

*Giving Wind Direction*

# WIND SYSTEMS

## Systems, Components, & Parts

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OBO Bettermann of  
North America**
- **Siemens 7-MW Offshore  
Wind Turbine Reaches  
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## Company Profile: OBO Bettermann of North America

*For more than a century, OBO Bettermann has forged a reputation as a quality producer of components for the electrical installation industry.*

*By Anna Claire Howard*

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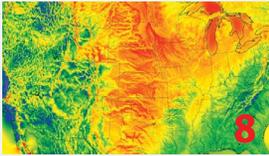
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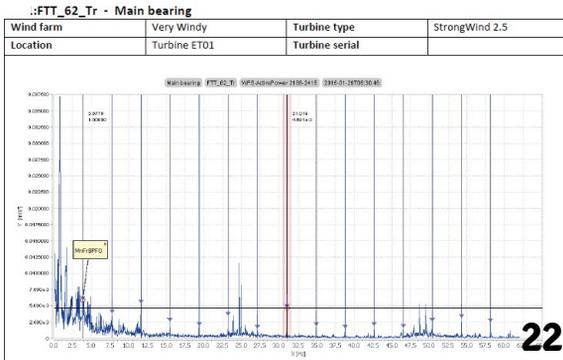
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GE's 6-MW Wind Generator To Accelerate Offshore Wind Growth



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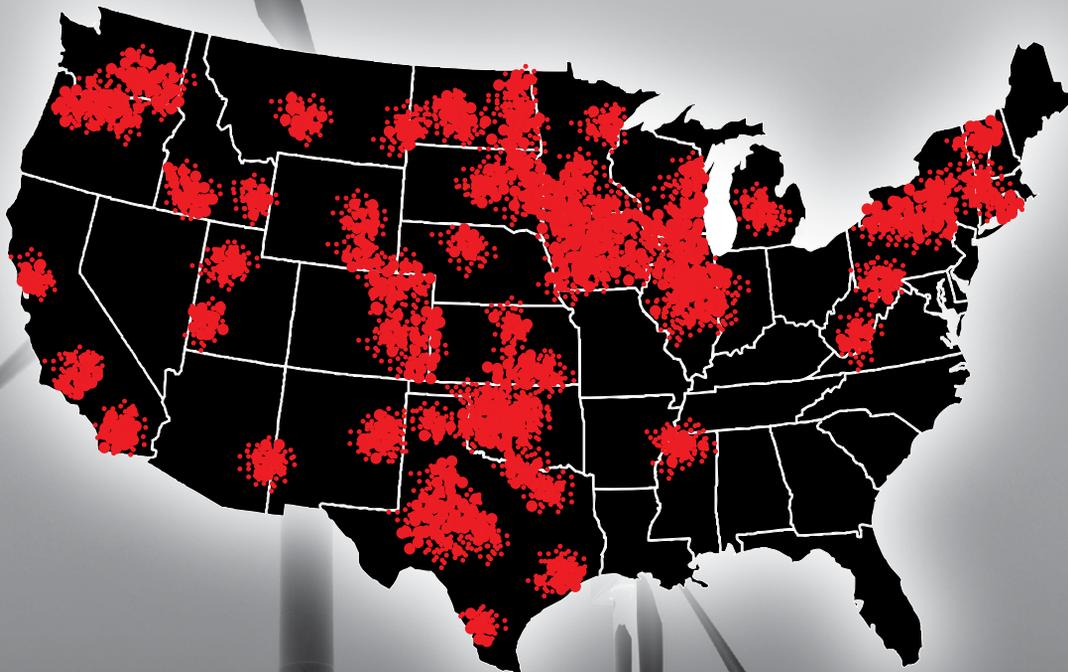
Wind Turbine Blades of the Future Could Be Recyclable



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# EDITOR'S DESK

MARCH 2016

While the prices of fossil fuels continue to decline, the clean energy industry is still booming, potentially heralding in a new age for wind energy development.

While oil prices have plunged to their lowest in 12 years at less than \$30 per barrel, making it easier on everyone's wallets at the pump, wind and other forms of renewable energy are growing, following Congress' extension of the federal production tax credit (PTC) in December 2015 for wind generators to include wind farms that are starting construction through the end of 2019. This competitiveness is new, since the last time oil was at this low price, the cost of renewable energy alternatives was much higher.

According to the American Wind Energy Association (AWEA), wind energy installed more electric generating capacity in 2015 than any other energy source in the U.S. Starting from a noticeably larger installed capacity base than solar, wind grew by 13 percent last year and is forecasted to continue to increase by 14 percent in 2016 and another 3 percent in 2017, contributing to the overall forecast of total renewables used in the electric power sector to increase by 8.1 percent in 2016 according to the U.S. Energy Information Administration (EIA).

Bloomberg New Energy Finance (BNEF) also recently published a new study in partnership with the Business Council for Sustainable Energy (BCSE) as a factbook about new energy technologies that have furthered critical advances in the U.S. and locked in long-term gains in 2015. According to BNEF, the fourth edition of the "Sustainable Energy in America Factbook" provides key facts and figures on the progression of the U.S. energy sector that concluded an estimated 8.5 GW of new build in wind capacity was installed in 2015 — 65 percent more than the same levels in 2014 as wind farm developers rushed to complete construction before the previous PTC expired.

This data is encouraging for the U.S. wind energy industry as it enters this new phase of operations in 2016 and in the years going forward, and it has us here at *Wind Systems* excited for what's in store.

This month's issue is dedicated to the systems, components, and parts that keep wind farms up and running. Our inFocus section features a company profile on OBO Bettermann of North America, a leading provider in meeting the high demands for quality and reliability in wind turbines and towers. You'll also find our conversation with Kyle Riegel, a research and design engineer at United Equipment Accessories, Inc., where we discuss the company's role as a leading slip ring assembly manufacturer in the wind market. Additionally, we feature a column by Bruce Bailey from AWS Truepower on the state of wind farm underperformance syndrome and ways to remedy it as well as articles from returning columnists Jeff Walkup of Gram & Juhl North America and Gordon Moran of the European Energy Centre who share their insights in their respective areas of expertise.

As always, thanks for reading!

*Anna Claire Howard*



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## FROM OUR ARCHIVES

### TURBINE COMPONENT SAFETY COMPLIANCE

A guide to avoiding costly missteps in component safety certification



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# DIRECTION

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## RAPID, AFFORDABLE ENERGY TRANSFORMATION POSSIBLE ACCORDING TO NEW STUDY

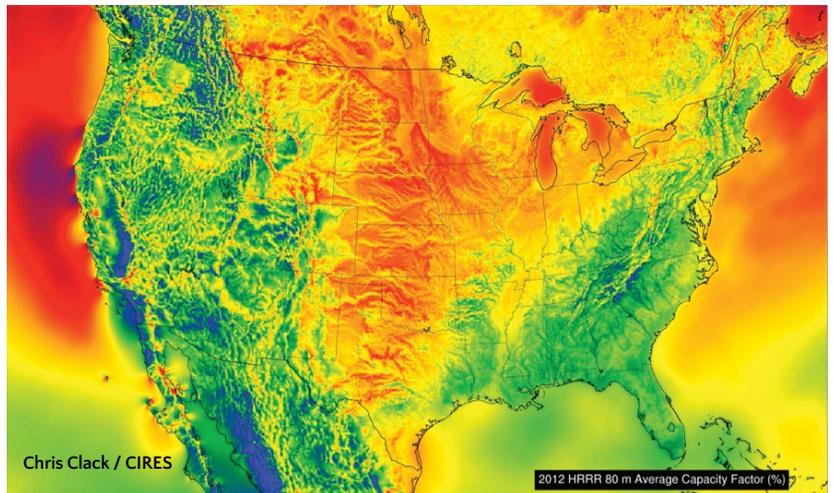
The United States could slash greenhouse gas emissions from power production by up to 78 percent below 1990 levels within 15 years while meeting increased demand, according to a new study by the National Oceanic and Atmospheric Administration (NOAA) and University of Colorado Boulder researchers.

The study used a sophisticated mathematical model to evaluate future cost, demand, generation, and transmission scenarios. It found that with improvements in transmission infrastructure, weather-driven renewable resources could supply most of the nation's electricity at costs similar to today.

"Our research shows that a transition to a reliable, low-carbon, electrical generation and transmission system can be accomplished with commercially available technology and within 15 years," said Alexander MacDonald, co-lead author and recently retired director of NOAA's Earth System Research Laboratory (ESRL) in Boulder, Colorado.

The paper was recently published online in the journal *Nature Climate Change*.

Although improvements in wind and solar generation have continued



A map based on NOAA weather data showing one measure of wind energy potential across the United States in 2012.

to ratchet down the cost of producing renewable energy, these energy resources are inherently intermittent. As a result, utilities have invested in surplus generation capacity to back up renewable energy generation with natural gas-fired generators and other reserves.

"In the future, they may not need to," said co-lead author Christopher Clack, a physicist and mathematician with the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado-Boulder.

Since winds are blowing (and the sun is shining) somewhere across the U.S. all of the time, MacDonald theorized that the key to resolving the dilemma of intermittent renewable generation might be to scale up the renewable energy generation system to match the scale of weather systems.

MacDonald, who has studied weather and worked to improve forecasts for more than 40 years, assembled a team of four other NOAA scientists to explore the idea. Using

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**10** Community Consent and Land Rights Key to Growth of Renewables

**11** Wind Energy Was a Top Source for New Electric Capacity in 2015



NOAA's high-resolution meteorological data, they built a model to evaluate the cost of integrating different sources of electricity into a national energy system. The model estimates renewable resource potential, energy demand, emissions of carbon dioxide (CO<sub>2</sub>), and the costs of expanding and operating electricity generation and transmission systems to meet future needs.

The model allowed researchers to evaluate the affordability, reliability, and greenhouse gas emissions of various energy mixes, including coal. It showed that low-cost and low-emissions are not mutually exclusive.

"The model relentlessly seeks the lowest-cost energy, whatever constraints are applied," Clack said. "And it always installs more renewable energy on the grid than exists today."

Even in a scenario where renewable energy costs more than experts predict, the model produced a system that cuts CO<sub>2</sub> emissions 33 percent below 1990 levels by 2030 and delivered electricity at about 8.6 cents per kilowatt hour. By comparison, electricity costs 9.4 cents per kWh in 2012.

If renewable energy costs were lower and natural gas costs higher, as is expected in the future, the modeled system would cut CO<sub>2</sub> emissions by 78 percent from 1990 levels

and delivered electricity at 10 cents per kWh. The year 1990 is a standard scientific benchmark for greenhouse gas analysis.

A scenario that included coal yielded lower cost (8.5 cents per kWh), but the highest emissions.

At the recent Paris climate summit, the U.S. pledged to cut greenhouse emissions from all sectors up to 28 percent below 2005 levels by 2025. The new paper suggests the U.S. could cut total CO<sub>2</sub> emissions 31 percent below 2005 levels by 2030 by making changes only within the electric sector, even though the electrical sector represents just 38 percent of the national CO<sub>2</sub> budget. These changes would include rapidly expanding renewable energy generation and improving transmission infrastructure.

In identifying low-cost solutions, researchers enabled the model to build and pay for transmission infrastructure improvements — specifically a new, high-voltage direct-current transmission grid (HVDC) to supplement the current electrical grid. HVDC lines that are used around the world reduce energy losses during long-distance transmission. The model did choose to use those lines extensively, and the study

found that investing in efficient, long-distance transmission was key to keeping costs low.

MacDonald compared the idea of a HVDC grid with the interstate highway system that transformed the U.S. economy in the 1950s.

"With an 'interstate for electrons,' renewable energy could be delivered anywhere in the country while emissions plummet," MacDonald said. "An HVDC grid would create a national electricity market in which all types of generation, including low-carbon sources, compete on a cost basis. The surprise was how dominant wind and solar could be."

The new model is drawing interest from other experts in the field.

"This study pushes the envelope," said Stanford University's Mark Jacobson, who commented on the findings in an editorial he wrote for the journal *Nature Climate Change*. "It shows that intermittent renewables plus transmission can eliminate most fossil-fuel electricity while matching power demand at lower cost than a fossil fuel-based grid — even before storage is considered." ↵

— Source: *Cooperative Institute for Research in Environmental Sciences (CIRES)*

For more information, go to [www.cires.colorado.edu](http://www.cires.colorado.edu).

## COMMUNITY CONSENT AND LAND RIGHTS KEY TO GROWTH OF RENEWABLES

According to a recent announcement by the nonprofit organization Equitable Origin (EO), conflicts over land rights and consultation with local communities present mounting risks to the global expansion of renewable energy. The announcement accompanied the organization's release of a case study on wind development in the Mexican state of Oaxaca, which is fraught with resistance from local and indigenous communities. The case study, "Defining and Addressing Community Resistance to Wind Development in Oaxaca," is available for download from the Equitable Origin website.

Community protest and a delayed wind energy project in Oaxaca represent a broader trend, according to EO's CEO Soledad Mills.

"Because most utility-scale renewable energy projects require vast areas of land, they carry a high likelihood of causing conflicts over land rights and land use, in addition to other local-level social and environmental impacts," Mills said. "As the important global push toward renewable energy ramps up and development expands to new parts of the globe, the potential for conflicts that delay projects and increase costs will grow."

Mills also said that developers of and investors in renewables projects have a unique opportunity to avoid the pitfalls of the past 100 years of energy development.

“The risks to renewables projects presented by land rights conflicts and community opposition are manageable, but if ignored, they could bring about a slow-down in renewable development at a time when the world needs it most,” Mills said. “Credible, independent standards for observing land rights and productively consulting with local communities can streamline projects and facilitate the rapid development that’s required to achieve climate goals and meet growing demand for clean energy.”

Mills added that EO’s case study on conflicts in Oaxaca offers insights into how to address them in other parts of the world.

“Our recommendations in the study for more inclusive, complete, and culturally sensitive engagement efforts can lead to better outcomes for communities and more efficient project implementation,” Mills said. “EO’s voluntary, community-oriented EO100 standard for responsible energy development, associated services, and experience in engagement with local and indigenous communities can help identify and implement best social practices with project stakeholders.”

According to Mills, the global renewable energy boom that received a major boost from the COP21 agreement offers great hope for mitigating climate change as well as an opportunity to raise the bar for social practices.

“At this exciting historical moment when there has never been more focus on combating climate change, we can facilitate efficient renewable energy development while ensuring that the benefits of a safer, cleaner energy future are shared with local and indigenous communities,” Mills said. “Now is the time for communities, companies, regulators, investors, and NGOs



[non-governmental organizations] to come together in support of responsible renewable energy development, in Mexico and around the world.” ↴

— Source: *Equitable Origin*

For more information, go to [www.equitableorigin.org](http://www.equitableorigin.org).

## WIND ENERGY WAS A TOP SOURCE FOR NEW ELECTRIC CAPACITY IN 2015

Wind energy installed more electric generating capacity last year than any other energy source in America.

The 8.6 GW of wind power capacity installed surpassed the 7.3 GW of new solar photovoltaic capacity and 6 GW installed by natural gas, according to data

from the American Wind Energy Association (AWEA) and the recently released Business Council for Sustainable Energy (BCSE) and Bloomberg New Energy and Finance (BNEF) 2016 Factbook. Wind accounted for more than 35 percent of new generating capacity, while all renewable resources

together provided 68 percent of the new capacity, according to the factbook.

“Wind’s growth is being propelled by cost reductions of two-thirds over the last six years, which now makes wind the lowest-cost source of new generation,” said Tom Kiernan, CEO of AWEA,

at the annual winter meeting of the National Association of Regulatory Utility Commissioners (NARUC) in Washington, D.C. “It’s one of the biggest, fastest, and cheapest ways we can reduce U.S. carbon emissions, and it’s the low-cost solution for power sector reductions. Utilities and other purchasers are turning to wind energy because it provides stably-priced energy with no fuel price risk and protects consumers by creating a more diverse energy portfolio.”

After a strong finish last year, wind energy is off to a good start in 2016 with an additional 9.4 GW under construction, an additional 4.9 GW in advanced stages of development, and a predictable federal production tax credit for the next several years.

“With long-term policy certainty in place, wind power is ready to keep this American success story going,” said Mike Garland, CEO of Pattern Energy and current AWEA board chair. “Further investments in our technology will enable utilities to cut costs and pass on the savings to American homeowners and businesses.”

According to Chris Brown, president of Vestas Americas, these impressive results drive home the point that wind is a cost-effective solution that makes business sense.

“More than 500 wind industry factories in 43 states are turning out taller turbines, longer blades, and other components that capture more energy, helping further drive down our costs and opening up new parts of the country for utility-scale wind farms,” Brown said.

When the U.S. Supreme Court put a temporary stay on certification of state plans under the federal Clean Power Plan, states and utilities continued to develop solutions to reduce carbon pollution from fossil power plants. Many utilities

have already indicated that the stay will not affect their planned generation changes. Many recognize that carbon reductions are inevitable, and the Supreme Court has already affirmed in multiple rulings that the EPA has the authority and obligation to regulate greenhouse gas emissions.

In a recent statement in which Xcel Energy said that it plans to invest \$6 billion in wind and solar energy, the company also said that while the Supreme Court’s ruling is a significant development in this case, the merits of the case have not been decided and the legal proceedings will continue.

“Xcel’s analysis of the strategy, which speeds up wind and solar investment in this decade, shows it to be a cost-effective way to reduce greenhouse gas emissions by 60 percent by 2030 — likely beyond Minnesota’s requirements under the Clean Power Plan,” said Laura McCarten, regional vice president for Xcel.

After the stay, Xcel said it would continue to work with states and stakeholders on plans “to create sustainable and affordable energy futures... This approach will not only ensure compliance with existing and new regulations, but also take advantage of new technologies, recognize evolving customer needs, and continue to drive improvements in how we produce and deliver energy.” Grid operators such as PJM Interconnection have also indicated that they plan to proceed with planning to accommodate the Clean Power Plan, as have many states.

With wind energy costs at an all-time low and the recent extension of key federal tax incentives for wind and solar, a new analysis using a Department of Energy modeling tool concludes that the tax extenders allow states to meet

pending carbon dioxide regulations almost exclusively with zero-emitting renewables.

Zero-emission wind energy also provides states and utilities with more flexible options for reducing pollution, relative to energy sources with some emissions that would require the replacement of far more existing generation to achieve the same level of emissions cuts.

### WIND POWER CUTTING COSTS

The rapid growth of renewables and the continued retirement of coal plants have not significantly impacted retail prices, according to BCSE and BNEF’s 2016 Factbook, which reported that retail electricity rates across the country remain 5.8 percent below the recent peak (2008).

Innovations by the wind industry have helped lower wind power’s costs by two-thirds in the last six years, as shown by the Lawrence Berkeley National Laboratory. The Wall Street investment firm Lazard also found a cost decline of more than 60 percent and notes that wind energy is the lowest-cost energy source for reducing emissions, even before tax incentives.

MidAmerican Energy recently obtained approval from the Iowa Utilities Board for the addition of 1,050 MW of wind energy in Iowa, for example. The expansion is planned to be built at no net cost to the company’s customers and will help stabilize electric rates over the long term by providing a rate reduction totaling \$10 million per year by 2017 with a \$3.3 million reduction in 2015, according to MidAmerican.

When Southern Company’s Alabama Power made its first wind power purchase, it said that the price of energy from the wind facility is expected to be lower than

the cost the company would incur to produce that energy from its own resource with the resulting energy savings flowing directly to the company's customers.

"The levelized cost of energy (LCOE) from wind has fallen dramatically in recent years," said David Engels, senior manager of operations renewable asset strategy for Alliant Energy and session chair for utility issues during this year's Windpower event in New Orleans from May 23 to 26. "Increases in overall turbine efficiencies coupled with reduced turbine costs have made wind competitive with alternate sources of generation. Independent power producers and utilities alike continue to evaluate and make investments in their wind portfolios."

### WIND POWER HELPING UTILITIES KEEP THE LIGHTS ON

With today's installed capacity, wind energy produces enough electricity to power more than 19 million U.S. homes.

Iowa, South Dakota, and Kansas all source more than 20 percent of their annual electricity from wind. Wind power already provides a total of nine states with 12 percent or more of their annual electricity production.

The Electric Reliability Council of Texas (ERCOT), the primary grid operator in Texas, has seen wind reliably meet as much as 44.7 percent of its electricity demand at certain points in time, peaking at 13,883 MW in December 2015. Wind supplied 18.4 percent of ERCOT's total demand for the full month of November 2015 and surpassed nuclear as the third largest source of generation in ERCOT for all of 2015. Wind has supplied as much as 12,720 MW in MISO, the grid operator for parts of 12 Midwest states. Last December,

wind production hit 9,948 MW in the Southwest Power Pool (SPP), the grid operator for all or parts of eight states. On the main Colorado grid, wind provided 66.4 percent of the electricity at one point in November 2015. These real-world examples demonstrate how utilities are reliably integrating large amounts of wind energy today.

However, barriers remain to spreading wind energy's low-cost benefits to all corners of the country. Access to sufficient transmission infrastructure will be an important catalyst for future growth of wind energy. Analyses by grid operators SPP and MISO confirm that transmission provides billions of dollars in net benefits to consumers by reducing costs and improving reliability, by gaining access to America's best wind resources.

The Department of Energy's (DOE) Wind Vision report shows a path for wind power to double in the next five years and supply 20 percent of U.S. electricity needs by 2030, creating tremendous economic and environmental benefits along the way. Consumer savings from wind are projected to reach \$14 billion a year by 2050, with cumulative savings on electricity bills reaching \$149 billion.

2015 ranks as the third highest year for wind installations on record. American wind power has installed as much as 13,124 MW in a single year (2012) when wind also was the largest source of new electrical generating capacity as it was last year. ↴

— Source: AWEA

For more information, go to [www.awea.org](http://www.awea.org).

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## inFOCUS

## Profile: OBO Bettermann of North America

*For more than a century, OBO Bettermann has forged a reputation as a quality producer of components for the electrical installation industry.*

*By Anna Claire Howard*

**W**ind-generated power has long been established as a continuous source of renewable, clean energy. Modern high-performance wind power systems result in high demands for the quality and reliability of the components and parts that are used. The electrical infrastructure in particular plays a crucial role in the functional safety of the entire system.

That's where OBO Bettermann of North America comes in.

With its parent company founded in Germany in 1911 by Franz Bettermann as a sheet metal factory for fastening technology, OBO Bettermann — derived from the German term “ohne bohren,” meaning without drilling — has made a name for itself in the wind industry, like all the industries it serves, by providing parts that incorporate the company's innovative thinking and its eye for high-quality value to both engineers and installers, all the while maintaining family ownership. According to Dennis Boone, the general manager at OBO Bettermann of North America, Inc., this is the key to the company's success over the last 100 years.

“Our customers have come to know us as both a company and a partner,” Boone said. “Many of the top wind

tower manufacturers from across the world are customers that have grown alongside OBO over the last century and even more recently. These relationships have given OBO the opportunity to supply cable management as well as surge and lightning protection products to today's most trusted wind tower manufacturers.”

OBO Bettermann has more than 3,000 employees in 60 countries and 40 subsidiaries with its global headquarters in Menden, Germany, and its North American headquarters in King of Prussia, Pennsylvania. According to Boone, a number of the 40,000 parts offered by the company were designed with the wind industry in mind. OBO Bettermann provides complete solutions for all of the electrical equipment for said wind power systems, from clamp clips and cable support systems to surge protection and lightning protection systems. It's able to offer the experience of a systems provider that is seasoned with working on global large-scale projects.

“Our products can be found in every aspect of the electrical infrastructure of the wind tower from the blade to the base,” Boone said. “Magnetic peak current sensor (PCS) cards installed in the blades can record pulsed or lightning currents. In the base, surge arrestors

protect expensive electrical equipment from damaging surges, and our equipotential bonding systems run through the foundation and up the tower to safely reduce lightning and current potential. Keeping the tower properly grounded, making sure cable trays can be easily accessed, and protecting against surges can all assist in lowering the amount of service required and reducing some of the risk associated with service and installation.”





OBO Bettermann's cable trays and cable ladders in the base of a wind tower

With more than 100 years of experience under its belt, the company is able to offer comprehensive solutions for the entire tower, from the turbines to the foundation, and it has learned that each project will have its own particular conditions and requirements for technical equipment.

“OBO Bettermann’s consultants and developers know exactly what is required and include important requirements with regard to type

class, location, control technology, and safety into the planning and construction processes from the start,” Boone said. “We have an excellently equipped testing center available, as well as a modern, flexible production facility. Here, not only are standard products tested, but so are special solutions for large-scale projects with exceptional requirements.”

The capabilities OBO Bettermann offers for wind turbines include mea-

## ALSO IN THIS SECTION

- 18** Siemens 7-MW Offshore Wind Turbine Reaches Final Stage in Development Process
- 20** Conversation: Kyle Riegel – United Equipment Accessories, Inc.

surging and test systems, junction box systems for safe IP protection of electrical cabling, cable and pipe fastening systems for vibration-proof routing of lighting and auxiliary current circuits, metal and plastic pipe systems, interception and arrestor systems, surge protection energy technology, surge protection data and information technology, mounting systems to support high cable loads, and mesh cable tray systems.

As far as what it offers for the tower, OBO Bettermann provides rail systems to accept single to triple clamp clips, clamp clip systems for vibration-proof routing of power and data cables, vertical cable ladder systems with matching wall brackets, equipotential bonding systems to optimize the shield action of individual data cables and connect tower segments in a way that reduces the impact of lightning, and fire protection systems.

For the base of the tower, OBO Bettermann offers surge protection energy technology, surge protection data and information technology, metal and plastic cable fastening systems, a wiring duct to route cables in the control cabinet in an organized way, equipotential bonding systems, and earthing systems to connect the reinforcement with the equipotential bonding.

OBO Bettermann's earthing systems for the foundation of the tower include diagonal clamps for the connection of reinforcing bars and flat conductors, diagonal clamps with welded bolts to connect additional earthing cables, bitumen corrosion protection bandage to protect the earth entry at the transition point to the concrete, flat conductors made of galvanized or stainless steel, and stainless steel cross-connectors to safely attach the flat conductor to the crossing points.

Innovation has been the key to OBO Bettermann's success across

the wide range of industries it serves, but this has been especially so in the wind energy industry where continuous development and technological advances are crucial.

"Our engineers and product development teams are consistently working to improve our existing products and develop new ideas and solutions

to current and future challenges facing every installer and designer," Boone said. "Our challenges are usually met when assisting customers at the design and build level. Specially modified parts to meet designer specifications or to fit exact layout requirements are daily struggles for industry partners looking to source



OBO Bettermann's MCF lightning arrestors installed in a wind turbine



RePower wind towers in Portugal's Vale Grande Wind Farm

OBO Bettermann of North America



RePower wind towers in Portugal's Vale Grande Wind Farm

material. We're always up for the challenge of assisting these companies to find exactly what they are looking for."

OBO Bettermann parts are found in a large number of the most widely used wind tower designs, according to Boone, and the company offers O&M contractors replacement parts for maintenance or services should they need them, as well as alternatives for outdated parts or parts that were originally supplied by other manufacturers.

Looking to the future, Boone said he expects the wind energy industry to see a continued dedication to

innovation from OBO Bettermann and its products.

"We have a positive outlook for the wind industry," Boone said. "It has proven itself to be a valuable tool in helping meet the energy production needs of this country, and many jobs and companies rely on the wind industry for work. It's even bigger now than just the positive impact it has on the environment. OBO Bettermann has benefited from the industry's expansion and continues to rely on the stability of this industry." ↵

For more information, go to [www.obous.com](http://www.obous.com).

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## SIEMENS 7-MW OFFSHORE WIND TURBINE REACHES FINAL STAGE IN DEVELOPMENT PROCESS

The development of Siemens' 7-MW offshore flagship wind turbine has successfully passed final type certification. Field testing of the SWT-7.0-154 was recently extended with a second prototype. Grid performance, quality, and safety are currently being tested on both machines.

Obtaining type certification marked the final milestone in the development process, allowing customers to make final investment decisions for offshore projects. Since many of the technological components in this new turbine are the same as those of the proven Siemens SWT-6.0-154 — including the 154-meter rotor — serial production is scheduled to begin in fall 2017. While the first prototype that was installed in summer 2015 was initially used for achieving the final type certificate, engineers are now able to use both prototypes for accelerated testing of all grid-related aspects such as performance, quality, and safety. As the upgrades in the turbine consist mainly of changes to the permanent magnet generator, the power converter, and medium voltage transformer, the startup of both SWT-7.0-154 prototypes ran smoothly.

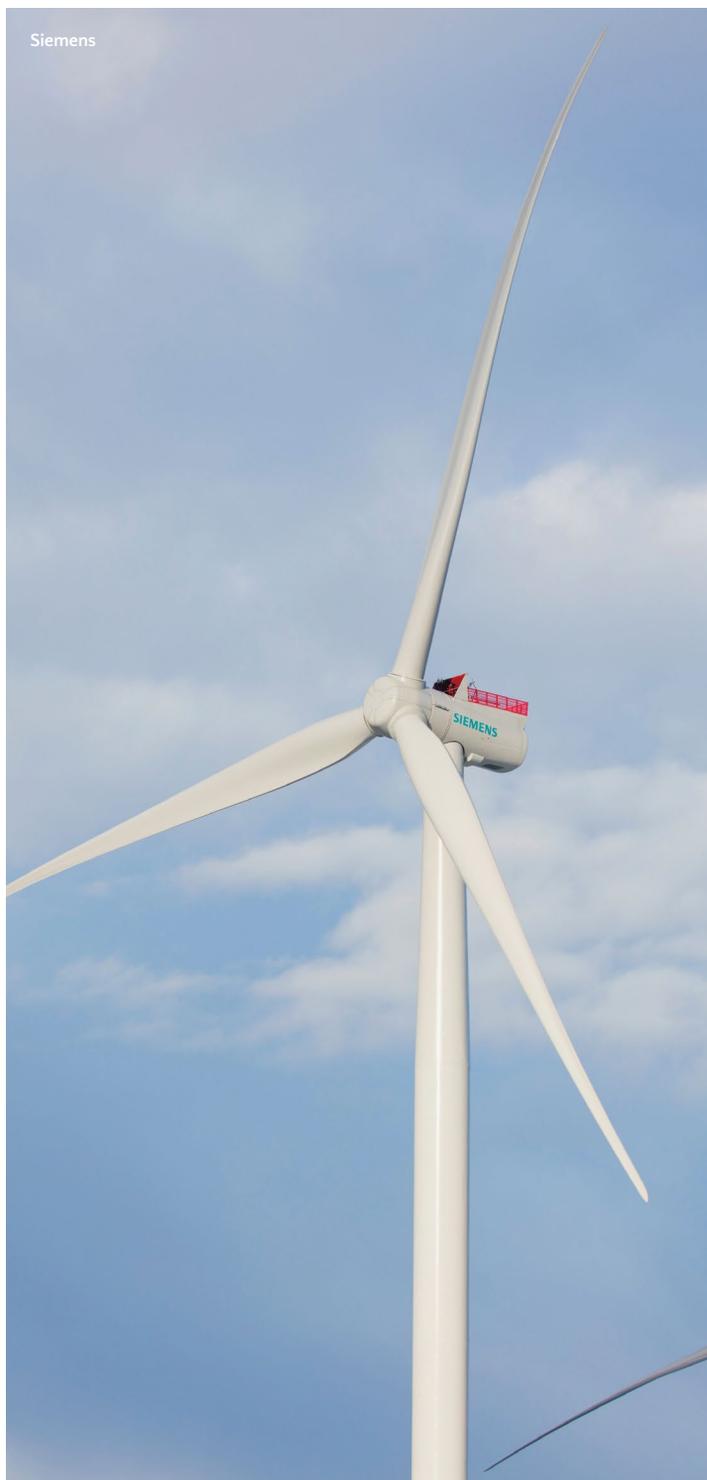
Whereas the generator's permanent magnets and segments as well as the transformer upgrades are required solely for the higher output requirement, the upgraded Siemens integrated control system (SICS) with enhanced power converter provides even more flexibility in the turbine response to voltage and frequency while also enabling compliance with the strictest international grid code requirements.

"The development of our SWT-7.0-154 has reached the final stage, and we are well on track," said Morten Rasmussen, head of technology at the Siemens Wind Power and Renewables Division. "We are proud to see our customers welcoming the upgrade, and, ultimately, it is our customers who will benefit from these improvements. Serial production will be ramped up in fall 2017."

First orders are already in place for the new project, as well as the Walney Extension East project in the U.K., to be installed in early 2018. Siemens direct drive wind turbines feature a proven and reliable technology with a long-term track record. Over 1,100 of the gearless Siemens wind turbines have been installed since 2010, and more than 60 of them are in operation offshore.

— Source: Siemens

For more information, go to [www.siemens.com/wind](http://www.siemens.com/wind).



Two prototypes were installed in Osterild, Denmark, to run comprehensive product tests of the 7-MW offshore wind turbine.



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## CONVERSATION

**Kyle Riegel**

Research and Design Engineer  
United Equipment Accessories, Inc.

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 United Equipment Accessories

 1-800-394-9986

 www.uea-inc.com



**Please give us a brief history on the company. How did United Equipment Accessories make a name for itself in the wind energy industry?**

Vern Iserman founded United Equipment Accessories (UEA) in 1952 as a small manufacturing operation out of his garage in Waverly, Iowa, with its initial roots in the construction industry. Our original product was a component remote control kit that was used to remotely operate truck-mounted cranes and excavators from the rear cab. Schield Bantam, now known as Terex Cranes, was located just down the road and was the company's first customer. They needed a more reliable slip ring with an electrical rotary joint, so they contacted Vern to make that happen. The rest is history.

Our path into wind wasn't so different from our beginnings serving

the construction industry. We heard complaints from wind farm owners and operators of their slip rings from other suppliers having issues, so we started to supply our slip rings to the aftermarket. Eventually, OEMs heard about our success, and we were able to supply our products to the turbine OEMs.

We now have slip ring assemblies installed in wind turbines in parts of Europe, India, China, and, of course, all across the United States. I believe we have approximately 14,000 slip ring assemblies in the field to date just for turbine use. All of our products are manufactured and assembled at our single site location based in Waverly, and we have approximately 130 employees total.

**What is the company's chief mission to the wind industry and its customers?**

Simply put, we want to succeed where others have failed. To me, an ideal project involves a potential customer coming to us with a problem and then working with our engineering team to get them a solution.

**Tell us about the range of products that UEA offers the wind energy industry.**

For the wind industry, we manufacture slip ring assemblies primarily used as a component of the pitch control system to provide power and

data communication to or from the stationary tower to the rotary hub. We also provide slip ring products for power transmission through the yaw of the turbine. We have more designs available now than ever before, and we specialize in custom products, meaning we can provide a slip ring for just about any application.

**How can those involved in the wind energy industry (such as wind farm owners and operators) benefit from working with UEA?**

The major benefit of partnering with UEA is that just about anyone working with our product can get in touch with an engineer, like myself, who has a history with the product. Cutting out some of the excess lines of communication allows us to quickly diagnose and solve problems. For example, earlier this year, we were contacted by a site manager for a job, and we were able to be at that wind farm within four days of the call and have conversations with the site manager and technicians face-to-face. We were contacted about the issue on a Thursday afternoon, and we were on a flight that following Sunday and climbing a wind tower at the site that was located more than 1,000 miles away by Monday, essentially one business day later. It sounds simple, but it is extremely helpful because if there is an issue in the field, the very

“ We have more designs available now than ever before, and we specialize in custom products, meaning we can provide a slip ring for just about any application. ”

person experiencing the problems can get in direct contact with someone like me who can implement a design to solve the issue at hand. The wind industry can expect us to continue this level of customer service going forward.

**Tell us about your role in the company and in engineering these components, and how you got involved in the wind energy industry.**

I joined the company in 2011 for research and development purposes, and that led me to the wind industry. Our product had 50-plus years of proven experience in other industries, yet we were still as new as the wind industry was at the time. In 2013, I became part of a team that developed a new proprietary brush grade, pushing the life of the product up to 200 million revolutions. One of the main focuses of my position is to continue to improve the life and reliability of our slip ring products.

**How does UEA set itself apart from other manufacturers like it in the wind industry?**

Our customer service, along with our ability to provide a customized solution to a customer with the best form fit and function, as well as industry-leading technology allow us to stand out.

**What is your outlook on the wind market following the recent five-year PTC extension and going into 2016? What does this stability mean for UEA, and what can the industry expect to see out of the company going forward?**

The PTC extension is crucial for the industry. I believe it will help the industry become more competitive with oil and other nonrenewable energy sources. At UEA, we expect to see growth in the domestic wind market. As far as what to expect from UEA — continued reliability and great customer service. ↴

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# MAINTENANCE

Operations • Service & Repair • Inspection • Safety • Equipment • Condition Monitoring • Lubrication

## CONDITION MONITORING: VIBRATION ANALYSIS SHOULD NOT BE INTIMIDATING

By Jeff Walkup

Vibration analysis is the most widespread monitoring technique used in wind turbines, and on a typical basis, it is the first and primary technology that operators tend to refer to. It is applied to rotating components — in particular, the main bearing, gearbox, drivetrain, and generator — where the direct and indirect costs of failure can be critical to O&M budgets. Signals from vibration sensors are monitored in real time using software-based techniques, such as Fast-Fourier Transforms, and can be compared against a signal recorded during known healthy running operations, which, in many circles, is referred to as a machine fingerprint. Complex algorithms are then established over a predetermined time with the goal in capturing said faults and other anomalies before substantial damages can develop or occur. It is here when the other technologies — such as the oil and grease analysis, filter examinations, and detailed inspections (including the use of borescopes) — confirm which

### Event Report

TCM® Monitoring

#### Main Bearing (MnFr): Outer race fault (BPFO)

Health Indicator	Description	Report Date	Author
80	(040) Component severely affected.	12/07/2015	

#### Recommended Action

Description	Action	Time for reaction
Clear and severe outer race fault on the main bearing. Trend shows further increase. Exchange of component expected.	Visual inspection of bearing and grease	< 14 days

#### !::FTT\_62\_Tr - Main bearing

Wind farm	Very Windy	Turbine type	StrongWind 2.5
Location	Turbine ET01	Turbine serial	

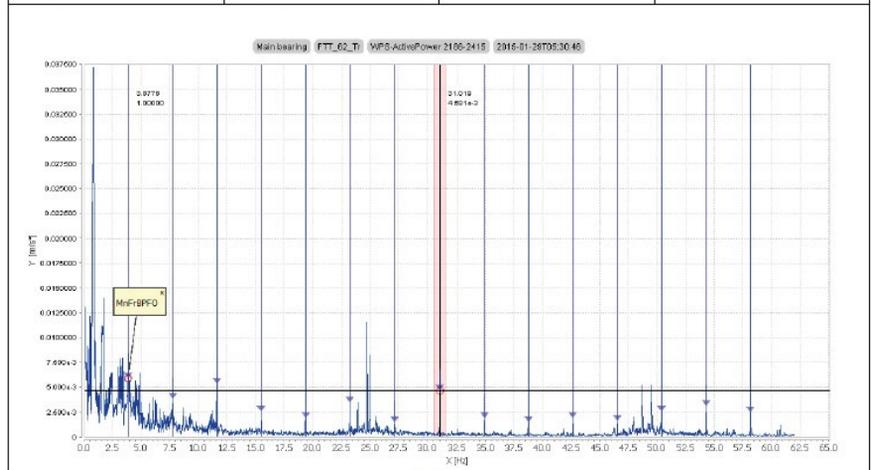


Figure 1

BPFO with distinctive harmonics.

### ALSO IN THIS SECTION

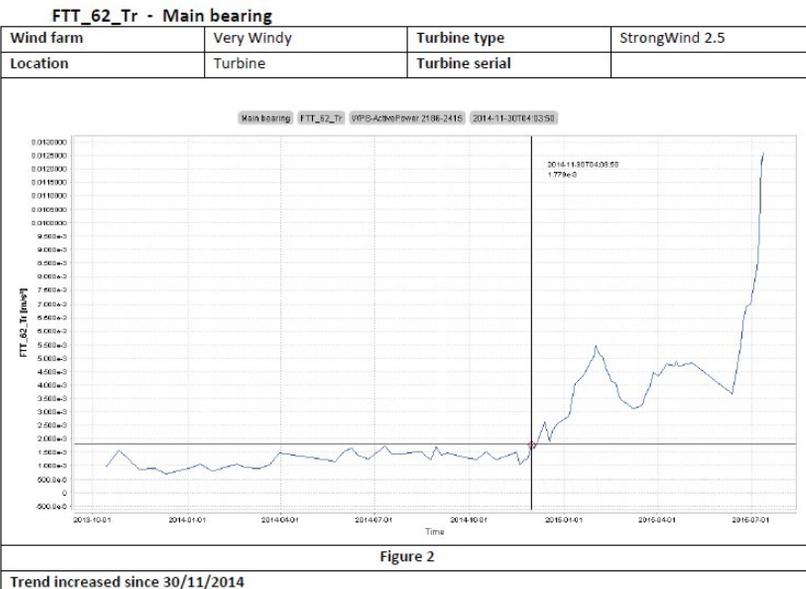
- 25 The State of Wind Farm Underperformance Syndrome

Event Report

vibration has been detected and can be employed. Analysis can help to identify defects in these components, allowing maintenance timings to be anticipated, especially when used in conjunction with historical data on past failures.

These windows for repairs can therefore be scheduled long before the risk of catastrophic failure and are often fitted into periods of low wind conditions when generation losses can be kept to a minimum. Wise and savvy reliability engineers and managers are constantly aware of the staggering amounts of data captured and recorded ultimately at their disposal in an ever-increasing arsenal of tools designed to assist in proactively addressing these failure modes before a catastrophic event occurs. With the number of turbines approaching end-of-service warranty, a great deal of opportunity awaits companies that are able to approach O&Ms with the ability to offer these tools to them that were most likely utilized by the OEM and their dedicated service providers only days and months before. In my experience, I have witnessed a gap in monitoring responsibility and the lack of a detailed plan for monitoring transference many times. Having said this, many reputable organizations exist in the world of condition monitoring (CM). End users are able to employ a plethora of tools, using a variety of companies and vendors, as well as in-house resources.

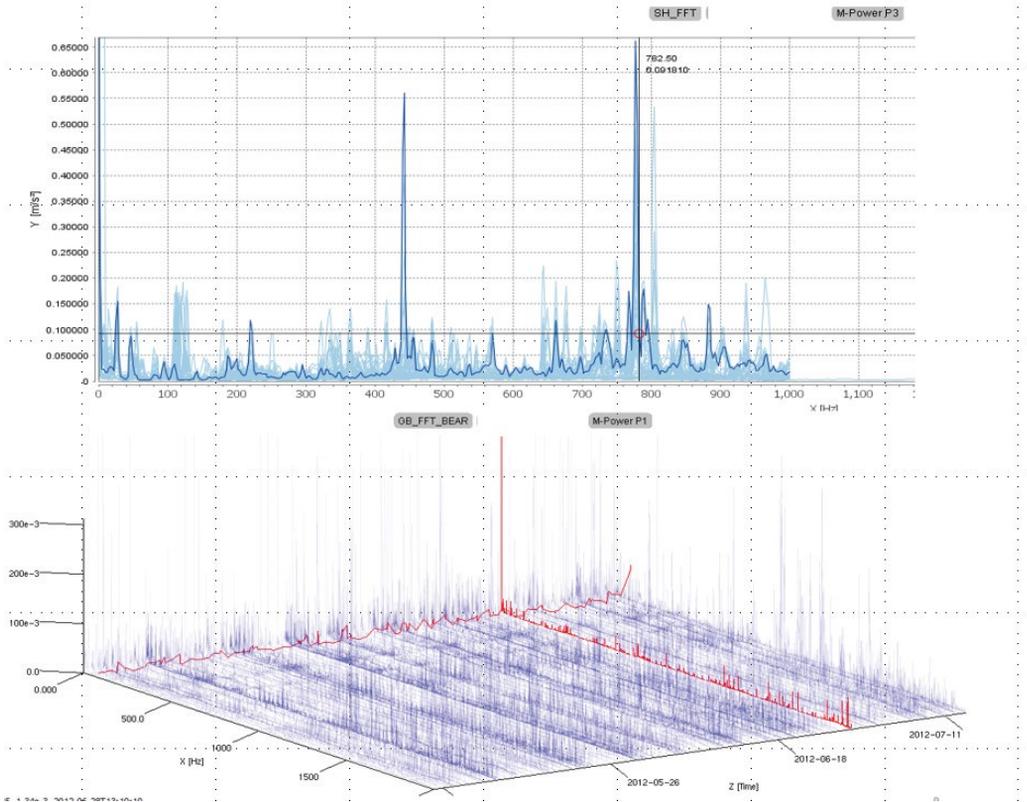
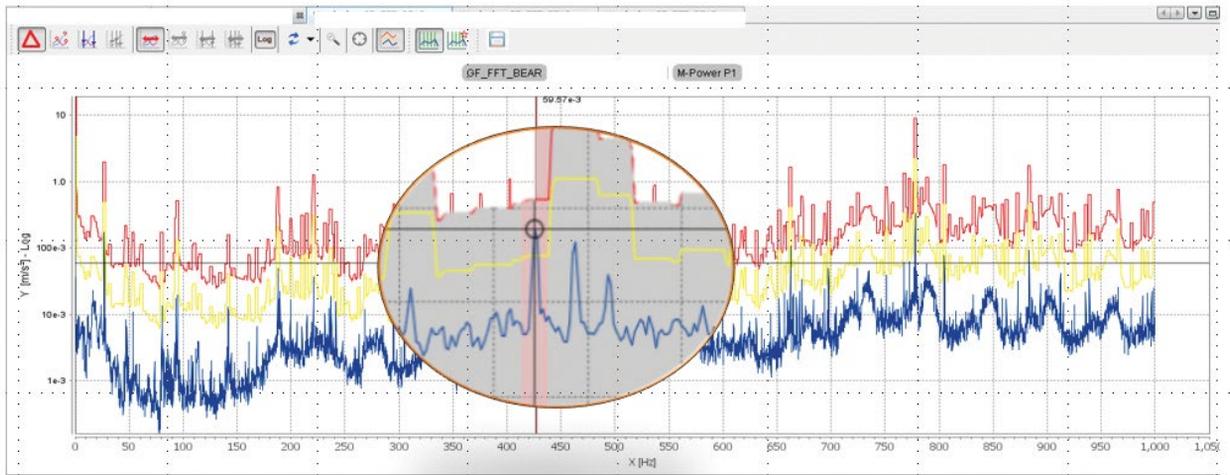
Many would agree there are a hundred ways to approach condition monitoring (CM) with the sky being the limit in the ways to track and report incidents discovered. To illustrate, I have added a few examples with all identifying information removed that showcases the value-added information that can be in the palm of your hands. The following questions remain: Are you using it, is it available, do you understand it, and are you willing to pay for it?



Property List of Measurement			
Condition	WPS-ActivePower 2186-2415	ConfigurationName	
Data Points	85	First Time Stamp	2013-10-14T12:55:07
Last Time Stamp	2015-07-12T09:50:00	Measured RPM	1441.826294
Trend Bound Lower	30.515625	Trend Bound Upper	31.523125
WPS-ActivePower	2315		

Name	Sensor	Severi...	Source	Typ
SL_800Lines	MB		Time	Spec
SK_1500Lines	MB		Time	Spec
SK_3700Lines	MB		Time	Spec
SK_6400Lines	MB		Time	Spec
SK_17800Lines	MB		Time	Spec
Kurt_HP	GF		TMC_HP	kurtf
Kurt_HP	GB		TMC_HP	kurtf

Operational Values	Value
Measured RPM	1381.209351
M-Power	320.16
overheat warning	0
bias warning	0
bias voltage (V)	11.4
Binning Parameters	
M-Power-Average	320.16
M-Power-Minimum	320.16
M-Power-Maximum	320.16



CM is based on advanced signal analysis on various signals such as vibration, strain, and process signals in combination with automation rules and algorithms for generating references and alarms. The system has a high degree of built-in automation presenting the conditions and alarms in a condensed form to the operator. An expert has the possibility to dig

into measurements and alarms by using an advanced data mining tool. Configuration of the system is based on a template philosophy, so it is possible to configure a large number of wind turbines in one operation. Alarm limits are automatically generated by the system based on expert rules. In addition, the overall system has a system daemon, watching and

ensuring that all parts are up and running, which is important in the reduction of human intervention.

Many years ago, I realized the value of vibration analysis and the information it can represent. Taking the time to educate ourselves in vibration analysis and applying that method on the job opens up a world of potential. ↵

# THE STATE OF WIND FARM UNDERPERFORMANCE SYNDROME

By Bruce H. Bailey

It is fair to expect that the energy output of an operating wind farm should be close to what it was designed to produce. If the wind conditions for a particular site are well-measured and the selected turbine is a well-known model, then logic would conclude that the energy prediction process is fairly straightforward. But is this an oversimplification? Industry experience has shown that it is, since the majority of operating wind farms don't meet their predicted P50 energy values in an average year.

The “underperformance syndrome” has been well-known within wind energy circles for years (recognizing that it could also be called the “overprediction syndrome”). The reasons for the phenomenon are now reasonably understood, but this wasn't the case 10 years ago. At that time, wind farms were falling short in production on average by roughly 10 percent relative to pre-construction estimates made several years earlier. Significant progress in both wind farm diagnostics and modeling techniques has reduced the observed energy shortfall by more than half for most modern projects. So, while the gap has narrowed, why hasn't it disappeared altogether?

## ORIGINS OF PRODUCTION SHORTFALLS

First, let's look at the forces behind the original shortfalls and how they've been addressed. In the late 1990s and early 2000s, the wind industry was primarily focused on development and did not have the sophisticated wind farm operations management systems that are in place today. Still in the emergent phase, the industry hadn't yet built the critical mass of operational history needed to signal a widespread underperformance problem.

There was a communications problem, too. The development and operations sides of many wind energy companies effectively operated as separate businesses with differing motivations. A company team responsible for getting projects developed had little interaction with the team responsible for construction and operations, so there was little opportunity for constructive feedback. Even third-party contractors involved in making pre-construction estimates of future energy production were kept in the dark about how the wind farms they had a hand in designing were actually performing. Performance and maintenance data was closely held and not shared outside the company.

## TODAY'S WIND INDUSTRY

The industry has since matured. There is a much larger base of operational experience now available, and com-

munications on performance issues are more open. Once wind plant performance data became more widely shared, it was quickly learned that the main contributors to the underperformance syndrome were higher-than-expected losses related to wind farm availability and sub-optimum turbine performance. Lesser factors included larger-than-modeled wake losses and unrepresentative wind resource data.

In the early days, a wind plant's availability was often predicted to be around 97 percent or equal to the contractual or warranted value established between the developer and the turbine supplier. This assumption overlooked non-contractual availability factors, such as the impacts of high-wind events or delays in getting spare parts. Occasional grid outages were also ignored. And, due to teething issues, first-year availability was typically lower than in later years. Current estimates for availability losses — as verified by wind farm data — are far more encompassing and average around 6 percent for a typical wind farm.

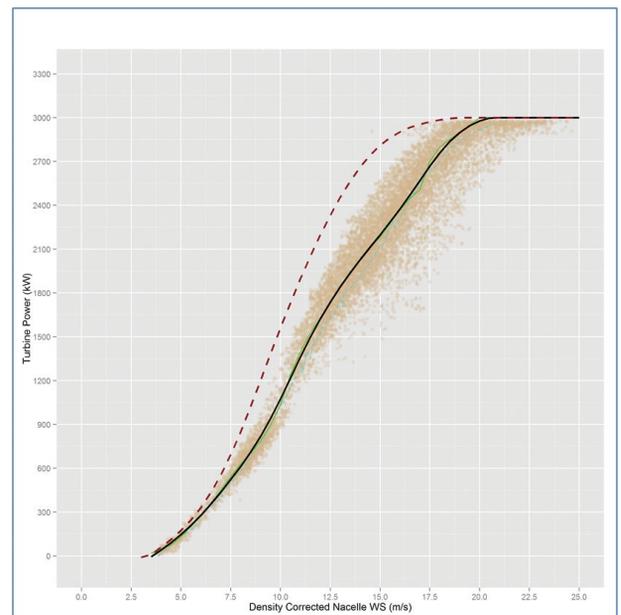


Figure 1: Power curve of a turbine with a pitch alignment problem compared to that of a well-operating turbine (dashed line)

Although a wind farm is “available” and operating, it does not necessarily mean it is operating at peak efficiency. In fact, sub-optimum performance is a common source of underperformance that is about twice as large as was first

assumed in the past. Contributing factors include blade pitch or yaw misalignments, anemometer calibration drift, and other control setting errors. The turbine's actual power curve is another loss source because it often does not match up with the official or advertised density-adjusted power curve, as seen in Figure 1. High-wind events that trigger a wind turbine to shut down and undergo a restart cycle when winds lighten (known as the wind hysteresis effect) are another source of lost energy. All told, typical performance-related losses among wind farms are around 4 percent.

### OTHER UNDERPERFORMANCE FACTORS

Another performance factor found for some projects has been the change in the as-built wind farm design compared to the planned design the energy analysis was based upon. It is not unusual for some last-minute design changes to occur in response to unforeseen permitting or construction constraints. Any change in the turbine layout or hub height will impact energy production to some degree.

Many underperforming wind farms had deficient wind measurement campaigns. In some cases, too few meteorological masts were deployed for the project's large footprint or complex terrain, and mast placement may have favored the highest terrain rather than a cross-section of elevations. This can lead to a biased, optimistic outcome when modeling the wind resource at every turbine location. Today, software tools such as Openwind are available to guide mast placement for the most representative results. Measurement campaigns that don't observe wind conditions at hub height (or higher) risk missing unexpected changes in wind shear and wind veer that could negatively impact turbine performance.

Unconsidered factors can play a role in the underperformance syndrome as

well. Grid and environmental curtailments, as well as the impacts of newly built wind farms on nearby existing ones, can be sources of production losses that were often not accounted for in past pre-construction energy estimates. This was intentional in some cases, and it was hard to quantify in others. Nonetheless, these items can be significant performance factors, resulting in energy shortfalls of up to several percent relative to original predictions.

Project location is often a factor in underperformance, too, particularly in mountain gaps or valleys with shallow thermal wind flows, such as California's Tehachapi Pass. In these environments, wakes can last longer and wind shear can relax with height — both of which can penalize performance. Northern climates prone to icing, such

as ridgetops in New England and Quebec, can be problematic, too. Icing can cause turbines to suffer outages or reduced production for extended periods during the windiest time of the year. Since ice deposition and its persistence on objects are not directly measured during a wind resource measurement campaign (and not during turbine operations, either), predictions of icing-related production losses can be hard to make. At some wind farms, ice-related production losses have been found to be two to three times greater than original estimates.

### PORTFOLIOS VERSUS PROJECTS

Insights gleaned from the investigation of hundreds of wind farms have greatly reduced the magnitude of the under-



performance syndrome. Across a large portfolio of projects, the mean performance bias is likely to be small — on the order of -2 percent or less when using the latest assessment techniques. Individual projects, however, may still see larger deviations for any number of reasons. This should be no surprise given that portfolio members are built at different times by different installers using different turbine models that are connected to different grid systems in different weather regimes using different O&M providers. Some risks are unavoidable if good practices during the development, construction, and operations phases are inconsistently followed. Inferior resource assessment campaigns or errors in blade pitch and wind vane alignment during construction will have their consequences, too. The caliber of the wind farm's O&M program is another important factor.

There is a tendency to downplay or ignore risks that cannot be easily quantified. Pre-construction energy uncertainty estimates are largely an exercise in quantitative risk assessment, which works well with well-behaved sources of losses and uncertainty such as measurement errors. It works less well with poorly understood or less easily predicted risks such as installation errors and grid curtailment. Qualitative assessments can be valuable and should be included in preconstruction energy studies where ap-

propriate. Anticipating potential problems at an early stage gives the most chance of dealing with them effectively.

## CONCLUSION

What can be done to address underperformance before it happens? First, it is important that stakeholders involved in project development, financing, construction, and operations recognize that they each have a role to play and share responsibility in a project's outcome. Breaking down walls that prevent communications between stakeholders will create opportunities for change. Second, better project risk assessment and management practices are needed. Risk assessment defines the nature of risks, their probabilities, and their consequences, and risk management encompasses the actions taken to accept, assume, and manage risk. Third, independent engineers can be an integrating force across project stakeholders and phases to provide overarching industry guidance. They possess the specialized technical and analytical skills to diagnose problems and recommend cost-effective solutions. Lastly, maximizing project availability should not come at the expense of energy production. Although it is harder to maximize production, the underperformance problem won't be fully resolved until priorities get straightened out. ↵



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# INNOVATION

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## ENORMOUS BLADES COULD LEAD TO MORE OFFSHORE WIND ENERGY IN THE U.S.



Sandia National Laboratories / Photo by Randy Montoya

Todd Griffith shows a cross-section of a 50-meter blade, which is part of the pathway to the 200-meter exascale turbines being planned under a DOE ARPA-E-funded program. The huge turbines could be the basis for 50-MW offshore wind energy installations in the years ahead.

A new design for gigantic blades longer than two football fields could help bring offshore 50-MW wind turbines to the United States and the world.

Sandia National Laboratories' research on the extreme-scale segmented ultralight morphing rotor (SUMR) is funded by the Department of Energy's

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- 33** Antaira Releases Industrial 8-Port Gigabit-Managed Switches

(DOE) Advanced Research Projects Agency-Energy program. The challenge is to design a low-cost offshore 50-MW turbine requiring a rotor blade that is more than 650 feet (200 meters) long — two-and-a-half times longer than any existing wind blade.

The team is led by the University of Virginia and includes Sandia and researchers from the University of Illinois, the University of Colorado, the Colorado School of Mines and the National Renewable Energy Laboratory. Corporate advisory partners include Dominion Resources, General Electric Co., Siemens AG, and Vestas Wind Systems.

“Exascale turbines take advantage of economies of scale,” said Todd Griffith, lead blade designer on the project and technical lead for Sandia’s offshore wind energy program.

Sandia’s previous work on 13-MW systems uses 100-meter blades (328 feet) on which the initial SUMR designs are based. While a 50-MW horizontal wind turbine is well beyond the size of any current design, studies show that load alignment can dramatically reduce peak stresses and fatigue on the rotor blades. This reduces costs and allows construction of blades big enough for a 50-MW system.

Most current U.S. wind turbines produce power in the 1- to 2-MW range, with blades about 165 feet (50 meters) long, while the largest commercially available turbine is rated at 8 MW with blades 262 feet (80 meters) long.

“The U.S. has great offshore wind energy potential, but offshore installations are expensive,” Griffith said. “Larger turbines are needed to capture that energy at an affordable cost.”

Barriers remain before designers can scale up to a 50-MW turbine — more than six times the power output of the largest current turbines.

“Conventional upwind blades are expensive to manufacture, deploy, and maintain beyond 10 to 15 MW,” Griffith said. “They must be stiff to

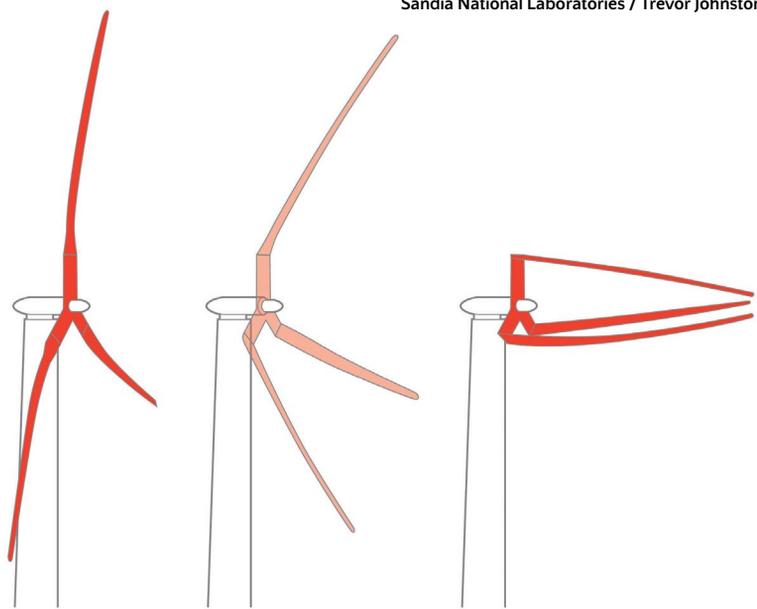
avoid fatigue and eliminate the risk of tower strikes in strong gusts. Those stiff blades are heavy, and their mass — which is directly related to cost — becomes even more problematic at the extreme scale due to gravity loads and other changes.”

According to Griffith, the new blades could be more easily manufactured in segments, making them more cost-effective and avoiding the unprecedented scale of equipment needed for transport and assembly of blades built as single units.

The exascale turbines would be sited downwind, unlike conventional turbines that are configured with the rotor blades upwind of the tower.

SUMR’s load alignment is bio-inspired by the way palm trees move in storms. The lightweight, segmented trunk approximates a series of cylindrical shells that bend in the wind while retaining segment stiffness. This alignment radically reduces the mass required for blade stiffening by reducing the forces on the blades using the palm tree-inspired load-alignment approach.

Segmented turbine blades have a significant advantage in parts of the



Sandia National Laboratories / Trevor Johnston

Sandia’s 100-meter blade is the basis for the SUMR, a new low-cost offshore 50-MW wind turbine. At dangerous wind speeds, the blades are stowed and aligned with the wind direction, reducing the risk of damage. At lower wind speeds, the blades spread out more to maximize energy production.

world at risk for severe storms, such as hurricanes, where offshore turbines must withstand tremendous wind speeds of more than 200 mph. The blades align themselves to reduce cantilever forces on the blade through a trunnion hinge near the hub that responds to changes in wind speed.

“At dangerous wind speeds, the blades are stowed and aligned with the wind direction, reducing the risk of damage,” Griffith said. “At lower wind speeds, the blades spread out more to maximize energy production.”

Moving toward exascale turbines could be a key way to meet the DOE’s goal of providing 20 percent of the nation’s energy from wind by 2030, as detailed in its recent Wind Vision Report. ↴

— Source: Sandia National Laboratories

For more information, go to [www.sandia.gov](http://www.sandia.gov).

## CARBON TRUST LAUNCHES TECHNOLOGY TRIAL TO CREATE 3-D WIND MAPS FOR OFFSHORE WIND FARMS

The Carbon Trust recently announced the start of the world's largest trial of scanning light detection and ranging (LiDAR) technology taking place in Dublin Bay, Ireland. This is the latest offshore wind accelerator (OWA) project designed to help reduce the cost of energy from offshore wind.

Over the next three months, the most comprehensive test of scanning LiDAR technology will take place where four different scanning LiDAR systems will be put through their paces alongside three vertical profiling LiDARs for validation purposes. The project is being supported by the independent renewable energy company Renewable Energy Systems (RES) and the maritime safety organization Commissioners of Irish Lights.

Accurate wind resource measurements are critical to wind farm development because they are used to calculate the potential energy yield from a wind farm, which dictates the terms of the project financing. This can be a significant proportion of the overall project cost, accounting for around 45 percent for an average wind farm.

Scanning LiDAR is not a new technology. Conventionally, it is used by the defense and aerospace industries to monitor for oncoming weather fronts, but it doesn't have a proven track record in offshore wind.

Wind resources are typically measured using large steel towers called met masts, which require a large capital investment incurred at risk before a project is approved adding significant upfront costs that could inhibit the exploration of new sites. The OWA project aims to test how accurately scanning LiDAR technology can measure wind resources



Carbon Trust

for potential wind farm sites, which could deliver significant cost savings in the early stages of wind farm development.

The OWA project has been working for the past few years to support more cost effective solutions and focusing on the development and commercialization of a number of floating LiDAR systems to significantly reduce upfront capital expenditure. However, measurements taken by both masts, and floating LiDAR are limited in that they only provide a measurement of the wind resource at a single point in space. For an offshore wind farm covering an area of up to 200 km<sup>2</sup>, this can create uncertainty on the wind speed at locations far from the measurement point. This is known as spatial variation, where measurements may not be representative of the entire site. It is translated into risk incurring additional financ-

ing costs to wind farm development.

Scanning LiDAR technology has the potential to reduce the risk associated with spatial variation. These systems are capable of scanning with a usable range of between 10 to 30 km, to impressive levels of detail, taking over 100 measurements per minute. This allows developers to build a much more detailed picture of a site, not only significantly reducing uncertainty of spatial variation, but also allowing developers to better plan the layouts of the turbines to best exploit the individual wind conditions at the site. Increasing confidence on spatial variation could reduce risk to minimal levels, potentially saving money on a project and reducing the cost of energy from offshore wind.

A difference of only 0.2 mph in wind speed can result in significant variation of yield calculations over

the lifetime of a wind farm. Therefore, it is critical that the industry has confidence in scanning LiDAR devices being sensitive enough to detect such small variations. The OWA trial aims to test the sensitivity of the devices to picking up these variations in wind resource.

The units involved in the trial are:

- Three Leosphere windcube vertical profiling LiDARs
- One Leosphere windcube 400s scanning LiDAR
- One Leosphere prototype scanning LiDAR
- Two Lockheed Martin WindTracer scanning LiDARs

“Many factors can impact available wind resources at a potential wind farm site, including its proximity to shore, neighboring wind farms, and as a result of tidal currents,” said Megan Smith, project manager for Wakes Research at the Carbon Trust. “This project forms a really important stage of the OWA’s efforts to increase the industry’s understanding of wind resource measurement and validate the technologies capable of delivering results. Project financing is a significant proportion of cost, so anything we can do to get a deeper understanding of yield will increase investor confidence and lower the cost of financing. Scanning LiDAR has the potential to take our understanding to a completely new level. It is the difference between taking a still photo compared to having a 3-D video with full sound. The need to test the sensitivity of the technology is the next frontier in getting industry acceptance.”

The Leosphere windcube 400s will be installed at the Baily lighthouse on the north side of Dublin Bay. ↗

— Source: Carbon Trust

For more information, go to [www.carbontrust.com](http://www.carbontrust.com).



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## KINEWELL KLOC SOFTWARE BRINGS ECONOMIC VALUE TO OFFSHORE WIND MARKET



Kinewell Energy recently demonstrated that its new software, KLOC, could have saved an operating offshore wind farm approximately \$2.5 million had the technology been available when the wind farm was designed. The northeast England-based company launched the KLOC software in November 2015 following two years of research and development. The innovative software optimizes the geographical layout of offshore wind electrical cables that collect the energy before it is sent to shore.

The 576-MW Gwynt-y-Môr offshore wind farm was redesigned in a case study to indicate the vast savings

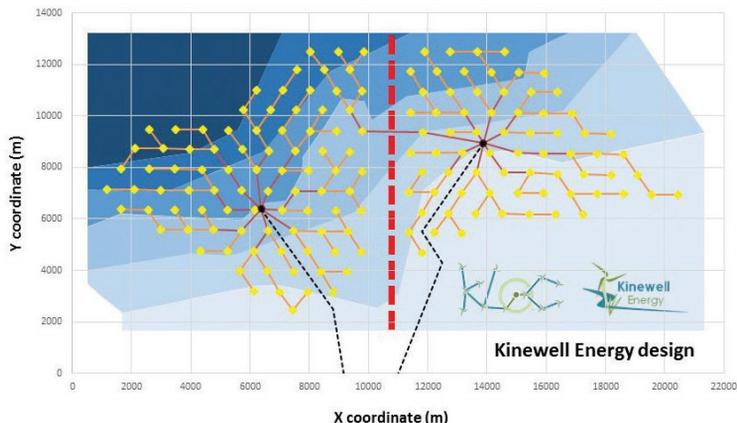
that could be achieved. During the study, Kinewell Energy found that approximately \$2.5 million, or 3 percent of the installed cable cost, could be saved by utilizing KLOC compared to traditional design techniques. The savings were realized by reducing the overall cable length by 1.7 km and through the reduction of electrical losses — some 1.2 GWh per year.

“We are very excited by the results of this case study,” said Andrew Jenkins, Kinewell Energy’s managing director. “It demonstrates the economic impact our innovative KLOC software will have on the U.K. energy market,

which will ultimately lead to savings on household utility bills. If our technology is used for all future U.K. offshore wind farms, we would expect an extra 70 GWh of electrical energy to reach the U.K. each year. That would negate around 27,000 tons of CO2 emissions annually while powering around 16,000 homes — energy that would otherwise be wasted heating the sea.” ↵

— Source: Kinewell Energy

For more information, go to [www.kinewell.co.uk](http://www.kinewell.co.uk).



## ANTAIRA RELEASES INDUSTRIAL 8-PORT GIGABIT-MANAGED SWITCHES

Antaira Technologies, a global leading developer and manufacturer of industrial device networking and communication product solutions for harsh environments, recently announced its expansion in the industrial networking infrastructure family with the LMX-0804G-SFP series.

Antaira’s new industrial gigabit-managed Ethernet switch series (LMX-0804G-SFP) has been designed to fulfill wind farm applications where demanding operating conditions require that on-site technicians perform maintenance or collect data that can be costly.

Antaira Technologies’ LMX-0804G-SFP series is a cost-effective, eight-port industrial gigabit-managed Ethernet switch designed with four 10/100/1000Tx RJ45 ports and four 100/1000 dual rate SFP slots for flexible fiber transmissions so that turbines can communicate over widely dispersed wind farm networks.

Four built-in fiber ports allows for redundancy and failover via ring topologies, making them ideal for wind farm environments in which downtime cannot be afforded. Multiple fiber ports on each switch provide two connections to the redun-

dant ring, plus one additional fiber port to run fiber to the top of the turbine, assuring EMI immunity and network uptime. Redundancy is also strengthened by dual-power inputs on the LMX-0804G-SFP Ethernet switch series that facilitate connections to both the DC power interface and the backup power system.

This industrial-managed Ethernet switch series boasts gigabit speeds and other advanced functionalities such as LAN traffic prioritization capabilities to efficiently handle data-intensive streams such as surveillance cameras, sensors, and network video recorders, which are all integral to today’s wind farm operations.

In addition, the LMX-0804G-SFP switch series supports a variety of useful management functions that are an important component of remote monitoring of turbines, which, in many situations, are only occasionally visited by people. When field switches are connected with the SCADA system and network management servers of the control center, the management software helps operators monitor network status by automatically discovering the network topology, displaying real-time

alarm information, and presenting traffic statistics and event logs for troubleshooting.

The LMX-0804G-SFP series is backed by a five-year warranty and the units are IP30 rated, compact, fanless, DIN-Rail and wall mountable. ↵

— Source: Antaira Technologies

For more information, go to [www.antaira.com](http://www.antaira.com).



Antaira Technologies

## KEY CONDITIONS THAT ARE CONDUCTIVE TO NEW INNOVATIONS IN WIND ENERGY

By Gordon Moran

Twenty years ago, onshore wind was a minor player that only had specific niches for roles such as small-scale off-grid installations. It now generates 10 to 20 percent of electricity supply in many countries with off-shore wind capacity growing rapidly around the globe. Many countries plan to increase their electricity generated from wind power to improve energy security and lower CO2 emissions. The largest growth area has been in Europe, although both China and the United States now account for the majority of installed turbines worldwide. Interest in and the deployment of wind energy has also grown in other parts of the world, including India and South America.

Innovation has played a crucial role in making this achievable, and new developments in wind technology have helped the sector mature over the past 30 years. The basic design of most turbines has remained constant over this period – primarily horizontal axis turbines on top of a tower with variations on scale and installation techniques between offshore and onshore. A range of innovations have helped improve this basic design and move the sector forward, leading to substantial inroads in conventional power generation. Some innovations included the development of sophisticated design software that enables wind farms to be built more cost effectively and maximize their efficiency. Research on effective engagement strategies with the public has also streamlined planning processes, and well-situated turbines have improved levels of public acceptance of the technology. More cost- and time-efficient methods to erect turbines and the capacity necessary to build larger turbines have also reduced costs through larger economies of scale and by hav-

ing machines that can generate larger amounts of power.

There are a number of factors that will affect the specific technological developments that may arise within a market. The geography of a country is one that can affect the nature of innovation. For example, China is currently increasing its wind energy generation capacity for a combination of energy security and environmental reasons. As a physically large country, it is primarily installing onshore wind farms using widely tested technologies on a large scale in sparsely populated regions. Japan is also looking to increase the proportion of its energy generated from renewables for environmental and energy security reasons, but it is far more densely populated. Japan also lacks large areas for onshore wind farm development or shallow seas in its territorial waters in which to build off-shore wind turbines. As a result, Japan has become one of the nations that is pioneering research into floating offshore wind turbines to exploit the resource despite its geographical restrictions.

Countries can also become innovative in certain technologies for somewhat counterintuitive reasons. The United Kingdom, for example, is a leading developer of offshore wind power. Though the country has ideal topography for onshore wind installations, offshore currently receives far greater government support due to concerns such as the aesthetic impact of onshore installations.

Government support for technology is key in most situations. The development of innovative products requires a policy landscape where copyright law is enforced in order for companies to invest and make new technologies commercially viable. There also needs to be a suitable domestic or international market for a company to be investing in, wherever it is on the supply chain. Due

to the time and money that is required for a new innovation to become established and adopted in the field, such factors are pivotal.

If a company is able to overcome such hurdles and commercialize a product, it may lead to substantial changes in the sector. One such innovation is a newly developed bladeless turbine from Portugal, which may make installations easier in urban areas of the U.S. and in countries with low levels of social acceptance of bladed onshore turbines. If such a technology can be adopted internationally, innovations that initially served a relatively small domestic market may have substantial development opportunities.

Companies need to be mindful of the factors involved in the development of new innovations in the field, whether they are bringing their own ideas to market or incorporating ones that improve the efficiency and profitability of their business. Innovations can occur at any stage of a supply chain, from more effective planning or manufacturing methods to the repair and decommissioning of turbines. The nature of a market is also important, as some countries such as China work much better with existing technologies while others such as the U.S. may benefit from new cutting-edge technologies to make wind power possible in new locations. It pays to consider the contextual nature of innovative development and accompanying factors that affect it, including copyright law enforcement, the requirements of the country, government support, interconnectedness with other markets, and developed supply chains. ↵

To learn more about renewable energy and energy efficiency through training courses, visit [www.euenergycentre.org](http://www.euenergycentre.org).

# CYBERHAWK CELEBRATES DOUBLE SHORTLISTING FOR ENERGY INNOVATION AWARDS

Cyberhawk Innovations Ltd. recently announced that it has been recognized as a finalist in the 2016 U.K. Energy Innovation Awards in the categories for best offshore renewable innovation and best electricity network improvement.

As a world leader in remotely operated aerial vehicles (ROAV), otherwise known as UAVs or drones, Cyberhawk continues to pioneer the use of this technology for inspection and survey, leading the way in converting ROAV captured data into powerful asset information used to inform strategic asset management decisions.

The company has been named as a finalist for best offshore renewable innovation as a result of the significant cost, time, and safety benefits it offers to both onshore and offshore wind turbine inspection.

Similarly, the shortlisting for best electricity network improvement also draws upon these benefits that Cyberhawk has demonstrated in projects around the world.

A critical part of the company's offering, covered within both categories, is iHawk. This cloud-based asset management software plays a key role in the company's service offering. Designed in-house, it allows clients to intuitively access the valuable asset management information that has been collected by Cyberhawk's ROAVs and analyzed by Cyberhawk's engineers using iHawk software. The unique software uses a map-based interface and displays asset status using a traffic light color-coding system, allowing users to drill into findings to view high definition images and engineering commentary.

"We are extremely proud to have been recognized for the powerful combination of ROAV data collection

and asset management software in two categories at this year's U.K. Energy Innovations Award," Craig Roberts, CEO at Cyberhawk. "Cyberhawk conducted the very first ROAV industrial inspection in 2010 and has since built an unrivalled track record in the utilities, wind, oil and gas, and rail sectors based on safe flight operations and on the conversion of drone-captured data into actionable asset management information in the cloud. This shortlisting is testament to our skilled and dedicated team and the progressive, innovative focus of our business."

Cyberhawk is headquartered in Livingston, Scotland, with bases in

the Middle East and Southeast Asia. The company has completed more than 25 world firsts, with blue-chip customers in more than 20 countries on four continents.

Now in its seventh year, the Energy Innovation Awards recognize the ideas and technologies developed by pioneering businesses that have the potential to shape the future of the energy sector. Winners will be announced at a prestigious awards ceremony on April 28 at the Hilton Manchester Deansgate in the U.K. ↵

— Source: *Cyberhawk Innovations*  
For more information, go to [www.thecyberhawk.com](http://www.thecyberhawk.com).



# MANUFACTURING

Production • Fabrication • Components • Supply Chain • Materials • Tooling • Machinery

## GE'S 6-MW WIND GENERATOR TO ACCELERATE OFFSHORE WIND GROWTH

Higher, bigger, and more reliable wind turbines are defining the future of offshore wind. Harsh environments demand the technology provider to come up with solutions that have high reliability and less maintenance requirements. It's a journey GE started years ago, and it's another example of how GE is helping customers build wind farms in some of the most challenging locations.

GE Power Conversion successfully completed manufacturing the first serial PMG in GE Renewable's offshore wind factory in Saint-Nazaire, France, which was inaugurated in late 2014. The factory is set up to have a capacity of manufacturing 100 generators per year.

As the first series, 300 generators will be manufactured on-site. The first recently completed generator will be installed in GE's Haliade™ 150-6MW-offshore wind turbine in Denmark. The turbine's power yield is 15 percent higher than that of other same-generation wind turbines, each capable of supplying 5,000 households per year. The power supplied by these turbines will become increasingly cost-effective as the volume of generators coming out of the



GE Power Conversion successfully completed manufacturing the first serial PMG in GE Renewable's offshore wind factory in Saint-Nazaire, which was inaugurated in late 2014.

Saint-Nazaire factory increases.

This highly sophisticated production site uses the air-cushion system that has been implemented to move generators within the site. The innovative way of manufacturing eliminates the need of cranes within the factory, driving down the infrastructure costs significantly. The site is also

equipped with a test bench, ensuring every generator coming out of the assembly line is ready to be deployed.

"The factory in Saint-Nazaire is the first offshore wind manufacturing site in France," said Frederic Maenhaut, renewables executive for GE Power Conversion. "It is a milestone in the nation's energy history. Now, by le-

### ALSO IN THIS SECTION

**38** Siemens To Supply Wind Turbines to First Finnish Offshore Wind Farm

**39** Nordex Makes Further Improvements in France

veraging technologies from different GE businesses, we are well-positioned to bring clean offshore wind energy to the domestic market and export to regions beyond France where energy is needed.”

The 6-MW PMG is one of the world’s largest generators built to date. Its direct drive system has no mechanical gearbox coupled to the generator. Low component count increases equipment reliability and, therefore, enables higher energy efficiency, which also leads to increased turbine availability. Less downtime and maintenance requirements ultimately can reduce the cost of wind energy.

The generator is split into three electrical circuits. In the unlikely event of two circuits going offline, the high level of redundancy enables the turbine to continuously produce power, even in the “degraded” mode. This is a critical el-

ement for offshore wind power plants as stormy weather and treacherous water can delay repair work for days or weeks and result in a high maintenance expenditure.

“Offshore wind is gaining increasing competitiveness in the power mix, and GE is well-positioned to serve this industry,” Maenhaut said. “We developed this PMG technology five years ago. It is ideal for offshore setting, helping increase wind turbines’ availability and optimizing energy production.”

GE’s PMGs have been previously selected to be installed on Block Island, America’s first offshore wind farm, which will help generate 30 MW of electricity in 2016. ↘

— Source: GE Power Conversion

For more information, go to [www.ge.com](http://www.ge.com) or [www.gepowerconversion.com](http://www.gepowerconversion.com).

## STEELCASE ANNOUNCES NEW WIND POWER INVESTMENT WITH APEX CLEAN ENERGY

Steelcase Inc., a global leader in the office furniture industry, recently announced a 12-year power purchase agreement (PPA) with Apex Clean Energy for 25 MW of wind power. Since 2014, Steelcase has invested in renewable energy credits equivalent to 100 percent of its global electricity consumption. This latest investment will make up nearly half of Steelcase’s renewable energy purchases, directly supporting the construction of a new clean energy facility set to begin operations in 2016 and further diversify the company’s renewable energy portfolio.

“Our decision to partner with Apex and execute a long-term renewable energy agreement reflects our longstanding commitment to drive a clean energy landscape,” said Jim Keane, Steelcase president and CEO. “At a time when businesses and governments are working to align on climate strategies, we maintain a sense of urgency and optimism. We are focused on finding new ways to reduce our overall energy use and investing in innovative, economically beneficial projects like this one to take one step closer to a sustainable energy future.”

Under Steelcase’s long-term PPA with Apex’s Grant Plains Wind project — a 150-MW facility in Grant County, Oklahoma — Steelcase is committed to support production of approximately 100 million kWh of clean, renewable wind energy each year. This amount is equal to approximately 70 percent of Steelcase’s U.S. electricity usage, roughly equal to the electricity needed to power 9,100 homes per year.



“Apex is proud to partner with Steelcase to help the company achieve its renewable energy goals,” said Mark Goodwin, president of Apex Clean Energy. “Our mission is to accelerate the shift to clean energy, and we do so by providing opportunities for visionary companies like Steelcase to participate in the energy market in the manner that makes the most sense for them. Steelcase has proven itself to be a leader in renewables investment, and we’re pleased that Grant Plains Wind fits with its corporate strategy.”

Steelcase has a long history of supporting renewable energy development that dates back to 2001. The company is one of the top 50 green power users in the United States, according to the Environmental Protection Agency (EPA), and received a Green Power Leadership Award from the EPA in 2014.

“After a record-setting year in 2015 for corporate renewable energy purchasing, we commend Steelcase for starting off 2016 with such a powerful long-term commitment for clean wind energy,” said Lily Donge, a principal at the Rocky Mountain Institute and its business renewables center, of which Steelcase and Apex are a member and sponsor, respectively. ↴

— Source: Apex Clean Energy

For more information, go to [www.apexcleanenergy.com](http://www.apexcleanenergy.com).

## SIEMENS TO SUPPLY WIND TURBINES TO FIRST FINNISH OFFSHORE WIND FARM



Ten Siemens SWT-4.0-130 wind turbines will supply clean energy for approximately 8,600 electrically heated Finnish households.

Siemens has been awarded its first commercial offshore wind order from Finland for which the company will supply, install, and commission 10 wind turbines, each with a capacity of 4 MW and a rotor diameter of 130 meters, for the Tahkoluoto offshore wind farm in the Baltic Sea. The customer is Suomen Hyötytuuli Oy, a wind power producer owned by eight Finnish utilities that is headquartered in Pori. Installation of the wind turbines is scheduled to begin in the summer of 2017 with the start of operations expected by fall of 2017. With a capacity of 40 MW and an annual net power production of more than 155 GWh, the offshore wind power plant will generate enough power to supply 8,600 electrically heated Finnish single-family houses with clean energy. Siemens will also be responsible for servicing the wind turbines.

“This order marks a significant milestone for Siemens,” said Michael Hannibal, CEO of Offshore for the Siemens Wind Power and Renewables Division. “The project is not only the first offshore wind farm in Finland, but will also be used by the Finnish government to demonstrate that offshore wind power is a feasible solution for this area. This project is attracting a great deal of attention throughout the entire Baltic region, and will open doors for Siemens in the emerging offshore markets in this region.”

The Tahkoluoto offshore wind farm is located approximately 0.5 to 3 km from shore in water ranging from 8 to 15 m deep. The wind turbines will be mounted on specially designed, gravity-based steel foundations in order to withstand heavy ice loading. The government of Finland is also contributing €20 million (approximately \$22 million) toward the demonstration project in icing conditions.

“The conditions for offshore wind power are excellent in Finland,” said Toni Sulameri, managing director of Suomen Hyötytuuli Oy. “We have a long coastline, windy conditions, shallow waters, and a hard seafloor.”

In 2010, Siemens supplied one wind turbine with a capacity of 2.3 MW to Suomen Hyötytuuli Oy for the Pori pilot project located 1.2 km off the Finnish coast. This pilot turbine will be surrounded by the 10 wind turbines located at the Tahkoluoto wind farm. Siemens has installed more than 5.8 GW of offshore wind power capacity worldwide with 2 GW commissioned in the last fiscal year. ↴

— Source: Siemens

For more information, go to [www.siemens.com/wind](http://www.siemens.com/wind).

# NORDEX MAKES FURTHER IMPROVEMENTS IN FRANCE

In 2015, the Nordex Group improved its position on the growing French market. With an output of approximately 155 MW newly installed turbines, Nordex has increased its market share from 9 percent in 2014 to 14 percent in 2015. Overall, the newly installed capacity in the onshore wind sector in France has increased to 1,073 MW in 2015. This means that the country has continued to maintain its position as one of the top markets for wind energy in Europe.

Most of Nordex' recent developments in France are based on the N100/2500, with 60 units in 2015. Due to a high order intake rate within the past months, Nordex expects good business in 2016 as well. The last project sold was an order for six N100/2500 for the Tenbonrev

project in the Champagne region. Nordex will deliver these turbines in September of this year.

Currently, the N117/2400 and N131/3000 are generating growing interest in the French market. With most of the new sites in France being light-wind areas, these turbine models should be used in the majority of the company's future projects.

One of these is the Morlange project located near the border to Luxembourg. For this wind farm, Nordex will deliver four N117/2400s within this year. As for Morlange, the company not only functions as manufacturer but also as developer. The wind farm is one of five recent projects generated via the Nordex Development distribution channel, a division fo-

cus on the development of wind farms with local partners. The company has been implementing projects developed in-house there in successful partnerships since the early 2000s.

As the French government last year specified its targets for increasing the use of renewable energy, following the growth in 2015 this year, too, the market offers plenty of potential for the wind sector. For example, the government has simplified administrative procedures in order to support the increase of the share of renewables in energy consumption to 23 percent by 2020 and 32 percent by 2030. ↘

— Source: Nordex

For more information, go to [www.nordex-online.com](http://www.nordex-online.com).



N117/2400 Gamma (2.4 MW) wind turbine

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# CONSTRUCTION

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## CLEAN LINE ENERGY TO PROVIDE LOW-COST RENEWABLE ENERGY TO TALLAHASSEE



Clean Line Energy recently announced an agreement with Tallahassee, Florida, that states the city's intention to purchase up to 50 MW of low-cost wind power from the Oklahoma Panhandle region. The clean energy would be delivered to Tallahassee customers via the Plains &

Eastern Clean Line. The Plains & Eastern Clean Line — America's largest clean energy infrastructure project — will deliver 4,000 MW of low-cost wind power from the Oklahoma Panhandle region to utilities and customers in Florida, Tennessee, Arkansas, and other markets in the

### ALSO IN THIS SECTION

**42** Transmission Upgrades Deliver Substantial Value to Southwest Power Pool Members

**43** Dong Energy To Build New Record-Sized Offshore Wind Farm

**44** ABS Group To Provide Certification and Design Verifications for Offshore Scotland Wind Farm

**44** First Reserve Acquires Mariah North Wind Power Project in the Texas Panhandle

Mid-South and Southeast. For many decades, Tallahassee’s municipal electric utility has provided low-cost, clean, and reliable power to approximately 118,000 residential and commercial customers.

“We commend Tallahassee for taking a leadership position and agreeing to provide their customers with access to some of the lowest-cost wind energy in the country,” said Michael Skelly, president of Clean Line. “This is another important step for the Plains & Eastern Clean Line, and we look forward to helping Tallahassee to deliver on their commitment to increase their clean energy usage while keeping costs low.”

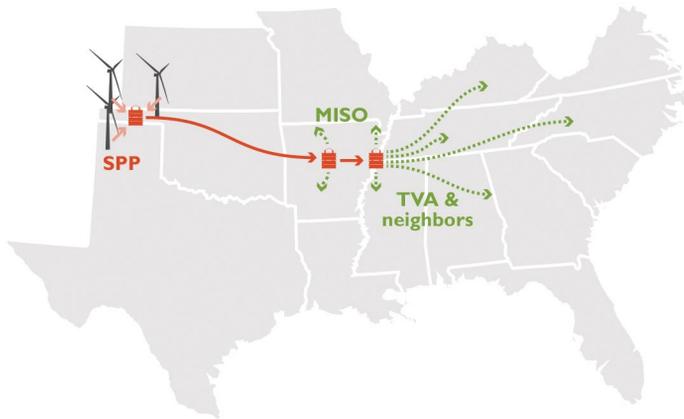
The Plains & Eastern Clean Line represents a \$2 billion investment in infrastructure that will provide low-cost renewable energy to the Mid-South and Southeast regions of the United States, areas that are currently lacking access to affordable renewable energy. The Plains & Eastern Clean Line will help unlock approximately \$7 billion in investments in new wind farms that could not otherwise be built due to the limitations of the existing electric grid. The infrastructure project will create and support thousands of jobs in manufacturing, construction, and operations while meeting the increase in demand for additional electric transmission capacity to deliver renewable energy.

“This type of agreement allows cities the ability to access world-class wind resources and deliver big savings to consumers,” said Andrew Gohn, Eastern state policy director for the American Wind Energy Association (AWEA). “Building new transmission is essential to bring the lowest-cost wind in the country to places where the majority of American families live and businesses operate. The Plains & Eastern Clean Line will deliver clean, reliable, low-cost electricity for all those who plug things in for years to come.”

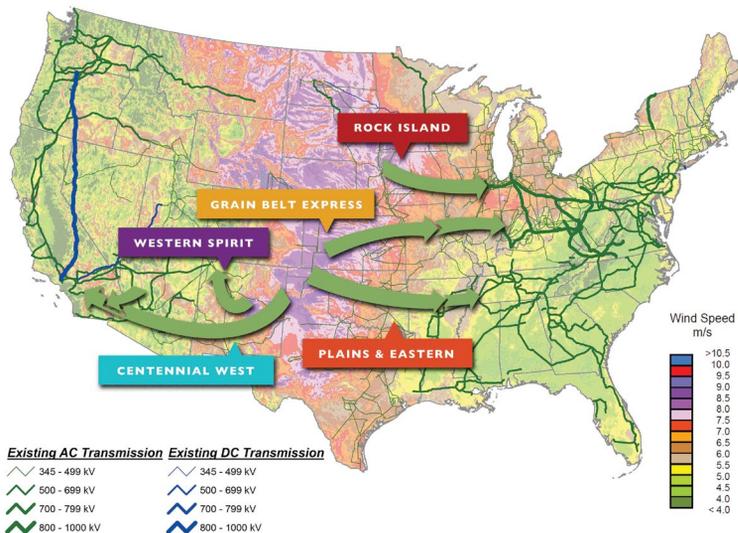
Construction of the Plains & Eastern Clean Line is estimated to begin in 2017 and will require approximately two to three years to complete. The Plains & Eastern Clean Line is expected to begin delivering electricity as early as 2019 and will provide clean power to more than 1 million American homes. ↘

— Source: Clean Line Energy Partners

For more information, go to [www.cleanlineenergy.com](http://www.cleanlineenergy.com).



This map is intended for illustration purposes only and does not represent a proposed route.



## TRANSMISSION UPGRADES DELIVER SUBSTANTIAL VALUE TO SOUTHWEST POWER POOL MEMBERS

The construction of electric transmission upgrades in the Southwest Power Pool (SPP) from 2012 to 2014 resulted in more than \$240 million in fuel cost savings for utilities during the first year of operation of the company's wholesale energy market, according to a new study from the regional power grid operator.

The study analyzed the value provided by 348 transmission upgrades that involved almost \$3.4 billion of capital investment.

Previous studies by SPP projected the expected future value of transmission construction based on the latest available forecast data. This study used historical operating data obtained during the first year of operation of SPP's integrated marketplace to document transmission value already realized.

In addition to fuel cost savings, the study quantified other benefits associated with the transmission expansion upgrades, including reliability and resource adequacy benefits, generation capacity cost savings, reduced transmission losses, increased wheeling revenues, and public policy benefits associated with more optimal wind development facilitated by the transmission upgrades. The net present value of all quantified benefits is expected to exceed \$16.6 billion over a 40-year period, resulting in a benefit-cost ratio of at least 3.5. This means the investments are expected to produce more than \$3.50 in overall benefits for every \$1 in transmission-related costs.

"Transmission does more than just keep the lights on," said Nick Brown, president and CEO of SPP. "It's an enabling resource that paves the way for numerous benefits to our stakeholders and their customers. A modernized transmission system increases reliability, reduces costs by providing access to a wholesale energy market and effectively integrates wind and other renewable energy to the grid."

In a letter accompanying the study, Johannes Pfeifenberger, Judy Chang, and Onur Aydin of the Brattle Group said that compared to transmission planning studies, it provides a more accurate estimate of the total benefits that a more robust and flexible transmission infrastructure provides to power marketers, market participants and, ultimately, retail electric customers. Additionally, the group said that "the estimated present value of the production cost savings in the SPP study likely is understated" due to several factors, including the fact that many of the major transmission projects evaluated were not yet in service during most of the period analyzed. ↵

— Source: Southwest Power Pool

For more information, go to [www.spp.org](http://www.spp.org).



ITC Holdings Corp.

# DONG ENERGY TO BUILD NEW RECORD-SIZED OFFSHORE WIND FARM

With a capacity of 1.2 GW, the Hornsea Project One offshore wind farm in the U.K. will be the world's first offshore wind farm to exceed 1,000 MW in capacity on completion and, by a large margin, become the world's largest offshore wind farm, making it able to meet the electricity needs of well over 1 million homes.

"We are excited about building this huge wind farm and pushing the boundaries of the offshore wind industry," said Henrik Poulsen, CEO of Dong Energy. "Hornsea together with Race Bank, Westermost Rough, and Lincs will make up a giant production area off the British east coast, supporting our efforts to deliver green and independent energy to society."

Hornsea was granted a final investment decision enabling contract (contract for difference) by the U.K. government in April 2014 and will receive a fixed tariff for the first 15 years of production. The wind farm is expected to be fully commissioned in 2020.

## FINAL STAGE TOWARD DELIVERING ON THE STRATEGIC TARGET

Hornsea will be the final stage toward Dong Energy delivering on its strategic target of installing 6.5 GW of offshore wind by 2020.

"Reaching our strategic target is important as volume is required to reduce the cost of a new technology," Poulsen said. "It is vital in order to make all players in the value chain advance up the learning curve. As such, Hornsea will be another major step in our ongoing efforts to significantly reduce the cost of electricity for offshore wind."

Hornsea will surpass Walney Extension, which had a final investment decision in October 2015, as the

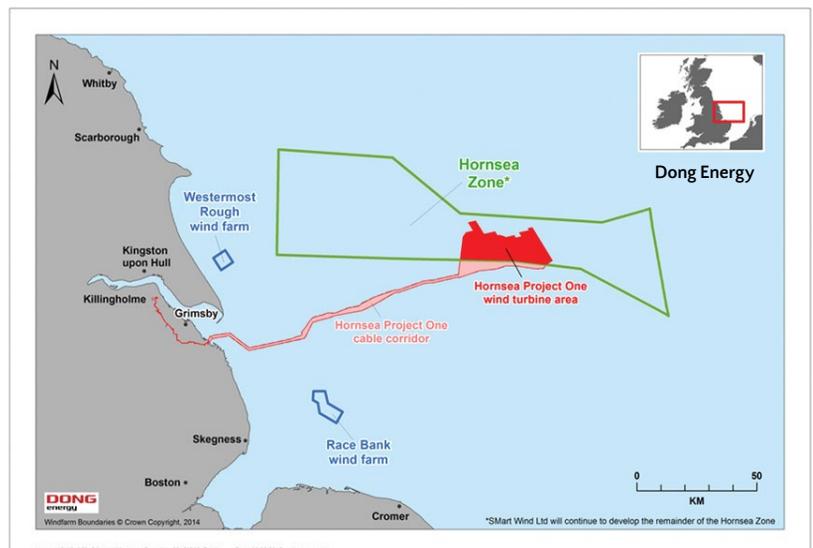
world's largest offshore wind farm. Walney Extension will have a capacity of 660 MW, meaning that Hornsea will be almost double its size.

"Our decision to construct this giant wind farm underlines our commitment to the U.K. market," said Brent Cheshire, country chairman for Dong Energy U.K. "Hornsea Project One will support the supply chain and help create local

jobs. To have the world's biggest offshore wind farm located off the Yorkshire coast is significant and highlights the vital role offshore wind will play in the need for new low-carbon energy in the U.K." ↵

— Source: Dong Energy

For more information, go to [www.dongenergy.com](http://www.dongenergy.com).



## ABS GROUP TO PROVIDE CERTIFICATION AND DESIGN VERIFICATIONS FOR OFFSHORE SCOTLAND WIND FARM

ABS Group Ltd., a leading provider of project certification and quality assurance services for offshore wind assets based in Houston, Texas, has received a contract to provide third-party certification and design verification services to Hexicon AB for the planned Dounreay Tri floating offshore wind farm demonstrator project in Scotland.

The Dounreay Tri Project, expected to be operational in 2018, is being developed by Hexicon and its partners to pilot a novel floating foundation design for offshore wind. When completed, the project will consist of two wind turbines, up to 6 MW each, mounted on Hexicon's platform that will be located offshore northern Scotland.

According to Hexicon, the platforms allow wind turbines to be deployed efficiently in remote areas where winds are stronger and more stable and the platforms are not limited by water depth. Therefore, wind energy parks can be operational out of sight and in areas where the environmental impact is minimal.

"We are excited to have engaged ABS Group in the Dounreay Tri Project," said Marcus Thor, project director at Hexicon. "In a groundbreaking project like this, it is im-



portant to have partners with verification and certification experience working with novel technology developments in addition to vast experience within the offshore industry."

ABS Group's certification scope will cover independent verification of the design basis, detailed design, manufacturing inspections, installation supervision, commissioning supervision, and in-service inspections. Work has commenced with ABS Group providing preliminary planning and advice in support of Hexicon's development process and will continue in subsequent certifi-

cation phases over the duration of the project.

"We are proud to support Hexicon on this innovative design project," said Thomas Adams, vice president of power business development for ABS Group. "Development of these types of new technologies will benefit the offshore wind industry through more cost-effective and adaptable projects." ↵

— Source: ABS Group

For more information, go to [www.abs-group.com](http://www.abs-group.com).

## FIRST RESERVE ACQUIRES MARIAH NORTH WIND POWER PROJECT IN THE TEXAS PANHANDLE

First Reserve, one of the largest global private equity and infrastructure investment firms exclusively focused on energy, recently announced the procurement of the Mariah North Wind project from Mariah Acquisition. Upon completion, Mariah North Wind is expected to generate 230 MW of wind power, serving the high-demand Electric Reliability Council of Texas (ERCOT) market in Parmer County, Texas, with a 13-year, fixed-price hedge for

its power production. The project will also construct and own a 27-mile, 345-kV transmission line to interconnect with the ERCOT competitive renewable energy zones (CREZ) system and is the first phase of an expected 600-MW development. The terms of the transaction were not disclosed.

The acquisition represents a continued expansion of First Reserve's wind power portfolio, which is expected to generate a total of more than 1,100 MW

upon completion of projects in the portfolio under construction. The acquisition also further geographically diversifies the firm's wind power exposure, which now spans several states in the United States, as well as Mexico, Spain, and Hungary.

Mariah Acquisition, an experienced wind development team backed by Arcas Capital Group, a Houston-based renewables boutique, will continue to oversee project development and will partner with affiliate Harvest Energy Services, Inc. to construct and operate the approximately \$350 million facility. The developers will maintain a minority interest in the project during the operating period. In addition, a turnkey engineering, procurement, and construction contract for the balance of the plant has been signed with Mortenson Construction as well as a fixed-price operations and maintenance services and turbine supply agreement with General Electric. Tax equity is being provided by BHE Renewables, Citigroup, and HSBC, with a sale leaseback with Hannon Armstrong for the transmission facilities and rights of way.

"We are pleased to be acquiring this construction-ready project backed by a strong, historically consistent wind resource," said Mark Florian, man-

aging director and head of Infrastructure Funds for First Reserve. "The Mariah North Wind opportunity represents an extension of the model followed by many of First Reserve's energy infrastructure investments, in which we have partnered with what we view to be solid counterparties with contractual structures designed to protect returns on behalf of our Limited Partners."

According to Michael Rucker, Mariah Acquisition's managing director, Mariah North Wind will make a positive economic impact on the Parmer County community generating valuable tax revenue and employment opportunities.

"Mariah Acquisition is proud to bring the project and its transmission line to financial close adding another source of clean power to the ERCOT grid, as the first of future wind and solar phases of the \$1 billion Mariah Renewable Energy Center," Rucker said.

The project is expected to be operational by the end of 2016. ↘

— Source: First Reserve

For more information, go to [www.firstreserve.com](http://www.firstreserve.com).

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# CROSSWINDS

## WIND TURBINE BLADES OF THE FUTURE COULD BE RECYCLABLE

What do you do with a wind turbine that is no longer operational? This question is becoming more and more relevant as the expiration date is drawing closer and closer for wind farms that were erected early on.

According to Mogens Hinge, an associate professor in the Department of Engineering at Aarhus University, who, along with his research team and industrial experts, has specialized in developing nanobinders, the first generation of wind turbines that have already been scrapped at enormous “graveyards” where the components are crushed and buried in the ground because it is virtually impossible to recycle the material.

“Components made of fiberglass have to go through a difficult procedure before they can be reused,” Hinge said. “This entails separating the glass from the plastic, and you can only do this if you heat the material for a long time at 600 degrees Celsius, which is far from profitable from both an energy and an economic standpoint.”

This acute problem in the wind turbine industry inspired them to develop a solvent with the opposite properties so that instead of binding materials to each other, it can separate them chemically with limited or no heating.

In the DreamWind project, researchers are working toward developing a chemical substance that will make it possible to separate composite materials from each other. This means that the large, expensive fiberglass components from wind turbines will be recyclable in the future.

### NEW BINDING AGENT FOR FIBERGLASS

The researchers are initially focusing on



There will be plenty of activity in the laboratories in the coming years when researchers develop new materials that make recycling wind turbines easier. Associate Professor Mogens Hinge (pictured here) works in the Department of Engineering.

designing an agent for fiberglass, and the first laboratory results are promising. The idea is that when the glass has been cleaned it can be reused for new structural fiberglass components such as wind turbines.

“This way, we can retain the value of the material instead of just discarding it,” Hinge said. “The technology holds great potential for recycling.”

At the same time, the technology can save the wind turbine industry a considerable amount of money and reduce carbon dioxide emissions.

“It’s expensive to manufacture fiberglass that can’t be recycled and to drive around with blades when they have to be scrapped,” Hinge said. “It’s expensive to smash them to pieces and bury them. Chemical research can provide the industry with an enormous boost of innovation.”

### CHEMICAL RESEARCH PAVES THE WAY FOR MORE RECYCLING

Innovation Fund Denmark has invested a total of DKK 17.6 million (approximately \$2.6 million) in the project,

which could influence the recycling of composite materials outside the wind turbine industry.

“With the investment from Innovation Fund Denmark, we now have an opportunity to develop smart new materials that can change shape or separate as required when they’re no longer in use,” said Kim Daasbjerg, a professor in the Department of Chemistry at Aarhus University. “This is an important project that could have a major impact on the way in which materials are recycled in the future.”

In the DreamWind project, Aarhus University will collaborate with partners including Vestas Wind Systems A/S and the Danish Technological Institute to develop new composite materials for wind turbine blades.

The parties expect to be ready with a chemical compound for separating fiberglass within four years. ↵

— Source: Aarhus University

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