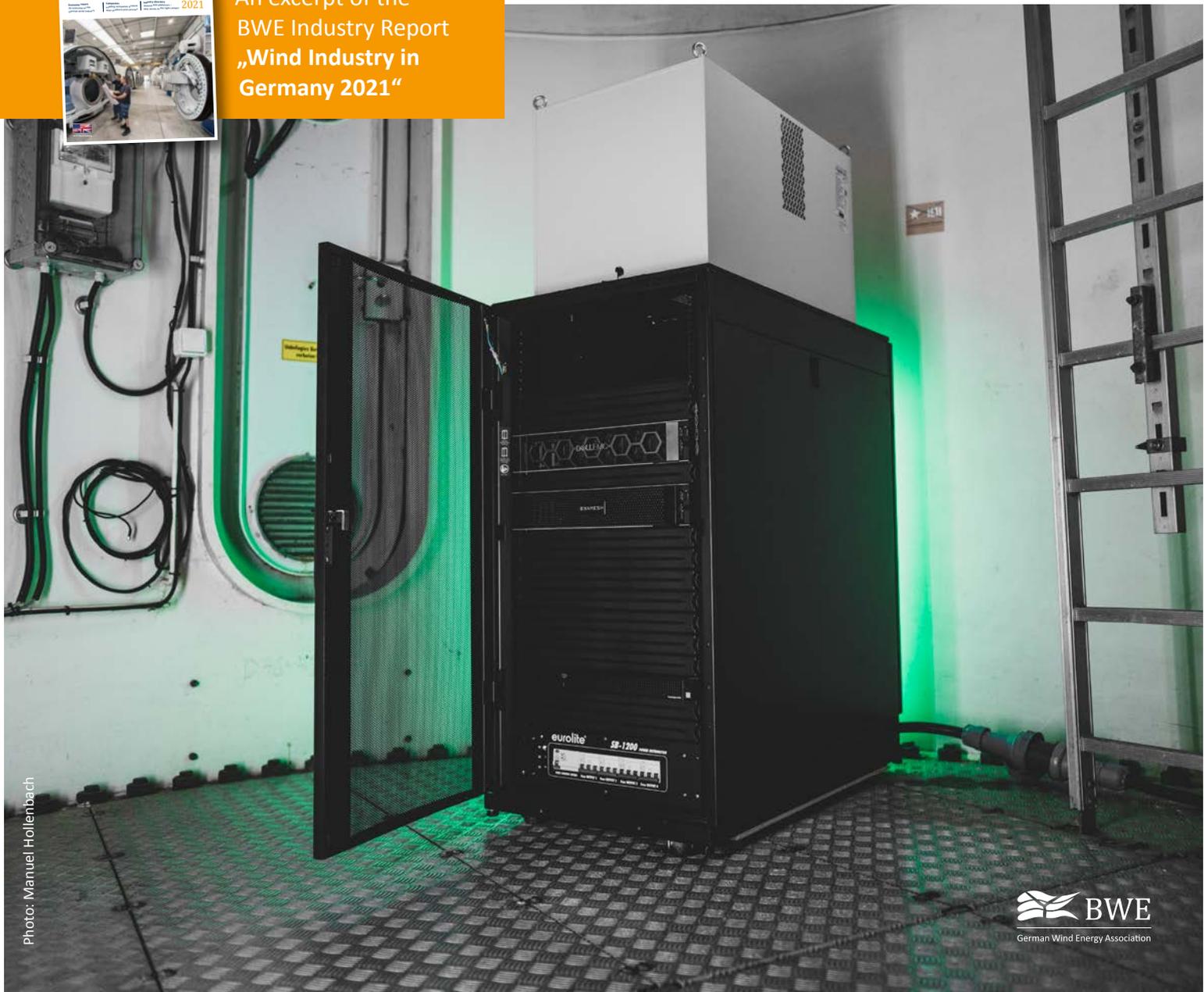


start up

Start-ups are entering the market with new ideas.
A selection is presented on the following pages.
Be inspired by their innovative power.



An excerpt of the
BWE Industry Report
„Wind Industry in
Germany 2021“



Robotic wind turbine services

Aerones robotic technology is changing the wind turbine maintenance industry by switching away from the less efficient manual services to automated robotic solutions. This way we are able to provide the services FAST and SAFELY.



Aerones has developed a specially designed wind turbine maintenance technology to provide blade services more efficiently in comparison to traditional solutions and does not require having the rope-access technicians working on the blade.

Aerones technology offers safe, efficient, and environmentally friendly maintenance services which substantially decrease the operation and maintenance costs for the wind turbine owners and operators. The solution is based on a special winch system which allows for delivering different kinds of robotic tools (also specially developed by Aerones) for providing the services. The provided services list include:

- Lightning Protection System inspections;
- Visual inspections;
- Drainage hole cleaning;
- Blade cleaning;
- Internal inspections;
- Blade leading edge surface preparation for the following repair.

We are constantly working on improving the current solutions to provide even better services for our customers. At the same time, we are working on new technology development, such as blade painting; filler/coating application; tower cleaning; ultrasound inspections, and other services. Our goal is to provide a full blade service package by the Aerones technology. What is more, we are working on a solution for servicing the offshore wind turbines as well.

The biggest benefits of using Aerones technology are safety, speed, and cost-effectiveness.

Safety: Aerones technology allows for avoiding the need of having the rope-access technicians climbing the blades and allows them to do the same job from the ground by operating the robotic unit on the blade which performs the job instead.



AERONES

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Founding year	Aerones: 2015 Started in wind industry: 2018
Number of employees	35
Focus	Wind turbine blade maintenance
We are looking for	Cooperation partners for developing offshore solutions



Conclusion

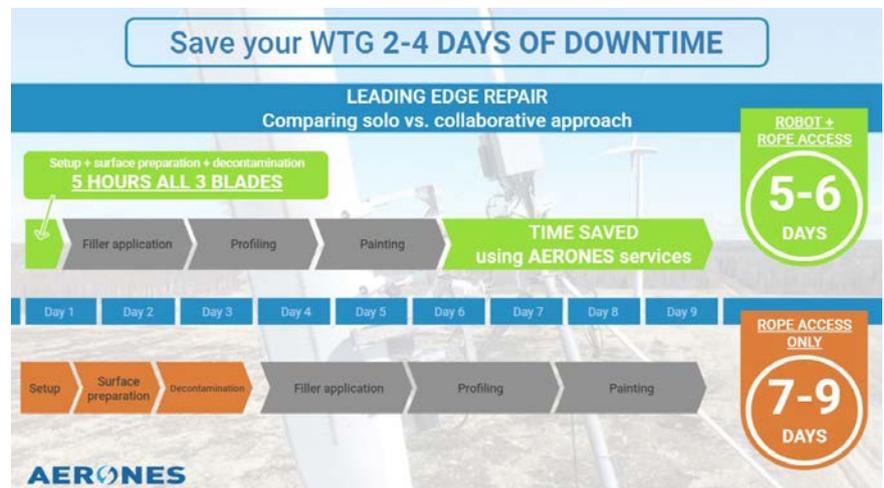
As the wind energy market is growing and wind turbines are becoming bigger, we believe that it is important to find an effective way to keep the turbines in good condition and maximize energy production. Innovation is the solution and Aerones technology could resolve these issues and improve the efficiency of wind turbine energy production in the long term.



Speed: The technology allows for much faster services in comparison to the traditional methods as it is much more mobile and can easily operate in a bigger area. Faster services allow to significantly reduce the downtime of the wind turbine during the services. For example, for the Lightning Protection System inspections, Aerones can provide the services for even up to 4 turbines per day, which is four times faster than by providing the services with the traditional methods. Also, by preparing the leading edge surface with the Aerones technology, we are able to save 2-4 days of the repair process per turbine.

Cost-effectiveness: By providing faster services, the downtime of the turbine is reduced as well, therefore saving the money for the customer in ungenerated electricity during the services. Also, as the services can be done by a robot, there is no need for highly experienced technicians to do the job, thus the costs of the services are lower as well.

The industry is highly interested in using such a solution for the wind turbine maintenance services as there are opportunities to reduce downtime, save money, and reduce the need for direct human labor to do the job. During this year, we have completed several projects for the biggest companies in the wind industry and it is expected to continue the cooperation with those companies in the long term.



Innovative Condition Monitoring

cms@wind is currently in its 5th year. In recent years, we have established ourselves as a provider of sophisticated solutions that go beyond the range of commercially available condition monitoring solutions.

Almost all newer wind turbines with a rated output above 3 MW already include integrated condition monitoring solutions. Often, the information flow is so complex and the output so diluted that there is no added value to the end user. In 2019 and 2020, cms@wind has increasingly focused on developing solutions to this specific information deficit.

To this end, we extended our simple CMS-mobil solution to the new CMS Universal solution. In addition to the traditional vibration measurement, it is now possible to use this mobile device to measure imbalances and to integrate further measured variables. From traditional temperature measurement to control system signals and traditional analogue input variables, almost anything is possible. The device is completely self-sufficient and can be operated remotely. We customise the device to meet our customers' individual requirements.

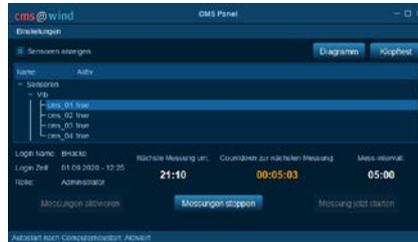
CMS Universal is ideally suited for the standalone detection of hidden defects during the warranty period and for the integration of different wind farm systems.

We had to completely revise our previous user interface to make the installation process easier for customers. As with traditional mensuration technology, it is now possible for trained commissioning engineers to adapt measured variables to turbine behaviour on site.



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Founding year	2015
Staff	4
Focus	Condition Monitoring for large slow-turning components in drive trains that move at variable speeds
We offer	<ul style="list-style-type: none"> - Independent measurements - Innovative CMS solutions for large slow-turning components in drive trains that move at variable speeds - Optimised for wind energy - Monitoring of slewing bearings, tested up to 4 m
We are looking for	<ul style="list-style-type: none"> - Contracts, new clients, partners - Interesting tasks related to measurement, periodic monitoring, new turbines, old turbines, reference measurements, resonance analysis, relation to other physical parameters - We start where others stop.



User-Interface

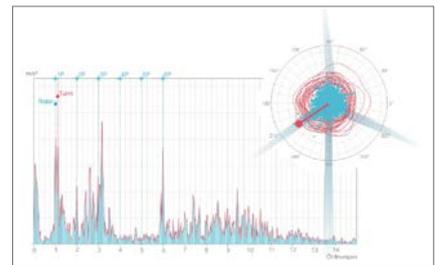
Turbine behaviour is displayed directly, rapidly and at high resolution on the monitor. Both the start-up of the turbine and component behaviour can be viewed immediately. To make this possible using inexpensive hardware has demanded a lot from us in recent months.

Defects which have long gone undetected, such as strong elevations when passing through the resonance range during operation, become immediately visible and can be recorded separately by on-site personnel. If necessary, we can provide support via remote access and/or can preconfigure the technology.



Screen output

Following our decision to include MEMS sensors in our online system portfolio in 2018, we have now integrated this sensor technology into our mobile solutions. In addition to traditional mass imbalances, the aerodynamic influence of blade angle deviations can now be measured.



Our core focus is on analysis. We process the database for our customers and are not fazed by large data volumes of up to 20 TB. We then compare the mobile device results with output from established providers.



Conclusion

As a recently established company we cover quite an exciting potpourri of applications and are looking forward to seeing how the wind energy market will develop in the next few years. We are always open to exciting challenges and are receiving more and more orders from other sectors in which we offer CMS development services, especially during the winter months. We have also been using large test benches for wind energy since 2019.

Solar folding roof for infrastructure zones

The **Horizon folding solar roof** is a patented lightweight structure that doubles the area of infrastructure zones without restricting the space below. A meteo-algorithm automatically controls and protects the lightweight construction against storms, hail, and snow.



For the first time ever, the Horizon folding solar roof enables the genuine dual use of infrastructure such as sewage treatment plants, parking, or logistics spaces. On the one hand, the ground, which has already been sealed is used twice, whilst on the other the spaces in question remain fully passable and manageable. Even trucks can drive under the solar folding roof without issues. The lightweight construction technology utilises glass-free modules, Swiss cable car technology and a meteoalgorithm and supports a structural height of 5–7 m above ground and column spacings of up to 30 m. The lightweight solar folding roof is only partially weath-erproof and is retracted into a protected

position during storms or in the event of hail or snow. Yet, at the same time, this retraction enables crane access to a given area and avoids yield losses due to snow. The pleasant shade keeps vehicles and goods cool in parking and storage spaces and reduces the formation of algae in wastewater treatment clarification tanks.

Dhp technology was founded in 2015 and currently employs 30 people and is managed by the two founding partners Andreas Hügli and Gian Andri Diem. Dhp technology has built a highly automated production line at the company site in Zizers in the canton of Graubünden, Switzerland, and can therefore deliver

The shady solar folding roof enables us to offer our guests who arrive by car even more comfort. I am also pleased that the Kronberg cable car company, has been able to construct this unique power station in collaboration with SAK, thus providing an example of how to implement the Energy Strategy 2050.

Thomas Bischofberger, Chairman of the Board of Directors of Luftseilbahn Jakobsbad-Kronberg AG



dhp technology AG
 www.dhp-technology.ch
 LinkedIn: www.linkedin.com/company/dhp-technology/
 Facebook: www.facebook.com/dhptechnology

Founding year	2015
Staff	30
Focus	Solar folding roof for integrating PV into infrastructure
We offer	A solar folding roof that allows dual use of infrastructure without restricting the primary use.
We are looking for	customers with areas > 1,000 m ² , EU sales partners and investors for growth within the EU



the folding roof component groups, each of which consists of 40 modules, to the project site fully assembled and cabled. Our services include the development, production, installation, and maintenance of the solar folding roof in addition to sales and planning, to which end we collaborate with selected partners. We completed seven projects in sewage treatment plants and one project in a car park between 2019–2020, all in Switzerland, and planning contracts are already in place with various German companies.

The Horizon folding solar roof makes an important contribution to the sustainable use of resources, such as space and soil, through the dual use of infrastructure spaces already in use. It increases the self-sufficiency level of sewage treatment plants by up to 50 % and gives the customer additional financial benefits through the shade. In combination with electro- and hydrogen mobility, the solar folding roof can transform any asphalted surface into a mobility hub and provide the required energy locally in a renewable and economic manner. Having a shade over asphalted surfaces also reduces the urban heat island problem, i.e., local heating of the microclimate which can have harmful consequences for health. Incoming heat is greatly reduced during the day and the retracted solar folding roof allows the residual heat to radiate upwards overnight.

Solar folding roofs can be built to cover an area of approximately 1000 m² or 120 kWp and can be scaled as required, whereby the layout must be rectangular. As with flat roof systems, the monocrystalline PV modules are set at an angle of 10°, which allows optimum use of solar energy regardless of the orientation. The yield loss due to wind is usually less than 3% and implementation requires a standard building permit.



Conclusion

The solar folding roof opens the door to infrastructure-integrated photovoltaics and represents a successful new application for decentralised solar power generation. The first projects have been implemented successfully and are inspiring building owners, operators, and site visitors. For more information about the Horizon folding solar roof please visit www.dhp-technology.ch.

2020+ EEG remuneration going out – computing services revenue coming in

ExaMesh builds data centers in wind turbines and sells the computing power worldwide. Thus we create a second revenue stream for operators and help them to continue producing clean electricity even after 2020.



The ExaMesh Edge DC in the base of a wind turbine; Source: ExaMesh; Photo: Manuel Hollenbach

ExaMesh GmbH links climate protection and digitalisation. The EEG subsidies for thousands of RE plants are set to expire at the end of 2020. To be able to cover their plant operating costs, operators need to find solutions to sell their electricity through third parties. The electricity market currently offers no solution. The price of electricity on exchanges is at the bottom, and not only due to the Covid-19 pandemic. The remuneration achievable per kWh output is not sufficient to enable continued operations. Climate change notwithstanding, the market economy is forcing a shutdown.

But the market also offers opportunities: digitisation is booming. There are fears that the available computing power will be insufficient to cover the rapid and constant developments in AI, among other things.

We take advantage of the demand by installing Edge Data Centers (Edge DC) in renewable energy plants. Small, self-sufficient Edge DCs provide computing power where clean electricity is available and computing power is needed for networked mobility, industry 4.0, and agriculture 4.0 and many other applications, available immediately and everywhere, just like electricity.

We are already selling computing power from the renewable energy plants we have equipped to customers all over the world. “AI Docker Instances” our proprietary product, is the first application for the Edge DC’s, and is used by programmers around the globe, from the USA to Germany, China, India, Turkey, and many other countries.

We share the revenue of our computing power with the plant operators. For example, we manage to pay the operator of a 600-kW plant in Saxony-Anhalt with a full-load capacity of 1,000 hours 2 ct/kWh which they produce, although our servers only require about 5 % of the generated electricity.

According to the operator: „together with the sale of the remaining 95 % to our direct marketers we can continue to operate the plant“.

We are also meeting with the approval of the digital sector: our idea won us the Ludwig Maximilian University of Munich’s „Digicon Award“ as well as Deutsche Telekom’s „Hubraum“ Tech Incubator.

EXAMESH

ExaMesh GmbH
www.examesh.de/en

Founding year	2018
Focus:	EDGE data centers
We offer	data centers for installation in wind turbines to maximise their profitability
We are looking for	Trusted partners in the market to upscale our business opportunities and owners of wind turbines open to innovative solutions.

The future of digitization is decentralisation. Renewable energy operators have occupied some of this area. Partner with us and allow us to use your facilities to enable nationwide digitalisation and to further protect the climate.

When the people in charge of our demonstration project at Telekom asked us whether it was really possible to get the many RE operators excited about this project, we said „YES“. We have decentralised energy, so why shouldn't we be able to do the same with computing power?



Left: The EDC (bottom right) in the base of a Nordtank 600 60/43.



Right: The installation, operation and maintenance of the EDC is carried out by ExaMesh. Source: ExaMesh; Photos: Manuel Hollenbach

We are a start-up company that depends on collaboration and is seeking partners. We are receiving initial funding for this from the EU, which wants to respond to the Internet giants with an alternative European platform known as GAIA-X: the idea is for the ExaMesh Edge DC to become a GAIA-X node demonstrator.

Let's use our systems to create 30,000 nodes and digitise Europe and successfully protect the climate!



Potential decentralised locations for ExaMesh Edge EDC's in Germany; Copyright: Ramboll Deutschland GmbH



Revenue development „Cloud System Infrastructure Services (IaaS)“ in € billion; Source: Gartner

Conclusion

Renewable energy producers will need support by the end of 2020. We have a solution that works best in collaboration. Climate protection and digitisation are converging. Europe is reinventing itself; the cards are being reshuffled and the odds are high.

ExaMesh can do digitisation and understands energy. We have proven that it works (www.examesh.de) and have convinced some major digital companies of our potential. However, we can only create change together.

Wind energy grid integration

morEnergy GmbH was founded in 2015 and manufactures innovative metering devices for the energy industry. The company stands for sustainable, green, and intelligent power supply with the aid of smart grids.



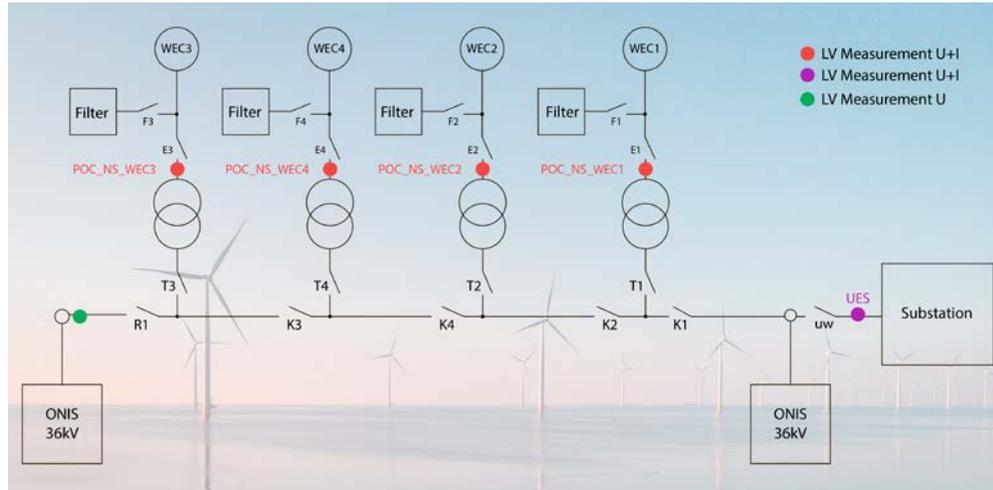
grid impedances in low voltage networks are measured quickly, objectively and during live operations using the ONIS-690V. It is possible to determine the grid short-circuit power from the grid connection points, which means that the connection conformity of wind turbines can be evaluated, taking particular account of their harmonics and other grid repercussions.

Furthermore, it is important not to neglect the increasing use of inverter systems by rapid electric car charging systems, high-rise elevators, server farms and photovoltaic systems, as they further exacerbate existing harmonic and power quality issues.

So, measuring the impedance makes an important contribution towards the integration of decentralised solutions into the power distribution grid therefore promoting the development of a sustainable infrastructure. Moreover, objectively measured frequency characteristics can be used to assess whether wind turbines comply with the applicable PQ regulations in a much more precise manner. Unleash the full performance potential of wind turbines with ONIS.

The original concept – our Online Network Impedance Spectrometer (ONIS)

The expansion and extension of wind turbines over the last 20 years poses new challenges for electrical grids. Whereas wind turbines use modern high-performance inverter systems and generally operate without issues, for them to operate reliably the interactions between frequency inverters and the power grid have to be well calculated when designing the controllers. Failure to do so results in operational instabilities which can lead to system failures. morEnergy's ONIS technology proactively prevents system integration issues and therefore system downtime and revenue losses. Local and frequency-dependent connection point



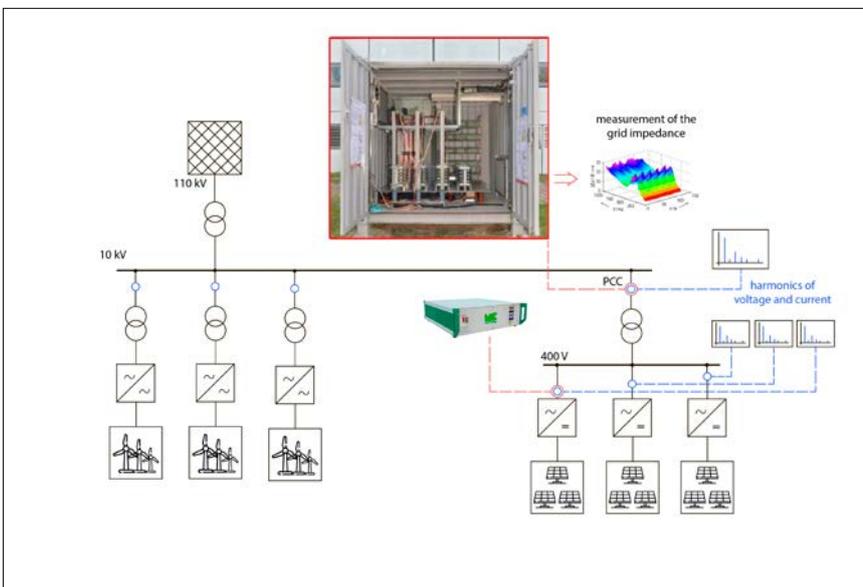
The next step – the MoMe for the grid 4.0

However, mains impedance measurements are only used selectively to avoid or eliminate problems, which, in and of itself, does not make existing grids smart. Yet, smart grids are necessary to develop the full potential of wind turbines by compensating for performance fluctuations.

morEnergy’s MoMe (MonitoringMe) tool is the answer to the digitalisation pressure of the distribution grids. The MoMe IoT platform enables efficient and secure data transfers between the mensuration units and the web servers.

morEnergy customers can access the distribution grid data via the intuitive MoMe web portal in real time and the mensuration data recorded is used to simulate the effects of performance changes on the grid in real time. This represents an unprecedented supply quality and enables grid operators to use real-time data for troubleshooting purposes in addition to enabling early warning messages to be issued in the event of critical operating states.

The MoMe application also provides the user with an overview of equipment ageing so that preventive maintenance measures can be planned and initiated before failures occur.



Conclusion

ONIS combined with MoMe – the electrical grid 4.0

The interaction between the ONIS and MoMe applications enables unprecedented real-time load management for voltage maintenance as well as for the prevention of grid overloads including predictive maintenance. Wind turbines and other generators can be connected at points where it makes the most technical and economic sense, avoiding unnecessary costs for grid upgrades and proactively identifying and eliminating fault sources.

The world's first modular wind energy system: efficient and scalable

The most important technical and economic challenge in the near future will be the supply of renewable, environmentally friendly and above all cost-effective energy. The Berlin-based start-up **MOWEA** is well aware of this and is taking on the challenge.

MOWEA provides small wind energy solutions based on the Lego principle. In a first step, the manufacturer is concentrating on scalable industries and B2B applications. While PV has benefited from increasing standardisation over the last two decades, enabling even small plants to operate efficiently, this is not the case in the field of small wind energy. MOWEA's aim is to set a new global standard and to become the world's first point of contact for flexible, demand-driven wind energy solutions.





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Founding year	2016
Focus	Energy technology & renewable energy systems
We offer	Efficient, scalable and modular small wind turbines and technical expertise
We are looking for	Industrial project partners, sales partners, production capacities



MOWEA was founded as a spin-off at Berlin Technical University. It all started with the IBB-ProFit R&D project “Mowian”, which successfully validated a method to reduce the costs of small wind turbines: a multi-rotor system consisting of a large number of highly efficient microturbines which can be produced in great numbers.

Traditional small wind turbines still lack quality and standardisation, which makes them cost-intensive and expensive. The decisive advantage of MOWEA wind turbines is the scalability of cost-effective, standardised and modular components designed for mass production. Through the innovative use of high-tech, highly efficient aerodynamics and state-of-the-art control technology, MOWEA is setting new standards in small wind turbine

technology and reaches top performance values in energy production (certified by Germanischer Lloyd).

MOWEA offers the ideal complement to solar/photovoltaic systems for independent energy supply in industry, real estate and urban areas. The use of several identical small wind generators in one interconnected plug and play technology system ensures high efficiency and allows for flexible applications of the MOWEA systems.

Together with the telecommunications giant Vodafone, MOWEA, was the first company to install a wind power system on a mobile phone mast in December last year. MOWEA is helping Vodafone to achieve their ambitious climate objectives in accordance with the motto “mobile telephony is going green”. A further 50 wind-power locations are in the planning stage and over 1000 potential roll-out sites have been defined.

MOWEA is also receiving support from the Vodafone Accelerator Uplift. The goal is to make MOWEA turbines for mobile phone masts a success story, and not only in Germany. Other regions in which Vodafone has a presence, and especially off-grid regions, such as India, are showing great interest in the technology.

Conclusion

Climate targets will only be achievable using hybrid systems and a mixture of various renewable energy sources. So far there has been a lack of efficient and above all cost-effective small wind power solutions with flexible application possibilities. MOWEA wants to complete this important piece of the puzzle.

Energy cost optimisation thanks to artificial intelligence (AI)

Olmatic GmbH is developing energy management and digital networking products. Their portfolio includes central control units and wireless sensors as well as power units for Industry 4.0 and the eMobility sector.

Many traditional energy efficiency measures designed to achieve the much needed CO₂ reductions often reach their limits and have to be replaced by novel and innovative technologies. Here it is important to reduce the increasing technical complexity at the customer end and to provide them with solutions that are easy to implement and can be integrated into existing systems without increasing costs.

This is precisely the focus of Olmatic GmbH, a startup founded by the brothers Tobias, Christian and Patrick Olma in 2016 and their “Olmatic Power Tracking” product. This energy management system is designed specifically for the industry. Energy sector load peaks are automatically recognised by an AI algorithm and compensated for by the intelligent purchase of regenerative energy sources and storage solutions. This significantly reduces energy costs for businesses, promotes important sources of electricity, such as wind energy, and also makes a sustainable contribution in terms of compliance with CO₂ reductions as required by law.





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Founding year	2016
Staff	7
Focus	energy management
We offer	We provide central control units, wireless sensors and power units for highly innovative energy management
We are looking for	industrial project partners, sales partners, collaboration opportunities



Peak load prediction using AI.

To optimise energy costs, the system uses integrated wireless energy measuring sensors to produce a permanent record of the relevant energy parameters of any given power consumer in real time. It then digitises them and stores them in a central storage location. The specially developed AI algorithms continuously analyse the database to identify patterns, which in turn provides information and inferences about when and for what reason a peak load occurred at the consumer end. "Making a peak load forecast as detailed as possible", says Tobias Olma, who is in charge of technical product development, "requires maximum transparency and a large amount of data per consumer. It is no longer sufficient to measure the total consumption at the main connection point alone. Instead, we need to collect data about the individual consumers who contribute to total consumption. This is the only way we can train AI in an optimised manner to make correct predictions for the future".

The in-house software supplied with the system generates a visual representation of the recorded data in real time. As soon as the software recognises or is able to predict a peak load with the support of AI, regenerative energy sources and storage can be added automatically. Alternatively, it is also possible to use targeted load shedding, i.e., targeted shutdowns or regulation of defined consumers to counteract the detected load peak. To illustrate just one part of the further possibilities of Olmatic's EMS system, wind energy load peaks, for example, could also be shifted to other sectors in an intelligent manner by means of targeted sector coupling.

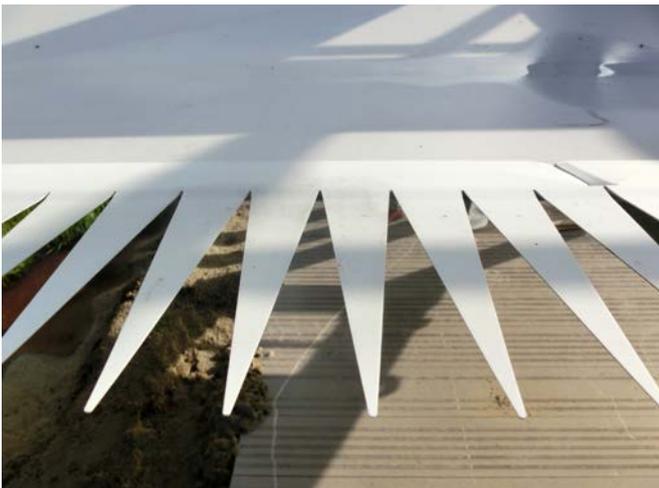


Conclusion

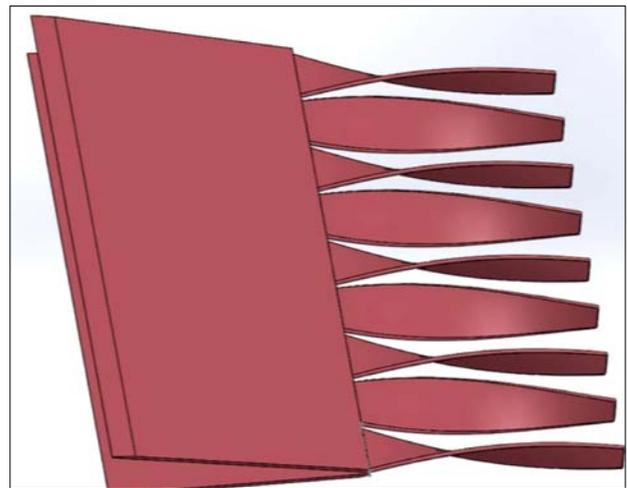
The start-up Olmatic delivers an innovative energy management system marketed under the name 'Olmatic Power Tracking' that achieves maximum added value for industry sector businesses through the intelligent use of renewable energy sources. Wireless sensors attached to any power consumer can create maximum transparency, and all energy parameters, which form the basis of an AI system, can be recorded. Proprietary algorithms make detailed peak load forecasts, thus saving the company excessive costs.

WTS 3D Serrations (silent-blades)

Wind-Tuning-Systems GmbH (WTS) has developed a novel 3D geometry for TES with a significantly higher noise reduction function of up to 3.2 dB(A), which enables new potentials for yield increases, improved night operations, site utilisation and repowering.



WTS' conventional 2D design



WTS' new WTS- 3D design

Reducing noise and increasing yield (win-win situation)

WTS has developed a new patent-protected 3D geometry for TES, which enables a significantly higher degree of noise reduction, currently of up to 3.2 dB(A), compared to the 2D designs that have been in use to date.

This makes it up to 3.2 dB(A) quieter compared with a wind turbine with no serrations. This is particularly noticeable in the 1,000–3,000 Hz range, to which human ears are most sensitive, which paves the way to new ways of increasing yields through improved night operations, expanded site utilisation, repowering and improved acceptance by neighbouring communities.

WTS specialises in the development and distribution of aerodynamic add-ons for wind turbines. In collaboration with a global serrations producer within the wind industry, we are able to offer our products in “Made in Germany” quality, in large quantities, and at an attractive price. The ROI for the operator is 1–2 years.



“In the middle of every difficulty lies opportunity.”

Albert Einstein



WTS – Wind-Tuning-Systems GmbH

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Founding year	2016
Focus	Energy technology, renewable energy systems, wind energy
We offer	Highly efficient noise reduction solutions / add-ons; serrations and technical expertise
We are looking for	further partners for pilot projects, rotor blade service providers, investors, licensees

Our fastening method (patent pending), which is installed simultaneously on the upper and lower side of the rotor blade using a V-shaped base element, enables an extremely durable fastening compared with current state-of-the-art methods. Having your turbine rotor blades fitted by experienced wind energy service providers will guarantee a very long service life for WTS-Serrations.

Based on our novel WTS-3D-Serrations design, WTS intends to achieve noise reduction levels of up to 6 dB(A) in the future by using additional noise reduction technologies and scattering effects, which is up to twice as much as can be achieved by the serrations currently available on the market, which typically reduce noise by 1.5 to 2.7 dB(A).

Thus, WTS is actively tackling the most urgent current issue in terms of the expansion and operation of onshore wind turbines, which is due, not least, to the LAI recalculations/remeasurements of the noise emissions of wind turbines in all German federal states.

Increased yields

The additional noise reduction has a direct effect on existing systems in the form of an increase in yield because it is possible to avoid night-time shut-offs and reduced night mode operations (3 - 6 % increase in yield). Wind turbines at noise-sensitive locations can be operated at the optimum operating levels without violating the noise emission limits.

The additional noise reduction of up to 3 dB(A) opens up new options for repowering wind farms, enabling the use of up to 100% more wind turbines at the same location.

Because of the additional noise reduction, using the WTS-Serrations technology on new turbines enables the use of longer rotor blades with a higher rated output.

Due to the high yield increase as a result of noise reduction, the ROI period for the retrofit investment is just 1 to 2 years.



WTS' novel noise scattering effect (green arrows) and reduced noise (purple arrow).

Conclusion

Current status: The WTS-3D-Serrations technology has already been confirmed in complex noise simulations. The validation testing was carried out with the support of our partner Dassault Systems using professional noise emission validation simulations. Our WTS-3D-Serrations will be certified in the near future based on certification testing on pilot turbines on a wind farm in Schleswig-Holstein.