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## WINDING DOWN MAINTENANCE COSTS

PROFILE

Dyson Corporation

JUNE 2020

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# ATTEND TOP-RATED CONFERENCES IN 2020



## AWEA Wind Resource & Project Energy Assessment Conference

September 29 - 30, 2020 | Minneapolis, MN

## AWEA Wind Project Siting and Environmental Compliance Conference

September 30 - October 1, 2020 | Minneapolis, MN

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## AWEA CLEANPOWER Strategy Summit

December 1 - 3, 2020 | Scottsdale, AZ

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For 10 years, *Wind Systems* magazine has been a leading authority on the wind-energy industry and its place in the world as a stable and sustainable source of renewable, clean energy.

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# FROM THE EDITOR

## We'll get through this — together

**T**hese past few months have definitely been a wild ride for not just the wind industry, but the world in general.

*Wind Systems* has not been immune to the repercussions of the COVID-19 pandemic, but in these challenging times, I want to assure you that we are still working hard to bring the latest wind-energy news to you each and every month.

According to a recent analysis from AWEA, the pandemic has certainly been challenging to the U.S. wind industry by putting about 25 GW of planned wind projects at risk. That represents a \$35 billion investment. The ripple effect could mean more than \$8 billion of lost revenue that would have gone to rural communities, not to mention the thousands of wind-turbine technicians, construction workers, and factory workers who may end up out of work.

The potential good news, according to AWEA, is that the industry is working with Congress and other leaders in the renewable-energy sector to make sure projects in the pipeline can continue as smoothly as

possible.

However, this major bump in the road will, hopefully, be temporary and not diminish the great strides the wind industry has made in the first quarter of 2020.

In fact, it was proving to be quite remarkable. Check out some of the first-quarter highlights in the FYI section on the next page if you have doubts.

The industry will definitely bounce back — no doubt stronger than ever. It may take a while, but wind has already made such a mark on energy production, that the goal of a greener energy future is still very much a given.

That's a solid reason for *Wind Systems* to be a visible and viable tool you can use to continue to get your word out to the industry.

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Stay safe and healthy out there, and, as always, thanks for reading!



**Kenneth Carter, editor**

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*Giving Wind Direction*



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## U.S. wind delivers strong first quarter

From AWEA

The U.S. wind industry installed more than 1,800 MW of new wind-power capacity in the first quarter, while the volume of projects under construction set a new record, according to AWEA's recently released Wind Powers America First Quarter Report 2020. Findings include:

- U.S. project developers installed more than double the amount of wind capacity in the first three months of 2020 than in the first quarter of 2019.
- Developers started construction on 4,124 MW of wind power, bringing total construction activity to 24,690 MW.
- 11 new wind projects totaling 1,821 MW became operational during the first quarter,
- Texas led the country with 540 MW of new wind projects installed, followed by Iowa, Illinois, and South Dakota.
- There are now 107,443 MW of operating wind-power capacity in the United States, with nearly 60,000 wind turbines operating in 41 states and two U.S. territories.
- Construction activity reached a new record in the first quarter of 2020, with 24,690 MW under construction across the country. That marks an 11 percent increase from the previous quarter.
- Utilities announced 1,719 MW of PPAs, led by Evergy and AEP Energy. Eversource Energy, National Grid, and Utili also signed PPAs for a combined 804 MW of offshore capacity.
- The first quarter saw the first 4 MW turbines in the U.S. start operations, with Vestas V150-4.2 machines installed at the Arbor Hill project in Iowa and the Timber Road IV project in Ohio.



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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# WindEnergy Group

## DIRECTION

THE FUTURE OF WIND



**meta center**



Just like previous years, WindEnergy Hamburg 2020 will maintain its traditional high standards, but it will also include new, digital formats. (Courtesy: Hamburg Messe und Congress/Stephan Wallocha)

# Pandemic forces WindEnergy Hamburg move to December

WindEnergy Hamburg, the global on & offshore wind event, has been postponed to December 1-4, 2020, in response to the Coronavirus pandemic and its global impact on major events and international travel.

"Unfortunately, it is currently difficult to predict the future development of COVID-19 and its consequences for large-scale international events planned for September 2020," said Bernd Aufderheide, president and CEO of Hamburg Messe und Congress. "We are therefore postponing WindEnergy Hamburg to the end of the year. By doing so, we hope to give our exhibitors and visitors a more reliable basis for their planning. We are delighted we have been able to identify a new time-frame for the fair."

Following intense consultations with the exhibitor advisory board, Hamburg Messe und Congress and its co-organizer WindEurope as well as the partners GWEC, VDMA, and BWE, agreed on the new dates. Originally, WindEnergy Hamburg was scheduled for September 22-25, 2020.

Hamburg Messe und Congress and its co-organizer WindEurope are planning to adapt the event concept. A roundtable meeting will be held for this purpose with health authorities and health & safety executives of selected exhibitors to guarantee a maximum level of safety and the best possible outcome for the fair.

"The big ambitions of the EU Green Deal and the economic recovery plans Europe is putting in place now make 2020 a pivotal year for the energy transition," said Giles Dickson, CEO of WindEurope. "We are pleased our joint event WindEnergy Hamburg will still go ahead this year. The further expansion of wind energy is central to the Green Deal and will deliver jobs and investments needed for recovery. Meeting in Hamburg, a key hub for our industry and when Germany has the Presidency of the EU will be the perfect time and place to show that the

wind industry is ready to deliver."

"WindEnergy Hamburg 2020 will not only maintain its traditional high standards but also include new, digital formats," Aufderheide said. "Parts of the conference and trade fair will be prepared as digital or hybrid offers. This will enable us to explore new pathways through this crisis. We look forward to welcoming the wind industry to Hamburg in December."

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

## ALLETE secures tax equity funding for its newest wind site

ALLETE Clean Energy recently sold Class A passive membership interests in Great American West Wind LLC to JPM Capital Corporation, in support of the South Peak wind site in Montana.

As announced in early January, the Great American West Wind LLC tax equity transaction also generated funding for ALLETE Clean Energy's Glen Ullin Energy Center wind site in North Dakota, which began commercial operations in December 2019.

"Investors continue to look favorably upon our growth strategy in the wind sector as demonstrated by this tax equity deal," said ALLETE Clean Energy Chief Financial Officer Laura Schauer.

"High-quality projects like Glen Ullin

and South Peak are successful in the tax equity market through a combination of relationships with respected counterparties, our development experience, use of the latest technology, and building trust with landowners in areas with first-rate wind resources. We plan to follow this effective approach as we execute our strategy with future projects."

The South Peak wind site is an 80-MW wind facility near Great Falls that delivers power to NorthWestern Energy through a 15-year power sales agreement. It began commercial operation in mid-April 2020.

Glen Ullin Energy Center is a 106-MW wind facility about 40 miles west of Bismarck that delivers power to Xcel Energy customers in the Upper Midwest through a 20-year power sales agreement.

ALLETE Clean Energy acquires, develops, and operates clean and renewable energy projects. ALLETE Clean Energy currently owns and operates, in six states, approximately 740 MW of nameplate capacity wind-energy generation contracted under PSAs of various durations. ALLETE Clean Energy also engages in the development of wind-energy facilities to operate under long-term PSAs or for sale to others upon completion, with an additional 300 MW scheduled to come online in 2020.

"Completed amidst the historic



The Great American West Wind LLC tax equity transaction also generated funding for ALLETE Clean Energy's Glen Ullin Energy Center wind site in North Dakota, which began commercial operations in December 2019. (Courtesy: ALLETE)

COVID-19 pandemic, successful construction and closing major financing such as Great American West Wind demonstrate ALLETE Clean Energy's adaptability and ability to deliver projects safely and efficiently," said ALLETE Clean Energy President Allan S. Rudeck Jr. "These clean-energy projects bring immediate and substantial economic benefits to the local host communities and provide our customers with carbon-free, sustainable energy sources. ALLETE Clean Energy is proud to bring customers what they want and industry what it needs, at a time of transformational change."

ALLETE Inc. is an energy company headquartered in Duluth, Minnesota. In addition to its electric utilities, Minnesota Power and Superior Water, Light and Power of Wisconsin, ALLETE owns ALLETE Clean Energy, based in Duluth; BNI Energy in Bismarck, North Dakota; and has an 8 percent equity interest in the American Transmission Co.

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

## WindESCo closes \$10 million Series B financing

WindESCo, Inc., a wind-energy performance optimization company, recently announced it has closed a \$10 million Series B funding round led by WAVE Equity Partners, with participation from an affiliate of Tenaska, Inc. as well as existing investors. Using a combination of wind-plant domain expertise, machine learning, and smart sensing, WindESCo is revolutionizing how wind plants leverage data to maximize profit and performance. The company will use the proceeds of the financing to further enhance its technology offerings, bolster growth through the expansion of its sales and customer success teams, forge joint development and channel partnerships, and take its solutions to the global marketplace.

"WindESCo's solutions fill a major

gap in the wind-energy performance optimization space," said Mo Dua, founder and CEO of WindESCo. "We have successfully applied our solutions to increasing the operating margins of wind plants for project owners. WAVE and Tenaska's investment validates our approach. The funds will allow WindESCo to expand our product offerings and further our customer-centric focus."

WindESCo is delivering powerful and proven solutions for the utility-scale wind-energy industry that optimize turbine performance and maximize profit by increasing annual energy production and reducing operating expenses. Providing validated revenue increases for its customers in actual dollars – not just on paper – WindESCo's comprehensive solutions have enabled customers to increase plant revenues between 1 percent and 7 percent. WindESCo is also pioneering the next generation of "Social Wind Farms," empowering turbines to seamlessly learn from one another in real time and to operate as a cooperative unit. The company has innovated in terms of both technology and business model. Several major wind plant owners are now deploying WindESCo's solutions.

"WAVE is grateful for the opportunity to work with WindESCo's smart founding team," said Praveen Sahay, managing partner at WAVE Equity Partners. "They have pioneered the best sensing and analytics system to optimize performance efficiency and operational health of wind turbines. The wind industry is facing multiple headwinds, including declining incentives and premature failure of equipment, that are hurting profits. By solving key pain points and improving profitability, WindESCo is playing a crucial role in securing a leading source of sustainable energy."

"As the economics of wind generation continue to face margin pressures, operational optimization and reduction in maintenance costs will have a significant impact on asset owners' cash flows and long-term sustainability," said Rishi Bhakar, Te-

naska vice president who oversees its sustainable energy investments. "Tenaska is excited to witness firsthand the progress that Mo and his fantastic team at WindESCo have made in developing innovative solutions for the wind industry. Tenaska's expertise in power marketing and trusted relationships with wind-asset owners, combined with WindESCo's advanced software-based strategy, will benefit our customers through innovative products and services."

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

## Siemens Gamesa's long-term prospects good post-pandemic

Siemens Gamesa's performance in the second quarter of FY 2020 (January-March) reflected the unexpected effect of the COVID-19 pandemic on its operations and commercial activity, with a direct impact of 56 million euros on the company's profitability. This complicated situation further intensified the challenges in the onshore business, mainly in the Indian market and the execution of projects in Northern Europe.

Siemens Gamesa reacted rapidly to address this unprecedented crisis and to safeguard the health and safety of its employees and the communities where it operates. The company enacted strict health and safety protocols ahead of official guidelines, both at plants and offices, and applied new solutions to assure operations continue – including re-routing certain supply chains, optimizing remote monitoring to guarantee service operations and, in offshore, extending periods for maintenance teams working at sea. The company has also maintained a sound liquidity position, with credit lines amounting to 4 billion euros, against which it has drawn just 1.1 billion euros.

Although the lack of short-term predictability has led the company to withdraw the guidance it issued

in the first quarter of 2020, the long-term prospects for the industry and Siemens Gamesa remain sound. The company registered a record order backlog of 28.6 billion euros (+21% YoY) and is well positioned to take advantage of sector growth outlook thanks to its geographical diversification and leadership in technology. According to the International Energy Agency, renewables will account for two-thirds of total capacity installed by 2040, with a sustained level of installations averaging 57 GW per year.

In this context, Markus Tacke, CEO of Siemens Gamesa, called for a green recovery. "We are experiencing a situation without precedent that has changed our lives in just weeks," he said. "Siemens Gamesa considers that the renewables industry must play a key role in the economic recovery to move toward a sustainable energy model that generates quality jobs. It is in our hands to avoid another crisis: the climate crisis. I would like to thank all our employees for keeping our business running and enabling us to continue serving our customers despite the difficulties. My most sincere gratitude for the responsibility and courage they demonstrate on a daily basis."

Siemens Gamesa ended the first half of its fiscal year (October 2019-March 2020) with a record order book: 28.6 billion euros (+21% YoY), which sustains good long-term prospects. This figure was achieved after signing 6.83 billion euros (+36% YoY) in the first half and integrating the service assets acquired from Senvion. Order intake between January and March amounted to 2.203 billion euros (-11% YoY), reflecting the normal volatility of the offshore market and the impact of COVID-19 on the signing of onshore contracts, some of which were deferred to subsequent quarters.

Onshore order intake in the last 12 months increased to 9,485 MW (13% YoY) despite the 6 percent YoY reduction in the second quarter to 1,645 MW.

Offshore order intake in the last 12 months increased by 56 percent YoY to 2,879 MW. In the second quarter, the

company signed a preferred supplier agreement with Ørsted for the Borkum Riffgrund 3 (900 MW) and Gode Wind 3 (242 MW) wind farms, raising the conditional pipeline to 10.7 GW. Siemens Gamesa is the clear leader in this segment, with firm orders for 5.5 GW.

Service performed extraordinarily well, boosted by the Senvion deal, having logged 3.87 billion euros in orders in the last 12 months (+75% YoY), and 779 million euros in orders in the second quarter (+4% YoY).

Despite the strong commercial activity in the quarter, the expansion of the coronavirus was reflected in the company's revenues and returns. Revenues fell by 8 percent between January and March, to 2.204 billion euros, affected by lower sales of wind turbine generators. Revenues in the first half amounted to 4.204 billion euros (-9.6% YoY).

EBIT pre-PPA and before integration and restructuring costs amounted to 33 million euros in the quarter, with an EBIT margin pre-PPA and before integration and restructuring costs of 1.5 percent. The decline in profitability includes the 56 million euros direct impact of the coronavirus (equivalent to 2.5 percent of revenues in the quarter) as well as additional costs derived from the slowdown in the Indian market and in the execution of projects in Northern Europe, partially offset by the agreement between Areva and Adwen to resolve all disputes, obligations and liabilities and any past, present, and future claims between them. EBIT pre PPA and before integration and restructuring costs amounted to 103 million euros in the first half, equivalent to a margin of -2.5 percent of revenues.

In this context, the company booked losses of 165 million euros in the second quarter, and 339 million euros in the first half.

The company has implemented a number of social initiatives to help combat the effects of COVID-19, many of them instigated by the company's employees.

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



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IN FOCUS

O&M: MAINTENANCE ▾ CONDITION MONITORING

# WINDING DOWN MAINTENANCE COSTS

In wind-turbine generators, wear often occurs in the rotating parts of the machine.  
(Courtesy: SIFCO ASC)



# *Why electroplating can be crucial to keeping wind-turbine generator repair costs down.*

By MARK MEYER

**I**t is no secret that the wind-turbine market is growing. Seen by many as the long-term answer to the future of power generation, the sector is expected to grow at a CAGR of more than 10 percent during the forecast period 2020-2025, according to Mordor Intelligence.

However, this renewable energy source still faces stiff competition for electricity sales. Fossil-fueled power generation is still typically the most cost-competitive way to generate electricity, while other renewable energies such as solar and hydro power are also rapidly advancing and driving costs down.

For wind-turbine operators, the challenge is clear — costs must be driven down wherever possible to ensure they can continue to have a part to play in future energy generation.

One such area where costs can quickly add up is in the repair and maintenance of the generators. This is especially the case in the bearing journals of the turbine and the slip rings that transfer the current from the rotors to the generator, where wear and tear happens daily.

## **WHEN BEARING SEATS AND SLIP RINGS WEAR**

In wind-turbine generators — or any generators or rotating machinery for that matter — wear often occurs in the rotating parts of the machine. In the specific example of bearing seats, over time the seat and the bearing ring can wear due to creep and/or fretting. They also can deteriorate from corrosive substances in the air, for example sea salt on offshore wind farms.

As the shaft and the bearing ring wear, tolerances increase, and the bearing fit continues to loosen. Over time, this can lead to increased vibrations, further exacerbating the problem and, in extreme cases, cause bearing-ring failure and bearing seizure. When this happens, the shaft and bearing are likely to be a complete loss and must be replaced at great cost. There's also the cost of lost production due to the unexpected downtime and emergency swap-out of the generator.

It is therefore of great importance that even small signs of wear on bearing seats get addressed by cleaning up the worn area and building the bearing seat on the shaft back up to original specifications. Ideally, this will be done during periodic maintenance cycles.

Other components subject to wear and requiring periodic maintenance and refurbishment are slip rings. Wear is caused by the mechanical action of brushes on the rings, often made worse by micro and macro particles. If oil or lubricant gets on the surface, these particles can create a highly efficient grinding paste that wears down the surface of the ring.

Another important wear mechanism present in slip rings is electrical discharge from the rotor currents they collect that can create grooves in the rings.

The slip rings themselves are usually made from copper and frequently plated with silver to improve conductivity. As the rotor of the turbine generator spins, the electrical current produced is conducted through the rotating slip ring to a set of carbon brushes. Typically, these brushes are held in optimum position by static brush holders with springs that allow them to move and stay in contact with the slip ring.

However, when these brushes lose contact with the slip ring, it causes electrical discharges, which then damage the rings. Known as "friction chatter," this loss of contact between the brush and slip ring interface leads to arcing, which first strips away the silver plating on the rings, and then the copper underneath it.

Once this occurs, not only does conductivity between the rotor and the slip ring lose effectiveness, causing the efficiency of the power transmission system to suffer, but the slip rings also will be damaged.

## REPAIR AND RENEW WITH SELECTIVE ELECTROPLATING

Thankfully, spotting the signs of wear-and-tear is becoming easier and easier. Advanced diagnostic equipment such as sensors and computer modeling, along with preventative maintenance procedures, can usually stop components from getting damaged beyond repair.

Once wear is spotted, it then becomes a choice of what restoration method to choose. For bearing seats and slip rings, selective electroplating is a proven, efficient, and economical way of performing these repairs.

Also known as brush plating, this surface treatment technology, such as the industry leading SIFCO Process®, is a portable plating method used to enhance, repair, and refurbish localized areas on manufactured components.

The process uses fundamental electrochemical principles. An electrolyte solution, which contains ions of the metal to be deposited, is introduced between the negatively charged part to be plated and the positively charged plating tool or anode. A portable powerpack provides the required direct current and allows precise control of amperage, voltage, and plating time for high quality and accurate plating results.

The circuit is completed when the anode touches the surface of the part to be plated. A suitable wrap around the tool provides a reservoir to evenly distribute the electrolyte. The current causes the metal ions in the electrolyte to bond with the surface of the part and build up the plating layer.

Compared to alternative methods of repair available, selective electroplating has a number of key advantages.

## LESS PREPARATION AND MACHINING

The first of those advantages is in preparation of the components for repair. Selective electroplating is a precisely targeted approach to repairing a damaged area. Preparation of the area to be plated requires minimal pre-plate machining. All



Brush plating presents operators with the answer to two common wear issues seen in wind-turbine generators, bearing seat damage, and slip ring wear. (Courtesy: SIFCO ASC)



Brush plating equipment is small, lightweight, and portable. (Courtesy: SIFCO ASC)

that is needed is to clean up any corroded, fretted, or otherwise mechanically damaged area in order to have a smooth starting area.

In fact, the less material is removed the better and the quicker the repair can be completed. Slip rings frequently require no machining but can be prepared by manual smoothing. Because selective plating is precise, minimal masking also is required. Repairs are targeted only at the worn areas, making brush plating also highly suitable for repairing small slip rings or grooves as small as a 1/4-inch in width and depth.

With alternative repair procedures such as welding and thermal spray, much larger amounts of the original material need to be machined away. This is so they can provide sufficient final-layer thickness to give the repair enough strength and provide reasonable adhesion. Not only does this take more time during the preparation phase, but it can lead to other issues as well.

## HIGH STRENGTH, DURABILITY, AND BONDS

For bearing seats in particular, which are subjected to high loads, these other issues can include fundamental changes to the original component's specification and properties that can create structural weaknesses.

Selective electroplating overcomes these issues as technicians can build the bearing seats and slip rings back to nominal specification by adding only minimal plating thickness

that also has excellent adhesion. Using a metal plating like nickel, hardness and toughness can be tailored to meet the requirements of the original component.

This means the component performs as it is expected to, if not better. With other methods, due to the way they can change the metallurgy or because of how much of the original component is machined off, a suitable repair may not be feasible without introducing risks of stress fractures or cracks when under operation.

As well as no loss of structural integrity, selective electroplating also creates a bond on the atomic level much stronger than the mechanical bond that thermal spray relies on. The atomic bond of selective plating with the SIFCO Process® is resistant to cyclical temperature fluctuations and direct impact. The dense, non-porous structure achieved with selective plating provides excellent corrosion protection, frequently surpassing that of the original base material, making it much more durable.

Tests run in accordance with ASTM C633-13 on the SIFCO Process® show that two commonly used nickel deposits had a bond strength exceeding the strength of the bonding agent used in the test.

## LITTLE TO NO POST-REPAIR PROCESSES

Selective plating is done at or near room temperature and, unlike welding, does not change the metallurgical structure of the base material. Therefore, selective plating requires no post plating heat treatment to restore the original properties of the base material.

Welding and thermal spray also deposit thick coatings that always require post-plating machining to bring the part back to specified dimensions. In many cases, selective plating can bring a part back to original dimensions without the need for post-plating machining, or it only requires minimal machining. In the case of slip rings, light hand sanding to create the desired surface finish can suffice.

Another advantage of selective plating is different materials can be seamlessly deposited one on top of the other. An example of this is if a slip ring is badly worn beyond the original silver layer and into the underlying copper. Selective electroplating allows technicians to first build the copper back up to the dimensional specification and then add the silver for enhanced conductivity and lubricity on top of the copper, all in the same plating session.

## WHY NOT GO TANK PLATING?

Electroplating can also be achieved by the process of tank plating, which is based on the same electrochemical principles as selective plating.

Unlike the SIFCO® process, which uses a minimal amount of electrolyte to target the repair to precise areas, tank plating involves completely submerging the part to be repaired in a tank of solution to electroplate them.

This requires extensive masking of that component so areas that do not need to be plated are not affected. In the case of most repairs, the area requiring plating is relatively

small compared to the overall part. Masking most of a part is time-consuming and costly.

Plating time is also much longer and more expensive with tank plating in comparison to selective electroplating. This is because of the way the two methods differ during the exchange of electrolyte solution.

Due to the brushing action of selective plating, this disturbs the boundary layer in the electrolyte during plating. This then ensures a good exchange of fresh electrolyte solution continuously reaches the surface of the part, and metal content of selective plating electrolytes can be higher than in those used for tank plating. These are two of the factors that result in plating rates that can be 50 times higher than in a tank.

Environmentally speaking, brush plating is also much friendlier. Unlike tank plating, brush plating uses only small amounts of electrolytes. This results in less evaporative loss and less waste.

Brush plating equipment is small, lightweight, and portable. This allows the process to come to the part, eliminating the need to ship a large part to a specialist plating house. This saves time and shipping cost, which with the typical size of components in the power generation industry, can be significant. SIFCO ASC has even performed up-tower repairs. When talking about generator components, in most cases they are usually too large to fit into a tank typically used for tank plating, thus eliminating tank plating as an option altogether.

All of this means that selective plating tends to be the more cost-effective and viable of the two electroplating methods.

## SELECTIVE PLATING CAN CHANGE THE FUTURE OF WIND

While there are continuous calls to use renewable-energy sources to fuel power generation, this can only be achieved if it is economical to do so.

For wind-farm operators, this ultimately means they must continue to find ways of bringing expenses down, whether that is from initial installation, operation, maintenance and servicing, or otherwise.

Brush plating presents operators with the answer to two common wear issues seen in wind-turbine generators, bearing seat damage, and slip ring wear. By being able to repair and build the thickness of these components back to specification in a fast and economical way, they become longer lasting, and capital outlay is reduced by not having to replace parts.

In one small way, this can help bring about the winds of change, and lead to a future where wind power leads the way to a world powered by clean energy. ↗

## ABOUT THE AUTHOR

Mark Meyer is sales manager, North America, at SIFCO ASC. For more about SIFCO ASC and its solutions, please visit [www.sifcoasc.com](http://www.sifcoasc.com).

# AI FOR ENHANCED WIND-TURBINE MONITORING

Detecting machine faults at an early stage of development is one of the fundamental concepts of machine condition monitoring.  
(Courtesy: Shutterstock)

*Artificial intelligence can both support individual condition-monitoring tasks typically done by a conventional CMS and a specialist, as well as support the entire condition-monitoring process up to determining the remaining useful life without intervention from a specialist.*

By MIKE HASTINGS SR.

**A**s the worldwide installed capacity of wind turbines increases and plays a bigger role in the energy market, so does the need to ensure maximum availability and production of these turbines, together with minimal leveled cost of energy. Machine condition monitoring is important in this respect and many of the new turbines delivered today already have a condition monitoring system (CMS) installed as standard. For offshore wind turbines, all have such a system because of their remoteness for maintenance.

Over the last 20 years, Brüel & Kjær Vibro (B&KVibro) has installed more than 25,000 data acquisition systems worldwide, with up to 12,000 of these being remotely monitored as a service. As a result of this, B&KVibro has accumulated a vast database of monitoring data that includes fault data on almost every imaginable potential failure mode.

This is what we call Big Data, which includes both machine vibration and process data under all kinds of operating conditions and with all kinds of wind turbine types and components. What value does this data have?

### STATISTICAL ANALYSIS DEPENDS ON BIG DATA

Big data fits very well into data-driven artificial intelligence (AI) and machine learning (ML) development and implementation, which in turn can further improve the value a condition monitoring solution can deliver. As there are only a few companies that have so much data, B&KVibro is in a key position to deliver accurate, reliable statistical analysis results using AI solutions.

AI and ML can potentially be implemented for the following condition-monitoring tasks:

- 1:** Fault detection optimization.
- 2:** Automatic fault identification.
- 3:** Prognosis for failure.

### FAULT DETECTION OPTIMIZATION

Detecting machine faults at an early stage of development is one of the fundamental concepts of machine condition monitoring. The objective is to detect developing faults as early as possible so the lead-time up to the point where operational/production capacity drops off as the fault develops and is sufficient for cost-effectively planning maintenance up until that time.

The symptoms of many types of developing machine faults can be detected early on by descriptors, i.e. fault indicators, where one or more of these can be configured to one or more potential failure modes. Configuring a descriptor is normally done by a specialist, but fault detection itself

is done automatically by the CMS. The individual descriptors and their configuration for fault detection have been optimized to a high level of reliability, repeatability, and early detection by diagnostic specialists with many years of experience.

One of the inherent benefits of AI is its ability to sift through vast quantities of CMS data to find patterns. Important "hidden" diagnostic information can sometimes be found by looking at a lot of historical data in the database. The optimized descriptors represent a good starting point for AI fault detection.

The following AI algorithms have been developed or are being developed for fault detection optimization.

### EARLIER AND MORE RELIABLE FAULT DETECTION

Diagnostic specialists use a range of vibration descriptors for detecting a developing machine component fault, such as bandpass measurements (peak-to-peak, RMS), residual value, Cepstrum, high-frequency crest factor, Kurtosis (statistical), proprietary REB measurements, envelope, etc. These fault detection descriptors have been successfully used for detecting bearing, gearbox, and other faults for many years. There are, however, some limitations to this monitoring strategy:

► **Alarm limits:** A developing machine fault is detected only after an alarm limit is violated in a conventional CMS. Although diagnostic specialists can statistically fine-tune the limits to be very accurate for the application, the application is still dependent on fixed limits for fault detection.

► **Origin of fault:** The standard fault detection descriptors measure the general health profile of a component but do not precisely identify the underlying potential failure mode(s). This is normally done by a specialist afterwards.

An AI algorithm can potentially be trained to not only look at individual descriptors, but all measurements at the same time, including process parameters. By looking at a large amount of historical data, a pattern can be found for a group of descriptors that corresponds to a particular fault as it is developing.

Once a pattern is recognized by AI, an alarm is issued. This is possible because an AI algorithm tirelessly analyzes all data to detect seemingly imperceptible changes and trends, therefore resulting in earlier fault detection.

Alarm management has been optimized to a high level in a modern CMS. Despite this, a number of relevant fault detection measurements for a given potential failure mode can all be trending upward, but this condition will never

be detected as a developing fault unless one or all of them exceeds the established alarm limit. This is not a problem for AI because it can be trained to look only for patterns, without even looking at fixed alarm limits. The result is earlier and more reliable fault detection.

Another limitation for a conventional CMS is that it often cannot distinguish between spurious process-related high vibration from that which results from a machine health issue. In either case, an alarm will be triggered in a conventional CMS in both situations if alarm limits were violated (after a pre-configured delay, if this was set up in the CMS). For AI detection, the spurious vibration data would be treated simply as outlying data. The result is less risk of false alarms.

Statistical analysis is a focus area for AI development because of the wide scope of benefits that can be achieved. Not only can the power of AI be harnessed for earlier fault detection, but it can be used in many of statistical analysis tasks, such as determining how a specific component is performing over specific operating conditions, reliability of maintenance, regional and climatic influences on component operation and maintenance, fleet monitoring, fine-tuning of degradation models, etc. This would benefit not only maintenance staff but also machine component manufacturers, wind-turbine manufacturers, service providers, wind-turbine insurers, and project planners. Therefore, much research is expected in this area.

### BEARING FAULT FREQUENCY DETECTION

As wind-turbine drive train components are almost exclusively supported on rolling-element bearings, bearing defects represent one of the more important potential failure modes to detect and diagnose. Most bearing defects generate bearing fault frequencies unique to each specific component of the bearing because of its geometry, i.e. the inner race, outer race, rolling element, and the cage. If, however, a bearing is replaced during maintenance that is not identical to the original, this will change the bearing fault frequencies, thus complicating fault diagnostics if the diagnostic specialist has not been informed of the switch.

An AI algorithm has been developed by B&K Vibro that automatically analyzes all peaks in a FFT frequency domain spectrum and determines the bearing fault frequencies without input from the wind-turbine maintenance staff. This not only reduces the risk of incorrect diagnostics being done because the maintenance crew did not inform the specialist of a different bearing replacement, but it also eliminates the risk of an incorrect bearing size replacement being reported by mistake.

### SPEED SENSOR SUBSTITUTE

Speed reference sensors are used extensively in wind-turbine condition monitoring. Wind turbines inherently operate at a wide range of speeds because of variable wind conditions, and because the gearbox itself has several speeds according to the stages built into it, ranging from the low-

speed blade hub up to the high-speed generator. Moreover, many potential failure modes are specifically speed related, such as bearing fault frequencies, gear tooth meshing frequencies, running speed harmonics, sideband spacing, etc. Order-tracking measurements are done to monitor these speed-related frequencies to take into account the variable running speed. If a speed-reference sensor stops functioning, this information is lost, resulting in less reliable or incomplete diagnostics.

An AI function was developed by B&K Vibro that automatically looks at the vibration signature to identify the running speed at all instances of time. In fact, a speed-reference sensor is no longer needed in this situation because this information is extracted from the vibration signature itself. This is a great cost savings for a large wind park with many turbines, where each one requires a speed sensor. It is important to note, however, that only the running speed information is extracted from the data. Phase information is lost if there is no speed-reference sensor, but this information is rarely used in wind-turbine monitoring applications.

### AUTOMATIC FAULT IDENTIFICATION

Once informed about an automatically detected anomaly in a machine's general health profile, one of the first actions of the diagnostic specialist is to try to identify the specific potential failure mode(s) that are developing. The point in time this is done and the amount of time it takes to do it depends on the specialist's availability, expertise, and resources. There are, of course, a number of diagnostic tasks the specialist has to do in addition to just identifying the developing fault, but these are described in the next section.

The basic rules for identifying a specific potential failure mode by vibration analysis are well documented in the literature and often refined by the specialist through experience.

All this experience can be learned, implemented, and further optimized by AI. As AI is working 24/7, it is constantly analyzing the data, learning from it, and updating the results. AI can present the fault identification results in different ways, but it is typically done as a listing of several possible potential failure modes, each with an individual probability of certainty. This can be optimized with ML.

B&K Vibro has in development neural-network automatic fault diagnostic products in the past, and this remains an area of interest for future refinement.

■ **AI analysis of the data does not start the first day the wind turbine is commissioned, but it will have already started ahead of time by looking at data from other wind turbines from the past. ■**

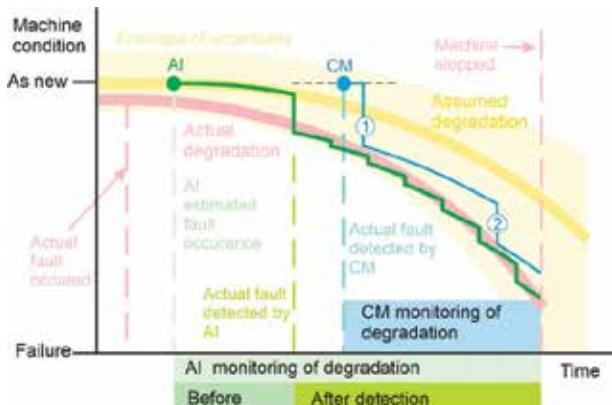


Figure 1: Comparison of AI and a specialist prognosis within a potential-for-failure plot (P-F). Data-driven AI estimates when degradation starts based on statistics, whereas the specialist can start only after a fault is detected. Moreover, AI more closely follows degradation because it is automated whereas the specialist, when available, can do analysis only at intervals (two shown). (Courtesy: B&K Vibro)

## PROGNOSTICS TO FAILURE

After a fault has been automatically detected and the specialist has sufficiently identified the fault, determined its severity, and established a trend, the next step is to predict when the component needs to be replaced or repaired with minimal maintenance intervention and without interrupting production. This is called prognostics, i.e. calculating the remaining useful life (RUL) of the defect component. This is the ultimate achievement of any machine health care strategy. It is also the diagnostic task that demands the most expertise from the specialist. The specialist's successful prognostics, again, depend on their availability, expertise, and resources.

For most rolling element bearing faults under constant operating conditions, the predicted RUL of the component can be fairly accurately estimated by specialists with sufficient lead-time. For planet gear bearing faults and numerous types of gearbox faults, this is not as easily predictable – oftentimes with less lead-time from the time of detection to maintenance. In either case, the prediction is made by the specialist only after a developing fault has been detected.

AI analysis of the data does not start the first day the wind turbine is commissioned, but it will have already started ahead of time by looking at data from other wind turbines from the past. The data-driven prognostic approach uses historical data to create a model that directly correlates the data to degradation and RUL. This way, the AI solution already has an idea on the health of the wind turbine long before the first symptoms of the fault are actually detected. The more data that is analyzed, the more accurate the assessment. Once a developing fault has been detected by AI, the analysis continues to a point where its diagnostics and prognostics analysis is constantly updated using new data. (See Figure 1)

This is certainly a key area of interest for development. It will not only benefit those who currently work with wind-turbine health care from an operational and maintenance point of view, but also long-term planners such as reliability managers.

## CONCLUSION

As can be seen, AI can both support individual condition-monitoring tasks typically done by a conventional CMS and a specialist, as well as support the entire condition-monitoring process up to determining the RUL without intervention from a specialist. From a fault detection perspective, AI can often detect faults earlier using the conventional descriptors and even invent new descriptors after discovering other symptoms or finding "hidden" correlation data that confirm the detection more reliably and earlier. From a diagnostics perspective, AI can, with sufficient data, analyze each potential failure mode of a specific component under all imaginable operating conditions for determining its severity at different points of development – both before and after a fault has been detected. Even the vibration analysis techniques that often are taken for granted can be fine-tuned by AI. The most experienced specialists can never learn as much in a lifetime about fault diagnostics and RUL as an AI algorithm can do within a few minutes, but again it is stressed that there has to be access to the proper quantity and quality of data for this to be achieved. If this is missing or is incorrect, the AI solution will not succeed.

Does AI replace the CMS and diagnostic specialist? The answer is absolutely not, in either case. First of all, an effective AI solution uses CMS data for fault detection and trending to optimize its own diagnostics and RUL calculation, and therefore cannot replace it. Secondly, AI is nothing more than a collection of statistical analysis algorithms, i.e. tools. It is not a finished condition-monitoring solution in itself. As an example, house building tools do not replace the builder, but they certainly help the craftsmen do the job faster, more accurately, and more reliably. The same can be said for AI tools. They help the specialist perform diagnostics and prognostics but do not replace the specialist out right. In fact, in addition to requiring the right quantity and quality of data to be effective, AI also requires a lot of support from the specialists. It requires the expertise of both data scientists and diagnostic specialists to properly program these tools and gain maximum benefit from them.

When all these requirements are met, AI provides an enhanced condition-monitoring solution as the end result. ↗

## ABOUT THE AUTHOR

Mike Hastings is a senior application engineer with Brüel & Kjaer Vibro where he has been working for the past 30 years. He is a condition monitoring specialist and has written many papers and articles on this subject. He is also a convenor and project leader for an ISO work group for creating standards on condition monitoring and diagnostics of machines.

PROFILE

DYSON CORPORATION

# HOLDING AMERICA TOGETHER SINCE 1884

## THE DYSON CORPORATION

FOUNDED  
1884

HEADQUARTERS  
Painesville, Ohio

WEBSITE  
[www.dysoncorp.com](http://www.dysoncorp.com)

Hex bolt blanks hot off the forging press. (Courtesy: Dyson Corporation)

*Beginning life as a small forging shop, Dyson Corporation has grown to becoming a key supplier of fasteners to many industries, including rods and nuts used to anchor wind-turbine foundations.*

By KENNETH CARTER ▶ Wind Systems editor

Dyson Corporation has been a specialty forge shop for many industries for more than 130 years, and for the last 15, the company has seen a need for its expertise in the growing wind-energy industry.

In that time, Dyson has become a supplier of anchor rods, nuts, PVC sleeves, grease, and bolt caps for turbine foundations.

"We did very large diameter forgings, special forgings, large diameter fasteners, and we were even making forged forklift forks for that industry up until sometime in the last decade or so," said John Kovatch, sales director of Dyson Corporation. "We got into the wind industry about 15 years ago, manufacturing fasteners for the foundations. In addition to the foundations, we were going all the way up the tower making hex flange bolts and blade bolts and other high-strength critical fasteners for the wind industry."

## WIND OFFERS OPPORTUNITIES

Dyson sees wind as a big opportunity for growth, and since the company already had decades of tangential experience with what was needed, wind became an obvious area in which to branch out, according to Kovatch.

"We've always been a manufacturer of highly critical fasteners, and when wind started to develop in the U.S., there was a need for manufacturers with our capabilities and expertise," he said. "The import markets just weren't a consideration at the time for those highly critical fasteners. So, we relied on the expertise that we've had in place for a hundred years, which is exotic materials, special heat treating, development, and meeting the critical needs of a new and growing marketplace. It fit really well with what we already did for our customers."

And it appealed to Dyson's desire to support the continued growth of green, renewable energy, according to Kovatch.

"We believe in wind as a source of clean energy for our country and the rest of the world, and want to be a part of the global solution for climate change and sustainability," he said. "We see it as an important part of the infrastructure of the U.S. and our economy. Our philosophy toward wind is we want to support it from a domestic manufacturing standpoint. We see ourselves as a continued supplier of the foundation anchors, nuts and washers, but we also feel the supply chain is going to begin moving back toward domestic, and we want to supply additional critical components beyond the anchor rods."

## OFFSHORE POSSIBILITIES

Part of that expansion may involve offshore wind, but that will depend on what types of anchoring systems will be needed for each potential project, according to Kovatch.

"There are a lot of different anchoring designs right now,"

he said. "It really depends on what kind of design they settle on. If it's a fixed anchoring or piling-type foundation, we would be in the anchoring systems. And as the industry develops the need for larger diameter, highly critical fasteners to support against the high offshore wind loads, we have the capabilities to supply those products as well. That could be a good market for us."

In that vein, Dyson employs a staff of engineers to help its customers with their needs, according to Kovatch.

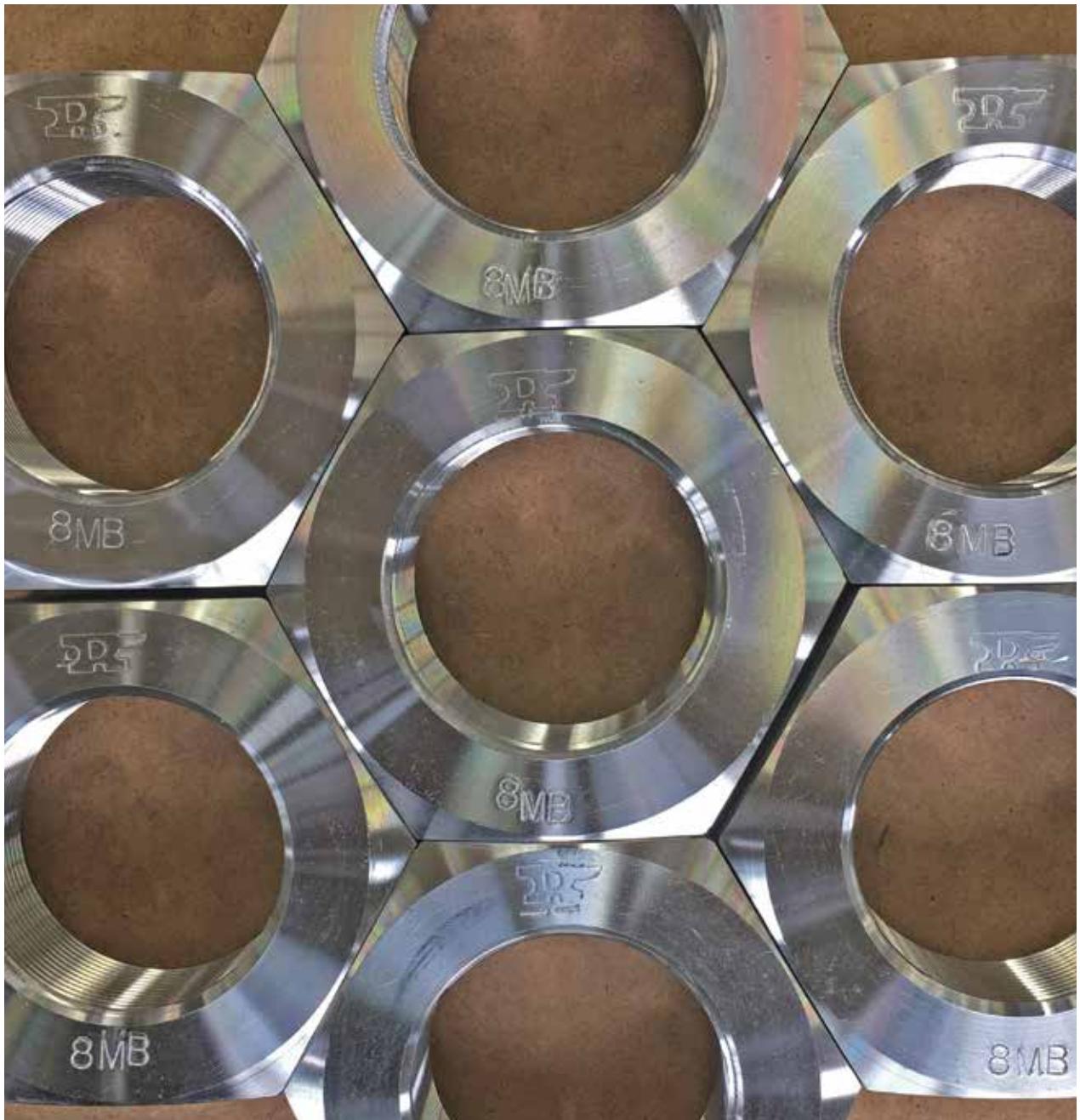
"Our background and our expertise is in fastening; it's in forging; it's in critical types of components, typically used in challenging environments and challenging applications," he said. "We've got a background of solving those kinds of problems. When our customers come to us with a problem, we work along with them as a development arm. We propose solutions, do prototype work through R&D, and work alongside our customer to develop a solution on the front end as the most cost effective product design. And when they come to us after the fact, when they've had a problem in the field, we do a full analysis to determine the root cause, then come up with a solution that will prevent it from happening again."

## MORE WIND OPPORTUNITIES

With Dyson starting out in the wind industry with a literal and figurative foothold, the company has begun to branch out as other areas of wind construction are needed, according to Kovatch.



Large diameter heavy hex bolts. (Courtesy: Dyson Corporation)



Forged and machined heavy hex nuts. (Courtesy: Dyson Corporation)

"We've certainly found our footing in the foundation rods," he said. "And now that we've got the materials and the specifications perfected and we understand that market, our goal is to drive our costs down by automating our manufacturing processes and exploring alternative materials. As far as future developments, we believe – at least in the near term – there's going to be a real drive toward domestic manufacturing for highly critical fasteners based on the current situation we're all living through. We're gearing

up our manufacturing capacity to support those kinds of demands in the market."

Kovatch emphasized that Dyson prides itself on being able to deliver its products in a flexible timeframe along with its customers' needs.

"When putting a foundation in the ground, weather has a big effect on timing, as does funding and machine availability," he said. "Therefore, it's important for us to be flexible with our manufacturing processes to support



▼ We've certainly found our footing in the foundation rods. And now that we've got the materials and the specifications perfected and we understand that market, our goal is to drive our costs down by automating our manufacturing processes and exploring alternative materials. ▼

the everchanging timelines of our customers. We're really proud of being able to do that. As far as other industries, we are a proud supplier to the U.S. Military for products used in the building of ships and submarines. Our Infrastructure division supplies products that end up on bridges, locks, and dams. Our products are on many popular bridges: The Golden Gate Bridge and the Brooklyn Bridge to name just a couple. Dyson products are everywhere around us. Our domestically made fasteners hold together the infrastructure of this country and help defend it."

Forged coupling bolts for shafts on naval ships. (Courtesy: Dyson Corporation)

#### 136 YEARS AND COUNTING

That diversity has been a driving force in Dyson's long history.

Dyson was founded in 1884 as a specialty forge shop in Cleveland, Ohio, and has grown to become a leading supplier of specialty fasteners and forgings ranging in size from 0.5 to 10,000 pounds and diameters up to 20 inches. In that time, the company has produced critical fasteners for use by the military, infrastructure, construction, and renewable energy industries. Products are produced to ASME, MIL, ANSI, SAE, and DIN standards, and Dyson is an ISO 9001:2015 certified manufacturer.

With all that experience and capabilities, Dyson has developed a reputation for quality and reliability, and it sees itself as a key supplier to the wind industry from the foundation to the nacelle both now and into the future, according to Kovatch.

"We would like to become the preferred supplier of domestically manufactured, highly critical fasteners," he said. "As the blades get longer and larger, carrying more loads, I think our engineering and manufacturing capabilities will find a real home in the wind industry." ↗



## Chris Huxley-Reynard

Managing director ▶ Reygar Ltd.

*“We supply innovative remote monitoring systems to many of the biggest CTV operators in Europe.”*

### ▶ Tell us about Reygar.

We're a small but fast-growing U.K.-based company specializing in remote monitoring systems for boats. We created a product called BareFLEET, which is a versatile remote monitoring and reporting system that brings all the real-time data from across a vessel's sensors into a single portal. We work with vessel operators across commercial marine – including towage, ferries, surveying, and pilotage – but most of our customers are crew transfer vessel operators in the offshore wind industry. That's about 90 percent of our business.

### ▶ In what capacity is Reygar involved with wind-energy projects?

We supply remote monitoring systems to probably half a dozen of the biggest CTV operators in Europe. That would include Seacat Services, CWind, High Speed Transfers, and World Marine Offshore. The monitoring and reporting system we supply meets a number of their commercial and operational needs, but also their customers' needs because they often share the performance data from their vessels with their wind-farm owner-operator customers. This is partly as a trust-building and transparency exercise and partly as a way for both parties to have an impartial measure of how each vessel is performing.

### ▶ Why is that vessel data important? And what makes it especially critical during this particular threat with COVID-19?

Before COVID-19 came along, there are two main areas where customers would see a benefit from BareFLEET. The first is in the planned and preventative maintenance area. The system can gather and record all sorts of operating data across critical machinery and engines, to running temperatures, oil pressures, engine alarms, machinery vibration – all those sorts of things. And because that's all reported remotely, it allows customers with large fleets of vessels to really keep on top of what's going on.

Essentially, BareFLEET is like having a pair of eyes in the

engine room without being there. When you have a lot of vessels to manage, that can really help you to spot problems early and prioritize maintenance activities so that you can maximize the uptime of the vessels. In the wind-turbine industry, the crew transfer vessels are working really hard. They're out pretty much every day. They can't afford to have a day off for maintenance. It costs them money. That's the first thing.

The second area that's really useful is in measuring the performance of the vessel both in terms of its fuel economy – its emissions and a breakdown of when excess fuel is being used – and, particularly for crew transfer vessels, in terms of the motion of the boat. The crew transfer industry is all about delivering engineers and technicians out to the wind farm in a fit state to work, and so things like measurements of motion sickness and measurements of the stability of the boat when it's parked up against the turbine – what's called “pushing on” – those are really important measurements. They tell both the vessel owner and the wind-farm operator if the vessel is delivering people in a fit state to work and if it is allowing them to transfer onto the turbines in a safe environment where the boat's not moving up and down excessively.

All of that information is gathered by BareFLEET and made available to the customer on shore. And it's presented in a very simple way. We can present the information they need to see clearly and succinctly as a “transfer score” that summarizes how successful the movement of the technicians from the vessel to the turbine was, rather than show them excessive data. It allows them, over a period of days or weeks or months, to do key performance analysis and say, “OK, this boat's performing well in these conditions; this site is better than that site; January is worse than July for transferring technicians.” That kind of information is really, really useful from an operational perspective.

That's kind of every day; it's just what BareFLEET does – but what we've noticed since COVID-19 is customers have been approaching us and saying: “We need this data, particularly the kind of maintenance-related engine health infor-

mation, more than ever because we're running a lean crew, and the engineering team is working from home." Vessel operators are trying to run the show from home, and it's much more challenging to manage the fleet when they can't actually walk down to the quay and take a look at the boats themselves.

They're relying on this remotely gathered information to be their eyes and ears on the boat. Sometimes they are coming to us with specific queries like "Can you help us understand this particular trend?" – for example an oil pressure trend, or engine-speed trend – but actually, what they're asking for most is more access to the BareFLEET database.

Where we would typically provide them our own daily reports, which are a kind of a concise presentation of what a boat's been doing on a particular day, they're now wanting access to the raw data so their engineers can go on to our system and look at their own trends of oil pressure, coolant temperatures, engine speeds, CO<sub>2</sub> emissions and fuel burn efficiency from home. They want to go in and look at the data themselves because they have experience with their boats that we will never have. We're providing them with access to that raw data, which is not something that we really focused on before.

#### ▀ How does that dovetail into the current crisis, and has BareFLEET been modified to look for this? Or is this something that it was already capable of doing?

It's a bit of both. The engine health, motion, and performance reporting is something that BareFLEET has always been able to do. The raw-data database access, which our customers have been asking about recently, is something that we've prioritized the development of, particularly in view of the current challenges with COVID-19. Database access is something we've been working on for a while, but I would say that it's been brought to a head by COVID-19 and caused us to prioritize that development.

#### ▀ What makes the interface particularly unique?

Where BareFLEET sets itself apart is in the way it's a complete comprehensive system that brings together data from all sensors across the vessel. Many companies provide systems that will look at fuel monitoring or systems that might look at engine health monitoring or systems that might look at vessel motion – but what we do is bring all that together because we understand what the customer needs. And they need all of that information to be accessible clearly and simply through one portal.

When a vessel operator is considering a remote monitoring system of any sort, there are a few basic things they are going to look for. First up, they've got a fleet of various types of boat – they've got different engines, different hull forms, different design, speeds, whatever – but the operator needs a system they can deploy across all those boats. They are not going to want a monitoring system that only works with one engine brand or one navigational system.

At the same time, they're not only going to be interested



Most of Reygar's customers are crew transfer vessel operators in the offshore wind industry. (Courtesy Seacat Services)

in fuel information or only interested in motion. They're interested in everything that affects the performance of the vessel and the variables that affect transfers. If they can get all of that through one system, that's an advantage to them because they don't want to be on four different web portals: one for motion, one for engine health, one for this, one for that, one for Caterpillar engines, one for Volvo engines. It's just not manageable. They want to go to a company that can provide it all through one service, and that's where we specialize.

#### ▀ Was it an easy transition from the standard use of the interface to going to the methods you're using now?

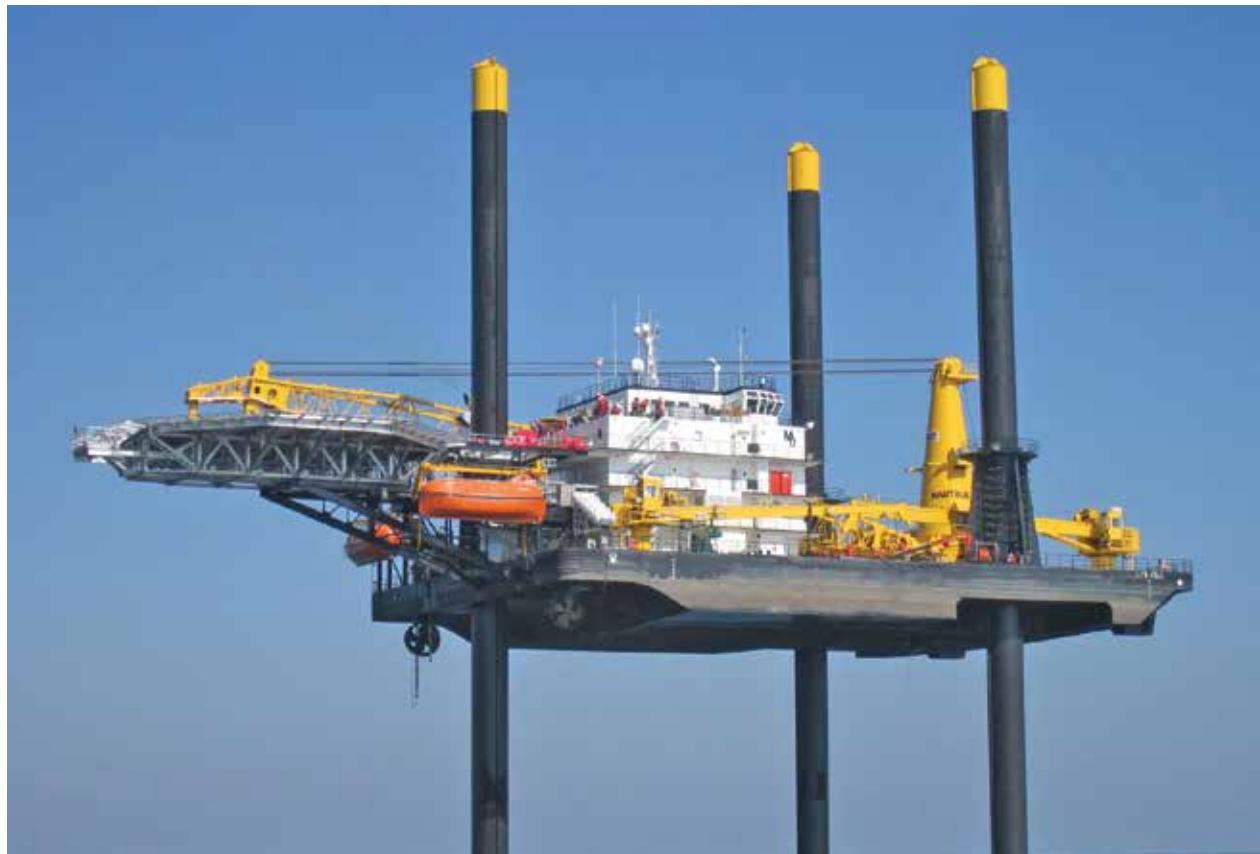
Providing access to the raw data through the new database features is something that we have had in the pipeline for a while. We always had an idea of how we were going to do it, but COVID-19 has given us the push to burn the midnight oil and focus on developing and implementing the new software to provide this raw data access.

#### ▀ Post-crisis, do you see the BareFLEET interface being used in even more applications and situations now that you've got this experience?

We certainly hope so. The U.S. market in particular is a really interesting one for us. We are already dipping a toe in the water in the U.S. with customers operating fleets of tug boats and ferries, but we are also looking at the growing opportunities for offshore wind in the U.S. In our view, the U.S. market is likely to adopt a lot of the best practices used in the more mature European market.

We are increasingly seeing longstanding clients of ours – European crew transfer vessel operators – looking to move into the U.S. market or partner with vessel operators out there and bring us with them. We are already seeing a lot of inquiries from local vessel operators and have installed BareFLEET systems on a couple of boats that will be operating on the East Coast. It's still quite the early days for U.S. offshore, but getting in there at the beginning and building those relationships with project owners and vessel operators is no less important. ↗

**MORE INFO** [www.reygar.co.uk](http://www.reygar.co.uk)



Liftboat Jill is a self-propelled DP2 vessel that can operate in the geotechnical, offshore wind, offshore construction, oil and gas, and cable-repair markets. (Courtesy: Fred. Olsen Windcarrier)

### ► CONSTRUCTION

## Fred. Olsen gets contract for Thor wind farm

Fred. Olsen Windcarrier has been contracted by the Danish company Geo to supply a vessel for the preliminary geotechnical investigations for the Thor offshore wind project in the Danish North Sea. Fred. Olsen Windcarrier will use the Liftboat Jill to support Geo with the offshore borehole campaign. Jill will provide a stable and robust platform for the campaign, which is scheduled to start June 2020. The purpose of the assignment is to acquire geotechnical and geological information about the subsurface to be used as

a basis for developers to assess the soil conditions for the Thor project.

"We are very excited to be working with Geo on this project," said Thomas Lund, sales manager at Fred. Olsen Windcarrier. "The two companies combine the best of maritime and offshore wind experience with the most extensive expertise within the fields of soil and seabed investigations."

"We are looking forward to do the first geotechnical work on Thor for Energinet.dk this summer," said Jens Brink Clausen, department director at Geo. "Our new cooperation with Fred. Olsen Windcarrier will ensure a very safe and robust solution for the drilling operations."

Liftboat Jill is a self-propelled DP2 vessel that can operate in the geotechnical, offshore wind, offshore con-

struction, oil and gas, and cable-repair markets. It is outfitted to support customers' construction, maintenance, production enhancement, and decommissioning projects. Jill is equipped with 102-meter-long legs, a rack-and-pinion hydraulic jacking system, a large cargo deck, and in addition to her main crane, crane coverage by three auxiliary cranes.

Fred. Olsen Windcarrier provides innovative and tailored services for the transport, installation, and maintenance of offshore wind farms.

Building on more than 170 years of offshore and marine experience, Fred. Olsen Windcarrier was established in 2008 to service the growing offshore wind sector. The company now operates three class-leading purpose-built jack-up vessels; Bold Tern, Brave Tern,

and Blue Tern. Recently, a long-term time charter for the O&M jack-up vessel Jill was signed, and she is now under commercial management of Fred. Olsen Windcarrier.

The Fred. Olsen Windcarrier vessels have installed 600 wind turbines offshore and gained extensive experience installing the latest generation offshore wind turbines on some of the world's largest wind farms.

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

## ► CONSTRUCTION

### Pemamek offers new flange fitting welding station

The new PEMA Flange Fitting Station enables fast, safe, and accurate fitting and welding of flanges to wind-tower and tower-foundation sections. Flange fitting is possible without flipping shells to a horizontal fitting table for flange fitting and then back to the original position for welding, which can be challenging for crane operators when lifting these heavy pieces. The PEMA FF station either minimizes or eliminates the need for a crane depending on part size.

As wind turbines continue to grow larger, the tower sections and flanges that comprise them are also growing in weight and diameter, making handling with an overhead crane more challenging and requiring special skills and tools from the crane operator. The FF station is flexible enough to handle many different variations of flange designs and can be integrated with PEMA column and boom, which enables welding to be done in the same place, reducing weld time and increasing welding efficiency. Additionally, repairs are minimal as there is no need for lifting clamps.

"Our FF Station can handle tubular and conical shells with different diameters and lengths and has changeable



Pemamek's PEMA Flange Fitting Station. (Courtesy: Pemamek)

tools to help to adjust the fit-up tool for different L- and T-type flanges," said Teemu Tolonen, Pemamek's application manager of Wind Energy. "Pemamek is also further developing the station with measuring tools, helping operators to perform perfect fittings."

Pemamek tested the FF welding process using an offshore transition-piece flange fitting. Fitting time was reduced from eight hours to two hours, keeping flatness and tolerances without the need for a milling operation.

Pemamek provides welding automation technology and integrated manufacturing solutions to a wide range of industries including shipbuilding, alternative energies, heavy fabrication, oil and gas, wind energy, and boiler manufacturing. The company offers welding positioners, column and boom units, roller beds, and robotic solutions as well as the proprietary PEMA WeldControl programming and control software, among other technologies.

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



ALL Family of Companies' Shared Equipment Program (SEP) is a new approach to equipment rental that can shave millions of dollars and many months off construction projects. (Courtesy: ALL Crane)

## CONSTRUCTION

### ALL Crane announces Shared Equipment Program (SEP)

Today's construction jobsites are evolving, and project owners demand partner companies that embrace new

methods to drive down costs without negatively affecting quality. It is with this in mind that the ALL Family of Companies recently announced its Shared Equipment Program (SEP), a new approach to equipment rental that can shave millions of dollars and many months off construction projects.

Here's how it works: A project's general contractor acts as the primary

renter of all lift equipment for the job and then rents it to the subcontractors — a method that helps to eliminate waste, cuts costs, improves productivity, and creates positive outcomes. More than just equipment, the project also gets support from the ALL team, including mechanics who conduct regular maintenance to keep machines in "rent-ready" condition as they change hands between subcontractors.

When multiple subcontractors arrange for their own equipment, depending on the job site, the ALL Family of Companies' SEP Program can eliminate redundancy and waste, which can be as much as one-third of total project cost. And equipment redundancy does more than add costs — it adds a level of congestion to job sites where space is a premium, which can affect everything from traffic to safety. The SEP addresses all these concerns, as ALL works with the general contractor to maximize efficient usage of lift equipment.

ALL developed the program to reinforce its unique blend of resources afforded general contractors, including a broad continental footprint, and an extensive and varied fleet. The program works best when all subcontractors have ready access to equipment that meets their needs, from steelworkers who may require hefty all-terrain equipment to painting and electrical contractors whose finishing work requires access equipment such as scissor lifts. ALL's equipment lineup includes crane types as small and versatile as mini/spider cranes or as large as 900-ton ATs and 1,000-ton crawlers, plus tower cranes, boom lifts/aerials/MEWPs, and boom trucks.

Beyond these extensive equipment resources, the company has the experience and willingness to collaborate both initially and then ongoing, which help make the equipment-sharing process successful. ALL has already executed projects using SEP, saving project owners tens of millions of dollars and helping to complete projects months ahead of schedule.

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



Biome Renewables' PowerCone® is a passive retrofit that bolts to the hub of a wind turbine as an effective turn-key solution that incorporates the aerodynamic elegance of a falling maple seed. (Courtesy: Biome Renewables)

## ► INNOVATION

### Biome presents PowerCone® tech to potential investors

Biome Renewables recently presented its PowerCone® Wind Turbine Technology to investors and industry representatives at the Virtual Industry Growth Forum (IGF) 2020 in April. The IGF, celebrating its 25th anniversary, was presented online this year. It was hosted by the U.S. Department of Energy's National Renewable Energy Laboratory and is one of the nation's premier events for cleantech entrepreneurs and other industry experts. Biome Renewables was selected from a field of more than 150 entrepreneurs following an extensive selection process.

Biome Renewables is a Toronto-based design and engineering firm that employs the power of nature to create a sustainable future. By using biomimicry in its design and engineering process, the company is able

to create world-leading technologies in the cleantech space. The PowerCone® is a passive retrofit that bolts to the hub of a wind turbine as an effective turn-key solution that incorporates the aerodynamic elegance of a falling maple seed. The result is not just more power, but power from a place where no bigger blade or smarter software can find it.

"We're thrilled to be presenting at this year's NREL Industry Growth Forum," said Ryan Church, founder and CEO of Biome Renewables. "We can't wait to show investors where we're at in the maturation of the PowerCone® technology, and what this will mean for the wind industry as a whole. The potential is enormous."

Several hundred cleantech investors, entrepreneurs, and industry representatives were expected to attend this year's Virtual IGF 2020. The online event included the pitch competition and one-on-one networking meetings, the heart of the IGF, over the course of two days. Among them were 40 of the nation's most promising start-up companies, including Biome Renew-

ables, that presented their cleantech innovations to potential investors and industry experts. In addition, the companies competed for the 2020 Clean Energy Venture Awards.

"It's our 25th anniversary and the IGF has become more crucial than ever," said Richard Adams, director of NREL's Innovation & Entrepreneurship Center that manages the IGF. "We are excited to see the clean technologies the IGF presenters deliver this year. These technologies not only address market needs but offer viable solutions to the world's energy challenges."

MORE INFO [www.biome-renewables.com](http://www.biome-renewables.com)

## ► INNOVATION

### Chartwell: Workboat sector must consider operational profile

Instead of waiting for breakthrough technological innovations to deliver low emission vessels, workboat oper-

ators have the opportunity to use the latest advances in hull design and alternative propulsion systems to achieve efficiency gains while tackling pollution problems in ports and other workboat sectors — and helping offshore wind to work toward emissions targets. This is the latest insight from Chartwell Marine, a pioneer in next generation vessel design.

The broader trend for workboats — which includes OESVs, tugs, pilot vessels, and survey vessels — in many key markets globally shows a clear and increasingly assertive move toward emissions reduction. The Clean Maritime Plan for net-zero emissions in domestic U.K. waters by 2050 is one example, while the EPA Tier 4 air quality regulations offers practical guidance at present for vessel operators in the U.S.

Hybrid designs are being trialed and successfully adopted across the industry and will continue to play a critical role in current and future decarbonization strategies. Chartwell Marine's own vessel portfolio includes the Chasewell pilot and patrol boat and Scanwell survey vessel range — both with hybrid propulsion options.

But with all workboat types, the financial factor may well prove decisive. Reducing fuel burn and finding more efficient ways to work leads to increased profitability across vessel operations. Chartwell Marine warns that, although hybrid and electric solutions are ideally suited for some contexts, the operational profile of the vessel must be carefully considered. Designing vessels with end-user requirements in mind is a vital part of ensuring they act effectively.

The port sector has struggled with NOx pollution, produced in large part by vessel operations. There are many areas where hybrid propulsion offers clear benefits outside of the obvious emissions reduction. Hybrid propulsion systems are especially effective for vessels operating at reduced speeds, such as those working in and around ports. Reducing fuel burn in port dramatically, while using increased torque from a hybrid system, will improve operational efficiency for tug-

boats, for example.

Hybrid technology is ideally suited for the survey sector as well due to dramatic reductions in acoustic interference. Quieter operations mean more accurate surveying, whether that is for scientific purposes, installation and maintenance of subsea infrastructure, or port dredging.

In offshore wind, there are clear incentives for the decarbonization of crew transfer vessels as the industry looks to bolster its green credentials. However, high-speed offshore wind CTVs are often less suitable for alternative propulsion because the power densities of energy sources such as batteries and hydrogen are not as efficient as diesel. In this case, smart and holistic vessel design is the most effective way forward. When a focus on the high-speed operational element prevails, Chartwell Marine looks toward the potential of using a combination of increased dynamic lift, active motion damping, and AI to increase operational efficiency.

"Alternative propulsion systems and energy sources are an exciting proposition, and in many operational contexts, already offer the best solution in terms of efficiency," said Andy Page, managing director of Chartwell Marine. "But as global operators increasingly look to enhance the efficiency of their fleets, it's worth considering that existing innovations in hull forms and other vessel technologies often have the greatest capacity to deliver savings."

"A strategic element is in play here as a diverse set of markets look to reduce their emissions," he said. "While it's certainly encouraging that stimulus from above is spurring research and development in the workboat sector, it is ultimately up to naval architects, engineers, and vessel operators to enable the necessary efficiency savings to be made."

Chartwell Marine was awarded a prize by the Carbon Trust last year for their part in designing an innovative new hull form for the Offshore Wind Accelerator competition and is working on the development and testing of

technologies to aid the ongoing decarbonization of vessels.

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

## ► INNOVATION

### 4Subsea installs IoT sensors on floating turbine Zefyros

4Subsea has installed advanced, retrofit sensors on floating turbine Zefyros (previously Hywind Demo) to prove cost reduction potential with a Digital Twin. A few hours after mobilization on April 20th, the autonomous sensors started streaming motion and load data to 4insight.io from Unitech's wind turbine off the west coast of Norway. The project aims to prove significant cost reduction potential in offshore wind by using a Digital Twin of the substructure to measure actual loads and fatigue on the turbine.

4Subsea has delivered digital decision support with Digital Twins to the oil and gas industry for years, and because of the many similar challenges with soil support, scouring, corrosion, and fatigue, it can use modified versions of its algorithms, AI agents, and trained models to extend the lifetime of substructures, predict cable repair/replacement, reduce production downtime with anomaly detection, and more.

4Subsea has developed a new generation of sensors for structural integrity and performance monitoring of offshore wind turbines. The sensors have a proven track record from offshore oil and gas where they are used to monitor both vessel motions and the behavior of fixed platforms. Different technology components from fish telemetry, micro drones, and telecom have been combined in order to make a solution dedicated for subsea assets in oil and gas and now for offshore wind turbines.

The sensor package combines a 6-axis IMU and four strain sensors for monitoring wind-turbine towers and



The Scanwell survey vessel. (Courtesy: Diverse Marine)



4Subsea has developed a new generation of sensors for structural integrity and performance monitoring of offshore wind turbines. (Courtesy: 4Subsea)

substructures. Sensor data will be combined with weather information and other data sources. The interpretation of the data will be available on 4insight.io, which is a digital service on Microsoft Azure. This enables the combination of many large data sets and cloud computing as a platform for machine learning and artificial intelligence.

The main goal of the project is to analyze the potential for reducing LCOE in the offshore wind industry. 4Subsea's operating philosophy is founded on continuous research and technology development to improve

the understanding of how underwater assets age over time when exposed to hydrodynamic, aerodynamic, and operational loading.

Within offshore wind, 4Subsea specializes in coupled analysis including aerodynamics and hydrodynamics as well as modeling of the turbine controller and modeling of soil interaction with the substructure.

4Subsea is a leading provider of technology and services that help operators optimize energy production from subsea oil and gas fields and offshore wind farms. They combine domain expertise with data analytics

and digital services to maximize the lifetime of assets, reduce operational cost, and optimize future projects through data-driven design.

MORE INFO [www.4subsea.com](http://www.4subsea.com)

## ► MAINTENANCE

### Siemens Gamesa sets foundations for service growth

Siemens Gamesa Renewable Energy has secured a long-term, 20-year contract to provide full-scope operation and maintenance services for a 135-MW Senvion wind farm in Victoria, Australia, ensuring support continuity and stable operations to maximize the customer's business case.

Under the agreement, the company will provide remote monitoring, supply chain access, and specialty tooling, design, and engineering support, as well as software updates. In addition, existing hardware and infrastructure on the site will be used to ensure the performance and reliability of the turbines throughout its extended lifetime of 25 years.

In order to provide better service to Senvion turbines in Australia, Siemens Gamesa has also invested in a substantial, immediately available stock of Senvion parts in the country, which will help to optimize the time needed to service projects as well as maximize the project economics for customers.

"Leveraging its 10-year expertise of servicing turbines of other manufacturers and our recent successful acquisition of Senvion's European Services assets and Intellectual Property, Siemens Gamesa is uniquely positioned to serve our customers in all markets," said Joris Mazille, service CEO of Siemens Gamesa for the APAC region. "This strong position in Asia Pacific is further strengthened by our growing investment in technical capability, a local service team, and competitive parts stock in Australia, demonstrat-



Siemens Gamesa expanded its multi-brand service portfolio in Asia Pacific with the addition of a 135-MW Senvion wind project in Victoria, Australia. (Courtesy: Siemens Gamesa)

ing our long-term commitment to enable customer success."

Siemens Gamesa completed the acquisition of selected assets from Senvion in January. The purchase increased the company's multi-brand footprint to about 10 GW. The addition of these service assets helps to diversify Siemens Gamesa's business mix and geographical exposure with contracts that offer long-term visibility and renewal rates that have been historically very high.

With nearly 72 GW under service globally, Siemens Gamesa is a leading service provider in the industry. The company has been expanding in the

Asia Pacific markets since the 1980s and has installed more than 8.4 GW of onshore turbines in China, Pakistan, Japan, South Korea, Indonesia, the Philippines, Vietnam, Thailand, Australia, and New Zealand.

In the offshore segment, the company successfully completed the installation of Taiwan's first offshore wind power project in 2019 (128 MW) and reached close to 2 GW of firm orders. The company also signed preferred supplier agreements for an additional 755 MW combined volume in Japan and Taiwan.

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

## ► MAINTENANCE

### Windsourcing.com launches B2B online shop

During the Coronavirus crisis, digital business models have emerged as reliable pillars for the procurement of products and services. The operation of wind turbines must be guaranteed around the clock, which is why there is a strong demand for comprehensive and directly accessible online offers for spare parts and repair materials. Windsourcing.com has been a competent distributor for years in after-sales market of the wind industry and now also offers its product range in a B2B online shop throughout Europe.

In 2019, wind energy supplied about 24.4 percent of German electricity production and is a supporting pillar of the energy revolution. Wind turbines have undergone rapid technical development. The complex systems that are exposed to changing loads require regular maintenance and repairs.

As a specialized dealer for the wind industry, Windsourcing.com has already delivered spare parts and repair materials for wind turbines to customers in Europe and increasingly worldwide. Now the company has reacted to the increased demands of the market and – in the spirit of the digital age – offers customers from EU countries many articles for direct purchase via a new B2B online shop. Associated with this are further service advantages, such as the display of the stock availability of all products, in order to guarantee the buyer planning security for necessary orders.

Once a customer account has been created, the uncomplicated ordering process ensures direct access to the online shop assortment with just a few clicks. The products offered include corrosion protection coating systems for wind turbines (onshore and offshore), adhesives and sealants, rotor blade repair materials, and hydraulic and electrotechnical products. If prod-



Windsourcing.com has been a competent distributor for years in after-sales market of the wind industry and now also offers its product range in a B2B online shop throughout Europe. (Courtesy: Windsourcing.com)

ucts are not yet available for purchase in the shop, customers can request them directly from the shop to receive an offer.

MORE INFO [www.windsourcing.com/en](http://www.windsourcing.com/en)

## ► MANUFACTURING

### Port of Vancouver receives shipment of longest wind blades

The Port of Vancouver USA recently received a shipment of nine wind turbines including the longest wind turbine blades it has handled to date. The delivery is a joint effort between the turbine manufacturer Goldwind and the wind project owner Potentia Renewables.

"During the COVID-19 pandemic, the port continues to operate to keep the supply chain and commodities moving," said CEO Julianna Marler. "The port has proven our unique ability to handle these types of large projects. Customers know our heavy lift mobile cranes, acres of laydown space, highly-skilled workforce, and dedication to renewable energy make the Port of Vancouver the perfect port for receiving wind energy components."

"During an extremely trying time

globally, we are grateful for our partners including ILWU Local 4, Local 40, Local 92, river and bar pilots who are still at work making it possible for us to handle this cargo," said Chief Commercial Officer Alex Strogen. "We also thank Jones Stevedoring, Totran Transportation Services and the ship MV Star Kilimanjaro operated by G2 Ocean. Their talented staff and crews, expertise, and hard work are integral to the port's continued commercial success."

The blades for Goldwind's GW136/4.2 MW turbines, each 67 meters in length (220 feet), were manufactured in and shipped from China. Goldwind Americas, the company's North American subsidiary headquartered in Chicago, Illinois, specializes in the sales, supply, operations, and maintenance of Goldwind's Permanent Magnet Direct Drive (PMDD) wind-turbine generators. Globally Goldwind has 60 GW, approximately 35,000 wind-turbine units, operating in 24 countries on six continents.

"Goldwind Americas is pleased to be working with the Port of Vancouver USA with their expertise in the receiving and movement of large-scale wind-turbine components, which now includes our 4S MW model blades," said David Sale, CEO of Goldwind Americas. "Goldwind's expanding

portfolio of turbines continues to push the technology envelope and define what is possible in the wind industry. This allows our customers to maximize project economics with larger turbine nameplate designs and rotor diameters."

The wind-turbine blades and components will travel to Assiniboia, Saskatchewan, Canada, to Potentia's Golden South Wind Energy Project on 34,000 acres of leased-agricultural land. Potentia is a Toronto-based developer, owner and operator of solar and wind energy assets. The Golden South Wind Project will use Goldwind's latest PMDD turbines and will generate approximately 900,000 MW/h of electricity and will significantly reduce CO<sub>2</sub> emissions compared to a coal-fired plant. The carbon reduction is equivalent to eliminating the pollution from half the vehicles in Regina or Saskatoon, Saskatchewan. The project broke ground in 2019 and is expected to open in 2021.

"We are very excited to see the project progress from the current preparatory construction efforts to the arrival of the wind turbine equipment at the site this summer," said Jeff Jenner, chief executive officer of Potentia Renewables Inc. "We thank everyone at the port and others involved in the transportation and handling of this equipment for their efforts during



The MV Star Kilimanjaro delivers 27 wind turbine blades and other components for a wind project in Canada. (Courtesy: Port of Vancouver USA)

these unusual times."

Once unloaded from the ship, the wind turbine blades (27 in total) and components will be moved to laydown space at the port's Terminal 2 and Terminal 5. From there, they will be transported by Totran Transportation Services over the span of 21 weeks to Saskatchewan, Canada.

The port will eventually handle 50 full turbines, a combination of the GW 136/4.2 and GW 155/4.2 MW models, moving through the port bound for the Golden South Wind Project. A complete turbine includes three blades, nacelle, generator, hub, five to six tower

sections, and other sub-components. Additional ships carrying turbines will arrive later this summer including blades measuring 76.2 meters (250 feet)—which will be the longest blades ever imported into any port in North America.

The Port of Vancouver USA has long been a leader in the port industry in supporting renewable energy projects and is one of the West Coast leaders in the movement of wind energy components to support new and existing wind energy projects.

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

## ► MANUFACTURING

### Vestas wins order with customized solution

E-Connection, a Dutch wind project developer with more than 30 years of experience in developing, realizing, and managing complex wind-energy projects, has placed an order for 11 turbines totaling 46 MW for the first phase of the wind project Oosterscheldekering Wind Optimization

that consists of the four wind parks Binnenhaven, Roggeplaat-West, Noordland Buiten and Vluchthaven.

Located directly on the waterfront on a storm surge barrier in the Zee-land province in the southwest of the Netherlands, Vestas has developed a wind-energy solution customized to the sites' high wind conditions with average windspeeds of more than 9 m/s at hub height. The project is a mix of new turbines and turbines that replace older turbine types and in total it features nine V136-4.2 MW turbines and two V117-4.2 MW turbines with site-specific towers, combined with a 15-year Active Output Management (AOM 4000) service contract to optimize annual energy production and offer competitive levelized cost of energy.

At Noordland Buiten and Vluchthaven wind parks, the current five V90-3.0 MW turbines will be replaced by five V136-4.2 MW turbines, which will significantly improve the sites' annual energy production due to the more efficient turbines. The Binnenhaven and Roggeplaat-West wind parks will feature four V136-4.2 MW turbines and two V117-4.2 MW turbines respectively.

"We appreciate partnering with a supportive partner like Vestas and collaborating with the province, municipalities, Rijkswaterstaat and environmental organizations," said Rick Wesser, director of E-Connection. "We are looking forward to commissioning phase one of this complex project in summer 2021, signifying a great step for the renewable power supply of the region. Collectively, from spring 2022, the turbines will generate as much wind power as 60,000 households in the Netherlands use annually."

"This order comes from our valued customer E-Connection, with whom we have had a productive partnership for about 15 years in the Netherlands," said Nils de Baar, president of Vestas Northern & Central Europe. "This project re-enforces the success of the V136-4.2 MW turbine for the Dutch market being installed at the sea defense walls at the North Sea in one of the country's

best wind locations. It emphasizes our capability to provide customized wind energy solutions for complex projects that significantly contribute to achieving the sustainable energy goals of the Netherlands, while at the same time, create maximum value for our customer's business case."

The four wind parks will feature a VestasOnline® Business SCADA solution, lowering turbine downtime and thus optimizing the energy output. The contract further includes supply, installation and commissioning of the wind turbines, as well as 15-year Active Output Management 4000 (AOM 4000) service agreement.

Deliveries are expected to begin in the third quarter of 2021 and commissioning is planned for the same quarter.

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

## ► MANUFACTURING

### GlobalData: Spanish turbine manufacturers get back to business

Vestas Wind Systems, LM Wind Power, Siemens Gamesa Renewable Energy, and Nordex recently reopened factories in Spain after the government relaxed lockdown measures. It was previously predicted that the COVID-19 pandemic would have negative effects on wind supply chains, with developers expected to undergo delays due to lockdown-related restrictions. Thus, these major companies getting back to business is a sign of a desperate attempt to protect matters from worsening further, says GlobalData, a leading data and analytics company.

"The annual installed capacity for wind in Spain, at the end of 2019, stood at 2.3GW, by the end of 2020, it is expected to be 1.7 GW," said Somik Das, power analyst at GlobalData. "The total cumulative wind installed capacity in 2019 was 25.9 GW, which is expected to accumulate to 27.6GW by the end of 2020."



The Oosterscheldekering Wind Optimization project is a mix of new turbines and turbines that replace older turbine types and in total it features nine V136-4.2 MW turbines and two V117-4.2 MW turbines with site-specific towers. (Courtesy: Vestas)

Danish company Vestas Wind Systems restarted full production at its Viveiro site in mid-April, while its factory at Daimiel also resumed operations at near full capacity. Meanwhile, blade maker LM Wind Power also restarted operations at its sites in Ponferrada and Castellon, and Siemens Gamesa Renewable Energy resumed operations after the Easter holidays in Lerma, Burgos, San Fernando, Somozas, Ágreda and Sigueiro, Asteasu, Mungia, Valencia, Cuenca, Aoiz, and Reinosa. Germany's Nordex SE also reopened its Spanish sites at the start of April after temporarily closing them March 30. The company restarted operations at its production facility in Chennai, India, as well, with limited capacity on April 6.

"These manufacturers have resumed operations adhering to the government guidelines and have undertaken strict measures such as social distancing, frequent spraying of disinfectant to clean surroundings, compulsory protective gear for workforce and allocation of shifts, Das said.

"These events indicate that the primary efforts of the major players in the sector are to limit the damage that has been caused by the pandemic. Also, if the performance of the sector needs to be improved in the second half of the year, then these major players would need to get back in business at the earliest." ↗

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

CROSSWINDS

THE FUTURE OF WIND

# PREVENTING THERMAL RUNAWAY BEFORE IT BEGINS



# *In Li-ion battery energy storage systems used with wind-power generation, off-gas detection up to 30 minutes before dangerous thermal runaway events enables action to deter potentially catastrophic cascading failure.*

By STEVE CUMMINGS

Utilities are increasingly turning to a battery energy storage systems (BESS) in a variety of sizes and power outputs to deliver reliable back-up power, avoid peak demand charges, and to store energy generated for use at a later time. Wind generation, in particular, benefits by incorporating energy-storage systems. When demand is low, excess power can be stored and released at a later time — such as during demand periods — with no lag time.

In this way, a BESS allows wind-power systems to perform more like traditional generating plants by facilitating the ability to predict and schedule output ahead of time. Given the rapid and unpredictable fluctuation in output with wind-power generation, this is a challenge without a BESS. In addition, a BESS provides wind leveling to ensure actual plant output matches scheduled output. If actual wind output is below what is expected, the BESS makes it up with stored energy generated when demand was low.

Given the expected growth in wind power coupled with the fact that most BESSs are designed by interconnecting a series of Lithium-ion (Li-ion) batteries, the industry is continuing to focus attention on measures designed to all-but-eliminate any potential for dangerous thermal runaway conditions.

Thermal runaway occurs when excess heat caused by defects, mechanical failures from damage, or improper operation of the system creates a reaction that further increases the temperature. If left unchecked by built-in system protections or the battery management system (BMS), this process can continue to drive up temperature and pressure until the battery cell ruptures. This can cause fires in affected and adjacent cells.

Fortunately, early detection systems have been developed that can now detect a unique pre-cursor event to thermal runaway — an off-gassing in the battery cell that occurs up to 30 minutes prior to a cascading failure. This distinctive and recognizable early warning sign enables the problem to be mitigated or by having the system shut down before thermal runaway can even begin.

Although virtually all quality BMS equipment monitors temperature and other variables to prevent thermal runaway by triggering protections before temperatures change in an unplanned way, the early detection of off-gassing provides a critical additional layer of protection for the entire system, the facility, and even personnel.

"Once a Li-ion BESS goes into thermal runaway you can-

not stop it (in that cell) — your goal is to try to stop the propagation of heat and thermal runaway to adjoining cells," said retired NYC firefighter Paul Rogers, a co-founder of Energy Storage Response Group (ESRG), a national fire safety consultancy with nearly 50 years of combined experience that specializes in the risk assessment, investigation, and safety testing of energy storage systems.

While still with the NYC Fire Department, Rogers oversaw the implementation of the department's first response protocols for how to deal with energy storage systems, and now he consults nationally on this as well as safety testing.

According to Rogers, while a BMS can provide data and shut down the BESS, depending on the safety integrity levels of the BMS component, there are times when the BMS can miss critical indicators or malfunction. Because of this, Rogers recognizes the need for a separate, redundant system that can indicate the potential of thermal runaway before it occurs, so the BESS can be shut down to prevent it.

"You need layers of protection to reduce your risk," Rogers said, who recommends incorporating an additional early warning system besides the BMS.

## EARLY DETECTION

The early detection of thermal runaway relies on four sequential stages of Li-ion battery failure, according to Nextris, a developer of gas sensors and monitors. The company worked with the U.S. Navy a decade ago to develop an off-gassing detection technology for Li-ion BESSs that would later be commercialized in a product called Li-ion Tamer, which is compatible with all Li-ion chemistries.

A Li-ion battery cell first begins to fail when it is subjected to an abuse factor like heat, overvoltage, etc. The second step is off-gassing. The third step is smoke, and the fourth step is fire. But smoke and fire often occur almost simultaneously. So, by the time smoke is detected, thermal runaway has typically already begun.

Off-gassing usually occurs due to a breakdown of a Li-ion battery cell electrolyte as a result of pressure buildup. Later, temperature increases, smoke is emitted, and then fire breaks out.

To enable offgassing detection at the earliest stage of a battery event after the initial abuse, the Li-ion Tamer system offers a battery off-gas monitor and sensor network designed specifically for lithium ion batteries.

Because the system can detect off-gassing at the ppm-level concentration range, it can detect individual cell failures



Given the expected growth in wind power coupled with the fact that most BESSs are designed by interconnecting a series of Lithium-ion (Li-ion) batteries, the industry is continuing to focus attention on measures designed to all-but-eliminate any potential for dangerous thermal runaway conditions. (Courtesy: Nexceris)

without contacting the cells. This enables action to prevent thermal runaway and its spread to adjacent cells as soon as a single battery cell begins to fail.

"There are hundreds, if not thousands, of (BESS) systems already deployed where single cell failure could result in loss of the system. So, the ability to detect cell failure before it results in thermal runaway — and stop it — could literally save the system, adjacent property, and human lives," said Nick Warner, an internationally recognized expert in energy storage safety, testing, and technology. Warner is principal engineer and founder of Warner Energy Storage Solutions and co-founder of Energy Storage Response Group.

"Early detection could help prevent thermal runaway before it starts, particularly those related to failure of the active primary control system," Warner said. "When I was involved with testing the Li-ion Tamer system, the earliest detection of imminent failure was 12 minutes before it occurred. For some of the most common failure modes, I've found that it offers the earliest possible warning of imminent failure, and I consider it a best practice technique."

▼ **The ability to detect cell failure before it results in thermal runaway — and stop it — could literally save the system, adjacent property, and human lives. ▼**

When working with Tier 1 providers, it is typical to have a well-integrated BMS with enough sensors to properly monitor various aspects of Li-ion usage, including the state of charge of individual cells and temperature in the system. However, this may not be the case when dealing with Tier 2 or 3 providers that sell batteries only and leave the BMS to the engineering, procurement, and construction (EPC) contractor.

"(Lower end, offshore) battery manufacturers have generally gone from monitoring every small cell group to having one thermocouple run an entire module, monitoring dozens of cells," Warner said. "As a result, the battery manage-

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A Li-ion specific system is designed to function as a network of sensors, which enhances its effectiveness in Li-ion off-gas detection. (Courtesy: Nexceris)

ment system is completely dependent on a voltage indication to detect any problems with the cells. But in many cases, voltage is not the perfect indicator of something potentially going wrong in the cell."

Even in the case of qualified Tier 1 battery suppliers, Warner recommends having an independent, redundant system such as an Li-ion Tamer. In the same way that seatbelts and airbags combined can reduce the risk of injury in a car crash, such an approach can help a qualified EPC integrate additional complementary safety measures into a safer, more comprehensive solution.

Warner notes that the detection system's sensitivity to Li-ion electrolyte off-gassing is much greater than traditional sensors for other kinds of gas monitoring.

"Most sensors that detect gases are either looking for a generic hydrocarbon gas or generic level of gas, and are only detecting at one physical location," Warner said. "The value of a Li-ion Tamer sensor is that it is specifically looking for the gas that is emitted from Li-ion batteries. It is incredibly sensitive and able to detect it at much lower levels than any other sensor."

Another advantage of such an advanced Li-ion specific system is that it is designed to function as a network of

sensors, which enhances its effectiveness in Li-ion off-gas detection. "Because it also allows multiple sensors to be deployed, it is much more effective at detecting gas as it disperses through the container. So, when off-gassing occurs, it is detected immediately, and an alarm is sent."

According to Warner, the Li-ion specific system is also more cost-effective than traditional fixed gas sensors.

"Typical fixed gas sensors are usually intended to have two or three installed and cost from \$1,500 to \$4,000 each," he said. "But they only measure at a certain point. If you want to extend that, you would need to buy and install 10 to 20. Then you would need to activate each individually to control the system, which adds to the cost." ↗

#### ABOUT THE AUTHOR

Steve Cummings is director of the Sensors Business Unit at Nexceris, a developer of gas sensors and monitors. The company worked with the U.S. Navy a decade ago to develop an off-gassing detection technology for li-ion BESSs that would later be commercialized in a product called Li-ion Tamer, compatible with all li-ion chemistries. For more information, contact Nexceris at 614-842-6606 or [nexceris.com](http://nexceris.com).



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