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*As the global demand for energy accelerates, wind and other renewable solutions are an increasingly integral piece of the global energy demand puzzle — and Lidar is an essential technology unlocking the future of the wind-energy industry.*

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CROSSWINDS

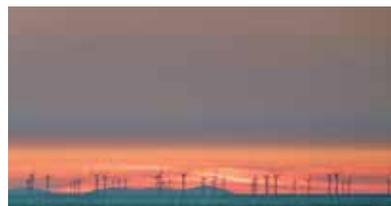
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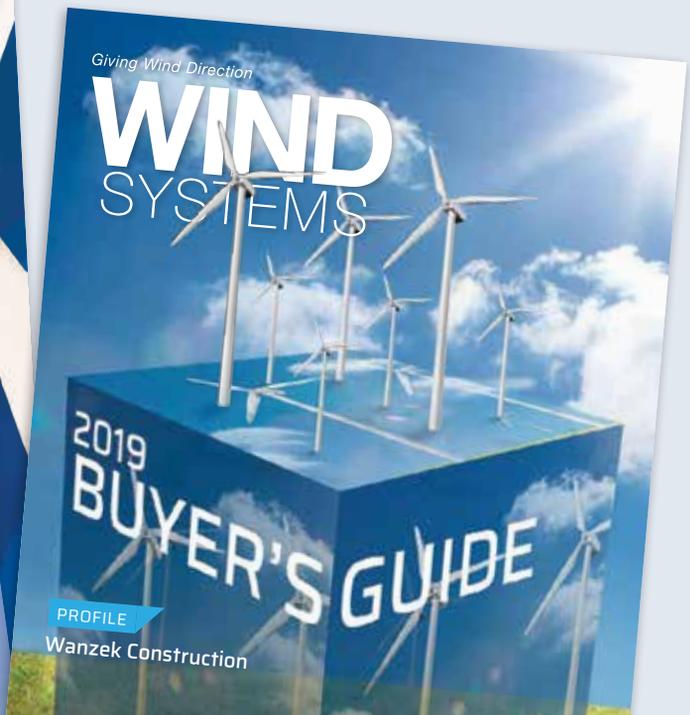
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## U.S. offshore wind stays promising

**W**ith the start of 2020, it's interesting to look at all the wind projects that are in the works, both here in the U.S., as well as internationally. The promise of a robust offshore wind development in the U.S. is still very much the buzz as we move into the new year.

Some of the more recent developments include New Jersey, where Gov. Phil Murphy recently committed to doubling future offshore wind to 7,500 MW by 2035. That's an impressive goal, but it doesn't end there.

This huge goal for offshore wind will stimulate the economy in a myriad of ways.

According to the Special Initiative on Offshore Wind, a \$70 billion supply chain opportunity will open up.

And offshore wind could create 36,000 new jobs, according to the U.S. Department of Energy.

Turning those goals into reality is going to take a lot of hard work and innovation. A lot of that type of work is reflected in this month's issue.

Making those turbines stand tall are simple bolts and the torquing that keeps them in place. In this issue, Joe Bruce, vice president and general manager of NTC Wind Energy, looks at the challenges of bolt tensioning as foundations grow larger and the number of rods in those foundations increases.

Wind measurement is also extremely important when it comes to making sure a turbine will perform optimally. As more projects are fast-tracked, it becomes a necessity to generate the much-needed data that is used to justify the need for a wind farm in a new location. With that in mind, Florian Rebyrat with Leosphere, a Vaisala company, takes a deep dive in how Lidar is being used to expedite wind-energy information.

But the wealth of wind information doesn't stop there. In our Crosswinds section, you'll also discover how obstruction lighting control radar is being used at Foxtail Wind Farm to safely operate drones and more.

I hope you enjoy those articles and much more as we enter the new year and continue to share the good news and fascinating stories of the wind industry. The good news just keeps getting better for this renewable energy source.

Happy New Year, and, as always, thanks for reading!



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## AWEA hires new senior director of communications

From AWEA

The American Wind Energy Association (AWEA) recently hired Stacey Kerans as senior director of communications. She will lead all strategic integrated communications efforts and oversee the day-to-day communications operations for AWEA.

Kerans brings more than 20 years of experience in consumer brand marketing and corporate communications. Most recently, she led integrated, cross-functional teams at two of the top global communications firms, FleishmanHillard, where she served as senior vice president, corporate communications and consumer marketing, and Ketchum, where she served as senior vice president, brand marketing. She has managed award-winning integrated communications campaigns across a broad array of organizations including AARP, AOL, AOL Foundation, Chocolate Manufacturers Association, Glass Packaging Institute, National Apartment Association, H&R Block, Library of Congress' National Book Festival, and The Sundance Film Festival.

"Stacey is a great addition to the AWEA team," said AWEA CEO Tom Kiernan. "Her combined experience in brand marketing and corporate communications makes her a perfect fit to help lead our public-facing communications efforts as we enter a critical industry phase of a changing marketplace and the new frontier of offshore wind."

As the senior director of communications, Kerans will be responsible for providing strategic vision and leadership for AWEA's communications efforts to promote positive perception of the organization's brand and nationwide advocacy initiatives. She will oversee a team responsible for implementing a multi-platform, comprehensive communications strategy to build AWEA brand awareness and thought leadership as well as drive the reputation of wind as a renewable energy source.



The American Wind Energy Association (AWEA) is the premier national trade association that represents the interests of America's wind energy industry. For more information, go to [www.awea.org](http://www.awea.org).



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# DIRECTION

## THE FUTURE OF WIND



While offshore wind at high seas clearly has barriers to overcome, it could drastically increase capacity by adding almost 70 percent more construction space to consider. (Courtesy: Chatham Partners)

# Wind development in the high seas could unlock offshore potential

The offshore wind industry is making great strides in developing technology. That means projects can be built further from shore, including technological innovations in floating foundations and hydrogen storage. However, a new report by Chatham Partners, a boutique law firm specializing in renewable energy, indicates that if such technology were to allow the construction of wind farms in the high seas, the current legal framework would not have the scope to cover such development.

The high seas are all regions of the sea that sit outside the control of a single nation. They make up 50 percent of the surface area of the planet and cover more than two thirds of the oceans. However, the lack of clear rules covering development in the high seas will be a challenge for using any of these areas for offshore wind. According to the report, “Offshore Wind in High Seas: Unlimited potential beyond national control?”, the industry should call for discussions to form a robust legal framework now or risk missing the opportunities the high seas could offer in decades to come.

Global efforts toward decarbonization have proven offshore wind to be a viable alternative power source to fossil fuels. However, the sector could still face challenges in developing close to shore due to countries’ desire to protect coastal ecosystems and conflicts with local industries and the military or simply inactivity. These would not be obstacles in most of the high seas.

While offshore wind at high seas clearly has barriers to overcome, it could drastically increase capacity by adding almost 70 percent more construction space to consider. However, if offshore wind were to look to the high seas for development, the lack of a legal framework will become a major obstacle.

In particular, uncertainty around right of use, ownership, and jurisdiction of the high seas presents a signifi-

cant challenge. Building close to shore in an Exclusive Economic Zone means that the relevant state has the remit to govern and authorize installation and operations of a wind farm under their national laws; but no such jurisdiction or governing body exists for the high seas. As such, offshore wind on the high seas would be too great a risk for any company to invest in.

Chatham Partners notes that precedents for international cooperation in order to take advantage of valuable resources already exist in the scope of current legislation. For example, fishing is regulated in the high seas by Regional Fisheries Management Organizations. The International Seabed Authority (ISA) acts as a governing body to authorize public and private organizations to extract minerals from the deep seabed outside their states’ jurisdiction. In addition, a treaty for biodiversity beyond national jurisdiction is currently proposed that may introduce so-called “area-based management tools” as well as various forms of governance — concepts that could include or serve as an example for a framework concerning offshore wind.

However, these precedents provide an example for the offshore wind industry of how many years a legal framework can take to be built. The ISA took more than 20 years of negotiation between member states to formally establish. The treaty concerning biodiversity has been negotiated since 2004 and will likely stay a draft for several years to come.

“Currently, offshore wind developers are only able to consider a third of the available sea when planning new sites,” said Felix Fischer, partner at Chatham Partners. “The high seas could have the potential to further unlock the expansion of offshore wind beyond what can be developed along coastlines if the industry deems it feasible from an economic and technical perspective. However, the technology

to allow development in these areas could outpace the legislation.”

“Without a legal framework, these sites will remain out of reach for developers for decades to come,” he said. “If the high seas should become part of the answer to expanding offshore wind development and contribute to global decarbonization, building a viable legal framework is critical.”

**MORE INFO** [chatham.partners/en/downloads](https://chatham.partners/en/downloads)

## Ducted Wind Turbines wins grant from Department of Energy

Ducted Wind Turbines, the company formed by Clarkson University Associate Professor of Mechanical & Aeronautical Engineering Ken Visser and his team has won a grant from the U.S. Department of Energy.

The DOE’s National Renewable Energy Laboratory (NREL), with funding from the DOE’s Office of Energy Efficiency and Renewable Energy Wind Energy Technologies Office, works with dozens of small business across the United States to enable wind technology as a distributed energy resource through the Competitiveness Improvement Project. The goals of the CIP are to make distributed wind energy cost-competitive, improve its interoperability with other distributed energy resources, and increase the number of small and mid-scale wind-turbine designs certified to national testing standards.

Launched in 2013, the CIP supports manufacturers of distributed wind turbines through competitively-awarded, cost-shared funding to optimize their designs for increased energy production and grid support, test turbines and components to national standards to verify performance and safety, and develop advanced manufacturing processes to reduce hard-

ware costs. Beyond funding support, awardees can receive technical assistance from NREL to improve their turbine designs and testing plans. Since 2013, NREL has awarded 36 subcontracts to 20 companies, totaling just more than \$8.4 million in investment, while leveraging millions in additional private-sector funding.

Ducted Wind Turbines will use the grant to advance the pre-prototype de-

sign of their new ducted 3-kW wind system, including a detailed technical review of their preliminary design and initial testing results.

The concept for the turbine came out of Visser's research and led to the incorporation of a company (Ducted Wind Turbines) through the Shipley Center. Faculty, staff members, alumni, and many students have been involved in the work on the project to

get to this point. Operation of the wind turbine will provide on-going opportunities for student research and design projects and will be a showcase for DWT.

Ducted Wind Turbines (DWT) is a wind-turbine company that focuses on providing the lowest cost per kilowatt hour in the small turbine market. DWT's design produces more than two times the energy of a conventional open bladed wind turbine of the same rotor diameter.

**MORE INFO** [www.energy.gov](http://www.energy.gov)

## Equinor cuts floating wind costs by 40% in design revamp

Equinor will use new installation techniques, concrete substructures and a shared mooring design to slice costs at its ground-breaking Hywind Tampen floating wind project in Norway, Halvor Hoen Hersleth, Operations Manager at Hywind Tampen, told the Offshore and Floating Wind Europe 2019 conference.

Developed by Equinor, Norway's state-owned oil and gas group, the 88-MW Hywind Tampen facility will be 140 kilometers from shore in water depths of 260 to 300 meters. Due online in 2022, the facility will supply 35 percent of the power needs of five platforms on the Snorre A and B and Gullfaks A, B, and C licenses.

In October, Equinor and oil field partners agreed to build the project at a total cost of NOK5 billion (\$545 million). Norwegian state fund Enova has agreed to fund NOK 2.3 billion and Norway's NOX fund will provide NOK 566 million. Norway is increasing its support for floating wind, aiming to turn oil and gas expertise into renewable trade exports.

Hywind Tampen follows Equinor's 30-MW Hywind Scotland floating wind project in the U.K., the world's first commercial-scale floating wind farm. Operational since October 2017, Hywind Scotland has collected over



Ducted Wind Turbines will use the DOE grant to advance the pre-prototype design of their new ducted 3-kW wind system. (Courtesy: Ducted Wind Turbines)



In Norway, Equinor will implement design and installation learnings gained since its Hywind Scotland project came online in 2017. (Courtesy: New Energy Update)

two years of operational data on five 6-MW Siemens direct drive turbines in water depths of 95 to 120 meters.

Floating wind developers must reduce costs to become competitive and secure larger commercial projects. The cost of bottom-fixed offshore wind farms has plummeted, and floating wind developers must demonstrate cost reductions and stable operations to lure investors.

Equinor will implement new installation methods and substructure designs to lower the cost of the Hywind Tampen project, Hersleth said. Equinor aims to reduce the cost of Hywind Tampen by 40 percent compared with Hywind Scotland.

“We are now moving onto the cost reduction phase ... Hywind Tampen is the next step in that journey,” he said.

Floating wind developers are targeting deeper water sites, typically at depths of more than 60 meters, where bottom-fixed designs are unsuitable. These deepwater sites could host some 4 TW of global offshore wind capacity, according to industry association WindEurope.

Developers are continuing to refine their designs and installation processes to reduce costs. For the early projects, developers are focusing on leaner designs that can be rapidly assembled and installed and towed to site for connection.

**MORE INFO** [analysis.newenergyupdate.com](http://analysis.newenergyupdate.com)

## Chartwell awarded low emission vessel technology prize

Pioneering next-generation naval architect, Chartwell Marine, and independent technical consultancy, Seaspeed Marine Consulting, have been awarded a prize by the Carbon Trust’s Offshore Wind Accelerator (OWA) for an innovative vessel design proposal. The OWA competition aims to facilitate the development of technologies aiding the ongoing de-carbonisation of Crew Transfer Vessels (CTVs) in the offshore wind industry.

The funding — 70,000 pounds of a total 300,000 pounds awarded to four winners — will be used to make the design proposal a reality. During the project, Chartwell will undertake the vessel design work, while Seaspeed will carry out R&D, testing, and hull-form development.

CTVs are an integral part of offshore wind activity, providing the backbone of operations & maintenance in the sector. By increasing the cost-effectiveness of vessel operations, the offshore wind industry is able to further consolidate the cost savings that have seen it significantly reduce the levelized cost of energy (LCOE).

The work program will run to May 2020, during which time the design will be modeled, designed, tested, and commercialized by Chartwell. This will lead to opportunities for vessel operators and project owners to benefit from new, cutting edge vessel technologies.

The designs submitted were assessed primarily for their capacity to reduce emissions but also for their cost-effectiveness and safety advantages. This aims to spur further innovation in the industry while enabling the best technologies and designs to be promoted.

Chartwell is able to draw on years of naval architecture experience in the offshore sector to develop designs that are safe, cost-effective, and sustainable — while Seaspeed has proven

experience in hull form development for challenging powering, maneuvering, and seakeeping requirements.

“The scope of the competition was broad, which gave us the flexibility to explore new avenues in vessel design,” said Andy Page, managing director of Chartwell Marine. “We agree strongly with the Carbon Trust and OWA partners that sustainability should be a focus for support vessels in offshore wind — and this goes hand in hand with increased efficiencies across the board.”

“At Chartwell, we have a strong track record in pioneering vessel designs that not only are ready for new hybrid technologies, but are also specified from the outset with efficiency in mind, helping low carbon industries like offshore wind increase their cost competitiveness,” he said.

“We are looking forward to supporting the development of the four winning technologies, which have the potential to reduce emissions and fuel consumption in the offshore wind industry,” said Dan Kyle Spearman, manager, Offshore Wind, the Carbon Trust. “SMEs, like Chartwell Marine and Seaspeed, have an important role to play in driving innovation, bringing their products and skills to support the cost reduction, and scaling of offshore wind.”

“The maritime industry as a whole has come a long way in reducing emissions,” said Stephen Phillips, managing director, Seaspeed Marine Consulting. “As the issue of climate change becomes more prominent, we are always looking to find new ways of creating cost-effective solutions for the emissions problem. We are honored to be able to use the award from the Carbon Trust to bring our latest R&D technologies into practice.”

The OWA is a collaboration between the Carbon Trust and nine industry partners, that between them account for 76 percent of the installed offshore wind capacity in Europe. The initiative aims to drive down the costs of offshore wind energy and advise on best practice in health and safety. ✈

**MORE INFO** [www.chartwellmarine.com](http://www.chartwellmarine.com)

IN FOCUS

WIND MEASUREMENT ▶ BOLTING & TORQUE

# THE NEED FOR REMOTE SENSING





Evolving remote sensing technologies like Lidar will play a crucial role in the future of wind-farm development. (Courtesy: Meridian Energy/University of Melbourne)

*As the global demand for energy accelerates, wind and other renewable solutions are an increasingly integral piece of the global energy demand puzzle — and Lidar is an essential technology unlocking the future of the wind-energy industry.*

By FLORIAN REBEYRAT

**A**utonomous vehicles. High-resolution maps. Weather forecasts. With advances propelling the technology forward over the past couple of decades, Lidar (light detection and ranging) has conquered an increasing amount of applications, radically altering every industry from agriculture to mining to robotics and spaceflight — and wind energy is the latest frontier.

The backbone of remote sensing, Lidar has been used for decades in atmospheric research to determine physical quantities such as gas and aerosol concentrations, temperature, pressure, and humidity. By leveraging pulsed laser light to measure atmospheric constituents such as aerosols, pollutants, and other particles, as well as their dynamics, Lidar has set the remote sensing revolution in motion.

Lidar provides the most quantitative and accurate measurement technique for wind-energy applications. When it comes to remote wind sensing, Lidar is able to measure the full wind regime, characteristics of the wind flow, and things such as windspeed, wind direction, and turbulence — all the way up to 200-plus meters in height when replacing a met mast — or in other instances, as far away as several kilometers.

## **EVOLVING TECH ADVANCES THE WIND ENERGY INDUSTRY**

Today, wind farms are being developed at an ever-increasing rate. Wind-farm real estate in flat, simple environments is being used. Consequently, more complex mountainous and forested terrains and offshore environments stretching farther from coastlines are now being prospected for possible wind-farm opportunities.

At the same time, turbines are growing bigger, reaching higher into the atmosphere, and established technologies, such as met masts, are struggling to keep up. Developers are finding that building, permitting, and installing correspondingly high met masts and instrumentation is be-



Lidar is an essential technology to unlocking the future of the wind-energy industry. (Courtesy: GWU)

coming increasingly cumbersome, time-intensive, and expensive. In fact, erecting 120-plus-meter met masts is either very complicated or not at all possible in many situations.

Since precise knowledge of the windspeed is necessary to know how much energy will be produced and whether on-site turbines will survive at a specific location, the industry has reached a point in which continuously growing met masts will simply not suffice. As such, evolving remote sensing technologies like Lidar will play a crucial role in the future of wind-farm development.

### ADVANTAGES OF REMOTE SENSING

Whether developing or operating a wind project, it's important to understand what the wind is doing — and Lidar empowers wind developers and owner-operators with precisely such data. From the technology's ease of use and cost efficiency to the time savings, it enables an ability to optimize wind collection; even at the tallest hub heights, Lidar is crucial for wind-resource assessment, power performance verification, and wind farm optimization.

**Ease of Use:** Lidar technology is remote and portable, and it can be positioned virtually anywhere. Wind sensing Lidars have small footprints and can be easily placed in a broad range of environments, from surroundings involving simple or complex terrain conditions to demanding offshore environments. Once placed, remote sensors are turnkey to use and provide ongoing measurements at multiple heights.

As turbine height grows, met towers are unable to deliver data at such height with reasonable costs and safety conditions. Additionally, as health and safety concerns grow in the industry, annual maintenance work at the top of the met mast is unnecessary when using remote sensing.

**Time Savings:** An incredible amount of time goes into wind-farm development before the first turbine starts to produce energy. Once a suitable site is found and agreements are made with owners, the energy-yield assessment can start with at least one year of wind measurement (“wind resource assessment”) as a key input to estimate the production over the lifetime of the wind farm. It can take months to secure permits to install a mast, especially as they grow taller — and during permitting, developers are unable to start measuring, which leads to less data being collected as planning is often time constrained. This leads to higher uncertainties on the energy-yield assessment, which can make or break a project in extreme cases.

With Lidar remote sensors, developers not only shave weeks or months off their development phase and ensure they have all data required, but if they need to move the sensor for additional measurements on the site, they can do so quickly and easily. There's no permitting required or tower to build. Lidars are mobile, compact, and they deploy in a straightforward and easy manner.

**Cost Efficiency:** With hub heights above 100 meters and rotor planes now reaching diameters of 130 meters or more on today's turbines, the wind over the rotor planes will no longer be representatively measured from the single hub



Lidar allows for accurate and more expansive measurements of the full wind profile in the development phase, helping determine the wind turbines to be selected and how much wind energy a future wind farm would produce. (Courtesy: Leosphere, a Vaisala company)

height measurement point a met mast delivers. As turbines grow larger, the corresponding masts are becoming prohibitively expensive to install and maintain. In fact, due to Federal Aviation Administration (FAA) regulations regarding mast height, when a mast exceeds 60 meters, the lighting and permitting required significantly increases met tower cost. Additionally, unlike met masts, wind Lidars are able to measure at multiple heights, providing a more robust view of the wind for no additional cost.

Embracing remote sensors will allow for more cost-effective wind prospecting, especially for offshore wind farms and wind farms in complex terrain. In environments with complicated terrain, such as mountains or forests, installing a met mast is either impossible or much more expensive, making Lidar even more cost efficient in those environments.

Lidar also enables enhanced offshore wind resource assessment in harsh offshore environments, where wind farms are currently the fastest-growing energy source in Europe. In fact, according to WindEurope, Europe's largest organization in the wind industry, Europe can have as much as 450 GW of capacity in offshore wind farms by 2050. If a developer wants to use a met mast, a multimillion-dollar foundation out in the ocean is required. However, Lidars have the ability to take offshore wind measurements from a vertical profiling Lidar, integrated onto a standalone float-



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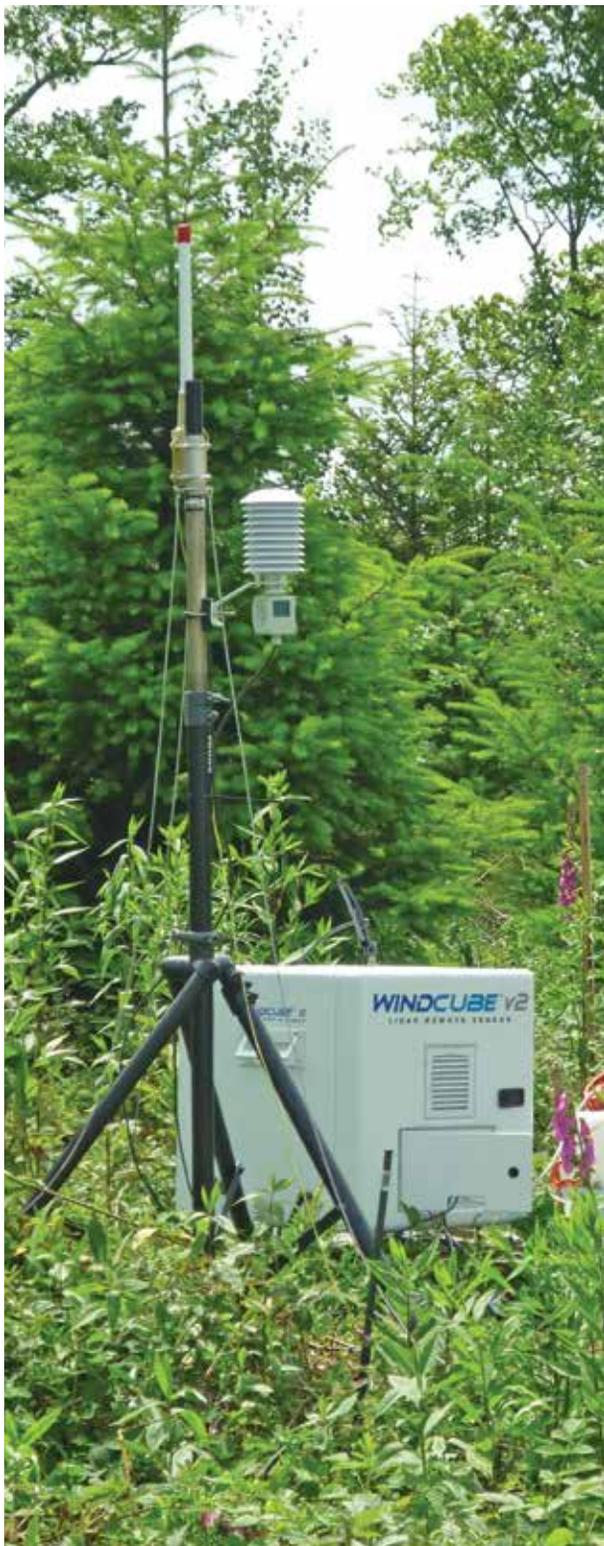
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Due to the increased wind complexity in complex terrain, which means increased risk of turbine damage and the need for more security, Lidar enables easier and more precise measurements — at multiple heights — to ensure their quality in complex sites. (Courtesy: GWU)

ing structure, such as a buoy, or placed on offshore platforms. Additionally, scanning Lidar systems enable developers to map the wind from the shore all the way out to up to 15 kilometers, providing enhanced measurements of wind speed and direction. Using Lidar significantly reduces offshore wind-measurement costs.

The more complex the installation — whether due to height, terrain, or location — the more expensive. Fortunately, Lidars can be deployed at a fraction of the price of a met mast to provide trusted data for a broad range of development requirements.

**Optimized Wind Collection:** Compared to met masts, Lidar allows for accurate and more expansive measurements of the full wind profile in the development phase, helping determine the wind turbines to be selected and how much wind energy a future wind farm would produce. With measurements up to 200-plus meters, systems that use multi-height remote sensing offer full coverage of the rotor, as well as the ability to make finer measurements at many (10 or more) heights, providing a finer understanding of the wind. This understanding, in turn, can lead to uncertainty reduction, which leads to projects that are safer to develop and more lucrative in the end.

Less data means less coverage of wind, which invariably leads to more uncertainty in the final reporting, which could hamper the amount of revenue the wind farm produces. Since Lidar accurately measures up to 200 meters, it supports existing and future wind-farm rotor and turbine heights. Met towers that don't grow with the turbine height are unable to deliver data with enough accuracy to even attain project funding or maximize the amount of revenue a wind farm produces.

Due to the increased wind complexity in complex terrain, which means increased risk of turbine damage and the need for more security, Lidar enables easier and more precise measurements — at multiple heights — to ensure their quality in complex sites.

**Operation, Verification, and Optimization of Wind-Farm Performance:** Now, Lidar technology is being mounted on the wind turbine's nacelle itself to scan in front of the turbine, measuring the wind that will hit the rotor. That way, wind-farm owners can use it as a diagnosis tool to verify and optimize their assets, securing revenue. Many wind-farm operators now use nacelle Lidar to do so during commissioning, where the Lidar is the contractual verification tool included in the turbine supply agreement (already with virtually every new offshore wind farm) or the operational phase of the wind farms. While Electric Power Research Institute (EPRI) data notes a 1 percent annual production increase at a typical wind farm can increase annual revenue by up to \$500,000, a theoretically similar decrease in revenue could be assumed as well.

**Next-Generation Turbines with Lidar:** Lidar can also be installed permanently as a turbine component to improve the reaction to evolving wind conditions and increase in energy production — through better alignment to the wind — and

turbine lifespan — by limiting the stress on key components such as gearbox, rotor, or tower. This is done by measuring the oncoming wind in front of the turbine and feeding the turbine controller with this information. This allows the turbine to proactively adjust blades to protect components and increase power. To that end, Goldwind, one of China's leading wind-turbine manufacturers, recently received the world's first certification for Lidar-assisted control technology verified to decrease a wind turbine's load level and stabilize its operation.

As the global demand for energy accelerates, speeding to its fastest pace in more than a decade, wind and other renewable solutions are an increasingly integral piece of the global energy demand puzzle — and Lidar is an essential technology to unlocking the future of the wind-energy industry.

## OVERCOMING OBSTACLES

As you know, wind-farm development stakeholders can be rather risk-averse. Consequently, many take a cautious approach when it comes to embracing change. From formal industry standards to reluctance on the part(s) of financiers and bank engineers, the predominant obstacles impeding mainstream adoption come down to the devil we know vs. the one we don't.

Although formalized International Electrotechnical Commission (IEC) requirements for using ground-based remote sensing for power curve measurement have existed since 2017 (IEC 61400-12-1 ed2), the wind-energy industry is still in the process of creating an IEC standard for the use of ground-based Lidar for wind-resource assessment (IEC 61400-15). Another standard (IEC 61400-50-3) for nacelle-mounted Lidar power curve measurement is set for the not-too-distant future, with planned releases in 2021 and 2020, respectively.

Plus, many leading independent bank engineers already are familiar with remote sensing as it's been used in Europe for years, and several international and national guidelines are already being used. Some have even written specific guidelines to address the lack of IEC standards. With increased adoption, more financiers and bank engineers will seek to understand the requirements for using Lidar in a bankable wind-resource assessment measurement campaign.

With 50 years of met tower data — good or bad — the industry feels like they know what to expect, while remote sensing is relatively new and unknown. But even as the technology and standards for its use evolve, the past decade has seen companies financing wind farms using Lidar.

While the first commercial Lidar products for meteorological, aviation, and wind-energy-related applications only reached the market two decades ago, Lidar matured very quickly. As the technology continues to advance, the revolutionary sensing technology will only find additional applications as it permeates new industries and continues to provide more accurate and more robust data. Clearly, remote

With Lidar remote sensors, developers not only shave months off their development phase and ensure they have all data required, but if they need to move the sensor for additional measurements, they can do so quickly and easily.

sensing using Lidar has become a proven technology that allows for more accurate and expansive measurements of wind during the development, verification of performance, and ongoing optimization phases of a wind-farm project.

## ABOUT THE AUTHOR

Florian Rebeyrat leads the business segment and product management function for the wind-energy product lines of Leosphere, a Vaisala company. Leosphere manufactures, sells, and services the leading wind sensing Lidar suite, with more than 1,600 Lidars installed in more than 50 countries around the world, including 150 in the U.S. With extensive wind-industry experience in Europe, Asia, and North America, Rebeyrat has a strong track record of bringing cutting-edge technology products to market.

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# CHALLENGES OF BOLT TENSIONING

NTC worker tensions bolts using a hollow-cylinder tensioning tool with a ratchet rundown gear. (Courtesy: NTC Wind Energy)

*As the number of rods in foundations increases, making sure those bolts are given the proper tension becomes a priority during construction and O&M projects.*

By **JOE BRUCE**

If you are involved in wind-energy construction or operations and maintenance, you know that foundation anchor bolt tensioning requires careful attention to the equipment and procedures to achieve effective and precise results. There have been some real challenges of late as engineers design foundations with larger rods, more rods, and greater tension.

To date, the highest number of rods in a foundation combined with the highest required tension that we have performed is 192 #11 grade 90 rods at 105 KIP and 152 #11 150 ksi rods at 153 KIP. With the increasing number of rods in a foundation, there is very little space left for tensioning tools that can reach the level of tension being called for.

## THE RIGHT TOOLS

The first challenge is finding the proper tensioning tools. The smaller the area to work with, the smaller the tensioning tool has to be. As the tool gets smaller, the effective working area of the hydraulic ram is necessarily reduced. This requires higher hydraulic pressure to achieve the desired tension. To determine the hydraulic pressure required to reach any desired tension, divide the desired tension in thousands of pounds by the effective working area of the cylinder in square inches. So, if you're trying to reach 152 KIP (152,000 pounds) and your cylinder has an effective working area of 7.5 square inches, your hydraulic pressure is equal to 20,267 pounds. This is very near the top of a typical 21,700-pound cylinder and pump's capacity. In the author's opinion, it is best to maximize the effective working area of the cylinder and reduce pressures to protect the seals in the cylinder and pump.

With hollow-cylinder tensioning tools, there are two ways to run the nut down once the rod is pulled: the Tommy bar and the ratchet rundown gear. There are advantages and disadvantages to both.

## THE TOMMY BAR METHOD

The Tommy bar method uses a socket around the nut with holes on its circumference properly sized to place the steel rod known as the Tommy bar into it. Once the foundation anchor bolt is pulled, the operator reaches into a window at the base of the tool and tightens the nut one notch at a time. The advantage of this method is that there are few moving parts to break. The disadvantages are that this method is very slow and most Tommy tools are made of mild steel that rounds off quickly. As a result, the tool slips out of the holes and takes even more time. In this case, a properly sized center punch is far better.

## THE RATCHET RUNDOWN GEAR

We like the ratchet rundown gear. It is made up of a pair

of gears attached to a 1-inch drive ratchet. The nut can be turned in either direction for left-hand threads and right-hand threads, and it is substantially faster. The disadvantage to the ratchet rundown gear is that there are several moving parts that can break. However, the base portion of most hollow-cylinder tensioning tools splits in two with the ram on top and the socket with the rundown gear on the bottom. The socket portion of the tool is relatively inexpensive and easily interchangeable. It is advisable to have at least one replacement on site during tensioning. The operator should be cautioned to put the tool over the nut gently and make sure the tool sits flat on the flange of the tower base before running up the pressure.

Another way to avoid damage is to use a torque wrench set at no more than 40 pounds and instruct the operator to stop pulling on the wrench when the torque wrench clicks. Inexperienced operators will often bear down on the nut in the false belief that his or her strength makes a positive contribution to a rod tensioned at over the weight of a loaded 18-wheeler. Not only is this hard on the operator, but it can potentially break the rundown gear.

## DIFFICULT NUTS

Occasionally, especially in new construction, a nut will be difficult to run down on the rod. This is normally due to damaged threads or grout on the rod. A disadvantage of both the Tommy tool method and rundown gear method is that both give you very limited ability to overcome this difficulty. In this case, run the nut back up the rod and attempt to correct the problem. This seems like a good time to mention that it is important to avoid damaging the threads on the rods in the process of setting the base section of the tower on the bolt pattern.

## DOUBLE-CYLINDER AND PUSH-PLATE

If you are using a double-cylinder and push-plate setup, you'll need to divide the desired tension by the effective working area of both cylinders to calculate your hydraulic pressure. The problem is that with such dense bolt patterns and high tension, it is not likely that a 30-ton flat jack, much less a 50-ton flat jack, can fit between the rods.

The rods can be pulled from the top with double-cylinder and push-plate equipment fabricated to reach down to the rod being tensioned, but this is less than ideal for several reasons. First, there are often grounding brackets, door flanges, and other accessories that will limit the clearance on top of the rods. Second, the rods are not always the exact same length or projection over the flange, meaning the push-plate would be pulling at an angle. This is not acceptable but can be compensated for by placing nuts on the adjacent rods being used as the bearing surface for the jacks



Associate Drew Yancey operates the tensioning pump. (Courtesy: NTC Wind Energy)

and running them up or down to level the jacks.

The advantage of the double-cylinder and push-plate set-up is that a large wrench can be used to run the nut down if there are defects in the threads of the rod.

### LOSS OF TENSION

Regardless of the equipment used to tension foundation anchor bolts, they always lose some tension on the first pull. This is primarily a result of foundation settlement and rod elasticity, among other factors. To compensate for this, mark down the nut and make a tick-mark on the flange. Run the nut up once and tighten it. Then, relax the tool, tighten the actuator on the top of the tool, and run it up a second time. Now, observe the rotation of the nut. This will give you a reference for all rods to see if you are deviating from proper tension. After completing the job, 10 percent of the rods should be re-tensioned at random. If any of them move more than a slight amount, the entire foundation should be re-tensioned.

The last test to perform is the “ping test,” which is simply to tap on each and every rod with a light hammer and listen to its tone. Rods are like guitar strings. When they have no tension, they thud. The more tension they have, the higher the tone. This is not a precise test. Some rods will ping slightly differently depending on their length and what they are in contact with under the foundation. It is only a test to determine that every rod has been tensioned. If a rod pings substantially different, it is advisable to note the elongation of that rod and the marks on the nut to determine whether the rod was tensioned within tolerance and/or re-tension it. It is not recommended to pull a rod repeatedly as they can hyperextend and lose elasticity altogether or break. ↘

### ABOUT THE AUTHOR

Joe Bruce is vice president and general manager of NTC Wind Energy, a subsidiary of J.W. Bruce & Company, LLC., based in Boerne, Texas.

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PROFILE

ROTOS 360

# SPECIALISTS IN ONSHORE AND OFFSHORE O&M

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Rotos 360, part of the UK's leading marine services provider - James Fisher and Sons plc, specializes in offshore complex blade repairs. (Courtesy: Rotos 360)

*Using the latest innovations in platform deployment, composite technology, and marine solutions, Rotos 360 has the expertise to identify and repair damage, excessive wear, and other potential issues that can affect wind-turbine blades.*

By **KENNETH CARTER** ▶ Wind Systems editor

**R**epairing turbine blades in the best conditions can be a difficult process, but when needed on turbines spinning miles off the coast, the difficulty level of those repairs increases significantly.

So, it's especially fortuitous that Rotos 360, part of the UK's leading marine services provider – James Fisher and Sons plc, specializes in offshore complex blade repairs.

“Probably 75 percent – maybe 80 percent depending on the year – of our work is offshore, covering all aspects of blade repair and inspection, but our specialty is complex blade repairs offshore using a platform, which is much more cost efficient than using rope access methods,” said Simon Sanderson, Rotos 360's technical director. “For onshore wind-turbine repairs, we use ropes, platforms, and utes – in the States, you might call them cherry pickers perhaps.”

The nuts and bolts of what Rotos 360 does may revolve around blade repair, but the company's goals go much deeper.

“When we set out, our key goal was to reduce the levelized cost of energy (LCOE),” Sanderson said. “This is to help bring the cost down. To do this, we have developed new-to-market techniques, particularly for offshore.”

## REDUCING THE LCOE

Working offshore can be difficult due to stronger winds, waves, and a colder, damper environment in general, according to Sanderson.

“We've reduced the levelized cost of energy, and the way we've done it is by increasing the window where we can conduct the work,” he said.

Part of that advancement has been to increase the amount of work possible during the offshore repair season, which typically runs from May to October, according to Sanderson. And during that timeframe, work can only be done about 50 percent of the time.

“The rest of the time you're weathered off,” he said. “So, in that window of opportunity, we've tried to get as much work done as possible.”

With Rotos 360's new processes, some of that work can now be performed at night when the wind speeds are lower, according to Sanderson.

“We've brought in techniques where you can repair blades at colder temperatures, higher humidity, and slightly higher wind speeds,” he said. “We've also worked out ways of transferring our guys to the turbines on bigger waves, and they can work longer hours.”

Repairing blades in the dark of night would seem to be a much more daunting task, but Sanderson said that's actually not the case.

“The nighttime repairs are really just as easy,” he said. “It was going through all the health and safety, making sure

that the lighting is good, just taking extra care with the working practices and then getting the method statements and risk assessments passed by the companies that we've worked for.”

And in some cases, night work actually makes repairs a little easier, according to Sanderson.

“If you're grinding or sanding, a sharper shadow is cast by a single light than daylight,” he said. “So, some things you can actually see clearer. The other thing is, because we work two weeks on, two weeks off, obviously the nighttime shift gets you to the nighttime pattern where a worker sleeps through the day and works through the night. When we were conducting our research project, we looked at it, and offshore wind turbines are built 24 hours a day in two shifts. Our thought process was this: On a day when you've got perfect conditions, why waste those 12 hours of night?”

Carving out more time per day for repairs is a valued part of Rotos 360's arsenal, but the company also implements some innovative technology to decrease the actual repair time, according to Sanderson.

## RENUVO UV CURE BLADE REPAIR

“We've got two systems that we're using: One is the RENUVO UV cure blade repair method,” he said.

With standard blade repair, a layer of propoxy is used, which takes about an hour to secure, and then it's cured with heater blankets for another five or six hours, according to Sanderson.

“With the UV cured repairs, it's similar to going to the dentist; you cure it with a UV lamp, which you use a little bit like a paintbrush,” he said. “And with 10 passes of the lamp, it's completely cured.”

A one-square-meter repair can be cured in 10 minutes, saving vast amounts of time, according to Sanderson.

“Time offshore is extremely expensive,” he said. “It's probably at least a factor of 10 more expensive than conducting repairs onshore. So, this is very important.”

Not only can the repairs be done quicker, but they can also be done in extremely cold environments, according to Sanderson.

“With the UV, you can conduct the repairs down to 5 Centigrade,” he said. “Normally with the resins, you can only use it down to 15 Centigrade. The other thing is the humidity. Normally you're limited to 70 percent humidity. With the UV cured repair system, we can cure in up to 90 percent humidity.”

## THE BLADE BUBBLE

Yet another tool that Rotos 360 employs is its blade bubble, which is basically a mini, portable habitat, according to



Rotos 360 performs work at night when the wind speeds are lower. (Courtesy: Rotos 360)

Sanderson. It was originally developed for Siemens Gamesa to meet its renewable energy goals.

“It’s like a little mini tent, a bit like the incubator that you use for babies,” he said. “It’s made from sail material; it’s transparent; it’s got a deep cross-section. And then, if it’s too cold — if it’s say 10 Centigrade and 90 percent humidity — you put the blade bubble over the top, and it’s got a little box, which has the heater and controller in it. It has a thermocouple cable that goes onto the blade, which measures the temperature. Within five or 10 minutes, it will take the temperature inside the bubble up to whatever you set it.”

The blade bubble has a zipper on the side that allows repair materials in. It also has two or more hand holes, according to Sanderson.

“The technicians put their hand through the hand hole and conduct the blade repair in this mini habitat, looking through the transparent blade bubble, which is over the top,” he said. “The latest version is waterproof as well, and you can set it to be any temperature you like. At 15 Centigrade, the resin may take one to two hours to cure. If you set it at 25 Centigrade, then the resin sets in maybe 20 or 30 minutes instead. But you still then have to remove the blade bubble and cure it out with a heated blanket over the top in the conventional way.”

### EVERLASTING LEADING EDGE PROTECTION

In addition to that, Sanderson said Rotos 360 is partnering with PolyTech on a product called ‘ELLE’, which stands for Everlasting Leading Edge protection. ELLE — used for both offshore and onshore turbines — consists of one-meter sections that glue over the leading edge of the blade to protect it.

“First, we come along, we repair the blade, get it back to its original state, and then we apply maybe somewhere between three and 10 of these one-meter sections on each blade,” he said.

Depending on the turbine’s location, the ELLE process is guaranteed for about five years, but Sanderson said it is expected to last even longer, possibly the lifetime of the blade.

And with offshore turbines, Rotos 360 is using platforms, a 24-hour work schedule, and the SOV, according to Sanderson. The SOV is a 50-meter vessel that can accommodate 40 workers and four platforms.

“We can work on four locations at any one time,” he said. “The SOV should be cheaper than a jackup, although there are some very cheap jackups at the moment. But we don’t run the risk of damaging the blade, taking them all off or putting them on again, or getting the jackup stuck into the seabed, which happens on quite a few occasions.”

### APPROACHING A CUSTOMER’S CHALLENGES

Rotos 360’s customers come to the company with a myriad of problems, and Sanderson points out that Rotos approaches each one on a case-by-case basis.

“It depends what type of problem it is, because there are many problems,” he said. “As an example, Siemens Gamesa came to us with the problem of the working environment



Carving out more time per day for repairs is a valued part of Rotos 360's arsenal, but the company also implements some innovative technology to decrease the actual repair time. (Courtesy: Rotos 360)

and wanted a habitat to conduct the repairs in. We just look at all the variables. We've got a history of conducting research in renewable energy, so we just take it from fundamental principles."

And if need be, Rotos 360 will bring in consultants, but most of the time, in-house experts are fully capable of handling the job, according to Sanderson.

"We'll look at maybe one or two different approaches, make some prototypes, and possibly go to specialist companies to help produce what we're looking at," he said. "Sometimes we produce it ourselves, because we've got the experience in producing various equipment. We've got the tools and the workshops to do this. We also have tech facilities. We'll have a five-meter section of blade suspended from the ceiling, so we can test these things inside a warehouse to just get the development program going quickly."

Once the solution is developed, validation tests and optimization are performed at wind farms, and then, finally, risk assessments and method statements are developed with the client, according to Sanderson.

## WORKING WITH A SAFETY-CONSCIOUS INDUSTRY

"The wind industry is very, very safety conscious," he said. "The manufacturers of the turbine or the owner of the wind farm will all have their health and safety people go over every aspect and ask us a lot of questions before we take it to a site. And then when we finally do take it out there for the validation, everyone takes a lot of care because this is the first time something new is being done to make sure, one, that it happens safely, but then also to analyze it. We'll have one person just analyzing it as it's done, just to see whether there's any unseen risk that's being taken on the validation."

Rotos 360 has made great strides in the blade repair busi-

ness since it began as a research project in 2013 where it eventually grew into the company's first offshore wind farm repair in June 2014 at BARD 1, the farthest offshore wind farm in the world, according to Sanderson. The BARD 1 work involved nighttime repair for the first time offshore, as well as implementing the RENUVO UV Blade Repair system.

Rotos 360 started as a joint venture between Emerald Energy and Safety Boat Services, an offshore vessel supply company.

In 2016, Rotos 360 was bought out by James Fisher and Sons plc, a large group that supports a number of global sectors, including construction, oil and gas, nuclear, defense, and renewables, according to Sanderson.

"We have a lot of sister companies, most notably James Fisher Marine Services (JFMS), supporting the renewables sector or otherwise, that we can combine offerings with and take learnings from," he said. "For instance, for NDT inspection, we talk to James Fisher NDT who've got experts in various types of fault inspection or radiography, that type of thing."

## LOOKING TO THE FUTURE

As the wind industry continues to evolve, Sanderson said Rotos 360 plans to expand into other innovative areas with the assistance of its sister companies.

"We aim to be at the cutting edge of the technology, and if we're not at the cutting edge of the technologies ourselves, we aim to partner with people who are," he said.

One of those areas is using robotics for inspections and repair, according to Sanderson.

"At the moment, we're talking to a company that is using infrared thermography on drones," he said. "Not only can you take photographs of the surface of the blade, but you can look down inside the structure of the blade using infrared. And then on the other side that, we really want to integrate our blade repair services with the rest of the operations and maintenance of an offshore wind farm."

That would involve JFMS offering five-year operation and maintenance packages for the offshore wind industry, and then Rotos 360 would do all of the wind turbine-related operation and maintenance, tying in different services at the same time, according to Sanderson.

"For instance, if we're on an offshore wind farm and we're conducting blade repair or inspection, at the same time the electricians could be looking at the high-voltage circuit and testing those, or people could be doing statutory inspections on the lifts and attachment points," he said. "Another service JFMS offers is gearbox oil exchanges. We could tie this all in, so we'd have larger vessels going out conducting complete operation and maintenance packages at the same time to help reduce the cost."

But, in the end, all the work that Rotos 360 and its sister companies does always circles back to the relationship with the customer.

"We become one team with our clients and their clients," Sanderson said. "We're always aiming to improve." ↪



## Andrew Wisniewski

Renewable Energy Sales Manager ▸ Dyson Corporation

*“We supply the anchor rods, nuts, washers, and PVC for the foundations, as well as rod caps and grease for when the project is complete that protects the exposed threads of the anchor rods.”*

### ▸ What’s a typical day like for you at Dyson Corporation?

I’m mostly in constant communication with our customers and then with our production team out on the floor. I’m doing quoting for the customers, trying to get status updates on projects that we have that are ongoing, updating current shipments schedules, making sure everything stays on track. And then we’re trying to get feedback from customers as well about the quality of the products they’re seeing on-site that’s coming from us — schedule changes and what small improvements we can make as these jobs go on that make things run smoother for them and make sure they’re still on schedule.

And then with our production team, we’re just making sure they’re on schedule, they’ve got all their equipment up and running well, or whatever ancillary things that they might need that just keep the project going and keep them running efficiently. That’s how most of my day is spent generally.

### ▸ What does Dyson do for the wind industry?

We supply the anchor rods, nuts, washers, and PVC for the foundations, as well as rod caps and grease for when the project is complete that protects the exposed threads of the anchor rods. All of our rods and nuts are 100 percent melted and manufactured in the U.S. Our manufacturing is all done in Painesville, Ohio. All of our material is 100 percent traceable. It all goes back to when the steel was melted at our steel supplier. We gauge and test all of our threads and all of the products that we’re sending out so we know that it all works properly. Everything is certified by a third-party testing lab that we use to make sure our materials are meeting the grades that are specified.

### ▸ What makes Dyson unique to wind?

We have a proprietary thread on our anchor rods and nuts that we developed in early 2000. We have the ability to pre-tension every rod that we ship out to the site to make sure it meets the standard of the spec for each rod and how it’s tensioned in the field, so we know that we’re not sending out a rod that’s going to break at that tension point. And we’ve got experience from our production manager and our director of engineering — about 40-years-experience together in the wind industry. We have a very knowledgeable staff here as well. We were also ISO9001:2015 Certified, so that quality specification is there as well.

### ▸ How do you work with a client when they come to you with a particular challenge?

Each wind project and each job site is very different. There are a lot of similarities, but there are a lot of small details that make each job unique. In our view, listening is the first thing. You have to be able to identify each small detail of the challenge that they’re facing. And then once we kind of nail all that down, really as I touched on our engineering and production experience, we kind of lean on them. They’ve done a great job of being able to identify solutions and work with our customers — whether it’s the engineer of record for the project or the engineers for our specific customers — just to find a solution for those problems. We can kind of take that and apply it to those challenges and use that to improve our processes as well as foresee some of those challenges in the future and apply it to our processes going forward.

### ▸ As the wind industry has evolved, how has Dyson evolved with it?

It’s taken off quite a bit in the last few years. Dyson is investing in the wind division. We’ve dedicated an entire business unit and entire division to the wind industry. We’ve added



A recently completed foundation where Dyson's anchor bolts were used. (Courtesy: Dyson Corporation)

some production lines, and we're running multiple shifts, so we're bringing in more quality people and doing continuous improvement and maintenance to our equipment.

I mentioned the tensioning ability that we have. We built the equipment for tensioning about four years ago. So, we can try to eliminate bolt failures out in the field, because that's the last thing you want once a bolt's been put in the ground and concrete poured around it. You don't want failure there. We know for sure that we're sending out a quality product.

And then we've allocated more resources and raw material on hand. And we have the manpower just so we can meet these increased quantity demands that we're seeing. We've seen an increase in tighter project schedules. Everybody wants to get these done a little bit quicker. We feel like with the more quality people here working on this line and more raw material on hand, we're going to be able to better meet those needs.

And we are continuing to improve quality and efficiency, taking those experiences and the challenges that we see our customers having in the field. With all that experience that we have on-site here with this industry, we can apply

that and make some little adjustments to how we do things going forward and make it easier on our customers.

#### ► Where do you see you wind energy in the next 10 to 20 years, and Dyson's place in that future?

We've got some things that we're working on in the future, but right now it seems like a lot of our customers are basically focused on wrapping up 2019 and the next two, three years going forward. We keep hearing that everything's going to just grow, and every year is going to be bigger than the next for the next couple of years. We had a very busy 2019, and 2020 and 2021 look to be even busier.

But beyond that, these energy companies are moving to work more and more toward renewable energy. Wind is a big part of that. They see that being more and more of a viable option with more and more of these wind farms out there. With our continued growth and with the investment that we are putting into that industry, we're in it for the long haul. ✌

**MORE INFO** [www.dysoncorp.com](http://www.dysoncorp.com)



Siemens Gamesa offshore project. (Courtesy: Siemens Gamesa)

## ► CONSTRUCTION

### Siemens Gamesa to supply 448 MW to Scottish project

Siemens Gamesa Renewable Energy (SGRE) recently announced the firm order to supply wind turbines for the 448 MW Neart na Gaoithe (NnG) offshore wind power project being developed by EDF Renewables in Scotland. The contract further cements SGRE's market-leading position.

The company will install 54 of its SG 8.0-167 DD offshore turbines, with a 167-meter rotor diameter and 208-meter tip height. The installation of the unique Direct Drive technology turbines at Neart na Gaoithe will take the figure of DD offshore turbines comfortably beyond 2,000 turbines

that SGRE has sold worldwide. The offshore wind-power plant is expected to be operational by 2023.

Neart na Gaoithe wind project, which means "Strength of the Wind," continues a partnership with EDF Renewables that began with the Round 1 development of Teesside wind park in 2011. The 448-MW offshore wind power plant is 20 kilometers from the east coast of Scotland and close to the Port of Dundee where pre-assembly work will take place. This project will use 81 meter-long B81 blades produced on the re-modeled production lines of the SGRE factory in Hull.

The market-leading Direct Drive turbines provide additional capacity through fewer turbines, compared with the original consent given for the project for 75 turbines. When fully operational, it will generate electricity for about 375,000 homes, or all of the

domestic properties in a city the size of Edinburgh, and displace 400,000 metric tons of CO<sub>2</sub> annually.

"Receiving the firm order for the Neart na Gaoithe project from EDF Renewables U.K. is excellent news for Siemens Gamesa," said Andreas Nauen, CEO of the Offshore Business Unit of Siemens Gamesa Renewable Energy. "We're fully prepared to deliver our reliable SGRE offshore Direct Drive technology and to doing our part to deliver clean energy to approximately 375,000 Scottish households when the project is in operation."

The order comes in a year that saw the U.K. register a three-month period where renewable energy was the leading source of energy, outstripping fossil fuels for the first time. Additionally, more than half of Scotland's energy consumption in 2019 was provided by renewable energy, while record-low

prices were also recorded for clean energy, falling to just 39.50 pounds per MW/h.

**MORE INFO** [www.siemensgamesa.com](http://www.siemensgamesa.com)

## CONSTRUCTION

### Fred. Olsen Windcarrier awarded installation contract

Fred. Olsen Windcarrier has been awarded a contract by EDF renewables (EDF) for the transport and installation of 54 SG 8.0-167 DD wind turbines for the Neart na Goithe (NnG) offshore wind farm 15.5 kilometers off the Fife coast, east of Scotland. Fred. Olsen Windcarrier will mobilize one of its vessels for the project, which starts in the spring of 2022.



Fred. Olsen Windcarrier's Blue Tern is in the foreground, and Brave Tern is in the background. (Courtesy: Fred. Olsen Windcarrier and Mineev Aleksandr)

EDF is a large French utility and a leading player within offshore wind with the mission to deliver renewable solutions to lead the transition to a sustainable energy future. This project demonstrates EDF Group's strong

ambition in being a leading global player in the offshore wind industry. EDF acquired NnG in 2018.

"This is our first direct contract with EDF, and we are extremely pleased with this major contract award," said

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Guillaume Bonnesoeur, Commercial Manager at Fred. Olsen Windcarrier. “We look very much forward to partnering up with EDF by sharing the challenges and shouldering the responsibilities. The turbines to be installed will be supplied by Siemens Gamesa Renewable Energy (SGRE) — our reliable partner in many previous projects. This contract with EDF cements our leading position in the offshore wind-turbine installation industry, and we look forward to working with them to safely deliver on this project.”

“We are excited to get work under way with our contractors and all Scottish companies and stakeholders participating in the project,” said Matthieu Hue, CEO at EDF Renewables. “The 450-MW NnG project will play an important role in de-carbonizing the U.K. electricity system and is a further example of EDF Renewables’ continuous investment and growth in Scotland.”

NnG will consist of 54 SG 8.0-167 DD wind turbines with the potential to generate 450 MW of renewable energy. Installation will be in Scotland on a site with large water depths. When fully operational, it will generate enough electricity to power over 375,000 households. Load-out port is Dundee in the U.K.

**MORE INFO** [www.windcarrier.com](http://www.windcarrier.com)

## CONSTRUCTION

### Partnership adds 750 MW to Wyoming’s wind-energy portfolio

Mortenson has been selected by valued partner Rocky Mountain Power, an operating entity of PacifiCorp (a subsidiary of Berkshire Hathaway Energy), to construct the TB Flats I & II Wind Energy Project and the Ekola Flats Wind Energy Project in Medicine Bow, Wyoming. The two projects are 20 miles apart and will have a combined wind energy capacity of 750 MW.



The buoy-ready Windcube’s new design will provide all of the innovation embodied in the Windcube but features a more robust casing in order to withstand difficult marine conditions in a moving platform at sea. (Courtesy: Vaisala/@Jacques Vapillon-AKROCEAN GEPS Techno)

“TB Flats I & II and Ekola Flats are key to PacifiCorp’s Energy Vision 2020 initiative of adding 1,150 MW of wind energy by the end of 2020,” said Tim Maag, vice president and general manager of Mortenson’s Wind Energy team. “We are very excited to be working with Rocky Mountain Power to significantly increase the state’s wind energy output, as Wyoming has the potential to become one of the nation’s strongest wind energy producers.”

TB Flats I & II spans 44 square miles and will contain 132 Vestas turbines totaling 500 MW. Ekola Flats spans 29 square miles and will contain 10 GE and 53 Vestas turbines totaling 250 MW. Erection at TB Flats I & II is scheduled to begin in April of 2020, and Ekola Flats will start in June 2020. Both projects are scheduled to complete in October of 2020. Currently, foundations are being placed at both projects.

Mortenson’s scope of work for both projects includes access roads, foundations, collection, substation, transmission lines, tower wiring and erection of turbines. Mortenson will self-perform all foundation, collection, turbine erection and substation construction. At peak construction, 200-250 people will be employed at each site.

Wyoming’s first wind energy was generated in 1982 by two wind turbines in Medicine Bow installed by NASA and the US-DOE. At the time, the wind turbines installed were the largest in the U.S., had two blades each,

and generated a combined 6.5 MW of wind energy. Currently, the state of Wyoming has an installed wind capacity of 1,488 MW with 3,753 MW under construction.

Upon completion, TB Flats I & II and Ekola will increase Wyoming’s wind-energy portfolio by 150 percent. Mortenson looks forward to helping Rocky Mountain Power increase Wyoming’s wind energy production.

**MORE INFO** [www.mortenson.com](http://www.mortenson.com)

## INNOVATION

### Leosphere enhances offshore offerings with Windcube

Leosphere, a Vaisala company that specializes in developing, manufacturing, and servicing turnkey wind Lidar (light detection and ranging) instruments for wind energy, aviation, meteorology, and air quality, recently announced the fortification of its suite of offshore solutions to include the incorporation of a buoy-ready Windcube system to enable enhanced offshore wind resource assessment, even in harsh offshore environments.

“The Windcube is the reference Lidar for all phases of wind development and operations internationally,” said Alexandre Sauvage, CEO of Leosphere,

a Vaisala company. “Already widely deployed across applications onshore, near-offshore and on platforms in the ocean, our new design enables customers to quickly leverage Windcube in an offshore floating environment.”

This buoy-ready offshore-environment solution retains all of the sought-after capabilities of the industry-leading Windcube system, which is used today onshore and offshore on fixed platforms. It provides bankable data by producing constant accuracy up to 200-plus meters over 12 simultaneous heights and is accepted onshore and offshore by all international standards and guidelines.

The new design will provide all of the innovation embodied in the Windcube but features a more robust casing in order to withstand difficult marine conditions in a moving platform at sea. It is also designed to be easily integrated into commercial floating buoys. Compared to traditional meteorological masts, floating Lidar systems offer many benefits, including quicker deployment and cheaper installation in which savings up to 90 percent are possible.

With the global demand for energy constantly growing, accelerating at its fastest pace in more than a decade, offshore wind and other carbon-free solutions are becoming a more important part of the world energy demand equation. According to a recent study by Global Industry Analysis, offshore wind capacity is forecast to grow by more than 80 GW through 2024, achieving an impressive compound annual growth rate (CAGR) of more than 25 percent in that period.

“The ability to measure wind speeds and direction from a floating Lidar solution instead of a met mast has been essential to accelerating the pace of offshore development,” said PS Reilly, CEO of AXYS Technologies, a global provider of data monitoring solutions and turnkey offshore monitoring campaigns. “The Windcube and its ability to accurately read wind characteristics has been a part of this industry breakthrough from the beginning, and the enhancements with this new model

will help us bring even more reliability and bankability to our clients.”

**MORE INFO** [www.leosphere.com](http://www.leosphere.com)

## INNOVATION

### TÜV NORD completes prototype certification for offshore turbine

On behalf of Siemens Gamesa Renewable Energy (SGRE), TÜV NORD has certified the prototype of one of the world’s largest offshore wind turbines. The first milestone in certification process was thus reached for the SG 10.0-193 DD. The new 10 MW turbines are expected to be ready for the market in 2022.

“We are very pleased to support our partner Siemens Gamesa Renewable Energy by completing this important step towards type certification of this new generation offshore wind turbine,” said Silvio Konrad, member of the Management Board of Industry Service at TÜV NORD and responsible for the strategic business area Energy.

TÜV NORD successfully evaluated the design of the prototype according to the IECRE scheme and corresponding Operational Documents (ODs). Furthermore, a prototype certificate was prepared according to the Danish “Executive Order on a technical certification scheme for wind turbines” (BEK73). The prototype is supposed to be installed at the Wind Test Center Østerild (Denmark) in the upcoming months.

Tests and measurements including load validation, safety, and functional tests as well as power performance measurements will be carried out on the prototype. Based on the obtained results, TÜV NORD will verify characteristics of the wind turbine as assumed in the design evaluation.

Toward the final type certification, TÜV NORD also performs the manufacturing evaluation of the main components as well as the nacelle and hub assembly. Compliance with the design

requirements and SGRE specifications at the production will be assured, confirming turbine’s readiness for high-quality series production.

With a diameter of 193 meters and a capacity of 10 MW, the SG 10.0-193 DD is one of the world’s largest offshore wind turbines. Thanks to the larger rotor blades, which almost correspond to the dimensions of a football field, the turbine produces 30 percent more energy annually than its 8-MW predecessor. The turbine can thus supply about 10,000 average European households with electricity per year.

**MORE INFO** [www.tuv-nord-group.com](http://www.tuv-nord-group.com)

## INNOVATION

### Green energy gets a boost with Clemson University project

Flooding at high tide has made Charleston one of the first South Carolina cities to directly feel the pain of climate change, so it’s fitting that a new green-energy research project is launching in the midst of the most vulnerable areas.

Clemson University researchers based in North Charleston recently received \$1.24 million from the U.S. Department of Energy to develop a new way to test a key piece of equipment on offshore wind turbines. The goal is to enhance their reliability, making them more cost-effective and attractive to build.

More wind power would make the world less reliant on fossil fuels that have been linked to climate change and sea-level rise. The rising water has contributed to more frequent flooding during high tide in Charleston and other coastal cities.

A team of researchers is doing its part to temper the effects of climate change in the Dominion Energy Innovation Center, a \$110-million Clemson facility that opened six years ago at the former naval base in North Charleston.



The test bed at the wind-turbine drivetrain testing facility. (Courtesy: Clemson)

J. Curtiss Fox, the director of research facilities at the center, said it's crucial to make offshore wind turbines as reliable as possible. They are located in windy, blustery environments, often far from land and difficult enough to reach that many come equipped with helicopter landing pads.

"To go out there and change a \$5 part becomes a very expensive endeavor," said Fox, the principal investigator on the grant funding the new research. "There's very little margin for error or your operating costs go up dramatically."

The new research project could provide a boost to a clean-energy source that already has some significant momentum. The global offshore wind market benefited from rapid technology improvements and grew nearly 30 percent per year between 2010 and 2018, according to a new report from the International Energy Agency.

**MORE INFO** [newsstand.clemson.edu](http://newsstand.clemson.edu)

## INNOVATION

### Aquarius Marine Coatings launches anti-foul solution

Aquarius Marine Coatings Ltd. (AMC) recently announced the launch of its

award-winning anti-foul coating, Coppercoat-Commercial, in the offshore energy sector. The coating, which contains exceptionally high levels of copper, a natural anti-microbial agent, protects sub-sea infrastructure from hosting layers of plant, animal, and microbe growth while meeting environmental and safety standards. It ensures that underwater infrastructure continues to meet expected performance levels, while lowering maintenance costs and reducing the potential for planned and unplanned outages.

The launch follows the completion of a five-year trial funded by EDF Energy and undertaken by Plymouth Marine Labs (PML) in the U.K., which concluded that Coppercoat-Commercial is the best protective anti-foul solution for underwater turbines. Although the trial was carried out with a view to support wave and hydropower facilities, the same coating can be applied equally to any static or dynamic sub-sea structure to enhance the longevity and efficiency of both fixed and floating wind farms, particularly in areas of significant marine flow.

Further research conducted by Dr. Tom Vance at PML looked at loss of paint thickness over time and showed that Coppercoat-Commercial was also the most effective anti-foul in terms of longevity, losing just 4.3 percent over the five-year trial period.

"We developed Coppercoat for the

marine industry 30 years ago," says Jayson Kenny of AMC. "Since then, we have perfected our products and gained plenty of first-hand experience of what happens to vessel's hulls and sub-sea equipment when left unprotected. Bio-fouling on sub-sea structures can cause all manner of problems, from accelerated aging, increases in weight, drag, and operating temperatures, through to the erosion of metalwork. Ever more commonly we are encountering reports of microbial induced corrosion (MIC), a problem to which Coppercoat-Commercial provides a reliable long-term solution."

The launch of Coppercoat-Commercial for the offshore energy sector comes at a key moment in the development of renewable offshore energy, as operators look to exploit opportunities in deeper waters where lifting, cleaning, and replacing subsea assets becomes significantly more difficult. Equally important, Coppercoat-Commercial is seen as a key component in extending the lifespan of the infrastructure necessary to support wave or hydropower and so can contribute toward making it a viable part of the energy mix.

AMC's experience in the marine sector has demonstrated that Coppercoat-Commercial can last for 20 to 30 years depending on usage and conditions. The hard-wearing, densely copper-filled resin is suitable for both cold



The launch follows the completion of a five-year trial funded by EDF Energy and undertaken by Plymouth Marine Labs (PML) in the U.K., which concluded that Coppercoat-Commercial is the best protective anti-foul solution for the underwater turbines. (Courtesy: Aspectus Group)

and tropical waters and can be applied by roller or spray and can be used on all surfaces including steel, concrete, aluminum, GRP, and various polymers. As it is both water-based and free from volatile organic compounds (VOCs), Coppercoat-Commercial is also the most environmentally safe bio-active anti-foul product on the market.

**MORE INFO** [www.aspectusgroup.com](http://www.aspectusgroup.com)

## MAINTENANCE

### O&M Summit includes solutions-focused program

The Canadian Wind Energy Association will host its 2020 Operations and Maintenance (O&M) Summit in Toronto, Ontario, January 29-30. Now in its sixth year, the O&M Summit program addresses both the global and regional issues facing a mature industry that seeks in-depth expertise and actionable solutions. The O&M Summit is the largest annual wind operations event in Canada and gathers more than 250 wind energy professionals from across Canada and the United States.

The two-day event will offer a

comprehensive series of sessions that include cutting-edge, technological insights and interactive, knowledge-sharing discussions. The solutions-focused opening plenary will set the stage for the event and dig into the details right away. Attendees will hear from industry professionals at the forefront of the O&M sector. Reflecting on the past 12 months, the speakers will reveal the specific solutions they developed or advanced, the challenges they maneuvered through, and the most important file on their desk right now.

Day two will open with Behind the Scenes of Canadian Wind Energy Innovation – a plenary of handpicked innovators, who will provide insight into the reality of developing new wind-energy solutions in Canada. This session will reflect on recent, specific solutions and then panelists will turn their gaze to the technology and techniques on the horizon. Concurrent sessions and discussion streams will focus on cyber security, end of financed life, multiple technologies, advanced inspections, and other pressing topics.

Health and safety continue to underpin all aspects of the operations and maintenance sector, and this will be clearly reflected at the O&M Summit, with its incorporation into every session and discussion. This year will

see a new special session, Health and Safety Spotlight, where representatives from two companies will discuss their individual pathways – and roadblocks – toward robust health and safety programs. Also, one of the most engaging and rewarding sessions is back by popular demand: the Elevator Pitches session, which will have five speakers pitch a product or service in just five minutes each and receive valuable feedback from the audience.

The O&M Summit is also the place to recognize excellence in Canada's wind-energy industry. Two prestigious awards will be presented at the O&M Awards Breakfast: the O&M Outstanding Achievement Award and the Health and Safety Excellence Award. Last year, TECHÉOL and Vestas were honored with the CanWEA awards, respectively.

The O&M Summit's hustling and bustling exhibition space will provide attendees the opportunity to learn about the latest technologies, innovations and services, and to connect with wind-energy professionals and decision makers from across the industry. With booths in and around the plenary room, attendees and exhibitors will benefit from easy access to deepen existing connections with their sector colleagues as well as to establish new connections for the future.

**MORE INFO** [canwea.ca/events/canwea-operations-and-maintenance-summit-2020](http://canwea.ca/events/canwea-operations-and-maintenance-summit-2020)

## MAINTENANCE

### Evacuator emergency descent system wins offshore wind award

Global safety specialist Survitec recently took home a prestigious East of England Energy Group (EEEGR) Award during a gala End of Year Celebration and Awards Dinner held at the U.K.'s historic Dunston Hall.

Safety and survival solutions specialists, Survitec, won the EEEGR Award in the Offshore Wind category

for the Evacuator system — an emergency wind-turbine descent system that the judging panel recognized as representing “a significant contribution” to renewable energy safety.

“We’re very pleased to award Survitec and Evacuator Worldwide the EEEGR Offshore Wind award for the pioneering Evacuator Emergency Descent System,” said Simon Gray, EEEGR CEO. “Their collaborative effort demonstrates their commitment to increase the safety of those working within the offshore energy sector and it’s great to have both companies with us as EEEGR members.”

“We are absolutely delighted to win this prestigious award, which we accept on behalf of Evacuator’s inventors Eugene Verstegen and Joris Veeger, from the Netherlands,” said Baba Devani, Survitec Marine CEO.

“With the U.K. set to more than double its total offshore wind power capacity by 2030, the safety of those installing, maintaining and servicing offshore wind turbines is crucial,” said Baba Devani, Survitec Marine CEO. “This award recognizes Evacuator’s capacity to keep offshore wind farm workers safe.”

“Winning this award so soon after Evacuator’s market introduction illustrates perfectly the reason behind the decision to partner with Survitec, not only in the U.K. but on a global basis,” said Verstegen, co-owner of Evacuator Worldwide. “Survitec has proven to be the right choice in ensuring that all those working in high-rise marine structures have access to the most optimum means of escape possible.”

“The Evacuator is the world’s most intuitive and only fire-proof, rapid collective evacuation/descent system,” Devani said. “The system, which is fully mechanical, does not require electrical power to operate — which guarantees its operational reliability, whatever the circumstances. Survitec launched this to the offshore energy sector in April this year, and it’s great to see that it is quickly becoming recognized as the evacuation system of choice for wind turbine operators.”

“During an emergency every sec-



The Evacuator E165 is designed for wind turbines up to 165 meters and is a fully mechanical evacuation system based on steel cables. (Courtesy: Survitec Group)

ond counts,” Verstegen said. “With wind turbine’s towering over 160 meters, the safety of personnel is of paramount importance. Having a simple and fire-proof system capable of evacuating personnel rapidly, simply and safely can mean the difference between life or death.”

Emergency evacuation from offshore wind turbines has usually been by way of rope-based rescue-kits. This slower method is not fire-proof and requires professional abseiling skills. The Evacuator system provides a safer and faster descent, increasing survivability of those that need to escape from heights in an emergency.

Fire-proofed up to 1,750°C for 30 minutes, the two-reel Evacuator E165, especially designed for wind turbines up to 165 meters, is a fully mechanical evacuation system based on steel cables. This provides a fully automatic emergency descent at a controlled descent-speed of one meter per second — just “click on and go.”

Capable of evacuating multiple personnel working at heights up to 300 meters to safety, personnel can click on each reel at the same time, providing their combined weight does not exceed 282 kilograms per reel. During evacuation, two reels can be used at the same time. With a lifespan of more than 30 years, it is easily installed, maintained, and comes with accompanying personal protective equipment in an “Evacuation Chest.”

The EEEGR Awards, now in their

17th year, celebrate the outstanding achievements and developments that have taken place within the energy sector over the last 12 months.

**MORE INFO** [www.survitecgroup.com](http://www.survitecgroup.com)

## MAINTENANCE

### 3M product training for wind-energy customers in January

In January 2020, WINDSOURCING.COM GmbH will again offer free product training for customers from the service market of the wind industry together with its supply partner 3M Deutschland GmbH. The product training is January 24, 2020, at the 3M Fall Protection Training Center in Hamburg and is aimed at all service companies involved in the maintenance and repair of wind turbines and rotor blades.

The training consists of three different modules:

After the successful application training in February 2019, customers again have the opportunity to get to know the new 3M™ Erosion Protection Tape 2.0 W8750/W8780. The participants will learn the correct application practically on a blade model and receive a certificate of participation as proof of training, which is partly also required by the OEM.



The SG 11.0-193 DD Flex offshore wind turbine features a 193-meter diameter rotor using the 94-meter long Siemens Gamesa B94 Integral Blades. (Courtesy: Siemens Gamesa)

In the second training module, 3M™ presents the Acrylic Foam Tape, which can be used for the attachment of aerodynamic parts such as vortex generators.

In the last module, participants get to know the 3M™ Peltor communication headset and learn where it can be used in wind energy.

The organizers expect service companies from all over Europe to participate in the training and therefore point out that the training will be offered in German and English.

**MORE INFO** [www.windsourcing.com/en/trainings/3m-product-training-2020](http://www.windsourcing.com/en/trainings/3m-product-training-2020)

## MANUFACTURING

### Siemens DD Flex increases capacity on large offshore turbine

Offshore wind industry leader Siemens Gamesa Renewable Energy (SGRE) recently expanded its product portfolio at the WindEurope Offshore 2019 Conference & Exhibition with the launch of the new Siemens Gamesa DD Flex concept and the SG 11.0-193 DD Flex offshore wind turbine. Built on the current largest offshore wind tur-

bine in the SGRE fleet, the SG 11.0-193 DD Flex can reach a capacity of 11 MW under specific site conditions.

“The SG 11.0-193 DD Flex is another example of how Siemens Gamesa constantly works to improve performance and provide greater value for our customers, ratepayers, and society-at-large,” said Andreas Nauen, CEO of the Siemens Gamesa Offshore Business Unit. “Digitalization allows us to increase the capacity of our current largest machine to 11 MW, boosting its annual energy production, while keeping the Levelized Cost of Energy (LCOE) down. In turn, our customers can deliver more clean, reliable energy to end-users at lower overall prices.”

The SG 11.0-193 DD Flex offshore wind turbine features a 193-meter diameter rotor using the 94-meter long Siemens Gamesa B94 Integral Blades. Constant digital observations are processed by the control system, increasing capacity up to 11 MW. The upgraded turbine has been created based on SGRE’s deep understanding and expertise within its proven offshore direct drive technology, gained over all five product generations since being launched in 2011.

SGRE will also soon install offshore turbine number 1,000 using its patented Direct Drive technology. These turbines are installed in all major markets

globally, including the U.K., Germany, Denmark, The Netherlands, Belgium, Taiwan, and more. Furthermore, confirmed orders for an additional 1,000 SGRE Offshore Direct Drive turbines have been received, with installations planned for the markets mentioned above and new offshore markets including the U.S., France, and Japan.

**MORE INFO** [www.siemensgamesa.com](http://www.siemensgamesa.com)

## MANUFACTURING

### Vestas wins multiple orders in United States

Vestas has received an order for 183 MW of V120-2.2 MW turbines for a wind project in the U.S. with a number of turbines operating in 2.0 MW. Including previously purchased 2-MW platform components, the project has a total nameplate capacity of 202 MW.

The order includes supply and commissioning of the turbines as well as a 10-year service agreement, designed to ensure optimized performance for the lifetime of the project. Turbine delivery will begin in the second quarter of 2020 with commissioning scheduled for the fourth quarter of 2020.

The project and customer are undisclosed.

Vestas also has received an order for 149 MW of turbines, consisting of 12 V110-2.0 MW turbines and 57 V120-2.2 MW turbines for a wind project in the U.S.

The order includes supply and commissioning of the turbines as well as a multi-year service agreement, designed to ensure optimized performance for the lifetime of the project. Turbine delivery will begin in the second quarter of 2020 with commissioning scheduled for the fourth quarter of 2020.

The project and customer are undisclosed. ✈

**MORE INFO** [www.vestas.com](http://www.vestas.com)

CROSSWINDS

THE FUTURE OF WIND

# TURNING OUT THE LIGHTS

TERMA®

A Terma SCANTER 5000 radar  
installed at a wind farm in  
Germany. (Courtesy: Terma)

*Foxtail Wind uses obstruction lighting control radar to safely operate drones, as well to help a community's skies stay as dark as possible.*

By EDWARD LUNDQUIST

**X**cel Energy's Foxtail Wind Farm in Dickey County, North Dakota, will soon be operational, bringing with it a convergence of technologies that will have far reaching implications beyond Foxtail's 75 turbines.

Wind farms are not uncommon in North Dakota. In fact, wind contributes 25.8 percent to the state's electrical grid. According to the American Wind Energy Association (AWEA), North Dakota generates 3,155 MW from wind, and has another 256 MW under construction, including Foxtail. As Xcel Energy's third wind farm in the state, the company will use Vestas V-120 and V-110 turbine generators to add 150 MW of electricity, enough to power 80,000 homes. The site was developed by Wanzek of Fargo, North Dakota.

North Dakota Lt. Gov. Brent Sanford, one of the speakers at the American Wind Week event at Foxtail on August 14, said that the state's wind industry continues to grow.

"Per capita, we are the No. 1 state for wind-generated power," he said. "North Dakota may represent only two-tenths of 1 percent of the nation's population, but as of May of 2019, we are now ranked ninth in the nation for total megawatts generated by wind."

"Wind plays a vital role in our energy portfolio — providing jobs, income to our rural communities, and tax revenue to our local and state governments while contributing to our nation's energy dominance," Sanford said. "Energy production is not a zero-sum game. As long as we continue to grow, our grid has room for everyone."

According to Teresa Mogensen, senior vice president, transmission at Xcel Energy, nearly 20 percent of Xcel's energy supply company-wide comes from wind energy, seven times what it was in 2005.

"We are expecting to surpass 11,000 MW of wind capacity on our system in the next few years, with a dozen new projects, including Foxtail," she said.

## MAINTAINING GOOD RELATIONS

At the event, Mogensen talked about the importance of maintaining good relations with land owners and the community.

"Being a good neighbor is also about listening," she said. "We understand that the flashing red warning lights on the towers are a critical safety tool, but they're also difficult to live with at all hours of the night."

North Dakota Public Service Commissioner Julie Fe-

dorchak said the state considers minimal impact to the environment and community organization when issuing permits for power-generation facilities such as wind farms, transmission lines, gas plants, and refineries.

"One of the big impacts that is a consistent concern for citizens is the annoyance of the blinking red lights," she said.

But, according to Fedorchak, Xcel Energy is actually doing something about it. Foxtail is the first facility where the Aircraft Detection Lighting System (ADLS) system will be up and running from day one of operations.

"It's a great way to mitigate one of the complaints about wind energy and make it more tolerable to all people living around it, without negatively impacting the efficiency of the project at all," she said.

▼ **When we started this entire project of trying to make turbine inspections more efficient, we didn't even know that there was going to be all these additional possibilities coming out of it. This was just an idea a year ago.** ►

## OLC SOLUTION

To meet that community desire for dark skies at night consistent with FAA safety requirements, Xcel Energy installed Terma North America's Obstruction Lighting Control (OLC) solution, featuring Terma's SCANTER 5202 surveillance radar to enable the aircraft warning lights anytime an aircraft is within three nautical miles of a wind turbine.

The SCANTER 5202 can be configured with a 12-foot compact antenna for a 23-mile diameter circle of coverage or an 18-foot high-gain antenna for a 32-mile diameter circle of coverage, depending on the size of the wind farm and the location of the radar.

"Our range, performance, and the ability to see extremely small targets in extremely harsh weather conditions, as well as unique technical capability that allows the SCANTER 5202 to detect and track targets despite the interference generated by the movement of the turbine blades, makes the SCANTER 5202 ideal for the FAA's ADLS requirements," said Jeff Schleicher, Terma's senior manager for wind-energy services.

Xcel Energy spokesman Matt Lindstrom said the decision to select Terma came from collaboration between internal Xcel Energy teams who evaluated all proposals and determined that Terma best met the project's requirements.

"We are planning to install more aircraft lighting detection systems on our Border and Courtney wind farms in North Dakota and our Blazing Star 1 and 2 wind farms in Minnesota," he said.

## MORE THAN JUST A LIGHT SWITCH

But Foxtail is first, and the 20,000-acre facility is unique in



Terma's Obstruction Light Control (OLC) vastly reduces light pollution, and increases public acceptance of wind farms. (Courtesy: Terma)

more ways than one. The radar, it turns out, can do more than switch the lights. With support from the state, the OLC radar is also enabling a fully autonomous solution for turbine inspection, wildlife assessment, security, and perimeter checks.

Xcel Energy already had partnered with the Northern Plains UAS Authority to use drones for transmission line inspections. To fly the drones beyond visual line of sight, the airspace must be clear of other aircraft.

That capability can be enabled by radar, and the Foxtail OLC radar can show the drone operator that the airspace is clear so they can safely use the drones at the wind farm to inspect the turbines and blades.

Nicholas T. Flom, executive director for the Northern Plains UAS Test Site, said the presence of the OLC radar at Foxtail created new possibilities beyond turbine inspections, such as using drones instead of manned "crop duster" aircraft for insect or weed control, for example.

"We are pursuing ways to take advantage of the radar technology to also allow us to safely operate drones — mul-

multiple drones — autonomously beyond the line of sight of the pilot," Flom said. "When we started this entire project of trying to make turbine inspections more efficient, we didn't even know that there was going to be all these additional possibilities coming out of it. This was just an idea a year ago."

The state is helping to make it happen. North Dakota Commissioner of Commerce Michelle Kommer said the state's Renewable Energy Program has provided a grant for \$500,000 to assist North Dakota software company Airtonomy to develop a framework for secure, remote, autonomous, multi-drone operations.

"Partnering with Airtonomy on this groundbreaking work is Xcel Energy and Microsoft," she said. "Xcel Energy will implement this solution at Foxtail, which will model innovative use of technology and demonstrate building blocks for autonomous operations featuring unmanned aircraft systems."

Furthermore, Kommer said the state invested nearly \$300,000 to work with the University of North Dakota's Research Institute for Autonomous Systems (RIAS) and the

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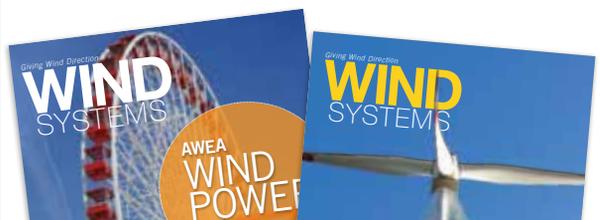
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Airtonomy CEO Josh Riedy (center) visits with University of North Dakota Ph.D. students Shudipto Sekhar Roy (right) and Ramtin Kardan with the UND Research Institute for Autonomous Systems (RIAS) at at Xcel's Foxtail Wind Farm. (Courtesy: Patrick C. Miller/UND Today/ University of North Dakota)

Northern Plains UAS Test Site to pursue a waiver that will allow Airtonomy to assist in securing autonomous multi-drone and beyond vision line-of-sight operations.

"This project also taps our Innovate ND program, which provides up to \$24,000 in funding for new and innovative approaches to doing business," she said.

### STATEWIDE NETWORK PLANNED

Flom said the state will eventually have a statewide network for operating UAS, enabled by radars at airports and wind farms.

"This is one of the trailblazing type efforts to utilize that, so thank you, Xcel," he said.

Josh Riedy, CEO of Airtonomy, said the drones will operate from containerized drone housing units that would typically be dispersed throughout a wind farm, with environmental monitoring kits to check wind speed, temperature, precipitation, and whether it's day or night, to ensure the flying conditions are acceptable.

"We have a launch sequence that verifies clear air space, and then checks with the Terma radar to ensure the area is devoid of manned aviation," he said. "When the system

gives the green light, it opens the respective housing unit, and the drones will go about doing their work, such as turbine inspection, wildlife assessments, security, or perimeter checks. When the assignments are complete, or when their battery limit is reached, the drones will come back and recharge and be tasked again."

Riedy said the combination of the Terma radar and Airtonomy software solution is scalable and repeatable, depending on the requirement, and can be applied at wind farms everywhere.

Thanks to the Terma radar, those annoying blinking red lights will come on only when they're needed, which is to warn an aircraft there's a wind farm nearby.

"Otherwise," Commissioner Fedorchak said, "the night sky will be dark, and the wind farm will be invisible to people — the night skies will be illuminated by the stars alone." ✨

### ABOUT THE AUTHOR

Edward Lundquist is from Springfield, Virginia, and writes on maritime, defense, transportation, and energy issues. He traveled to Kulm, North Dakota, to report this article.

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