorrow

Produce and utilize energy locally.

We work closely with you to design the right energy supply and mobility concept for your residential or industrial site. During our unique planning process, we devise the most efficient ways to use renewable energy in your project.



01 | 110 kV substation at onshore wind farm

02 | Energy storage system

03 | Integrated energy sites



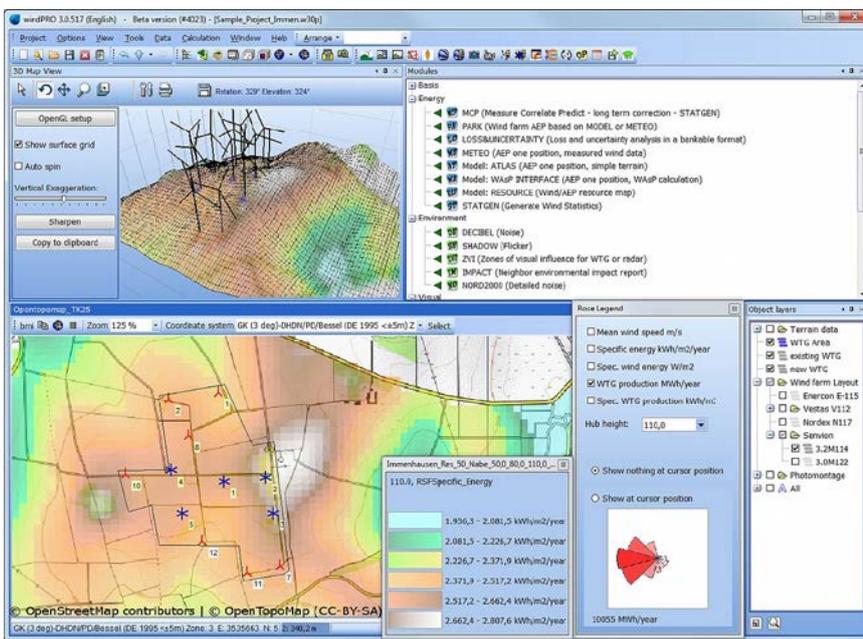
egrid applications & consulting GmbH

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87435 Kempten**
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E-Mail **info@egrid.de**
Web **www.egrid.de**
Profile **Grids & grid connection**
Category **Planning**
Turnover **€ 225 million (Group)**
Employees **350 (Group)**
Founding year **2013**

EMD Deutschland GbR

windPRO, windOPS, energyPRO, Training and Support

EMD Deutschland is the exclusive sales agency and training provider of EMD International A/S for Central Europe, the Balkan States and the German speaking countries.



windPRO 3.0 map window with wind resources and 3D view



windPRO

windPRO – software for wind energy project design and planning

windPRO is a module-based software package suited for project design and planning of both single WTGs and large wind farms. windPRO covers different areas, from energy yield calculations via wind data analysis, performance checking and environmental impact calculations to grid connection calculation. With its integrated online data services, a user friendly interface and continuous development to integrate new research and knowledge, it is now the world leading software for wind energy project design. User groups include project developers, independent experts, WTG manufacturers, grid operators, banks and authorities.



EMD Deutschland GbR
www.emd.dk



windOPS

windOPS – web software for performance analysis of your wind farm

windOPS is a web-based wind power management and analytics software service developed for the daily performance monitoring and to compare, analyse and report operational and financial data for wind farm assets on a regular basis. Present and past operation data of WTGs from different manufacturers are shown in a unified view and summarized in a well-arranged portfolio view.



energyPRO

energyPRO – software for the simulation of distributed energy systems

energyPRO is the most advanced and flexible modelling software for combined techno-economic optimisation and analysis of a variety of heat, CHP, process and cooling related energy projects. In energyPRO you can model virtually any type of technologies from well-known, fossil fuel based production units to state-of-the-art renewables.

EMD Deutschland GbR

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Web **www.emd.dk**
Profile **Software solutions**
Category **Other services**
Turnover **> € 5 million (EMD Int.A/S)**
Employees **6 (EMD Deutschland)**
Founding year **1999**

EnBW Energie Baden-Württemberg AG

Whether in development, acquisition, construction, operation or direct marketing – EnBW is active along the entire value added chain, independently, as a partner and as a service provider.



EnBW is consistently expanding its involvement in the area of wind energy. We were one of the pioneers of wind energy at sea with our wind farm EnBW Baltic 1 – the first commercial offshore wind farm in Germany in the Baltic Sea. It was then followed by EnBW Baltic 2. This means we currently have 337 MW of installed output in the Baltic Sea. We are now switching course to the North Sea where we will continue to grow: The joint construction of EnBW Hohe See and EnBW Albatros will provide an additional 610 MW of output for transforming fresh wind into clean electricity. The construction of our third North Sea wind farm – EnBW He Dreiht – is due to start in 2023.

- 01 | EnBW Baltic 2 offshore wind farm
- 02 | EnBW Rot am See wind farm
- 03 | EnBW is also a service provider to third parties



In the onshore sector, EnBW expanded its 2017 portfolio by around 190 MW across the whole of Germany by the end of the year. It now has a total onshore output of around 460 MW, and a further 30 MW is currently under construction. In the last few years, we have already developed and implemented wind energy projects in cooperation with other project developers. In an increasingly complex market environment, reliable partnerships will become even more important in the future. We consider this important, and want to continue to develop and successfully implement wind energy projects together with other project developers.



EnBW Energie Baden-Württemberg AG

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E-Mail	windkraft@enbw.com
Web	www.enbw.com
Profile	Energy services
Category	Construction, operation and direct marketing
Turnover	€ 15.3 billion (9.2017)
Employees	21,298 (9.2017)
Founding year	1997

Energieallianz Bayern GmbH & Co. KG

Consulting and services for the energy transition

Energieallianz Bayern plans, builds and operates wind turbines throughout Germany. As a subsidiary of municipal utility companies and energy cooperatives, we are your long-term partner.



Responsibility for future generations, protection of the world's climate, safe CO₂-free energy for people and businesses, electricity produced in the region for the region – there are many reasons to help shape the energy transition. As a committed citizen, a far-sighted community, an innovative company or a responsible investor. We provide you with all these services and our full commitment every step of the way.

Location planning and management

- Examination of location suitability
- Creation of wind farm layouts
- Conclusion of licence agreements
- Security of grid connection and cabling/routing
- Technical planning

Approval procedures and EEG invitation to tender

- Furnishing of all assessments
- Drawing up of approval documents
- Assistance with urban land-use planning
- Planning of compensatory and substitute measures
- Participation in the EEG tender procedure

Contract management and construction supervision

- Procurement of outside capital
- Economic evaluation, negotiation of contracts
- General contracting
- Construction supervision
- Construction inspection and billing
- Examination of warranty

Asset management and operations management

- Business management and investment management
- Fulfilment of all reporting obligations and permit conditions
- Independent technical and commercial management
- Data collection and provision
- Supervision and monitoring of all contracts
- Cost and revenue optimisation
- Direct marketing and other forms of marketing

As an installer and operator of our own wind farms, we are familiar with all aspects of the value chain. We can provide advice during every project phase.

As a community of numerous shareholders, we understand how to implement cooperation models. We use our creativity to get the most out of your wind farm.



Energieallianz Bayern GmbH & Co. KG

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Web **www.energieallianz-bayern.de
www.energieallianz-projekt.de**
Profile **Planners & project developers**
Category **Planning**
Turnover **€ 10 million
(Energieallianz-Gruppe)**
Employees **Wind energy: 10**
Founding year **2009**



01 | Ziegler wind farm, Velburg municipality, Oberpfalz (Upper Palatinate)

02 | Headquarters of the Energieallianz Bayern Group

Energiekontor AG

The Energiekontor Group plans and implements wind farms and solar parks in Germany and abroad. With more than 25 years of experience, the company is a pioneer in its field.

Founded in 1990 in Bremerhaven, Energiekontor is a pioneer in the wind energy sector and one of the leading German project developers with currently about 180 employees. The group's core business ranges from planning and construction to the operational management of wind farms in Germany and abroad; solar energy is also part of the portfolio. In addition, Energiekontor currently operates 35 own wind farms with a nominal capacity of around 270 MW.

Apart from our headquarters in Bremen, Energiekontor has offices in Bremerhaven, Hagen im Bremischen, Aachen, Bernau near Berlin and Dortmund. Through its subsidiaries the company is also represented in England (Leeds), Scotland (Glasgow), Portugal (Lisbon) and the Netherlands (Nijmegen). Further subsidiaries are currently being developed in the USA and France.

Since 1990, the company has planned and set up 118 wind farms with more than 621 wind turbines and a total rated capacity of nearly 940 MW. The total investment volume for these projects is over 1.5 billion euros.

Energiekontor aims to grow sustainably based on three business areas: Successful project development in selected national markets and focal regions, a growing portfolio of company-owned wind farms, as well as ongoing optimisation of value addition by means of increased efficiency and innovation, together with an expansion of operational management.



Some of the projects developed are sold, but others remain within the company. The continuous income from electricity sales and operational management provides a solid foundation for project development where earnings tend to be more volatile. The company's strategy is to create financial stability for sustainable growth also in new regions and international markets.



EnergieKontor

Energiekontor AG

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Profile	Planners & project developers
Category	Planning
Turnover	€ 201.8 million (2016)
Employees	180
Founding year	1990

Energiequelle GmbH

Energiequelle has been implementing wind energy projects from planning to grid connection since 1997. With sites in Germany, France and Finland, it is at the forefront of the energy transition. The company also looks after the technical and commercial management of the turbines, with very good rating in customer satisfaction and a new modular system.



Energiequelle GmbH

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E-Mail **info@energiequelle.de**
Web **www.energiequelle.de**
Profile **Planners & project developers**
Category **Planning**
Turnover **approx. € 100 million**
Employees **200**
Founding year **1997**

Energiequelle has been implementing wind energy projects from planning to grid connection since 1997. The company also looks after the technical and commercial management of the turbines. With sites in Germany and France, it is at the forefront of the energy transition.



20 years' experience

Last year, Energiequelle, the Brandenburg-based project developer and operator, celebrated its 20th anniversary. But this was no reason for Joachim Uecker, Michael Raschemann and their team of more than 200 employees to rest on their laurels. Energiequelle brings together different operations under one roof. In recent years, it has developed a broad portfolio that covers virtually everything a client may need. This includes not only project planning, installation and operation of wind, biogas and PV power plants, but also the planning and implementation of storage facilities, transformer stations and innovative energy concepts.

With more than 750 managed renewable energy plants to date, this global company is one of the largest German operators on the market.

Operations management by Energiequelle GmbH: high customer satisfaction and a new modular system

Our operations management clients are very satisfied with the service they receive from Energiequelle. In the current customer satisfaction survey from 2017, Energiequelle got an overall rating of 1.36 based on 448 evaluated projects. The survey looked at all aspects of the entire offering: from reporting to response times. Those surveyed particularly mentioned that their contacts are easy to reach and have a customer-friendly approach.

Lars Schiller, Head of Operations Management at Energiequelle, is very pleased with the customer feedback, but also sees a downside: “Once again, we’re very pleased with the results of the customer satisfaction survey, but unfortunately there’s no benchmark in the industry for us to compare our services with other operators. We want to keep on improving and adapt to constantly changing market conditions.”

The new modular system

This is why Schiller and his operations management team have pulled together a new structure for their offering that will enable customers to use services on a modular and more customised basis for new projects. This is just one example of Energiequelle implementing a customer request as a result of substantial feedback from customer satisfaction surveys.

Thirty-two modules have been developed for operations, which can be flexibly implemented depending on project requirements. Energiequelle now expects even greater levels of bespoke solutions to meet customer needs on the market. Lars Schiller explains in an interview what this means in practice.



Interview with Lars Schiller, Head of Operations Management at Energiequelle

“Mr Schiller, why did Energiequelle opt for a modular system for its offering?”

“We noticed that many operators are now establishing their own expertise on a number of asset management topics. Therefore, they don’t need the complete range of services of an operations manager and we want to respond to this situation with a needs-based concept. We mustn’t forget that rapid market development creates new service areas, while older ones disappear or level off. A modular system enables us to respond very flexibly and quickly. Just like our customers who, regardless of their operations management contract, can easily book our modules or unsubscribe from them as needed.”

OM modular system

- Technical operations management – basic
- 24-hour control room/ on-call service
- Inspections
- HSE management
- Energiequelle team on-site
- Assessment management
- Warranty management
- Feed-in management calculations
- Infrastructure management
- Approval-compliant operation
- Major component management
- CMS evaluation
- Insurance management
- Site maintenance
- Report management
- Customer access WIS
- Turbine responsibility
- Operator responsibility
- Electrical management
- Contract management
- Performance check
- Cost optimisation of purchased energy
- Direct marketing
- Lease management
- Accounting
- Budget and forecast planning
- Commercial correspondence
- Continued operation
- Compensation and replacement measures management
- Establishing reference yield
- Dismantling
- Unexpected events

“What are the benefits to customers?”

“Cost transparency and flexibility because customers only receive the services that are really pertinent to their needs. Each module is calculated on a project-specific basis and thus is tailor-made. Flat-rate calculations and contracts are now a thing of the past.”

ENGIE Deutschland GmbH – Windpark Betriebsführung

ENGIE – Innovative, renewable, efficient

ENGIE Deutschland Windpark Betriebsführung is part of the ENGIE group, active in over 70 countries.



01 + 02 | Copyright:
ENGIE / HAVAS / GOUHIER NICOLAS



**ENGIE Deutschland GmbH -
Windpark Betriebsführung**

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E-Mail **matthias.gladasch@
de.engie.com**
Web **www.engie-deutschland.de**
Profile **Technical & commercial
operational management**
Category **Operation & service**
Employees **Wind energy: 14**
Founding year **2006**

ENGIE develops solutions in the field of renewable energies, energy efficiency and digitalisation.

The group operates 2500 wind turbines with a total capacity of 4.8 GW worldwide. Therefore, ENGIE has extensive experience with all major wind turbine types at different sites and with the analysis and monitoring of a huge amount of operational data. ENGIE Deutschland GmbH uses this know-how for the technical and commercial management of its own windfarms, as well as for those of its customers. The captive test laboratory and the technical experts provide all relevant information to operate the windfarms under management in the best possible interest of their owners.

The long-time experienced commercial and technical employees of ENGIE Deutschland have currently 276 MW under operational management in Germany. ENGIE also takes over the full risk of the

plant responsibility for the wind turbines and guarantees the complete fulfilment of all legal obligations. With the captive Control Centre there is also 24/7 monitoring available.

Scope of services for windfarms

- Technical and commercial management
- Taking over owners plant responsibility and performing DGUV 3 tests, maintenance and inspections of transformer and transmission stations
- Direct marketing for windfarms under EEG feed in tariff
- Project development and repowering
- Support in health and safety

Facts

- Experience in analysis and monitoring of operational data of 2500 wind turbines / approx. 4.8 GW installed capacity worldwide
- In Germany, ENGIE has currently 175 turbines with a total capacity of 276 MW under operational management
- Captive test laboratory, as well as technical experts in wind energy



envia THERM GmbH

As a reliable partner for wind energy projects, envia THERM covers all services from project development to construction, repowering and operations management.

envia THERM is a wholly owned subsidiary of envia Mitteldeutsche Energie AG (enviaM), currently the leading regional energy provider in eastern Germany.

The company has many years' experience in energy production and combines all the generation activities of the enviaM Group. The portfolio includes bioenergy, solar PV, hydropower and wind power in circa 60 locations.

envia THERM's aim is to actively shape the energy transition in eastern Germany by expanding and developing renewable energies. The energy service provider has extensive expertise in site analysis, project development and the construction of wind turbines. The same applies to operations – from contract management and direct marketing to commercial and technical operations management and repowering of wind turbines.

In addition to in-house development of wind farms and implementation of cooperation projects, envia THERM is also interested in acquiring project rights and purchasing equipment.



03



01 | Wind farm in Kolkwitz / Brandenburg

02 | Plant engineering for envia Mitteldeutsche Energie AG

03 | Value added chain renewable energies: Securing sites, planning, approval, construction, operation



The company is particularly keen on establishing confidence with local players and developing a sustainable collaboration with their full involvement. This includes individual participation models for citizens, local authorities and utilities.

envia THERM is a reliable and service-oriented partner for plant operators, project developers, local authorities and utilities with the necessary experience and competence to implement energy transition projects reliably and in full partnership with its clients.

envia THERM GmbH

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Web **www.envia-therm.de**
Profile **Planners & project developers**
Category **Planning**
Turnover **€ 131 million (2017)**
Employees **156 (2017)**
Founding year **2006**

EWE ERNEUERBARE ENERGIEN GmbH

EEG payment about to run out? Inject some fresh air with EWE
 From 2020, wind farms will no longer be entitled to EEG payments. But this doesn't have to mean the scrap heap for all your old wind turbines. Find the right solution with EWE.



No operation without Renewable Energy Act (EEG) payment?

Even if the EEG payments for your wind farm ends, dismantling the plant isn't necessarily the next step. Further operation beyond the scheduled service life is also an option. In addition to technical requirements, an economic concept for electricity marketing is crucial for successful continued operation. Another challenge is the optimisation of maintenance measures and costs. We offer attractive solutions tailored to your needs!

EWE – your partner for the future
 At an early stage, EWE made good use of its native region, the flat and windy landscape of northern Germany, to generate energy from wind. The Group has over 25 years' experience. EWE ERNEUERBARE ENERGIEN GmbH is a wholly owned subsidiary of EWE AG and has been the centre of excellence for renewable energies since 2013. In addition to setting up new wind farms, the development of an economic concept for existing plants is also gaining in importance. We develop optimal models for further commercial operation or repowering.

Repowering for renewed performance
 Not every wind farm is suitable for continued operation beyond its useful life. As an alternative, repowering is one possible option. By replacing old installations with new and more efficient ones, the site can also be used to generate climate-friendly energy beyond the lifetime of the existing wind farm. A repowering project is associated with stringent planning laws. We are happy to check if and how repowering can be implemented and, if necessary, handle planning, implementation and operations for you. Together we can bring new power to your location.



EWE ERNEUERBARE ENERGIEN GmbH

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Profile **Planners & project developers**

Category **Planning**

Turnover **€ 132.2 million**

Employees **41**

Founding year **2013**



01 | Wind farm in Köhlen, Lower Saxony
 02 | Dr. Jörg Buddenberg and Alwin Schlörmann, Managing Directors of EWE ERNEUERBARE ENERGIEN GmbH

FGH – Research Association for Power Systems and Power Economics

Your partner in grid integration of generating plants – professional, reliable, experienced.

For the past 90 years FGH e. V. has been providing tailored R&D services for all aspects related to electricity supply. As the first accredited independent certification body, today incorporated in the spin-off FGH Certifikationsgesellschaft mbH, we are a pioneer and market leader with respect to certified grid integration of decentralized generating plants.

Our portfolio includes certification of units and plants according to international grid codes such as the RfG as well as the certification of products and components, for instance storage solutions, power plant controllers and grid control units. In addition to that, the FGH also commands an accredited test laboratory for qualified conformity and type testing.

The FGH GmbH as a further subsidiary provides electrotechnical engineering services for manufacturers, project developers and grid operators. These services include e.g. grid and system studies, planning and engineering of electrical layouts, configurations and components, engineering of mobile fault-ride-through (FRT-) testing laboratories, implementation of simulation models in differing software environments and consulting services concerning grid integration of international projects. Concerning decentralized generating plants, FGH offers grid code compliance studies, protection testing, compliance monitoring, network analysis and assessment of equipment.

Our long-term experience deriving from the relevant standardization committees of FGW, DKE and IEC, combined with our high level of methodological expertise, guarantee highest quality and technical accuracy of our services. We constantly develop our methods in national and international R&D projects and share this knowledge regularly in seminars with industry experts for a broad specialist audience.



- 01 | Core competence reliable grid integration
- 02 | Expert knowledge in all generating technologies
- 03 | New: FGH test laboratory for your comprehensive conformity certificates



FGH – Research Association for Power Systems and Power Economics

Address **Besselstr. 20-22
68219 Mannheim**
Phone **+49 (0) 621 976807-50**
Fax **+49 (0) 621 976807-70**
E-Mail **hanna.johnen@fgh-ma.de**
Web **www.fgh-ma.de**
Profile **Certification**
Category **Experts**
Turnover **approx. € 8.4 million**
Employees **100**
Founding year **1921**

Fichtner GmbH & Co. KG

Engineering and Consultancy for Wind Farms All Over the World

For decades, Fichtner has been using the experience it has gained in all aspects of sustainable energy generation and utilization to oversee all phases of onshore and offshore wind power projects.



01 | As owner’s engineer, Fichtner assists in all technical and commercial aspects – for example for an 80 MW wind farm project in Jordan

02 | As lender’s engineer, Fichtner prepares due diligence reports – for example for a wind farm portfolio in Central America

FICHTNER

Fichtner GmbH & Co. KG

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Phone	+49 (0)711 8995-0
Fax	+49 (0)711 8995-459
E-Mail	info@fichtner.de
Web	www.fichtner.de
Profile	Planners & project developers
Category	Planning
Turnover	€ 281 million (Group)
Employees	1,500 (worldwide)
Founding year	1922

Fichtner is Germany’s biggest independent engineering and consultancy enterprise for infrastructure projects in the sectors of energy, water, environment, traffic engineering, and IT.

Many decades of experience

Fichtner has been playing an active role in the success story of wind energy since the 1980s. For example, Fichtner as owner’s engineer rendered consultancy services for the first wind farms in Germany, and advised the German Research and Development Ministry on its first wind energy program.

International project teams covering all disciplines

Today, the Fichtner Group offers a network of highly qualified engineers and consultants with expertise in all aspects of onshore and offshore wind energy. Fichtner’s experts are equally conver-

sant with the challenges of German and international investors and development banks as they are with local energy supply markets, tariff structures and permit application procedures.

Broad range of services

As owner’s engineer, Fichtner assists its clients in all technical and commercial aspects, from initial project idea up to wind farm commissioning. As lender’s engineer, Fichtner prepares due diligence reports and oversees project realization and commissioning.

Specific services

- Owner’s engineer in all phases of onshore and offshore projects
- Geotechnics and morphodynamics
- Scour protection, jacking appraisals and pile dynamics
- Due diligences
- Layout and permit planning
- Wind measurements, wind studies and energy yield assessments
- Operation and maintenance concepts
- Inspections
- Analyses of residual service life



GAIA mbH

Everything from a single source

Your professional partner for planning, development, project coordination, service and management of wind turbines and photovoltaic systems.

The “Gesellschaft für Alternative Ingenieurtechnische Anwendungen“, GAIA, is one of the pioneers in renewable energy in Rheinland-Pfalz. Our expertise is the planning and construction of wind and solar power plants as well as the development of individual sustainable energy concepts. Following the successful implementation of a project, we take over the management of wind turbines, wind farms and photovoltaic systems and offer service and maintenance.

Established in 1999 by Dipl.-Kfm. Torsten Szielasko and Dipl.-Ing. Michael Wahl as an engineering company, GAIA currently employs 46 highly motivated and qualified members of staff. Their work contributes to the transition towards a sustainable energy system, a form of practical environmental protection.

Integrated, sustainable, flexible

“Everything from a single source“ – The keystone of GAIA’s business philosophy. We cover all processes in the development of wind and solar projects: From initiation to the turnkey handover to the operator, we take care of all aspects of project management.

In addition, we offer our customers a wide range of individual services: Our GIS-based analyzes help you to find and evaluate the potentials of the project and to identify project risks early on. The project appraisal and evaluation team will accompany you at every stage of development, identify project risks at an early stage and ensure the success of your project or project acquisition. We accompany and control your construction project. Always with the aim of reducing construction costs and minimizing risks, we find innovative solutions to the challenges of your project.



01 | Wind turbine in the Groß-/Kleinniedesheim wind farm. Commissioning of the wind farm in June 2016

02 | Wind turbine in Hambucher Wald, commissioned in April 2017

03 | GAIA headquarters: An older building that now produces energy



GAIA 
erneuerbare Energien

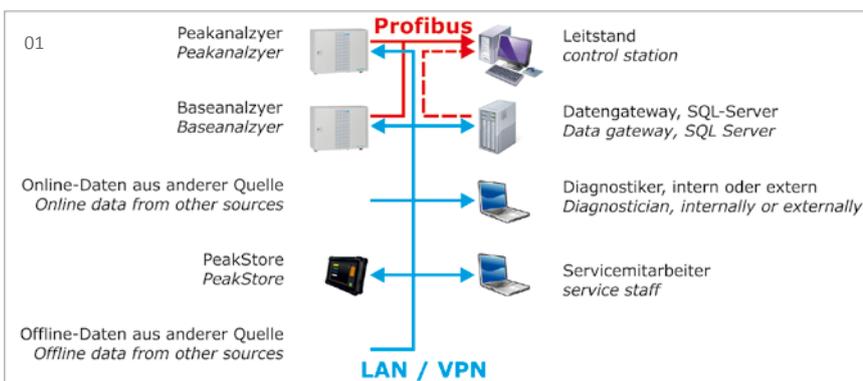
GAIA mbH

Address **Jahnstr. 28
67245 Lamsheim**
Phone **+49 (0)6233 35944-00**
Fax **+49 (0)6233 35944-01**
E-Mail **info@gaia-mbh.de**
Web **www.gaia-mbh.de**
Profile **Planners & project developers**
Category **Planning**
Turnover **€ 7.5 million**
Employees **46**
Founding year **1999**

GfM Gesellschaft für Maschinendiagnose mbH

We keep your drive running!

GfM Gesellschaft für Maschinendiagnose mbH offers online condition monitoring, offline drive train diagnosis as well as gear endoscopy, blade bearing diagnostics and foundation monitoring.



The CMS “Peakalyzer“ does not need a learning phase and only requires relatively minor support. This is achieved by integrating DVS analysis within the device which largely automates the analysis of irregularities. During the development of the system and method, data quality was a prime focus. The analysis preferably occurs in the order spectra that are created by resampling. Furthermore, it is possible to integrate a particle counter in the two- to 32-channel system for lubricant analysis. In addition, relevant events or conditions can be signalled.

02



The damage state of rolling bearings and gearboxes can be reliably determined by means of measured vibrations. This is normally done during load operation of the system, making it unnecessary to open components. Only offline measurements require a short stop of the system.

GfM is an independent company. There are absolutely no commitments to replacement part distributors, maintenance companies or insurance companies for drive engineering. Our diagnosis and expert reports are therefore entirely neutral.

- 01 | Hardware overview
- 02 | Offline diagnosis system PeakStore5xx
- 03 | Water flow chart
- 04 | Spectrogram

The GfM Gesellschaft für Maschinen-diagnose mbH offers:

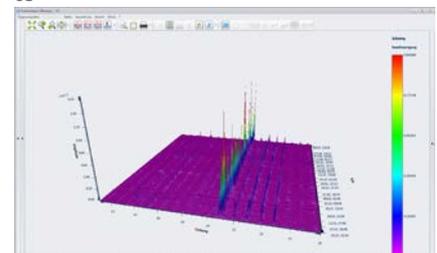
- Online condition monitoring systems
- Monitoring service for online CMS
- Online foundation monitoring
- Offline foundation measurements
- Offline vibration diagnostics
- Torque analysis
- Blade bearing diagnosis at WTG
- Offline measurement systems
- Diagnosis service for offline measured data
- Inspections / technical expert opinion
- Video endoscopy on gearboxes
- Trouble shooting
- Seminars



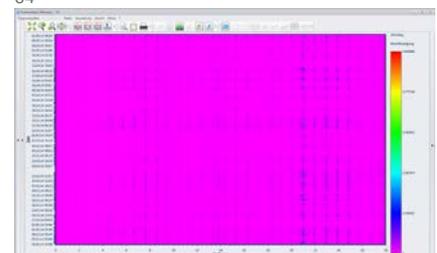
GfM Gesellschaft für Maschinendiagnose mbH

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12555 Berlin**
 Phone **+49 (0)30 65762565**
 Fax **+49 (0)30 65762564**
 E-Mail **mailbox@maschinendiagnose.de**
 Web **www.maschinendiagnose.de**
 Profile **Service, maintenance & repair**
 Category **Operation & service**
 Turnover **€ 1.6 million**
 Employees **15**
 Founding year **1999**

03



04



GMA-Werkstoffprüfung GmbH

Global wind power services: Quality in every phase of your wind farm

GMA is a service provider accredited according to DIN EN ISO 17025, with quality and safety services as well as innovative materials testing methods for each phase of a wind energy project.

GMA-Werkstoffprüfung GmbH supports you in increasing the availability of your onshore and offshore wind farms. Our service portfolio includes quality assurance activities for manufacturers and suppliers of wind turbines and their components, during the transport and assembly process and as continuous monitoring, analysis and optimisation of turbines in operation.

In order to optimise the yield of your wind turbines and increase operational safety, we continuously monitor the condition of your wind turbines and carry out remaining service life analyses, as GMA specialises in testing and inspecting wind turbines:

Non-destructive testing

- All components of a wind turbine including rotor blades (ultrasound, surface crack, X-ray and eddy-current testing, phased array, thermography)
- Training and R&D centre of rotor blades
- Expert know-how for testing all materials including composites

Destructive testing and sample preparation

- Material approval and verification of production processes
- Damage analysis (mechanical, analytical, metallographic materials testing)

3D Measurement

- High-precision geometry acquisition and reverse engineering to ensure your products and support your manufacturing processes



01 | UT Scanner in action

02 | Automated ILSS tests

Complete services around the wind turbine

- Inside/outside rotor blade inspection (e. g. visual, ultrasound, lightning protection measurement) and (e. g. repairs) by means of rope access technology, riser, from the platform or on the ground
- Recurring inspections
- Mechanical and electrical maintenance
- Training and R&D centre for rotor blade testing
- Production monitoring, customer acceptance tests
- Preparation and qualification of repair and inspection instructions
- Scada remote monitoring, troubleshooting



A MEMBER OF MISTRAS

GMA-WERKSTOFFPRÜFUNG.GMBH

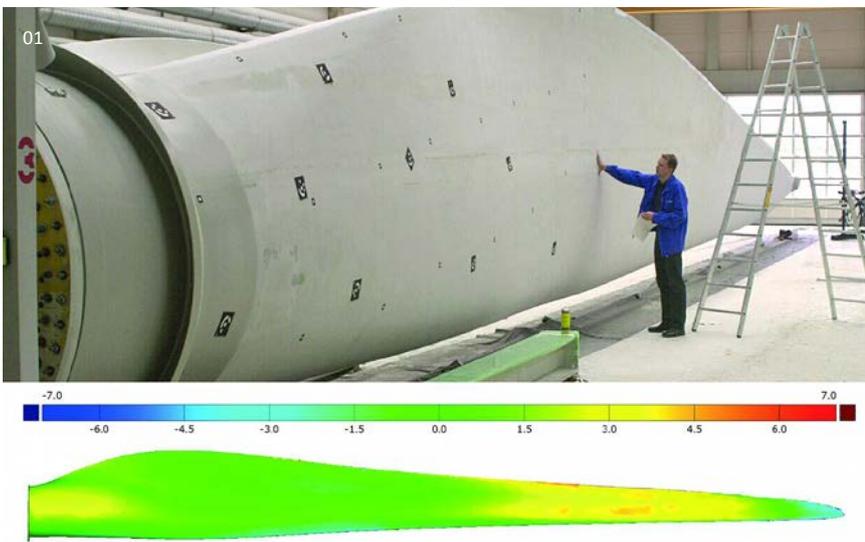
GMA-Werkstoffprüfung GmbH CFRP-Testing Center

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21684 Stade**
Phone **+49 (0)4141 7944-0**
Fax **+49 (0)4141 7944-299**
E-Mail **stade@gma-group.com**
Web **www.gma-group.com**
Profile **Quality assurance**
Category **Operation & service**
Turnover **€ 59 million**
Employees **approx. 700**
Founding year **1984**

GOM GmbH

GOM – Precise Industrial 3D Metrology

Quick and flexible component tests and coordinate measurements for the wind industry.



01 | Inspection of very large components with optical 3D coordinate measuring
 02 | Monitoring of movement, stress and deformation



GOM GmbH

Address **Schmitzstraße 2
 38122 Braunschweig**
 Phone **+49 (0)531 39029-0**
 Fax **+49 (0)531 39029-15**
 E-Mail **info@gom.com**
 Web **www.gom.com**
 Profile **Quality assurance**
 Category **Operation & service**
 Employees **450**
 Founding year **1990**

GOM is a global manufacturer that develops, produces and distributes software, machines and systems for industrial and automated 3D coordinate measuring technology and 3D testing.

The non-contact measuring systems from GOM are flexible and mobile tools for product development, quality assurance and maintenance in the wind industry.

Fast inspection of wind turbine components

Wind turbine components and production tools need to be manufactured accurately in order to guarantee long operation times. When manufacturing mold halves for rotor blades, GOM systems ensure precise dimensional stability. For flow-efficient profiles, shape and dimensions of rotor blades and turbines can be quickly digitized. The measured data can be compared with CAD or the master data set

on a full-surface and point-to-point basis. They also provide a complete data base for reverse engineering and the reproduction of an optimal rotor.

Coordinate measurements on site

Optical 3D coordinate measurement by GOM is possible even under demanding conditions and on large components such as towers and nacelles. It allows individual construction components, such as assembly bolts and surfaces, to be quickly inspected and any problems remedied before assembly. This is also possible for offshore foundations and structures.

Deformation analysis

The dynamic monitoring of movement, stress and deformation is indispensable for analyzing components. GOM systems provide measurements for wind turbine structures under load, either at specific points or across the entire surface. They replace conventional position sensors, strain gauges and accelerometers and can be used for fatigue testing, for investigating the dynamic behavior of rotor blades and for gearbox testing.



GP JOULE GmbH

Successful tenders. Customised solutions. Profitable concepts.

GP JOULE is the perfect partner for land owners, local authorities, wind farm operators and investors – from securing a location to project planning/funding and management.

MW class projects are our specialty. We have initiated and constructed a large proportion ourselves. Shouldering commercial risk is routine for us, and for our business partners it is a sign of our experience and financial strength.

Since our foundation in 2009, we have installed over 600 MW both in Germany and abroad. Our highly qualified team, based in Reußenköge in northern Germany and Bittenwiesen in the south, has around 20 years of industry experience.

Taking to the skies.

Landowners are our partners and we carry out projects together. With our background firmly rooted in agriculture, our approach to precious land is particularly responsible.

We support **local authorities** in the planning of sites for community wind farms and integration into the local grid.



We support **wind farm operators** with repowering old turbines and we provide a modular range of services – around-the-clock monitoring, including the use of live data by app – through our experience in technical and commercial management.

Investors can carry out and market projects with us or participate in or fully take over a plant following installation and commissioning. Even after the hand-over, GP JOULE remains responsible for ensuring the projected amounts through its management of the installation. We naturally offer a comprehensive and neutral evaluation of the investment.

TRUST YOUR ENERGY.

We are firmly convinced that a 100% renewable energy is feasible. This is why GP JOULE is committed to developing and implementing energy and operating concepts for the promising use of sun, wind, biomass and energy storage solutions.

01 | Wind farm Schimmendorf (rated capacity: 16.8 MW; type: Nordex N117)

02 | Schimmendorf was commissioned by GP JOULE in 02/2017 as one of the largest renewable power plants in southern Germany.

GP JOULE
TRUST YOUR ENERGY.



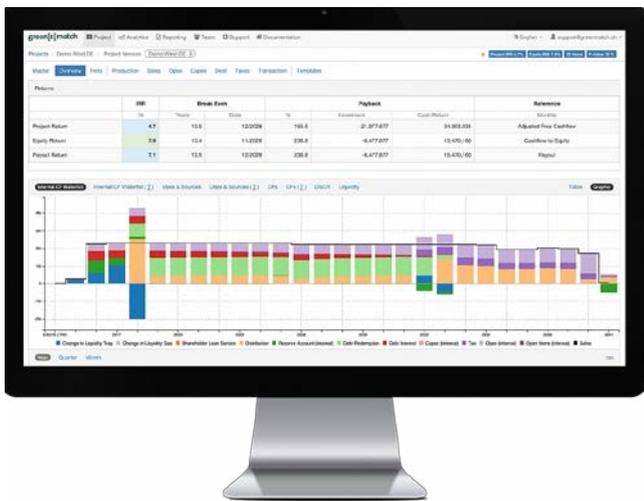
GP JOULE GmbH

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25821 Reußenköge**
Phone **+49 (0)4671 6074-0**
E-Mail **info@gp-joule.de**
Web **www.gp-joule.de**
Profile **Planners & project developers**
Category **Planning**
Employees **more than 200**
Founding year **2009**

greenmatch AG

Web-based financial modelling for renewable energy projects

With greenmatch you can model the financial part of your projects – independent of technology, project stage and country.



greenmatch project overview with cashflow waterfall

Greenmatch offers you a highly flexible integrated financial model with certified, standardised algorithms.

With greenmatch you can:

- Model cashflows and calculate performance indicators
- Calculate simulations and scenarios
- Evaluate portfolios and plan their performance
- Buy and sell projects on the digital marketplace

Gain competitive advantages thanks to greenmatch

- **Efficient:** Accelerate your transaction process, save time and keep the risks under control
- **Reliable:** Trust the certified market standard
- **Independent and secure:** As an independent platform we follow strict principles regarding data integrity and security according to Swiss standards and values

Buy & sell projects on the greenmatch Marketplace

The digital Marketplace brings together buyers and sellers of renewable energy projects. greenmatch makes projects comparable and significantly shortens transaction time.

Explore interesting publications on our blog!

We frequently publish articles by experienced industry experts about hot topics in the fields of renewable energies, project finance and digitalisation.

www.greenmatch.ch/blog

Try greenmatch for free!

Sign up for free and without obligation: www.greenmatch.ch

Follow us on social media!

Twitter: <https://twitter.com/greenmatch>

LinkedIn: <http://www.linkedin.com/company/greenmatch-gmbh>

green[::]match

greenmatch AG

Address **Hauptstrasse 67
4102 Binningen**
Phone **+41 (0)61 301 50 00**
E-Mail **info@greenmatch.ch**
Web **www.greenmatch.ch**
Profile **Software solutions**
Category **Other services**
Founding year **2013**

Solutions for project developers, investors, banks and advisors

Greenmatch combines the perspectives of all market participants on one single platform and allows for an efficient interaction. Thanks to the independent, certified market standard, discussions regarding deviations between the financial models do no longer occur.

Grzib Elektrotechnik GmbH & Co. KG

Electrotechnical full-service provider with more than 15 years of experience in the European wind industry

We are not only available in Germany, but also in other European countries: So far, we have successfully constructed and installed around 2,500 wind turbines all over Europe.

The requirements of planning and erecting a wind farm are diverse. Especially external partners need to be reliable, flexible and professional, demonstrating their work experience at its best in order to complete these projects successfully and failure-free. In us you will find a competent and flexible partner in the electrical project area. We know the challenges of major projects and are therefore able to offer you customer-oriented services to avoid disturbances and difficulties.

Our range of services during new construction projects and repowering includes:

Working in the low-voltage range: Visible installations such as inner and outer tower lighting, connections of switches and sockets, etc., cabling of power cables, e.g. connecting the inverter to the transformer, and implementing transformer and plant protection.

Working in the medium-voltage range:

Connection of medium-voltage switchgear to the transformer, commissioning of transformers and medium-voltage switchgears, switching operations in the medium-voltage range up to 36 kV.

Implementation of earthing and lightning protection concepts

Working in the field of measurement and control technology such as cabling of superior park controllers and their signal exchange.

Maintenance and Service of transformers, medium-voltage switchgear and converters.

Other services such as delivery and installation of cable support systems in steel and hybrid towers, WTG-specific safety equipment or pre-assembled medium-voltage cable bridges according to customer requirements.

We have convinced our customers with our **flexibility, know-how, huge industry experience** and high **safety standards**.

For more information go to www.grzib-elektrotechnik.de



01 | Andreas Grzib | Managing Director

02 | Lothar Grzib | Founder & Managing Director



Grzib Elektrotechnik GmbH & Co. KG

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46117 Oberhausen**
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Fax **+49 (0)201 634 61 775**
E-Mail **info@grzib-elektrotechnik.de**
Web **www.grzib-elektrotechnik.de**
Profile **Service, maintenance & repair**
Category **Operation & service**
Turnover **€ 1.5 million**
Employees **25 (Wind energy: 25)**
Founding year **1998**

Hamburg Messe und Congress GmbH

the global on- & offshore expo
The world's leading expo for wind energy.



Hamburg Messe und Congress GmbH

Adress **Messeplatz 1
20357 Hamburg**
Phone **+49 (0)40 3569-2263**
Fax **+49 (0)40 3569-692263**
E-Mail **andreas.arnheim@hamburg-messe.de**
Web **www.windenergyhamburg.com/en**
Profile **Trade fairs & conferences for the wind energy industry**
Category **Other services**
Turnover **€ 76–111 million**
Employees **more than 300**
Founding year **1972**

WindEnergy Hamburg shows wind energy on a global scale. The world's leading trade fair is the only global meeting place for the onshore and offshore industries. From 25 to 28 September 2018, all leading international companies, as well as special suppliers in the entire value-added chain, will present themselves at Hamburg Messe. A total of 1,400 exhibitors are expected to showcase their latest products and services for all areas of wind energy, and some 35,000 visitors from across the world are expected to attend.

Together with WindEurope's global conference, WindEnergy Hamburg, the world's leading trade fair, will be hosting the Global Wind Summit for business, networking and information for the entire wind industry: both onshore and offshore. Both top events will be held in parallel from 25 to 28 September 2018 in the

exhibition centre in Hamburg. The Global Wind Summit covers all topics of this innovative industry and examines trends and international markets.

At WindEnergy Hamburg, manufacturers of turbines and components, project developers, service providers and other specialists and solution providers in the energy sector will be in attendance across 65,000 square meters of optimal space for business and marketing. The interest particularly among international companies of coming to Hamburg continues to grow. Numerous countries from across the globe present their expertise in wind energy in their own national pavilions. Trade visitors and political delegations from every continent are expected.

More information at windenergyhamburg.com

HUSUM Wind / Messe Husum & Congress

The trade fair for on- and offshore wind energy in Germany
Home of the wind industry – for 30 years.

For 30 years, HUSUM Wind, the cradle of the German wind industry, has been the most important trade fair for the German wind market. Every two years it offers a forum for representatives of the wind industry to compare notes about important national topics – from the EEG amendment, service and maintenance to grid expansion – and about the latest developments and product innovations in the German and international markets.

The established meeting place of the wind industry in Wind State Schleswig-Holstein attracts trade visitors and experts from all sectors of the industry. The HUSUM Wind trade fairs are host to the Who's Who of turbine manufacturers as well as project developers, component producers, suppliers, service providers and consultancy firms. They all meet here to discuss current political and technical topics such as the tendering process, maintenance concepts and repowering.

We are expecting 17,500 trade visitors and 650 exhibitors from Germany and its neighbouring countries, who will be showcasing their products and services along the entire value chain.



Long-standing partners of HUSUM Wind include the industry associations BWE, VDMA and the Schleswig-Holstein Renewable Energy Network Agency (EE.SH). In line with an updated exhibition concept, every fair will also include special exhibitions that will focus on trend-setting areas of the wind industry. In 2017, the special themes were offshore wind Energy and sector coupling and grid integration.

The biennial HUSUM Wind takes place in alternate years to its partner exhibition WindEnergy Hamburg, which is considered to be the leading trade fair for the global wind energy market.



01 | From 10 to 13 Sept. 2019 HUSUM Wind will be again the home of the wind industry for a week.

02 | Established meeting point of the industry: HUSUM Wind will be welcoming trade visitors and experts from all sectors of the wind industry.

03 | The HUSUM Wind is accompanied by a specific and top-class congress program.

04 | The HUSUM Wind is a showcase of technologies such as efficiency, digitization and sector coupling.



HUSUM Wind / Messe Husum & Congress / The German Trade Fair and Congress / 10. – 13. September 2019

Address **Am Messeplatz 12–18
25813 Husum**

Phone **+49 (0)4841 902-0**

Fax **+49 (0)4841 902-246**

E-Mail **info@husumwind.com**

Web **www.husumwind.com**

Profile **Trade fairs & conferences for the wind energy industry**

Category **Other services**

Employees **40 (Wind energy: 10)**

Founding year **1989**

juwi AG

Energy is here

We support you from start to finish in planning a successful project: finding the best locations, turnkey erection of turbines, and performing technical and operational management. We also take on project rights and will gladly assist you in the development of your site as an experienced partner.



juwi group wind farms: from self-developed projects to general contractor for EPC projects, juwi is the competent partner.



Competent and experienced partners:

We plan and install your wind farm

juwi is one of the leading specialists in wind and solar energy projects, and can provide complete project development and other services related to the construction and management of renewable power plants.

juwi was founded in 1996 in the Rhine-land-Palatinate region in Germany. Around the world, the juwi group employs some 1,000 staff with projects and subsidiaries on every continent.

Know-how for complex locations

Across Germany, juwi has installed 750 wind turbines with a rated capacity of over 1,850 megawatts – juwi has proven expertise, even in very complex locations with a hilly or forested terrain.

A pioneering partnership

Towards the end of 2014, the juwi group and the Mannheim-based company MVV Energie AG agreed on a pioneering partnership with the aim of creating a high-performance, safe and environmentally-friendly energy system. The result was a sustainable business model that covers the entire energy economy value chain.

Our strengths at a glance

- Long-term' experience: we have been developing and managing wind farms since 1996
- Strong partnership with Mannheim-based MVV Energie, one of the largest German energy suppliers
- Complete range of services: from finding sites to installation
- Cooperation with all major turbine and component suppliers
- Strong regional presence throughout Germany
- Participation of citizens and councils
- Confident business relationships with banks and investors
- High level of customer satisfaction with technical and commercial management
- Concept development and implementation of repowering projects



juwi AG

Address	Energie-Allee 1 55286 Wörrstadt
Phone	+49 (0)6732 9657-0
E-Mail	info@juwi.de
Web	www.juwi.com
Profile	Planners & project developers
Category	Planning
Turnover	€ 777 million (2016)
Employees	approx. 1,000 (Wind energy: approx. 500)
Founding year	1996

Koopmann Group

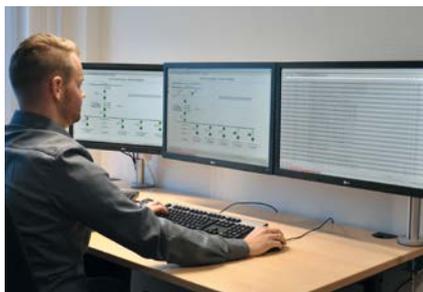
Professional services for energy suppliers

The functionality of a system can be ensured only if all individual components are taken into consideration during maintenance.

With more than 35 years of experience in diagnostics and cable fault location, cable measurement technology is one of our core competencies.

Our equipment includes cable-monitoring and diagnostic cars as well as various mobile measuring systems including pre-locating and pin-pointing, partial discharge measuring systems, high-voltage testing systems up to 250 kV, the CPC 100 test system and measuring devices for insulation, transmission ratio, winding resistance and dielectric frequency response measurements to check transformers.

Our “The Beast” cable-monitoring car with the proven Centrix technology has the world’s most powerful VLF test system for cables of up to 100 km in length and 60 kV with a buffering gear for MS and HV cables. In addition, there is also a high-performance measuring system, installed in a seaworthy container which enables the precise localisation of cable faults both onshore and offshore.



Our portfolio in the field of wind energy includes installation, maintenance, repairs, inspections, commissioning and delivery of turnkey distribution and switching stations. Our fields of activity include new installations of switching stations, cable sections and transformers up to 110 kV. The field of installation and assembly is extended with commissioning and repeat tests.

We also offer management of energy systems. Our service includes technical management, the performance of duties as a responsible electrician as well as the inspection, maintenance and repair of the equipment. All services are coordinated in our control centre.

As an experienced partner we are available for reliable and long-term operation of energy supply facilities.

01 | “The Beast” cable-measuring car, business units, high-performance measuring system in sea containers, reflection measurement on HV cables.

02 | Control centre



Koopmann Group

Address	Zum Brook 19 49661 Cloppenburg
Phone	+49 (0)4471 9494-0
Fax	+49 (0)4471 84895
E-Mail	info@hk-c.de
Web	www.hk-c.de
Profile	Service, maintenance & repair
Category	Operation & service
Turnover	€ 27,8 million
Employees	176
Founding year	1982

The Liebherr Group

A Strong Partner for the Wind Industry

For more than 65 years, the Liebherr name has stood for excellent, benefit-oriented products and services. The Group is not only one of the world's leading manufacturers of construction machinery; it is also a major supplier in many other fields of engineering like the wind industry.



01 | From single components to final assembly, Liebherr offers the matching solution for different demands of the wind industry.

LIEBHERR

**Liebherr-International
Deutschland GmbH**

Address **Hans-Liebherr-Str. 45
88400 Biberach an der Riss**

Phone **+49 (0)7351 41-0**

Fax **+49 (0)7351 41-265**

E-Mail **info.lho@liebherr.com**

Web **www.liebherr.com**

Profile **Crane companies, crane hire,
special transport, components**

Category **Transport & logistics**

Turnover **more than € 9 billion (2016)**

Employees **more than 42,000**

Founding year **1949**

Liebherr is a powerful partner for the wind industry and offers convincing solutions for a wide range of requirements: On the one hand, components manufactured by Liebherr are installed directly into wind turbines. On the other hand, the company's mobile, crawler, offshore and tower cranes, for example, are used for erecting wind turbines and constructing wind farms.

Offering large diameter bearings, slewing drives, electric machines, frequency converters and hydraulic cylinders, Liebherr is the only manufacturer worldwide that provides not only single components, but also entire systems for electromechanical and hydraulic pitch and yaw adjustment in wind turbines.

One of the major elements of cooperation with customers from all over the world is application-specific engineering to

perfectly adapt each of the components. In the wind industry, Liebherr collaborates with nearly all leading turbine manufacturers and so far has equipped numerous wind turbines with its own components. The product portfolio comprises components for turbines from 800 kW up to solutions for multi-megawatt offshore turbines.

With their innovative technology, high quality, profitability and longevity, mobile and crawler cranes from Liebherr own a leading position in the world market. For decades, they have also been proving their value in the construction of wind farms. As well as telescopic mobile cranes, Liebherr also provides lattice boom mobile cranes and crawler cranes to erect wind power systems, in a variety of performance classes, specifically matched to meet the needs of the wind power industry. The Group keeps pace



with the development of larger and more efficient turbines as well as the increasing hub heights by offering cranes with optimized performance and new jib systems, reaching higher lifting capacities. Cranes on narrow crawler travel gears especially developed for the construction of wind farms can move on the narrow tracks from one unit to the next in full setup condition, that is including jib and full ballast. This is especially economical, because machine and equipment have to be mounted only once.

For erecting wind turbines with a hub height of 110 m or more in low-wind areas, Liebherr also offers specially devel-

oped tower cranes with lifting capacities of up to 125 t. They are mounted on the wind turbine and are configured in a way that the necessary lifting height can be reached by guying the crane to the mast at one point only. Advantages are reduced space required by the crane, the ability to work despite high wind speeds and sensitive lifting of loads using Micromove.

Liebherr also offers efficient solutions for the erection of offshore wind turbines. Heavy duty cranes for offshore applications are able to lift up to 5,000 t and reach a lifting height of 180 m above deck. Thereby the Group's offshore portfolio meets challenging requirements, such



02 | Heavy duty CAL 45000-1200 Litronic® offshore crane during the installation of rotor stars in the North Sea.

03 | Liebherr LTM 1750-9.1 mobile crane installs the rotor star at a hub height of 80 m.

04 | Liebherr tower cranes of the type 1000 EC-B are specially designed to erect wind turbines and work extremely precise with a space-saving design.

as the provision of diesel or electrical drive units, explosion protected cranes and cranes for ambient temperatures between +40 °C and -50 °C. Liebherr cranes are not only used successfully for the construction of offshore wind turbines, but also on oil and gas platforms, for offshore construction, pipe-laying or subsea operations down to 3,600 m below sea level.

M.O.E. GmbH

Moeller Operating Engineering GmbH

M.O.E. is an accredited test laboratory and certification and inspection body, which offers services to ensure the long-lasting operation of wind turbines.



The M.O.E. team in front of the company's headquarters in Itzehoe



M.O.E. GmbH

Address **Fraunhoferstr. 3
25524 Itzehoe**
 Phone **+49 (0)4821 40636-0**
 Fax **+49 (0)4821 40636-40**
 E-Mail **info@moe-service.com**
 Web **www.moe-service.com**
 Profile **Certification**
 Category **Experts**
 Turnover **€ 4.9 million**
 Employees **78**
 Founding year **2009**

The main business areas of Moeller Operating Engineering GmbH (M.O.E.) are certification, measurement and inspection in relation to the grid integration of decentralised energy generators. Since the introduction of guidelines for the certification of generation plants in Germany, M.O.E. has been closely involved with their implementation and has gained accreditation as a certification and inspection body and a test laboratory from the German national accreditation body DAkkS.



M.O.E. has developed a broad range of services which are constantly evolving with the customer's interests in mind, so that all plant integration services are available to the customer from a single source. In addition to certifying plants, units and components in accordance with the relevant grid codes, M.O.E. also offers examinations of the mechanical, electrical and acoustic characteristics of wind turbines. In order to examine the design of components and thus assess the lifespan of wind turbines, the M.O.E. test laboratory carries out load measurements on the main mechanical components and calculates performance curves.

The inspection body also offers safety checks and inspections in accordance with German Social Accident Insurance (DGUV) regulation 3 to ensure plant and personal safety, and carries out regular inspections in compliance with the German Wind Energy Association (BWE) standard. Represented in three locations in northern Germany, the company has established itself as a highly qualified competence centre both within Germany and abroad, and is recommended by the German Association of Energy and Water Industries (BDEW).

M.O.S.S. Computer Grafik Systeme GmbH

Domain-specific planning application and GIS based optimization of wind farm planning
M.O.S.S. offers planning application services, as well as integration solutions and consulting services with respect to optimizing the processes of planning wind farms.



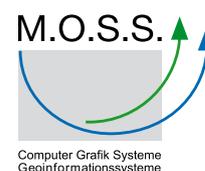
Wind farm planning using Web-GIS and option management under Wind-PIA

WebService for buffering official building footprints for restriction area analysis

M.O.S.S. has acquired the full ALKIS database of building footprints including their attributes for all of Germany and prepared them as a password-protected web service. On this basis, wind farm planners are able to buffer settlement areas in the area under consideration in a differentiated manner. In doing so, wind farm planners can be guided by the specifications of the respective planning authorities and buffer each building type in a differentiated way, depending on whether it is located in an inner (agglomeration) or outer zone (rural region). Buffer results are made available for download as shapefiles, so that they can easily be merged with other basic data in a local GIS.

Wind farm planning & IT infrastructure (Wind-PIA)

Wind farm planning processes do not run chronologically, but iteratively. Supposedly reliable results can change again and again during the planning process. For project developers it is therefore all the more important to work with a structured, standardized and coordinated planning process. Wind-PIA can make wind farm planning more efficient by means of standardized geodata and information exchange. Technical, structural and organizational obstacles in the planning process are identified and reduced; e.g. by reducing duplication, avoiding data conversions and projection changes, or local and redundant data storage. Working with Wind-PIA can make wind farm planning processes up to 20% more efficient.



M.O.S.S. Computer Grafik Systeme GmbH

Address **Hohenbrunner Weg 13
82024 Taufkirchen**
Phone **+49 (0)89 66675-100**
Fax **+49 (0)89 66675-180**
E-Mail **info@moss.de**
Web **www.moss.de**
Profile **Software solutions**
Category **Other services**
Employees **65 (Wind energy: 10)**
Founding year **1987**

N.T.E.S. GmbH Windkraftservice

Maintenance • Repair • Inspection • Optimization

Wind turbine service since 2000. Independent maintenance and repair across Germany using the latest technology.



N.T.E.S. GmbH Windkraftservice is a service provider in the fields of REPAIR, INSPECTION, OPTIMIZATION, THERMOGRAPHY and MEASUREMENT primarily for “Bonus” and “Siemens” wind turbines with capacities between 150kW and 2,3MW.

Our highly skilled teams operate right across Germany. Flexibility and a fast response rate distinguish us.



N.T.E.S. GmbH Windkraftservice

Address **Handelshof 8
27432 Bremervörde**
Phone **+49 (0)4761 92612-0**
Fax **+49 (0)4761 92612-99**
E-Mail **wkas@ntes-service.de**
Web **www.ntes-service.de**
Profile **Service, maintenance & repair**
Category **Operation & service**
Employees **30 (Wind energy: 24)**
Founding year **2000**

Over 20 years experience in wind turbine service form an ideal basis for achieving optimum results both in case of repair work and prevention through servicing or inspection. In a survey of operators by the German Wind Energy Association (BWE) we achieved an overall rating of GOOD for the categories “regular service”, “unscheduled repair” and “extraordinary service”.

An overview of our services:

Maintenance

- Carrying out annual/biannual maintenance work
- Transformer maintenance
- Blade maintenance

Repairs

- 24-hour fault elimination service with remote data monitoring and maintenance
- Quick response time for repair work
- Large stock of replacement parts
- Inexpensive repairs thanks to our large stock of exchange parts

Inspections

- Blade inspection
- Blade reports
- Gearbox inspection
- Failure analysis

Optimisation

- Suggestions and implementation

Thermography

- Troubleshooting and prevention of breakdowns
- Documentation of the current condition

Measurements

- Laser-supported generator alignment
- Earthing measurement
- Bearing condition check

Other

- Component repairs:
 - Electronic components
 - Small yaw gearboxes
- Development of new components:
 - Compensation systems
 - Electrical switchgear
 - Hydraulics
- Component exchange:
 - Gearboxes
 - Generators
 - Main bearings

Netze BW GmbH

From engineering and approval planning to the construction of a turnkey transformer station, Netze BW ensures wind farms feed into the 110kV grid efficiently.

Netze BW's "wind power outlet" is a standardized 110/30 or 110/20kV supply substation, which can be tailored precisely to the requirements of the renewable energy project in question by means of modular and performance-dependent components. It enables technically mature, cost-effective, direct supply to the high-voltage grid. The transformer station is constructed on a turn-key basis in just 10 months, including approval planning. Netze BW takes care of all the tasks involved, from planning and project development to construction and commissioning.

The services of Netze BW at a glance:

- Planning, project development and construction of 110/30 or 110/20kV feeder substations or the entire wind farm infrastructure
- Planning, project development and construction of medium-voltage installations
- Planning and construction of internal wind farm cabling
- Integration of the wind farm into the grid of the regional grid operator
- Management of all medium- and high-voltage plants with assumption of plant responsibility
- 24/7 on-call service and fault clearance for the wind turbines and wind farm infrastructure
- Certification of transformer station and wind farm



01-03 | Supply substations



Netze BW GmbH
Sparte Dienstleistungen

Address **Schelmenwasenstrasse 15**
70567 Stuttgart

Phone **+49 (0)711 289-46000**
Fax **+49 (0)711 289-46765**
E-Mail **dienstleistungen-hs@netze-bw.de**
Web **www.netze-bw.de/**
dienstleistungen

Profile **Grids & grid connection**
Category **Planning**
Employees **about 3,600**
Founding year **2014**

Nord/LB

Norddeutsche Landesbank -Girozentrale-

NORD/LB – a strong partner for your wind energy projects.



As the leading universal bank in the north, NORD/LB is one of the largest banks in Germany. Our bank has branches in key global financial centres for your local customers.

At NORD/LB, we're not only the first address for medium-sized corporate clients, as well as private and business customers, we also have excellent knowledge in the field of renewable energies. We finance your project in Germany or in many relevant international markets. This is what makes us a reliable partner in the wind energy sector.

Nord/LB Norddeutsche Landesbank -Girozentrale-

Adress **Markt 12
26122 Oldenburg**

Phone **+49 (0)441 237 1667**

Fax **+49 (0)441 237 1650**

E-Mail **gerrit.schmidt@nordlb.de**

Web **www.nordlb.de**

Profile **Banks, financial institutions &
financial service providers**

Category **Finance & Law**

Turnover **Total assets (per 30.9.2017):
€ 165 billion**

Employees **about 6,000**

Founding year **1970**

01 | Breathtaking view: This wind turbine has a hub height of 149 meters and a wing length of around 57 meters.

NOTUS energy

Power on your side

NOTUS energy has been initiating, implementing and operating wind power projects for nearly 20 years.

The Potsdam-based company has to date planned and built more than 520 wind turbines. NOTUS energy provides a complete range of services from planning to maintenance of wind farms from a single source.

Services

Project Development

- Identification of suitable potential areas and acquisition of the required plots of land
- Investigation of wind conditions and economic profitability
- Establishing conformity with regional planning law and eligibility for planning permission
- Avifaunal mapping

Planning

- Approval procedure according to BImSchM
- Location selection, planning of infrastructure and grid connection
- Expert investigations and surveys of noise, shadow casting and turbulence
- Energy yield, wind measurement and wind survey assessments
- Evaluation of environmental compatibility and introduction of species protection measures



02

Construction management

- Construction planning and preparation of construction work
- Tendering and contracting to individual subcontractors
- Constructional supervision and technical support
- Health and safety coordination
- Certification according to DIN EN ISO 9001

Operational management

- Technical and commercial operational management of wind farms
- Optimal coordination of maintenance work and repair
- Billing of operating companies
- Direct marketing
- Certification according to DIN EN ISO 9001

Financing and marketing

- Standard project financing according to LMA standard
- Sale of turnkey wind power plants
- Regular participation in tenders

External services

- Undertaking third-party services in the fields of planning permission, construction management and operational management
- General contractor services for turnkey erection of wind farms



01

01 | Headquarters of NOTUS energy in Potsdam

02 | NOTUS wind turbine



NOTUS energy

Address	Parkstraße 1 14469 Potsdam
Phone	+49 (0)331 62043-40
Fax	+49 (0)331 62043-44
E-Mail	windkraft@notus.de
Web	www.notus.de
Profile	Planners & project developers
Category	Planning
Employees	about 125
Founding year	2001

PFALZWERKE AKTIENGESELLSCHAFT

Wind energy with Pfalzwerke: shared knowledge for complete success.

Pfalzwerke has successfully implemented more than 70 wind turbines and is always on hand to support you as a competent partner in the development and operation of your wind farm.



Technical management with a broad reach

Pfalzwerke's optimal technical management offers you a comprehensive package of services that can be flexibly adapted to your requirements. In addition to all the traditional services, our portfolio also includes management of the medium-voltage infrastructure, as well as IT security.

Repowering for higher energy yields

With our professional repowering concepts, you can generate more energy with fewer turbines. Replacing old installations with new, modern wind turbines ensures increased efficiency and a positive impact on the landscape.

About us

For more than 100 years, Pfalzwerke has stood for quality and reliability in ensuring a regional energy supply. With around 1,100 employees and together with our partners in the region, we offer you a complete service package for the supply of electricity, gas and heating, as well as telecommunications. We always keep a close eye on the environment and a decentralised power production. You can trust our technical expertise, professionalism, competence and transparency.

Project development from planning to implementation

Transparency is essential at all times for successful project development. Our experts in project development are here to support the project from A to Z – from designing the wind farm layout to property contracts and successful construction and commissioning.



PFALZWERKE AKTIENGESELLSCHAFT

Adress **Kurfürstenstraße 29
67061 Ludwigshafen**
Phone **+49 (0)621 585-2275**
Fax **+49 (0)621 585-2714**
E-Mail **windenergie@pfalzwerke.de**
Web **www.wind.pfalzwerke.de**
Profile **Planners & project developers**
Category **Planning**
Turnover **ca. € 1.6 billion (group)**
Employees **1,100 (group)**
Founding year **1912**

PNE WIND AG

Passion for Energy

Planning, implementation, operation and management of wind farms.
International, onshore and offshore.

Overview

PNE WIND develops wind farms. Our services cover all phases of wind farm development, from the initial idea to on-going operation. To date, the PNE WIND Group (consisting of the brands PNE WIND and WKN) has implemented onshore wind farms with a total output of around 2,500 MW. Our activities currently span Europe, North America and South Africa. PNE WIND also develops offshore wind farms to the point when they are ready to be constructed. Borkum Riffgrund and Gode Wind are among our successfully developed wind farms at sea.

Wind farm development from a single source

Site acquisition, reports and environmental studies, approval procedures, project financing, construction management, grid connection, turnkey installation, operation and maintenance services, repowering.

Wind farm management

After commissioning we usually stay in charge of the technical and commercial management of the wind farm for our customers. We make sure it is regularly serviced and maintained and that it runs as efficiently as possible. The wind farms managed by us have a total capacity of approx. 1,400 MW.

Repowering after the end of the life cycle

As a group committed to sustainability, PNE WIND replaces older wind turbines with more modern and efficient systems. Modernization of wind farms can lead to a considerable increase in output.

Partner for wind power planners

Owing to our extensive experience in wind farm project development, we can act as a partner for other developers and all those who are planning with wind power. We will acquire projects that are already under development or we can help as a partner to complete any remaining steps.



- 01 | Altenbruch wind farm, Lower Saxony
- 02 | Calau wind farm, Brandenburg
- 03 | Gode Wind offshore wind farm, North Sea



PNE WIND AG

Address **Peter-Henlein-Strasse 2-4
27472 Cuxhaven**
Phone **+49 (0)4721 718 06**
Fax **+49 (0)4721 718 200**
E-Mail **info@pnewind.com**
Web **www.pnewind.com**
Profile **Planners & project developers**
Category **Planning**
Employees **approx. 360**
Founding year **1995**

ProfEC Ventus GmbH

closer, committed, competitive

Accredited consulting firm specialized in wind measurements (160 m masts/LIDAR), power performance measurements, turbulence & energy yield (CFD) assessments, MEASNET anemometer & wind vane calibrations.



01 | Installation of calibrated sensors for accredited power performance verification in accordance to EC 61400-12-2

02 | MEASNET-Anemometer- and Wind Vane Calibrations

03 | Accredited 120m wind met mast at class-IA site with Certificate of Bankability

04 | One Stop Wind Shop @ <https://shop.profec-ventus.com>



ProfEC Ventus GmbH
One Stop Wind Shop

Adress **Im Ofenerfeld 23**
26127 Oldenburg
Phone **+49 (0)4421 209089-0**
Fax **+49 (0)4421 209089-9**
E-Mail **info@profec-ventus.com**
Web **www.profec-ventus.com**
https://shop.profec-ventus.com

Profile **WindExperts**

Category **Experts**

Founding year **2011**



“We aim to increase planning safety; identify, quantify and minimise risks; and determine residual uncertainties and possible losses!”:

In addition to wind met masts, measurement equipment and sensor calibrations offered at **ONE STOP WIND SHOP (<https://shop.profec-ventus.com>)**, ProfEC Ventus offers a wide ranging portfolio of services to reliably support essential project-related investment and planning decisions.

Our procedures and processes are founded on the latest findings and in line with internationally recognised **best practices**.

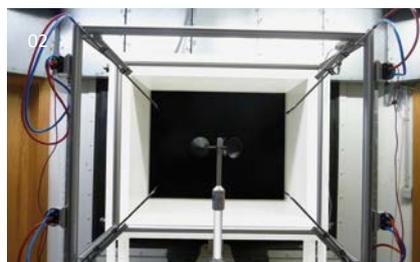
Our ISO/IEC 17025 DAKKS-accreditations as a testing laboratory and as calibration laboratory, as well as our MEASNET membership and FGW conformity, warrant acceptance of our works and expert opinion reports by banks and investors worldwide.

Our first class services allow us to serve international requirements and to meet the expectations of project developers, governments, public institutions, banks, investors and manufacturers.

Our expertise already has been successfully employed in **more than 35 countries** around the globe.

We support wind projects from the initial idea and optimal site finding via calibration of complete measurement systems, energy yield assessments, measurement and validation of power performance, optimisation of wind farm operation and performance enhancement, and analysis of problems in existing wind power projects.

ProfEC Ventus offers **worldwide bankable, accredited services** and **accredited wind measurements**, proven by a **Certificate of Bankability**. Our independent experts are keen to advise you in the role of owner’s or lender’s/bank’s engineer.



psm Nature Power Service & Management GmbH & Co. KG

Manufacturer-independent full-service provider: We offer you every aspect of technical and commercial management, plus servicing for wind turbines and solar plants.



Your full-service provider – for full success

At psm you have access to every service you require during the lifetime of your wind turbine or solar plant – from both a technical and a commercial perspective. As a manufacturer-independent company we always have both sides in mind. Because we know what makes sense from a technical perspective, we can always develop the most cost-effective solution for you. Profit from our 20 years of experience as a service company for renewable energies.



We offer:

Wind power

- Technical management
- Maintenance and repair
- Commercial management
- Replacement of large components
- Service for frequency converters
- Gear endoscopy
- Servicing transformer stations
- Repowering
- Consulting

Photovoltaics

- Technical management
- Commercial management

Fully dedicated with a fair approach

The psm team – now around 120 strong – are genuinely enthusiastic about every project and give 100 percent, whether the task is replacing a gear unit or creating a profit forecast. What is particularly important to us? Open and honest communication with our customers: we say what we think. And we act when others are still talking.

Locally across Europe

The focus of our business is in Germany. We are represented here by an extensive network of locations and look after both wind turbines and solar plants in North Rhine-Westphalia, Saxony, Saxony-Anhalt, Rhineland-Palatinate and Schleswig-Holstein. We do, however, also have a local presence in southern Europe.



psm Nature Power Service & Management GmbH & Co. KG

Address **Juelicher Strasse 10–12
41812 Erkelenz**

Phone **+49 (0)2431 9733-6**

Fax **+49 (0)2431 9733-777**

E-Mail **service@psm-service.com**

Web **www.psm-service.com/
home-psm.html**

Profile **Service, maintenance & repair**

Category **Operation & service**

Turnover **€ 11 million**

Employees **120 (Wind energy: 100)**

Founding year **1998**

R+V Group

R+V offers comprehensive insurance cover for wind turbines.

From planning and installation through to the operational phase, wind turbines require comprehensive insurance cover. This is now available all under one roof with R+V's new wind insurance concept.



R+V adviser Jan Kehnnappel (left) is a competent contact for Mr Petersen, an onshore wind farm operator.



R+V Group

Address **Raiffeisenplatz 1
65189 Wiesbaden**
Phone **+49 (0)611 533-98751**
E-Mail **G_KompetenzZentrumEE
@ruv.de**
Web **www.kompetenzzentrumee.de**
Profile **Insurance companies**
Category **Finance & Law**
Turnover **€ 16.2 billion**
Employees **15,800**
Founding year **1922**

R+V is part of the German cooperative banking group Volksbanken Raiffeisenbanken (VR), making it part of a strong alliance. What we offer our customers, in addition to the latest products and extensive knowledge, is our local presence. Across the 1,000 VR banks and their 12,000 branches, our customers find a named contact for all their insurance matters. You can be sure that we are always there for you.

First-hand knowledge all under one roof – Competence Centre for Renewable Energies

As one of the largest insurers for renewable energy plants, R+V has over 30 years' experience in this field. To strengthen our position in the rapidly growing renewables market, we have bundled our knowledge and expertise in the Competence Centre for Renewable Energies. Our team

of experts implements new product ideas across all areas and continuously develops the existing product offer.

Our staff are always identifying the latest trends in the fields of wind power, solar energy and biogas in cooperation with leading companies and associations. Helping you make sustainable use of our solutions well into the future.

R+V insurance solutions for your wind turbines

Wind turbine operators are making an important contribution to the success of the energy transition. This way of generating power is especially climate-friendly and particularly lucrative – provided you are sufficiently well insured.

From planning and installation to the operational phase, R+V offers comprehensive cover all under one roof with its new insurance concept especially for wind energy.

Let us join forces at the early stages of your project so we can offer you the very best support and advice.



Ramboll

As a full-service provider, Ramboll supports wind projects of all kinds. We are part of one of the world's leading consulting companies and are able to combine global know-how with local expertise.

Since the development of the first Ramboll wind turbines in 1986, we have rapidly expanded our involvement in wind energy projects. Ramboll is now considered the world's leading consultancy in offshore wind energy – more than 65% of offshore wind turbines are based on foundations planned by Ramboll.

In August 2016, Ramboll expanded its service portfolio with the acquisition of the two onshore consulting specialists BBB and CUBE, simultaneously gaining more than 20 years of onshore wind project experience. Its presence on the German market was also significantly strengthened.

With our international, interdisciplinary and wind-energy-specific expertise, we are a full-bandwidth planner and consultant for wind energy projects. Ramboll offers comprehensive expert services for the various project phases, from feasibility studies, business plans and compatibility studies to wind measurements (LiDAR and masts), planning, design, execution and maintenance.



Ramboll manages projects effectively and works with other experts in the various subprojects, according to customer needs. Not only do we offer one-stop-shop consulting with global competence centres, we also have a network of branch offices to serve our customers directly on site. As a full-service provider for wind energy projects of all kinds, we support our customers along the entire value chain and have the resources necessary to be able to implement challenging wind energy projects.

01 | Offshore wind farm near Copenhagen

02 | LiDAR measurement at an onshore wind farm



Ramboll

Address **Stadtdeich 7
20097 Hamburg**

Phone **+49 (0)40 302020-132**

Fax **+49 (0)40 302020-199**

E-Mail **info@ramboll.de**

Web **www.ramboll.com/energy**

Profile **Technical consultants**

Category **Experts**

Turnover **€ 1.4 billion (2016, worldwide)**

Employees **13,000 (worldwide) (Wind energy: 350 (worldwide))**

Founding year **1945**

RoSch Industrieservice GmbH

Your proficient, certified service provider for all-inclusive, professional wind power services

We offer our worldwide clients reliable, professional service for flawless, efficient operation of complete wind turbines, both on- and offshore.



celle. We therefore invest heavily in work safety and certify our employees as per DEKRA guidelines and SCC regulations. Thanks to this high qualification standard, we are able to undertake challenging work on safety- and test-relevant components and structures in industrial plant installations.

On- and offshore

Our versatile service offerings are tailored to your individual needs. In addition to professional installation of your turbine, services also include regular maintenance as per manufacturer specifications, servicing procedures, a repair service for turbine components, and development of special, customized solutions. In the offshore segment, we also manage to excel with a well-positioned concept, and are thus also able to satisfy special requirements offshore.

In April 2017, we became an independent service provider affiliated to ROBUR Industry Service Group GmbH with a view to stimulating growth. The ROBUR Group is the 14th largest industry service company in Germany. Together, we aim to harness synergies within the group, use innovative technologies, and an extensive service portfolio to open up new markets worldwide, and invest in future location expansion.

As a certified, quality service provider, we complete extremely challenging tasks which require expertise and many years' experience. We adopt a flexible approach to clients' individual requirements and take the latest technological developments as a starting point at all times. In doing so, we keep an eye on turbines for the long term to provide a timely response to malfunctions during operation and prevent breakdowns. Our employees' safety is a priority for us, whether they are on the ground or high up in the na-



RoSch Industrieservice GmbH

Address **Bernardstr. 29
49809 Lingen**
 Phone **+49 (0)591 800990-0**
 Fax **+49 (0)591 800990-19**
 E-Mail **info@rosch-industrieservice.de**
 Web **www.rosch-industrieservice.de**
 Profile **Service, maintenance & repair**
 Category **Operation & service**
 Turnover **approx. € 11 million**
 Employees **120**
 Founding year **2008**



01 | Services with personality

02 | Wind specialists with a passion

SSC Wind GmbH

International services for wind turbines
onshore.offshore.engineering.

For more than 16 years, SSC Wind GmbH has been offering a wide range of services relating to wind turbines as well as extensive consulting and engineering services. The company has a wealth of experience on land and at sea, with more than 1,700 installed facilities throughout Europe, making it one of the leading service providers in the European wind industry.

With strong partners within the SSC Wind EMEA group and with locations in Poland, Romania and Turkey, SSC Wind GmbH is able to offer the highest quality of service.

Its own HSE & Quality department ensures a high standard of occupational safety and quality. Tailor-made software for workforce planning, project controlling and tool management enables consistent, professional performance



on construction sites. The in-house maintenance and calibration of tools on our own test stands as well as the use of RFID technology for tools and machines support the logistics in an optimal way.

A selection of the company's extensive services:

Onshore:

Installation, commissioning, maintenance, service and repair of wind turbines, repowering, retrofits, large-component replacement, wind farm regulation, construction site management, rotor blade service, VLF measurements.

Offshore:

Installation, commissioning, service, repair, large component replacement, pre-assembly in port.

Engineering:

Concept development, installation, commissioning, maintenance and repair of measuring, control, and electrical technology including underwater sensors, foundation maintenance, planning and realisation of complex data transmission systems.

SSC Wind GmbH is certified in accordance with DIN EN ISO 9001:2015 | BS OHSAS 18001:2007.



SSC Wind GmbH

Address	Stockenkamp 15 a 27793 Wildeshausen
Phone	+49 (0)4431 738090
Fax	+49 (0)4431 73809-10
E-Mail	info@ssc-wind.de
Web	www.ssc-wind.de
Profile	Service, maintenance & repair
Category	Operation & service
Turnover	€ 31 million
Employees	135
Founding year	2001

Statkraft Markets GmbH

As the market leader in direct marketing, Statkraft will support you in the long run. With a pioneering spirit, Statkraft is pushing ahead with the technical and economical integration of renewable energies.



01

Continued operations after 2020

The continued operation of wind turbines beyond the expiry of EEG subsidies is one of the key topics in the coming years – not only for operators and owners of wind farms. Statkraft is already working with an international and multidisciplinary team on a sustainable and long-term concept that will enable the continued economic operation of old plants even after the subsidy runs out.

Our team is a reliable partner with sound know-how. Statkraft makes all this possible not only in Germany, but also in Belgium, France, Great Britain, the Netherlands, Poland, Turkey and Scandinavia.



More than 120 years of experience as an operator of own power plants as well as in trading create the best conditions for reliable direct marketing of renewable generation. In addition to standard services such as generation forecasts, the marketing of electricity on the spot market and balancing, we support our customers in making their everyday life easier. If desired, Statkraft will handle the settlement with transmission system operators and take over the settlement of compensation payments according to feed-in management measures (*Statkraft EisMan*) or supply electricity from 100% German hydropower for your plants with *Statkraft BezugStrom*.

Feel free to contact us if you have any questions about direct marketing or the operation of your plants after 2020. You can also meet us at wind industry days and at trade fairs in person. Just have a look at the calendar on our website.

Statkraft Markets GmbH

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Fax **+49 (0)211 60244-199**
E-Mail **direktvermarktung@statkraft.de**
Web **www.statkraftdirektvermarktung.de**
Profile **Direct marketers**
Category **Direct marketing**
Turnover **€ 18.05 billion**
Employees **466**
Founding year **1999**

01 | The Statkraft direct marketing team: we will manage it for you.

02 | Market integration: we will make it.



02

THEOLIA Naturenergien GmbH

With fresh energy behind you

We stand out from the crowd - through performance, competency and our fascination with generating power from wind. This fascination is tangibly present in the range of services we offer.

THEOLIA Naturenergien GmbH offers you:

- Commercial and technical management of your wind turbines
- Accounting management of your wind farm company
- Modular building block principle for designing your personal management package
- Assistance with mergers & acquisitions, real estate issues and project planning
- Support for direct marketing, insurance, communication and repairs

With around 350 wind turbines and a combined energy output of 500 MW from third-party and company-owned plant distributed throughout Germany, THEOLIA is one of Germany's leading independent electricity producers and plant management companies.

Our many years of experience and our comprehensive know-how are critical assets when it comes to commercial and technical operational management. THEOLIA's highly-skilled staff working throughout the entire value-added chain ensure that we are able to operate wind turbines from any manufacturer and in any performance class in a commercially and technically optimised manner. This



is reflected in the 98% availability we achieve for our wind power portfolio.

THEOLIA's proposition to customers is even more attractive. With higher levels of service orientation, quality, and safety, both commercial and private customers will find exactly what they need within our modular operational management package.

Having 89 wind turbines of our own we are familiar with the optimisation potential and the realities of wind farms as well as operational management requirements. This sets us apart from our competitors and we set a high benchmark for ourselves – all in the interests of our customers.

Take us at our word and contact us for a no-obligation quote or come and talk to us. The THEOLIA team look forward to seeing you.



THEOLIA Naturenergien GmbH

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70771 Leinfelden-Echterdingen**
Phone **+49 (0)711 23860-0**
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E-Mail **kundenservice@
futuren-group.com**
Web **www.windparkbetreuung.de**
Profile **Technical & commercial
operational management**
Category **Operation & service**
Employees **35**
Founding year **2000**

UKA-Group

Leading onshore developer

The UKA Group installs wind farms and their associated infrastructure in Germany and the US. With around 850 megawatts of installed capacity and more than one gigawatt at an advanced planning stage, UKA is one of the top onshore developers in Germany.



01



**UKA – Umweltgerechte
Kraftanlagen GmbH & Co. KG**

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01662 Meißen**
Phone **+49 (0)3521 72 80 60**
E-Mail **zentrale@uka-gruppe.de**
Web **www.uka-gruppe.de/en**
Profile **Project developers**
Category **Planning**
Employees **460**
Founding year **1999**

End-to-end solutions for decentralized energy generation

The UKA Group is a reliable, financially sound partner for the development, financing, construction, and operation of wind energy projects. As an engineering, procurement and construction contractor, the UKA Group offers a broad range of services for customers and business partners – from planning to implementation.

The UKA Group provides tailored asset management solutions for wind energy projects and strives to optimize every portion of a wind asset during its lifetime in the fields, of site administration, finance, accounting, taxation management and commercial asset management. Moreover, the UKA Group owns own

wind assets and substations, for which it assumes the role of an independent energy producer.



02

📍 UKA sites in Germany



The strength of the UKA Group is founded on the knowledge and expertise of its staff. With almost 20 years of market experience, the UKA Group has positioned itself as a reliable partner for landowners, stakeholders and local communities.

As an expert for wind energy in forest areas, UKA has already put several wind farms in forests into operation. UKA also successfully implements repowering projects.

The UKB Umweltgerechte Kraftanlagen Betriebsführung GmbH ensures the optimal technical and economical performance of the turbines. UKA Projektträger GmbH & Co. KG, headquartered in Lohmen (Mecklenburg, Germany) is responsible for the realisation of all construction projects for the UKA Group.

The UKA Group has around 460 employees at its sites in Meissen, Cottbus, Rostock, Erfurt, Oldenburg, Bielefeld, Hanover, Lohmen (Mecklenburg), Grebenstein (near Kassel) and the US.



01 | Wind farm in Uebigau (Brandenburg)

02 | UKA sites in Germany

03 | Commissioning of the world's first Vestas V136-3.45 MW in Lieskau (Brandenburg)

04 | Range of services provided by UKA group

TÜV NORD SysTec GmbH & Co. KG

Full-Service Provider for the Wind Industry

TÜV NORD certifies wind turbines to all international standards and regulations, evaluates specific site conditions and supports operation of wind turbines over their entire lifecycle.



Type certification begins with the design assessment of loads, safety concept and all components of the WTG. Prototype tests then verify the assumptions made during design assessment and measure the power curve. On major components such as gearboxes and rotor blades, separate prototype tests are performed. The third mandatory part of certification is the evaluation of manufacturing with respect to the quality system and the implementation of the design requirements during production. Major components can also be certified individually.

Besides the well known type certification for manufacturers and project certification for project developers, all services for wind energy projects can also be offered as a one-stop shop. The entire range of project-related assessment services including life time extension is available to wind farm planners, operators and providers of finance.

With more than 13,000 employees and experts in nearly all technical disciplines, TÜV NORD Group is one of the world's largest technical service providers. We owe our leading market position to our technical competence and a wide range of services in the field of consulting, testing and certification in our business units of Mobility, Industry Services and International. We operate in over 70 countries worldwide.

Within the field of wind energy TÜV NORD offers services in certification, site assessment and inspection of wind turbines (WTG) and projects. TÜV NORD is one of the leading accredited certification bodies for wind turbines certifying on- and offshore WTG according to all major guidelines such as IEC, IECRE, DNVGL, EN, GL, the Danish approval scheme, TAPS and BSH.



TÜV NORD SysTec GmbH & Co. KG
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 Web **www.tuev-nord.de**
 Profile **WindExperts**
 Category **Experts**
 Turnover **n.a.**

VERBUND

VERBUND is one of the largest producers of hydro-electricity in Europe and the German-speaking world

Today, the major challenge is the integration of renewables. We offer flexible product marketing, efficient storage and pool solutions, and impressive service concepts.

Individual solutions for existing and new turbines

Whether wind, water, photovoltaics or biomass, direct marketing in accordance with the EEG has been compulsory for new generating plants of 100 kilowatts or more since 2016. VERBUND Trading & Sales Deutschland, a trading subsidiary of the largest electricity concern in Austria, carries out direct marketing of its green electricity for turbine operators throughout Germany.

As an experienced player on the electricity market, VERBUND has the required expertise to master the challenges in this dynamic environment in a cooperative way.

Our offer:

- Optimum green electricity marketing on intraday, spot and futures markets
- New for 2018: regional verification as an additional source of income for turbine operators and municipal utilities
- Many years' experience of producing forecasts
- Networking in virtual VERBUND power plant
- Registration and re-registration of turbines
- Participation in the electricity balancing market
- Individual contract periods

Benefits:

- Low prices thanks to optimum electricity marketing and flexible power stations
- Extra yield compared to EEG feed-in tariff
- Downtime remuneration if feed-in performance is reduced
- Financial security thanks to excellent financial standing
- Personal contacts in Munich and Düsseldorf

VERBUND – Europe's green battery

With its flexible 8,200 megawatt power plant, VERBUND is the largest producer of hydro-electricity in Austria and Bavaria. This is ideally supplemented by VERBUND's own wind farms and those marketed for third parties.

Flexibility products

The generation portfolio consisting of hydro and wind power is the basis for flexibility products designed specifically for the requirements of the market. Where necessary, companies receive electricity, energy-related products and services, combined with innovative solutions for the efficient use of energy.



VERBUND wind farm Bruck an der Leitha, Vienna

Verbund

Am Strom der Zukunft

VERBUND Trading & Sales Deutschland GmbH

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Fax	+49 (0)89 890 56 21950
E-Mail	direktvermarktung@verbund.de
Web	www.verbund.de
Profile	Direct marketers
Category	Direct marketing
Turnover	VERBUND AG: € 2.79 billion
Employees	about 3,150
Founding year	1947

Volkswind GmbH

Production of clean and renewable onshore wind energy



After the take-over by the Swiss utility Axpo in 2015, Volkswind is even stronger positioned in the market for the further expansion and diversification of its project portfolio, also with view to regulatory changes in the energy market.

The Axpo Group produces trades and distributes energy reliably in Switzerland and in over 30 countries throughout Europe. Around 4,200 employees combine the expertise from 100 years of climate-friendly power production with innovative strength for a sustainable energy future.

Axpo is a global leader in energy trading and the development of customized energy solutions for its clients. Axpo's energy know-how and its market and industry experience ensure a strong strategic partnership in the wind energy sector.

Besides a further expansion of the business activities in the core markets Germany and France this partnership comprises also the expansion of the operational management and asset management.



Volkswind has been one of the leading wind energy producers in Europe since 1993. Its core business comprises the planning, projection, construction and operation of wind turbines.

Being a pioneer of the German wind energy business with over 75 realized wind farms Volkswind is nowadays one of the leading European developers and operators of onshore wind farms. This comprises a diversified portfolio with regards to geographies as well as clients.

Volkswind GmbH

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 E-Mail **info@volkswind.de**
 Web **www.volkswind.de**
 Profile **Planners & project developers**
 Category **Planning**
 Employees **approx. 80**
 Founding year **1993**

VSB Group

Development . Planning . Construction . Project Acquisition . Repowering
Trust in more than 20 years of experience and more than 860 megawatt of installed capacity. We provide profitable solutions throughout the entire value chain of wind energy projects.

Wind is our passion and project development is our core competence. We accompany every step from securing land through approval planning to the implementation of wind farms, for which we are also your contact when it comes to technical and commercial management. Choose between the whole package with VSB as a general contractor or a tailored set of individual services. To prepare for the electricity market of tomorrow, we also focus on storage solutions for matching demand and supply of renewable electricity.

Empathy and Acceptance

The energy transition can only succeed if all stakeholders act in concert. Therefore, our projects are put into practice in close cooperation with residents, municipalities, and local representatives. This results in highly individual solutions regarding turbine locations, windfarm layouts and compensation measures. Above that, scheduled receipts and financial rewards for citizens add to making renewable energies a long-term benefit for local communities.



Tested Quality

VSB has received certification according to the DIN EN ISO 9001:2015 in Germany and France. What does this mean for our everyday business? It ensures that responsibilities are clearly assigned, processes are bindingly defined and knowledge is documented in a systematic manner. Hence, you can put your trust in legal compliance, reliable yield projections and a strict monitoring of project costs.

In Your Vicinity

Climate action does not stop at regional borders. Consequently, our experts work internationally on implementing a sustainable energy supply. With our headquarters in Dresden and three regional German offices as well as subsidiaries in France, Finland, Italy, Poland, Romania and Tunisia we are always in reach when accompanying your project from the beginning to the end.

- 01 | Regional Value Added: Wölkisch wind farm (Saxony, 20.5 MW)
- 02 | Wipperdorf wind farm (Thuringia, 14.4 MW)



VSB Group

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Fax	+49 (0)351 21183-44
E-Mail	info@vsb.energy
Web	www.vsb.energy
Profile	Planners & project developers
Category	Planning
Employees	more than 300
Founding year	1996

Windrad Engineering GmbH

Strong in detail ... tracking the whole

Windrad Engineering GmbH has been offering independent engineering services for the wind industry since 2002: Engineering. Simulation. Consulting. Offshore.



01 | View into the 3D nacelle model of a 2MW wind turbine

02 | Seal "Innovation through Research" by Stifterverband für die Deutsche Wissenschaft e.V.

03 | Design of test facility and blade fatigue test conducted by Windrad Engineering at the customer's site.



Windrad Engineering GmbH

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Phone **+49 (0)38203 77630**
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E-Mail **mail@windrad-online.de**
Web **www.windrad-online.de**
Profile **Development & construction**
Category **Other services**
Employees **10**
Founding year **2002**

Serving more than 50 satisfied customers, Windrad Engineering has conducted more than 300 projects of different sizes.

Our portfolio covers the entire field necessary to develop a complete wind turbine. Our core competences are simulation, design, analyses, optimization and technical consulting for onshore and offshore projects.

It is our strong ambition to support you as a competent partner for making wind turbines more reliable and cost-effective. Based on our own R & D projects we continuously develop our methods and tools, also in close cooperation projects with Universities and Research Centers.

Representative projects

- Complete design of wind turbines: From small to multi-megawatt
- Modeling and aeroelastic simulation for very different configurations: Horizontal/vertical, upwind/downwind, onshore/offshore, gearbox/gearless, as well as controller optimization
- Design and dimensioning of all components/systems

02

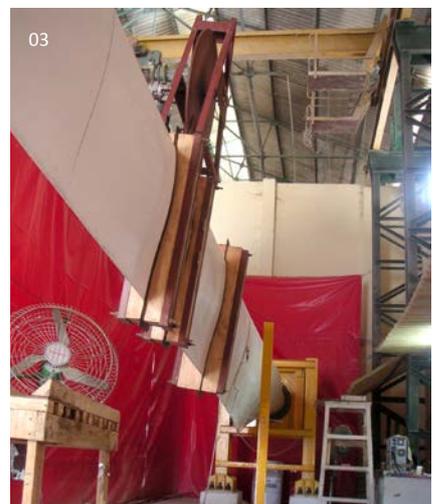


- Structural optimization of all main components such as foundation, tower, machine frame, hub, nacelle shell
- Documentation of all necessary strength and stability analyses
- Specification of all components and systems for suppliers and certification
- Feasibility studies and research projects, expert opinions
- Measurements, e.g., vibration measurements and their analyses
- Documentation for certification

Customers say

"At all times during our long-standing cooperation we could fully count on the comprehensive competence and high reliability of Windrad Engineering GmbH."

"It has always been a pleasure working with the entire WINDRAD team. Everyone was exceptionally good, efficient and effective."



03

Windwärts Energie GmbH

A company of the MVV Energie Group

With more than 20 years of experience Windwärts is one of the pioneers of the sector. As part of the MVV Energie Group it is contributing significantly to the energy transformation.

Experience in onshore wind energy

Our areas of business are project development, financing, implementation and management of onshore wind turbines in Germany and France. In addition, the company offers construction and planning services (EPC), the re-powering of projects and partnerships with citizens' energy companies and other actors. The prominent focus in Germany is Lower Saxony, Schleswig-Holstein and East Westphalia Lip. To date, Windwärts has connected 170 wind turbines to the grid, with a total rated capacity of 318 megawatts. Management takes care of a total rated capacity of 585 MW and ensures the highest possible yields.

Expertise and enthusiasm for the energy transition

Windwärts understands its trade, from locating suitable areas through to planning, financing and constructing the wind farm to commercial and technical management over the entire service life of the turbines. The expertise of the 95 members of staff in all these areas is as much a central feature of Windwärts' work as the company's reputation for care and attention to detail. It helps to assess risks and eliminate the obstacles in complex



approval procedures. And our staff always have one objective in mind, which feeds their drive and commitment: they want to make the energy transition a concrete reality at every location.

Strong implementation

Public utility companies and energy suppliers benefit from this experience and motivation, in addition to site owners, councils and investors for whom Windwärts plans and builds wind turbines. Since 2014, Windwärts has been part of the MVV Energie group, making it part of one of Germany's leading energy companies.

01 | In good hands: Windwärts has been developing, building and operating onshore wind energy projects for more than twenty years.

02 | Successful: Our management achieves the best for you.



Windwärts Energie GmbH
A company of the
MVV Energie Group

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E-Mail **info@windwaerts.de**
Web **www.windwaerts.de**
Profile **Planners & project developers**
Category **Planning**
Employees **95**
Founding year **1994/2014**

WKN AG

Renewable energies for today and tomorrow

WKN AG has been one of the leading project developers in Germany, Europe as well as the US for almost thirty years now. The German wind experts always keep an eye on new markets.



It was this pronounced pioneering spirit which took WKN to international markets very early on. Since 2007 the fruits of these markets have been harvested: large-scale wind energy projects have been built in the US, Italy, Spain, Poland as well as France, and many further projects are currently being realized. Needless to say that WKN consistently keeps an eye on new and further markets.

In all projects, WKN relies on long-term strategies and cooperation with local partners. Wind energy projects developed by WKN are being acquired by renowned major company groups, investment trusts as well as energy providers. WKN's business activities include site evaluation and development, planning, financing, turn-key construction and operation through to commercial and technical management of the wind farm. Up until the end of 2017, WKN AG had realized more than 1,400 megawatts of installed capacity in about 115 projects.

In mid-2013 PNE WIND AG, Cuxhaven/ Germany became the WKN majority shareholder.



WKN AG has been planning, developing, financing and building first-class wind farms since 1990. As one of the pioneers of the German wind energy scene the Husum-based company has been one of the leading developers for decades and is also represented on various international markets. The WKN team consists of renowned wind energy experts who consider each project as a new challenge and who strive to find the best possible solution by working closely with the project partners on site.



WKN AG

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Web **www.wkn-ag.de**

Profile **Planners & project developers**

Category **Planning**

Employees **160**

Founding year **1990**

01 | Local heroes for international challenges

02 | Wind farm Kropp-Tetenhusen, Deutschland

Wölfel Wind Systems GmbH

Experts for Structural Dynamics, Acoustics and Vibration Reduction

Wölfel Wind Systems is focused on the production and installation of condition monitoring systems (CMS) for the reduction of vibrations and structure-borne noise for onshore and offshore wind turbines.



Ice detection or reduction of tonalities, structural health monitoring (SHM) of rotor blades, towers or foundations or rotor blade inspections – our products and services focus on engineering in the field of structural mechanics and on the dynamics of your individual wind turbine (WT).

In signal analysis, we combine our findings from Third Party Inspection and recurrent inspection with the measuring data from the WT. In the past decades, Wölfel has built up and extended a unique core competence in this field. We extract the really relevant technical information from the masses of data. We provide information about structural damage on the blade, the tower or the foundation, about fatigue loads and the related lifetime consumption of your WT. We measure sound emissions and immissions and our experienced rotor blade inspectors assist you in all matters related to fibre composites.

The experience gained in research and service projects is taken into account and incorporated in the development of specific products. The systems IDD. Blade® (for ice detection), SHM.Blade® (for condition monitoring of rotor blades) – both certified by DNV GL – and the active damper system ADD.Sound® (for the reduction of the tonal components in airborne noise) are impressive examples for the development of application-oriented solutions. Our damping system TMD.Tower reduces tower vibrations and thus increases the lifetime of your WT.



Our latest technological innovation is SHM.Tower® – a system for load monitoring and life cycle prognosis of your WT. It is easy to retrofit and energy self-sufficient and thus quickly made its way to international markets.

Wölfel Wind Systems – we transform measurement data into knowledge.

With this knowledge you are on the safe side and have economic success!



Wölfel Wind Systems GmbH

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E-Mail **info@woelfel.de**

Web **www.woelfel.de**

Profile **Condition monitoring systems /
Seals & vibration control /
Technical consultants**

Category **Experts / Suppliers of electrical
and electronic components**

Founding year **1971**

wpd windmanager GmbH & Co. KG

All services from a single source – that’s efficient wind farm management.
 Optimized operation of wind farms, guaranteed through our long-term experience and comprehensive market knowledge.



Our certified specialists deal with all other technical wind farm issues. Experienced wind farm managers ensure the optimum operation of turbines on site and the implementation of all necessary measures.

Commercial Management

We have extensive knowledge of all matters relating to taxation, legislation, and accountancy. In conjunction with central contact persons, our comprehensive information management system quickly provides our customers with information tailored to their specific requirements. We also monitor deadlines and produce annual reports.

Additional Services

Our optional additional services, which are also available outside of a plant management contract, are designed to increase productivity and profitability even more. These cover such areas as information technology, Quality, Health, Safety, Environment (QHSE), wind turbine components, wind farm infrastructure, electrical engineering and consulting onshore.

Since 1998, wpd windmanager have been managing all tasks relating to the commercial and technical operation of wind farms. All our clients benefit from a customised selection of wind farm services optimised for profitability. We currently employ more than 365 staff in around 355 wind farms at home and abroad, encompassing 1,965 individual turbines producing a total output of over 4,000 megawatts.

Technical Management

Considering that rapid response times are key to minimising profit losses, our service entails a complete technical support package, the core of which is 24/7 monitoring directed from our central control room. Among other things, our technical operational management team is responsible for operational monitoring, documentation and the management of contracts and warranty agreements.



**wpd windmanager
 GmbH & Co. KG**

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Web **www.windmanager.de**

Profile **Technical & commercial
 operational management**

Category **Operation & service**

Turnover **€ 10 million**

Employees **> 365**

Founding year **1998**



The
Who's Who
of the German
wind industry –
be part of it!

Published in German and English.

**Your company is not listed in the publication?
You'd like to be included again next year?**

Then don't hesitate!

Specification:

- Company profile and/or Address entry in the printed Industry Report
- Free distribution around the world at trade fairs and conferences
- Your entry in the online industry portal www.windindustry-in-germany.com
- Editing and graphics of your company profile
- Free copies for your own marketing

We'll be glad to advise you:
Branchenreport@wind-energie.de



Publisher:

German Wind Energy Association

Working closely with its cooperation partners, the German Wind Energy Association (BWE) publishes a comprehensive overview of the industry in a publication entitled “Wind Industry in Germany”.



The expert committees at the German Wind Energy Association (BWE)

Advisory boards – Forums – Working groups

At the BWE, operators, manufacturers, suppliers and service providers are organised into expert committees such as advisory boards, working groups and forums.



At the advisory board meetings, companies in the wind energy sector meet to discuss and resolve current issues and to develop long-term strategies concerning the most important issues in the industry. Within their specialist areas, they therefore function as an important exchange of information. The work carried out by these expert leads to position papers and statements; the standards developed then act as a guideline for the entire wind industry. Each advisory board has a chairman who sits on the federal executive board of the BWE, giving them a strong say in the association's policies.

Expert advisory board

The expert advisory board discusses and develops policies and procedural guidelines for the technical examination of wind energy systems.

Finance advisory board

The finance advisory board is open to all banks and financing companies with activities in the wind energy industry. It acts as a forum for the exchange of ideas between different companies, such as the financial impacts of relevant legislation.

Advisory board of operational managers

The advisory board of operational managers deals with all commercial and technical aspects related to wind turbine operation. Its members are also active in other associations to work towards guidelines.

Investor's advisory board

The investor's advisory board is concerned with the quality of investment opportunities in wind farms. It analyses annual financial statements and collects important information on the financial situation and profitability of numerous wind farm projects.

Citizen's wind energy advisory board

The citizen's wind energy advisory board brings together operators of citizen's wind farms. Concerned with implementing the energy transition through citizen's and community-owned energy projects, it represents the interests of citizen's wind farm operators within the BWE.

Legal advisory board

The legal advisory board comprises over 100 lawyers and in-house legal counsels who together discuss current legal questions relating to wind energy. This involves the exchange of valuable information on current court cases. The latest legal proceedings are also discussed by the legal advisory board and written opinions submitted.



The expert committees at the German Wind Energy Association (BWE)

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Web **www.wind-energie.de**
Profile **Associations**
Category **Organisations &
public institutions**
Founding year **1996**

Manufacturer and supplier board

Through the companies represented in it, the committee brings together representatives of the German wind industry in the BWE. The Board works closely with the BWE on industry-related topics.

Operators' advisory board

On the six operator forums at the BWE, members exchange knowledge about each manufacturers' wind turbines. Operators of both individual and multiple wind turbines are organised in such forums. The speakers of the forums meet regularly to discuss their experiences in the operators' advisory board.

Planning advisory board

The planning advisory board is an important platform for the exchange of information by planning companies. Expert presentations accompany the discussion of major topics such as local and national planning laws, the future shape of the EEG, and European energy policy. Members support the positioning of the BWE regarding planning questions.



Scientific advisory board

As a forum for BWE members active in research and science, the scientific advisory board deepens current scientific discourses and establishes future research needs.

Wind consultant advisory board

The focus of the wind consultant advisory board is on improving onshore wind forecasts in Germany. Constant exchange of experiences and regular presentations on the topic are a foundation of its work, which particularly results in the definition of minimum standards for expert reports.

Working groups are established at short notice to deal with current issues and problems. They are organised across different boards, are able to act quickly, and can also hire external experts if necessary. Representatives from around 131 member companies are currently involved in working groups for networks, radar, obstruction lighting, nature conservation and wind energy, foundations, and continued operation.

All 2,200 operator companies who are members of the BWE are organised in the operators' advisory board via operator forums. Of the 1,100 manufacturers, suppliers and service providers who are members, 220 companies are members of the boards of the BWE. Each board meets between 2 and 4 times a year. For further information on the work of the boards and working groups and to view the lists of members, go to: www.wind-energie.de/verband/fachgremien.

German Wind Energy Association (BWE) – Events & Corporate Publishing

Knowledge about wind – networking – qualification



The German Wind Energy Association – knowledge & networking

In addition to political work, knowledge & networking is a central impetus for the German Wind Energy Association. BWE has accompanied the economic and technical progress of the industry for many years with its education events and publications from which everyone, novice and expert alike, can obtain the latest information about the wind industry.

BWE events

Networking events bring together all the important players in the wind energy sector. Short talks by experts and company presentations get things off to a flying start, no matter whether the topic being discussed is a change to financing concepts or the latest turbine technology.

At the seminars, principles are passed on and solutions for the everyday challenges in the wind sector are talked through. Experienced speakers – frequently experts from the BWE expert committees – impart their knowledge about topics including project planning, production management and direct marketing. Particularly in 2017 BWE events have been highly sought after, so that companies can adapt to new business models. An overview of all events can be found here: www.bwe-seminare.de

The German Wind Energy Association – a strong partner

With around 20,000 members it is the world's largest association for renewable energies. For many years the BWE has been campaigning for a sustainable and efficient extension of wind energy in Germany, with ever greater success.

With its ambitious expansion targets, the wind power sector is the main driver behind the switch to renewables. Together with its members, the BWE is fully committed to continuing the success story of German wind energy and to ensuring that the vision of "100 percent electricity from renewable energy" in Germany becomes a reality soon.



German Wind Energy Association (BWE) – Events & Corporate Publishing

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In addition to events, the German Wind Energy Association is also packing its knowledge into countless specialist publications. For example, for the last 25 years it has published the wind energy handbook. Also known for providing a market overview, it offers an excellent overview of the facts, figures and data and the development of both the market and technology in Germany. Furthermore, in it you will also find the operating results of 2,500 German wind power plants.

BWE also publishes specialist publications devoted to topics from the fields of law, financing, service, project planning, and recently even small wind turbines. The knowledge gained through them can be utilised in important company decisions, thereby promoting the continued sustainable growth of the industry. You can find an overview of all BWE publications here:

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The industry directory

The wind industry sector report in Germany, which the German Wind Energy Association has circulated since 2010, developed from the BWE market overview. The economic report is the flagship for the entire sector, in which companies can present their services and products to a broad target group. The comprehensive address section means it is also a real reference book for anyone looking for partners in the wind industry. Accessible online as an industry portal at:

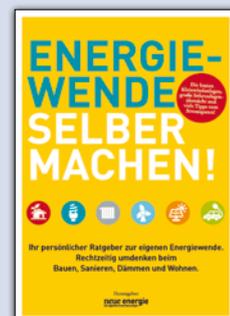
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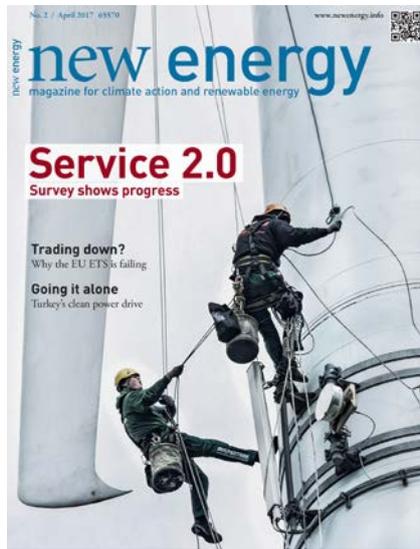


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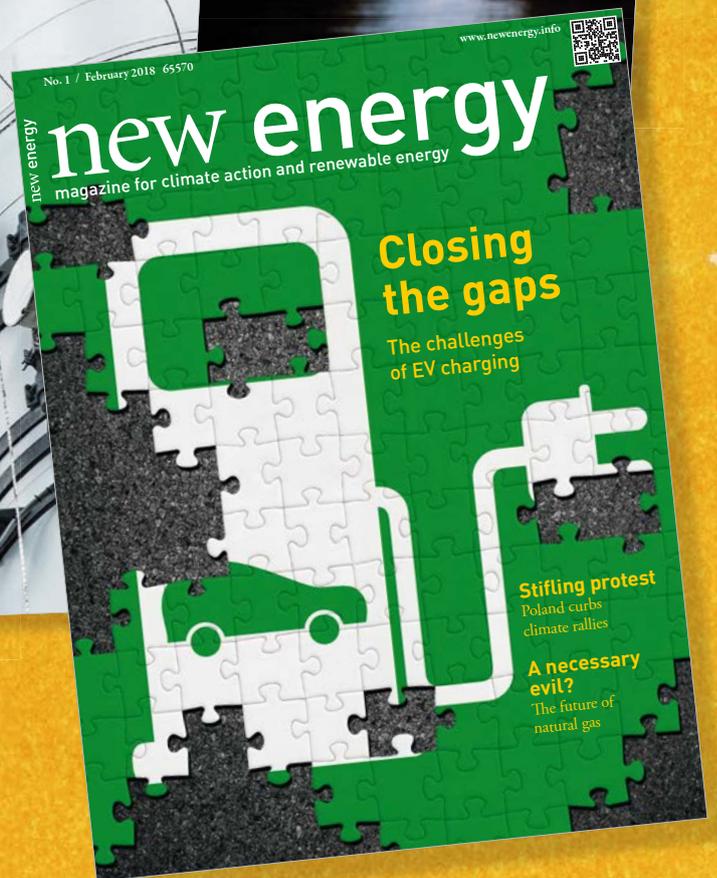
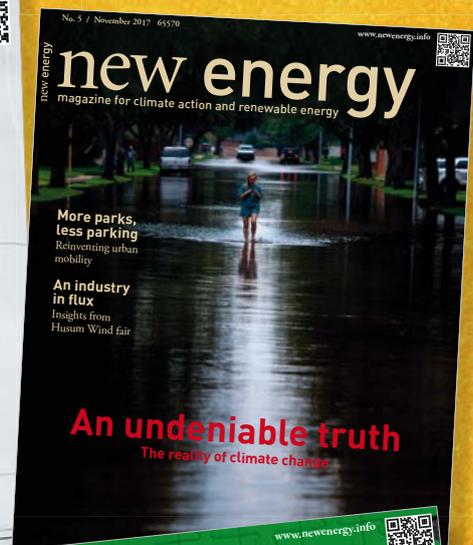
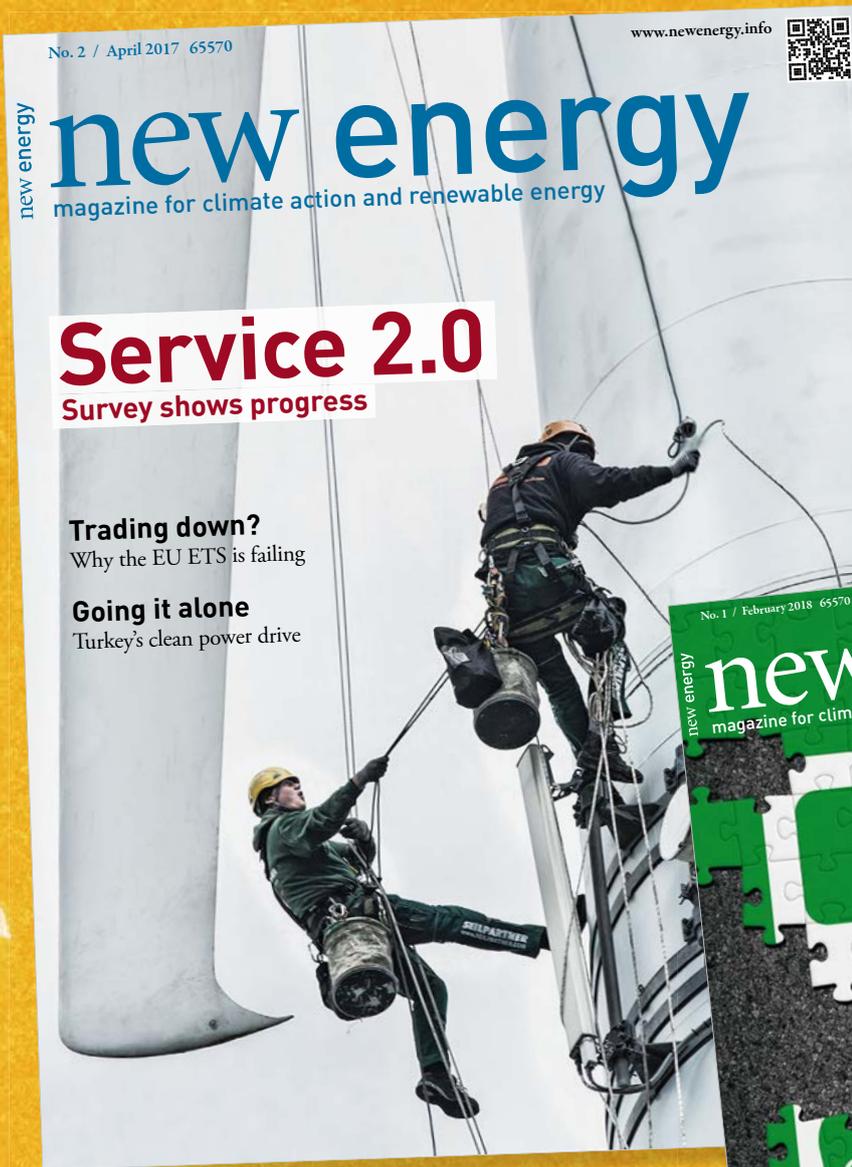
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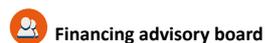
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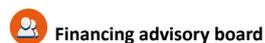
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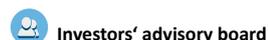
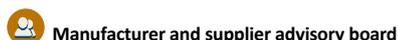
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