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WIND SYSTEMS

MARKET OUTLOOK

WIND-POWER BOOM

U.S. capacity reaching record levels

ALSO

IN FOCUS: Lubrication / Foundations ▶ PROFILE: Sotek Inc.

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12

WIND-POWER BOOM IN U.S.

2019's first quarter boasts more than 39,000 MW of wind-energy capacity either under construction or in the planning stages.

▶ ALSO

The long and windy road: Clearing obstacles to getting a wind project up and running **18**

Women in renewables: Pioneers of inclusivity **24**

IN FOCUS

LUBRICATE NOW, SAVE MORE LATER

*If a lubricant is not considered in a wind-turbine's design phase, it is more likely to experience unexpected maintenance issues as the systems age. **30***

CRACKING DOWN ON FOUNDATION CRACKS

*During annual inspections, it's of paramount importance to inspect foundations every year for cracks as an integral part of proper turbine maintenance. **34***

▶ PROFILE

Sotek Inc. has been a leader in the manufacturing of precision metal stampings, stator, and rotor assemblies for 35 years. **38**



▶ CONVERSATION

Peter Walper, managing member for Thermal Cam USA says his drone-inspection company looks at the wind industry outside of the box. **42**

A man with dark hair and a beard, wearing a high-visibility yellow and green safety vest over a red shirt and dark blue work pants, stands in a field of golden wheat. He is holding a yellow hard hat and has a safety harness with various tools attached to his waist. In the background, a large white wind turbine is visible against a blue sky with light clouds. The turbine's blades are partially obscured by a green, wireframe graphic that resembles a turbine's internal structure.

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▸ THE FUTURE OF WIND



DIRECTION

8

A global 261 GW wind portfolio hints at offshore wind evolution
 ▸ U.S. offshore CEOs call for East Coast supply hubs to beat competition ▸ AWEA: Offshore tax credit extension will jumpstart U.S. industry



CROSSWINDS

52

BETTER TOOLS OF THE TRADE

New designs in torque and tethered tools are helping technicians do the job more safely and efficiently.

TAILWINDS

THE BUSINESS OF WIND



▸ CONSTRUCTION

Advanced route planning helps transport 61 wind turbines in Chile **44**

▸ INNOVATION

Covestro delivers first commercial order of raw materials to China **46**



▸ MAINTENANCE

Formosa Offshore Wind, Dropsafe tackle dropped object risk at Taiwan wind farm **49**

▸ MANUFACTURING

Vestas to supply one of the world's largest citizen-owned parks **50**





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The future of wind keeps looking great

When you read about the state of wind energy in the U.S., one word keeps buzzing around the renewables collective consciousness: offshore.

Although there is only one offshore wind facility currently creating power (Block Island), there are more in the pipeline.

Getting steel in the water, especially off the East Coast, is essential to meeting some extremely ambitious goals put into place by states such as New York and New Jersey. Not just that, but it just makes sense to build facilities creat-

ing reliable, clean energy in close proximity to some of the most heavily populated areas in the country.

How the industry, as well as state and local governments, are dealing with this next exciting phase of wind is a large part of this issue's annual Market Outlook report.

Every year, *Wind Systems* shines a spotlight on various aspects of the future of wind, particularly in the U.S., and this year is no exception.

Our cover story is brought to you by AWEA's vice president of Research & Analytics, John Hensley. He offers an in-depth look at the first quarter of 2019 and how it is already breaking records with more than 39,000 MW of wind-energy capacity in various stages of development.

The regulations involved with getting a wind farm up and running can be labyrinthine. That's why efforts are being made to streamline the process to expedite more wind farms. I had the pleasure of chatting with Hilary Tompkins, who was a Solicitor of the Interior in the Obama administration. In the article, Tompkins shares her personal experience of what needs to be done to get wind moving faster, as well as what lessons were learned from past wind projects.

A growing workforce is also needed to ensure the continued viability of wind energy. An article from NES Global Talent details a recent study showing the renewable-energy sector resonates with women and represents the future of energy-sector jobs.

But that's not all to be found in this issue. In addition to our bonus section featuring our Market Outlook, the August issue also takes a look at lubrication, turbine foundations, and much more.

The Market Outlook issue is always one of my favorites, bringing into sharp focus just how promising wind energy is and will continue to be.

I'm sure you're going to enjoy this issue as much as I enjoyed putting it together. I definitely learned some new things, and I hope you do, too.

As always, thanks for reading!



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AWEA hires regulatory attorney to advocate for offshore wind

From AWEA

The American Wind Energy Association (AWEA) recently hired Laura Smith Morton to lead policy and regulatory efforts for the U.S. wind industry's rapidly emerging offshore sector. In her new role as senior director, Policy and Regulatory Affairs, Offshore Wind, Morton takes the helm of AWEA's offshore wind program during a crucial growth period — as the nascent U.S. industry prepares to build its first large-scale projects off the Eastern seaboard.

"It's immensely gratifying to be back working on offshore wind issues," Morton said. "As this new American energy industry scales up, we must strike the right balance with policies that encourage development, job creation, and the revitalization of coastal infrastructure while also engaging with other ocean users to ensure all can prosper."

Morton has more than 10 years of experience in offshore wind policy and regulatory issues, both as an attorney and through senior roles at the Department of Energy (DOE), Council on Environmental Quality, and the National Oceanic and Atmospheric Administration. She contributed to the original National Offshore Wind Strategy published by the DOE and Department of the Interior, which charted a course to build the U.S. offshore wind industry, and led multiple interagency teams charged with creating efficiencies in the permitting process for clean energy projects.

Morton will lead AWEA efforts in close coordination with the Association's member companies to resolve permitting and regulatory challenges impacting offshore wind projects in development and facilities in operation. Key issues in Morton's portfolio include offshore wind leasing and the Bureau of Ocean Energy Management regulatory process, multiple-use compatibility with other ocean users, environmental impacts, and others.



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

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DIRECTION

THE FUTURE OF WIND



Offshore wind developers are demonstrating a willingness to invest a significant amount of money to break into new markets by acquiring pipelines or companies. (Courtesy: Shutterstock)

A global 261 GW wind portfolio hints at offshore wind evolution

“The growing 261 GW offshore wind portfolio is a clear testament to the prospects of offshore wind across the globe,” said Soeren Lassen, offshore wind analyst at Wood Mackenzie and author of a new report on offshore wind asset ownership, development and transactions and added that “the big are going to get bigger.”

With growth and ongoing consolidation as the backdrop, three other key trends are shaping offshore wind asset development and ownership.

First, leading European players are pursuing higher returns by breaking into emerging markets while Chinese companies command a large and growing domestic pipeline.

Second, the pool of offshore wind investors is being reshaped and expanded.

Third, the data reveals the rise of bidding consortiums in tenders and alliances among offshore companies.

Ambitious European companies are looking to emerging markets for partnerships and acquisition of pipelines and even companies to position themselves for future growth. Consequently, there was a spike in offshore asset transactions in 2018 of 19.5 GW – 69 percent of which came from emerging markets, such as the United States, Taiwan, Poland, and Ireland.

Emerging markets with maturing regulatory frameworks are the most appealing, though activity can begin well before the ink has dried on the page. Offshore wind developers are demonstrating a willingness to invest a significant amount of money to break into new markets, both by acquiring pipelines or companies. Both are on the table in some cases, as with Ørsted’s acquisition of U.S. offshore wind company Deepwater Wind.

While European players dominate the pursuit of new wind opportunities in the offshore wind industry globally, only one European company has secured a pipeline in China. Chinese state-owned companies have a corner

on the huge domestic 84-GW Chinese pipeline. The level of market consolidation is such that three out of the five largest offshore wind development portfolios are developed by Chinese companies.

Second, the pool of investors expands as institutional investors, APAC conglomerates, and oil and gas majors are increasingly flocking to offshore assets. The growing investment appetite is fueled by a better understanding of construction and development risks from institutional investors combined with oil and gas majors and APAC conglomerates’ eagerness to break into the offshore wind industry. This trend is also apparent in U.S. lease auctions, where both Shell and Equinor have secured capacity in two of the past three auctions.

The final set of trends in offshore wind ownership is the rise of tenders as well as the rise of alliances and bidding consortiums.

As the majority of demand moves into tenders and competition increases, analysts are seeing an increasing use of bidding consortiums in these tenders. In fact, almost 90 percent of companies participating in tenders in 2019 are expected to participate through bidding consortiums.

Moreover, alliances are increasingly being used by developers to break into, or fortify their position, in new markets – in 2018 alone, 15 alliances were formed.

MORE INFO www.woodmac.com

AWEA: Tax credit extension will drive U.S. offshore wind

The American Wind Energy Association (AWEA) issued a recent statement in support of two bills introduced in the U.S. Senate, which would both extend the federal Investment Tax Credit (ITC) for offshore wind energy. The legislation comes at a critical time for

offshore wind in America, as energy developers prepare to start construction on the first wave of large-scale projects.

AWEA supports two bills that would achieve tax policy parity for offshore wind. The Offshore Wind Incentives for New Development Act introduced by Senators Ed Markey (D-MA), Sheldon Whitehouse (D-RI), and Rep. Jim Langevin (D-RI), as well as the Incentivizing Offshore Wind Power Act introduced by Senators Tom Carper (D-DE) and Susan Collins (R-ME) would extend the ITC at 30 percent of the project’s total value for six years and eight years respectively. The biggest difference between the bills relates to how they are positioned in the tax code.

Promoting investment in offshore wind will strengthen and diversify American energy production. With world-class resource potential off the East Coast, West Coast, and in the Great Lakes, offshore wind is well-suited to meet consumer demand for large amounts of reliable clean energy near America’s largest population centers.

There’s also a huge opportunity for U.S. supply chain businesses, including those with experience in offshore oil and gas, to construct and service



Promoting investment in offshore wind will strengthen and diversify American energy production, AWEA says. (Courtesy: AWEA/ Daniel Turner)

offshore wind farms. According to the University of Delaware's Special Initiative on Offshore Wind, building 18.6 GW of offshore wind capacity by 2030 would create a nearly \$70 billion opportunity for businesses in the industry supply chain. And investing in offshore wind at scale will help revitalize coastal infrastructure and create thousands of high-skilled, well-paying careers for Americans.

MORE INFO awea.org

U.S. offshore CEOs call for supply hubs to beat competition

The U.S. offshore sector must create regional East Coast supply chains and public-private initiatives that accelerate training and port investments to ensure long-term competitiveness, leading developers told the U.S. Offshore Wind 2019 Conference.

New Jersey's recent decision to select Ørsted's giant 1.1 GW Ocean Wind project for its first large-scale facility highlights the rapid growth taking place in the U.S. offshore wind sector.

The 800 MW Vineyard Wind 1 and 2 project in Massachusetts will dominate installation activity in 2020-22, but deployment will rapidly spread to other states. By 2023, annual U.S. offshore installations are forecast to hike to 1.8 GW and remain between 1.2 GW and 2.2 GW between 2024 and 2030, according to BloombergNEF.

European offshore wind specialists have flocked to the emerging U.S. offshore wind market, partnering with U.S. firms to gain a competitive edge.

European project learnings have sliced prices and boosted demand for U.S. projects. Contracted U.S. offshore wind capacity is forecast to rise to about 4 GW by the end of 2019, the University of Delaware said in a recent report. A further 5.5 GW of new capacity is expected to be procured in 2020-2022, followed by 6.4 GW in 2022-2025, it said.

Growing demand from state authorities and utilities is supporting the development of a U.S. offshore wind



U.S. East Coast developers want to use multi-state supply networks to optimize growing project portfolios. (Courtesy: New Energy Update/Sanderstock)

supply chain but challenges remain, leading developers told the conference in Boston on June 10.

To become competitive, the U.S. offshore wind sector must take a wider regional approach to supply chain build-out and work with U.S. institutions to create hiring and port infrastructure solutions, developers said.

The Vineyard Wind project, co-owned by Avangrid Renewables and Copenhagen Infrastructure Partners represents the U.S.' first large-scale offshore wind project and is made up of two 400 MW units.

In July 2018, the project partners secured 20-year power purchase agreements (PPAs) with Massachusetts electric distribution companies (EDCs) at starting prices of \$74/MWh for unit 1 and \$65/MWh for unit 2. Taking into account tax credits and additional revenue streams, the levelized revenue of energy (LROE) for the entire project is estimated at \$98/MWh, competitive with some European projects despite the lack of local infrastructure, the U.S. National Renewable Energy Laboratory (NREL) said in a report.

The Vineyard Wind project will install 9.5 MW MHI Vestas turbines, the largest capacity turbines currently available on the market. Turbine capac-

ities are continuing to rise as developers seek to boost revenue and reduce the levelized cost of energy (LCOE).

MHI Vestas recently opened its first U.S. office in Boston, and the company is planning to hire about 40 technical staff in the U.S. ahead of turbine installation in 2021, Philippe Kavafyan, CEO, MHI Vestas, told the conference.

"We are gearing up," Kavafyan said. "The first challenge is to ramp up and bring up to speed with the right training, the technicians we will need to drive the construction phase, and the services phase of this project."

Training will be conducted at European projects this year, he said.

The strong U.S. labor market is creating hiring challenges, and offshore operators will need to work with colleges, unions, and state and federal governments to implement efficient training programs, said John Hartnett, CEO of Mayflower Wind, a joint venture by Shell and EDP Renewables.

"Finding staff for our companies in the front-end development and execution phases is extremely challenging — there is competition within the industry as well as competition across all industries," Hartnett said. ↘

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MARKET OUTLOOK

THE FUTURE OF WIND

U.S. EXPERIENCING WIND-POWER BOOM





The first quarter of 2019 boasts a record of more than 39,000 MW of wind-energy capacity either under construction or in the planning stages.

By JOHN HENSLEY

American wind power has seen a consistent string of strong years and so far, 2019 is proving to be no exception. In fact, in the first quarter of this year, the volume of U.S. wind-power capacity under construction and in development reached a record level. The American Wind Energy Association's (AWEA) U.S. Wind Industry First Quarter 2019 Market Report revealed that U.S. wind pipeline grew to a record-breaking 39,161 MW, an 11 percent increase over the previous quarter. That is nearly the equivalent of the current total wind capacity of Texas, Iowa, and California combined.

Of the total pipeline, 17,213 MW were under construction across 21 states. Texas continues to show its renewable energy potential with more than 6,528 MW under construction, 1,255 MW of which started going up in 2019. The remaining 21,949 MW of wind capacity in the pipeline is in an advanced stage of development. Projects classified as in advanced development either secured a long-term contract for offtake, placed turbine orders, or are proceeding under utility ownership. While construction has not begun on these projects, it is likely to begin in the near-term.

In the first quarter of 2019, 841 MW of wind capacity came online. This is a 107-percent increase over the first quarter of 2018 and continues the robust growth trend the industry has seen in recent years. Iowa leads this growth with more than 536 MW brought online so far this year. With the new projects added in the first quarter, the United States' total installed capacity climbed to a

In the first quarter of 2019, 841 MW of wind capacity came online. (Courtesy: AWEA)



In 2018 alone, the U.S. wind industry paid out more than \$1 billion in state and local taxes and land lease payments. (Courtesy: AWEA)

record 97,223 MW. That's enough to power the equivalent of 30 million homes. Currently, eight states are on track to double their installed wind capacity in the near-term. Another 14 states have enough capacity to grow their total installations by 50 percent or more.

DEMAND FOR WIND DRIVES RECORD ACTIVITY

Strong construction and development numbers show high demand for American wind power. 2018 was a record-setting year for corporate wind purchasing as calls from customers for affordable, clean energy grew. A recent study by consulting firm Deloitte found about 67 percent of businesses reported getting pressure from customers to transition powering their operations to renewable energy. As a result, more companies are publicizing their renewable purchases with 72 percent reporting their wind and solar contracts. This has provided businesses with the opportunity to directly respond to their customers' desires.

Who could miss Budweiser's popular "Wind Never Felt Better" Super Bowl LIII commercial? Complete with the brand's signature Clydesdales, the minute-long ad announced Budweiser's commitment to brewing 100 percent of its beer with wind power.

"As a leading brewer, Anheuser-Busch understands sustainability is not just related to our business, it is our busi-

ness," said Angie Slaughter, vice president of Sustainability at Anheuser-Busch. "We are proud that Budweiser is the first major beer brand to be brewed with 100 percent renewable electricity from wind power; we hope our efforts inspire others in our pursuit for a more sustainable future."

But good press and sustainability are not the only benefits American businesses are receiving. Since 2009, the cost of wind has fallen 69 percent. In many parts of the United States, wind power is now the cheapest source of new electricity. That is why many companies are choosing to enter long-term contracts to buy wind. Long-term contracts like power purchase agreements (PPAs) and other arrangements allow businesses to secure reliable, renewable energy at a low, fixed cost. Because costs are fixed, businesses can better plan financially and are insulated from spikes in fuel prices.

"The U.S. has amazing wind and sun resources that will never run out," an IKEA official said while announcing its investment in the Illinois Hoopeston Wind Project. "We invest in our own renewable energy sources so that we can control our exposure to fluctuating electricity costs."

In 2018 alone, commercial and industrial (C&I) customers signed more than 4,203 MW worth of wind deals. That's 66 percent more than the previous record set in 2015. It is clear American businesses and non-utility buyers such as municipalities and universities value the price stability,

low costs, and environmental benefits wind power delivers.

Data from the Business Renewables Center shows wind provides more energy to corporate brands than any other renewable source. In fact, many popular household brands have added wind to their energy portfolio. Last year, a mix of repeat buyers such as Facebook, Walmart, and Microsoft, along with first-time buyers such as AT&T, Shell Energy, Boston University, and Royal Caribbean Cruise Lines secured long-term contracts for wind power.

As time goes on and more businesses grow comfortable with wind investments, expect to hear more companies talking about how buying wind helps their bottom line.

“When looking at wind deals, cost savings are one attribute I can bring up when I talk to our finance and accounting department,” said Rob Threlkeld, general manager of Renewable Energy at General Motors. “Have you ever seen your electric bill go down for multiple years at a time?”

MATURE TECHNOLOGY DELIVERING VALUE

Years of hard work and innovation are yielding more efficient turbines. That means new opportunities for the wind industry to deliver added value to customers. In 2018, the U.S. wind industry installed more than 3,123 new turbines. Over that time, the average nameplate capacity increased to 2.43 MW from 2.32 MW in 2017. Newer, more powerful turbine models allow developers to better design wind farms to their unique site needs. These advancements help modern turbines reach stronger, steadier winds and improve production and capacity factors. Innovation is expanding the number of economically viable areas for wind development.

AMERICA'S OFFSHORE WIND RESOURCE RIPE FOR PICKING

Technological progress and wind-related R&D are helping open new frontiers for the industry. One area that boasts enormous potential is offshore. Three years since “first power” at America’s first offshore wind farm near Block Island, the country’s offshore sector is bullish. Currently, the U.S. boasts an offshore wind potential of more than 2,000 GW. Nearly 25,700 MW are already in the pipeline across 10 states.

The proliferation of offshore wind looks promising from the Atlantic to the Pacific and the Great Lakes in between. The prospect of thousands of new jobs and billions in investment creates fierce but friendly competition between states for an advantage. In May, Maryland adopted the Clean Energy Jobs Act, which included plans for developing more than 1,200 MW of wind off the coast. A hundred miles north, New York Gov. Andrew Cuomo announced his intention to triple the state’s offshore wind target to 9 GW by 2035. Less than six months later, the New York legislature agreed and codified the target.

As states are setting ambitious future targets, several states are well on their way to putting steel in the water. This June, New Jersey regulators announced it selected Ørsted to develop a 1,100-MW offshore wind project off the

Wind by the numbers

39,161 MW

U.S. wind pipeline growth, first quarter, 2019

17,213 MW

Pipeline growth under construction, first quarter, 2019

841 MW

Wind online, first quarter, 2019

3,123

New turbines installed in 2018

2,000 GW

U.S. offshore wind potential

25,700 MW

Offshore wind in the pipeline

\$1 billion

State, local taxes from land-lease payments

114,000

Americans with wind-powered jobs

coast of Atlantic City. This was a major leap forward toward achieving Gov. Phil Murphy’s goal of installing 3,500 MW by 2030. It also shows states are eager to see their plans through.

“I really am having difficulty grasping the reality of the moment,” reflected Board of Public Utilities President Joseph Fiordaliso. “After so many years, New Jersey is going to finally be open for business as far as offshore wind is concerned.”

Currently, the Bureau of Ocean Energy Management (BOEM) is evaluating potential new Wind Energy Areas (WEAs) off the coast. As of mid-2019, BOEM is evaluating areas off California, Hawaii, New York, North Carolina, and South Carolina. BOEM already has awarded 16 commercial wind-energy leases.

STRONG DEMAND AND NEW DEVELOPMENT CREATE OPPORTUNITY

As the offshore wind sector readies for rapid deployment and job growth in the coming years, back on land, wind power is continuing to deliver economic and environmental benefits to communities across the country. The enormous pool of benefits from jobs to investment will only grow as the country’s wind fleet blooms.

In 2018 alone, the U.S. wind industry paid out more than \$1 billion in state and local taxes and land lease payments. This additional revenue allows states and municipalities to invest in their infrastructure, fund education programs, and support public services. The quarter of a billion dol-



In 2018, the U.S. wind industry installed more than 3,123 new turbines. (Courtesy: AWEA)

lars paid to farmers and ranchers in land-lease payments provide financial stability for many. Hosting wind turbines provides them with a hedge against poor crop yields and fluctuating commodity prices.

More than 114,000 Americans across 50 states now have wind-powered jobs. Jobs range from manufacturing at one of the more than 500 U.S.-based wind-related facilities to climbing the towers as a wind tech and many roles in between. According to the Bureau of Labor Statistics, wind technician is the second-fastest growing job in the United States, second only to solar installers. These quality jobs are in rural and low-income areas, where 99 percent of America's wind fleet stands. New employment opportunities are providing an avenue for families and communities to stay together instead of moving in search of work.

Access to abundant, low-cost renewable energy is an incentive for businesses to set up shop in rural communities. This gives states with strong wind resources a competitive advantage. For example, Facebook recently opened its new Papillion data center in Sarpy County, Nebraska. The location was perfect because the company committed to 100 percent renewable energy for its data centers. The facility represents more than \$1 billion in investment and will create more than 200 jobs.

▾ I really am having difficulty grasping the reality of the moment. After so many years, New Jersey is going to finally be open for business as far as offshore wind is concerned. ▸

“Getting a high-profile company like Facebook, which is just a really world-class company, really demonstrates that Nebraska is a place to invest; that companies want to come here because we’ve got great people that they can hire,” Gov. Pete Ricketts told *The World-Herald*. “We’ve got a business-friendly environment.”

Nebraska is not alone. Just across the Missouri River in Iowa, which boasts the second highest percentage of in-state energy generation from wind in the country, similar stories are playing out, and the state’s leaders are noticing.

“Iowa is proud to be the top-ranked state for renewable energy procurement by the nation’s retail and technology industries,” said Iowa Gov. Kim Reynolds. “Access to low-cost renewable energy is a critical part of our economic development strategy. These job-creating businesses cite our access to low-cost renewable energy as a major reason for locating in Iowa.

WIND IS INNOVATING AND COLLABORATING

There is no doubt of wind’s success in recent years. U.S. wind power’s future is bright as technology advances, new frontiers for development open, and collaboration with partners such as solar and storage increases. Like wind energy, solar and storage technologies bring advantages and unique properties that create value for consumers and the grid. As the industry becomes more “multi-tech,” the opportunities for growth multiply.

As companies rapidly diversify their portfolios to include all three of these renewable technologies, among others, the American Wind Energy Association is meeting the growing demand for collaboration. During the WINDPOWER 2019 Exhibition and Conference, AWEA CEO Tom Kiernan announced future WINDPOWER shows will be housed within a new CLEANPOWER exhibition hub. The new hub will bring together utility-scale wind power, solar power, and energy-storage industries to create a more efficient and valuable experience for attendees who are working more in multi-technology businesses. AWEA’s first CLEANPOWER will launch June 1-4, 2020 in Denver and marks an exciting step in the right direction for the U.S. wind industry. ↗

ABOUT THE AUTHOR

John Hensley is vice president of Research & Analytics at the American Wind Energy Association.



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protocols (OPC UA, IEC 61400-25, ...)

THE LONG AND WINDY ROAD

Recently, the Bureau of Ocean Energy Management (BOEM) identified large geographic regions and auctioned off leases where regions will undergo site assessment to determine the proper spots for future wind projects. (Courtesy: Shutterstock)

A photograph of several offshore wind turbines in the ocean. The turbines are white with three blades each, mounted on dark green or black towers. They are set against a clear blue sky with a few wispy clouds. The water is a deep blue. The turbines are arranged in a line, receding into the distance.

Getting a wind project up and running can often seem like a pictureless jigsaw puzzle, but streamlining the regulations with new technology and old-fashioned footwork can go a long way to help quicken the process.

By **KENNETH CARTER** ▸ Wind Systems editor

It may be easy to look at spinning wind turbines and not be in awe of the plethora of hoops developers have to jump through before an asset ever starts producing power.

But regulations are a fact of life for almost any massive project, and wind farms, both offshore and on land, are proving to have even more hurdles to overcome.

Lessons have been learned as the U.S. takes baby steps to generating electricity with offshore wind turbines, but that building knowledge is slowly coming together.

In a recent panel hosted by AWEA in Albuquerque, New Mexico, industry representatives came together to discuss regulatory reform and what it means for U.S. wind projects.

One of those experts was Hilary Tompkins, former Solicitor of the Interior in the Obama administration under Secretaries Ken Salazar and Sally Jewell and now a partner with Hogan-Lovells in Washington, D.C.

“We talked about issues that the industry confronts with the federal regulatory and permitting requirements, and the challenges that they face and ways in which we can maybe help streamline those processes and simplify the amount of data that’s required,” she said. “There are very lengthy, time-consuming, and costly environmental and cultural resources reviews that the wind industry has to go through in order to launch a project.”

HELP COMES IN 2005

The EPAC Law Energy Policy Act of 2005 opened the doors to authorize renewable energy development on public lands and public waters, and the Obama Administration’s Department of the Interior finalized regulations in 2009 to imple-

ment those laws, according to Tompkins.

“We were also coming at a time where the legal regime was being established, and we were in the boat of launching these first projects on public lands,” she said. “That’s how I really got started.”

Even though more privately-owned lands — mainly through green-driven companies — have taken a strong lead in developing wind energy, the use of public lands, and even tribal lands, is important to getting assets up and spinning, according to Tompkins.

“Public lands are an untapped resource; there’s a lot of capacity,” she said. “But I do think there are things that could be improved to make it more hospitable for the realities of launching a utility-scale commercial project. And one of the things we did under the last administration was a fast track renewable energy project initiative.”

Strong leadership in federal areas that include the Department of the Interior, and its offices such as the Bureau of Land Management, the Bureau of Ocean Energy Management, the Fish and Wildlife Service, and others are going to be key in building those opportunities, according to Tompkins.

“This applies even if you have a private land project; sometimes other federal requirements get triggered,” she said.

TRACKING PROJECTS WITH TECH

Advancements in technology also will be paramount in keeping track of all the multiple facets of a project’s development, according to Tompkins.

“We need really current and sophisticated databases with all of the wildlife and environmental information in electronic format that is constantly updated, along with all the new mapping tools that are becoming more available,” she said. “I really see that as something the government should invest in and consider doing.”

That’s important for projects that are outside public lands, too, because often some federal resources can be triggered for legal review, according to Tompkins.

“The more we move into a digitized age with all these environmental reviews, I think the faster we can move through the environmental review process,” she said. “When I was Solicitor at Interior, the lawyers would get different NEPA documents in different formats with different information from various parts of Interior. We had to spend a lot of time redrafting those documents and recompiling the information. It was just not streamlined or efficient. And, certainly, for my former legal team, it was really challenging and time consuming.”

CONGRESSIONAL SUPPORT

Of course, in order for a database of this nature to become a reality, it will take an act of Congress — literally, according to Tompkins.

“I think it takes Congress supporting the funding needed to bring all of that information into the 21st century,” she said. “It would also take leadership and the political will to



Block Island Wind Farm off the coast of Rhode Island learned from the mistakes made with the Cape Wind project. (Courtesy: AWEA)

harmonize those reviews and make sure that they’re not duplicating effort. The current administration is trying to do that with the fossil-fuel industry, but it really takes creating systems that can compile all that information, analyze it, and churn out conclusions and documents that can support the agency’s actions in a nimble and streamlined way — even between federal agencies.”

With the fossil-fuel industry already taking advantage of a growing database, it brings up the possibility of industries clashing over the same piece of land, but Tompkins said, surprisingly, that wasn’t the case.

“It’s identifying where on the public lands you want fossil fuels and what areas are most hospitable for renewables and if they are distinct, and we found there was — more often than not — no overlap,” she said. “I do think we were at the tip of the iceberg of doing landscape scale regional renewable planning, like the desert renewable energy conservation plan and the solar PEIS. We were trying to get to wind, but we ran out of time.”

LESSONS LEARNED

Looking back at the first offshore wind project with Cape Wind exposes a lot of important lessons that were learned when it was time to move on to the next project, according to Tompkins.

“We learned how to not only coordinate internally with BOEM and the Fish and Wildlife Service, but also with the FAA, NOAA, and the Department of Defense,” she said. “There are so many layers just on the federal family side that you need to be sure are coordinated and that you’re on top of all the various federal review components. Streamlining that process is going to be key.”

A programmatic land management planning approach could help ease potential complications, which is what's happening for offshore Atlantic, according to Tompkins.

"After that challenging experience of Cape Wind, the Interior Department learned its lesson, and they carved out big wind-energy areas where they had determined the conflicts were less and less likely to have legal challenges," she said. "That's the current regime we're in now."

Recently, the Bureau of Ocean Energy Management (BOEM) identified large geographic regions and auctioned off leases where regions will undergo site assessment to determine the proper spots for future wind projects, according to Tompkins.

"It's a phased approach looking at site assessment," she said. "If you clear that hurdle — which is a multiyear assessment hurdle — then you move into the construction phase, and you only have to do the really heavy-duty environmental review in the construction phase of your wind project. Hopefully, that gives the industry some comfort that those areas offshore have passed some court review."

ADDRESSING CLIMATE CHANGE

Part of streamlining regulations will certainly involve climate change as a talking point, but Tompkins feels like, even though it's an important crisis to be addressed, the development of more renewables won't necessarily rely on federal policy on that issue in order to grow.

"Even if you don't believe in climate change, the realities of state climate energy targets are real, and the industry's going to respond to that and will be driven to meet those targets regardless of what the federal policy is," she said. "And I also think that, economically, we're seeing an increase in the amount of renewables and a decrease in the cost of renewables along with natural gas, of course. But I think those market dynamics will show an incentive or create an incentive to support renewables. And then we're also seeing utilities declaring major renewable energy commitments along with corporate America, who are making commitments about buying renewable energy in significant amounts. All of those market dynamics will support the growth of renewables regardless of your views on climate change."

Cape Wind faced a lot of obstacles, including local support for its location, it being a historical area, and there were Indian tribes that had cultural connections with the ocean and the horizon, according to Tompkins. There were also shipping lane concerns.

"There was just a lot of opposition and resistance to having that project in the location it was sited," she said. "And that made it really, really challenging. I think the other lesson

we learned is understanding all the different federal components and authorities, meaning the different federal agencies that need to sign off on a project like that. Doing that in a way that does not create delays is really important. We also learned, and all of this was in litigation, that we were trying to streamline, and there were some things that we had BOEM do that the court said, 'No, you can't outsource that to BOEM. That's what the Fish and Wildlife Service does.'"

KNOWING WHEN TO STREAMLINE

The biggest takeaway was that streamlining can be effective, but too much streamlining too quickly can sometimes have the opposite effect, according to Tompkins.

"What we learned is you can try and fast track; you can streamline, there are ways to sequence all of those reviews and the different governmental approvals," she said. "But you can't take too many shortcuts, because then you can end up in court with a judge saying you have to go back and fix things. That's what happened with Cape Wind. It's always tough being the first, but I think we learned a lot from it, and we can use that knowledge to help avoid those issues in the future."

And that next project was the Block Island Wind Farm off the coast of Rhode Island.

"It's in the same region, but it's in a completely different area," Tompkins said. "And if you look on a map, it was in an area that had less impact and less likelihood of opposition. And that was purposeful. That's an example of how the knowledge from Cape Wind helped inform the next one. I think that's a hopeful message for folks that we are moving in a more informed direction

moving forward."

That also shows how wind energy is getting savvy about community engagement and building a local awareness and support for projects, according to Tompkins.

"I also think we're finding that wind is becoming a very valuable source of energy in rural America where, not only is it providing energy, but it's also a significant income in terms of tax payments to local governments and states and lease payments to private-property owners," she said. "There are real benefits on the ground to local communities that we're seeing and, in particular, in these remote areas. There's been a lot of support in that regard."

WIND ON TRIBAL LANDS

Tompkins also feels that an, as yet mostly untouched, resource for wind projects can be found on tribal lands.

"I think it's not happening because folks might not feel comfortable reaching out into Indian country and understanding the legal regime and the different issues that arise

▼ Even if you don't believe in climate change, the realities of state climate energy targets are real, and the industry's going to respond to that and will be driven to meet those targets regardless of what the federal policy is. ▼

when you're working on a project in Indian country," she said. "But let me tell you, I think it's an untapped opportunity. The wind belt in the United States covers a lot of Indian lands, and under the last administration, we passed new regulations to help streamline renewable projects and wind projects, in particular, on tribal land. So, it's a great opportunity. I am highly supportive and interested in finding those opportunities. It's a part of my focus now that I'm out of the government to bridge that gap that seems to be there between tribes and the wind industry."

Already, in some tribal areas, fossil fuels are being switched to renewables, according to Tompkins.

"They have fossil-fuel development on their lands, and they're interested in converting, and also they need power," she said. "Many tribes don't even have basic electricity in their homes, which I find appalling in this day and age. There's also a social responsibility component to exploring opportunities to build renewables in Indian country. I think renewables and the low impact that they have on greenhouse gas emissions, for instance, are the sorts of things that are very in sync with Native American culture and values."

INFRASTRUCTURE AND THE SUPPLY CHAIN

Another important piece of the regulatory puzzle is making sure the right infrastructure, as well as an upgraded supply

chain, is in place, because that can involve a lot more tap dancing than one might think, according to Tompkins.

"You need to figure out how to connect from the federal waters into the coastal areas of the Atlantic," she said. "And one of the things we found at Interior was how critical it was to engage with the state governors and ensure that where we were siting projects made sense in terms of an offtake into the state system and ensuring, too, that their proposals for buying power are in sync with the timing in place of federal opportunities to build the power. There's a lot of coordination and cart-before-the-horse issues that you need to think about before you launch and be sure that the federal government is speaking, not only within that big federal family, but also with the state governments and the local communities and the interstate transmission systems that exist."

It boils down to, essentially, reading the grid and having a system that can embrace different forms of electricity, while supporting research and development, new technologies, and the long-term storage of renewable power, according to Tompkins.

"It's like when you're building any national infrastructure project — be it bridges or highways or hydropower dams," she said. "We've done it before, and I think it's just a matter of saying: This is a priority, and we need to upgrade the grid to reflect the changing nature of energy." ↵

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A woman wearing a blue hard hat and an orange safety vest is focused on adjusting a yellow surveying instrument mounted on a silver tripod. She is standing in an open field under a clear blue sky. The text 'WOMEN IN RENEWABLES: PIONEERS OF INCLUSIVITY' is overlaid in large white letters across the center of the image.

WOMEN IN RENEWABLES:
**PIONEERS OF
INCLUSIVITY**



The progressive, forward-thinking renewable-energy sector resonates with women and represents the future of energy-sector jobs.

By VICKI CODD

It's no secret that renewable energy is a rapidly growing market. With more than 250,000 expected new jobs in renewables by 2020 in the U.S. alone, the energy industry is seeing both men and women choosing this field over the more traditional energy fields.

The idea of playing a leading role, and being at the forefront of a ground-breaking industry, is attractive for many, particularly graduate-engineering candidates. Renewable energy is a fast-changing and diverse sector consisting of a variety of technologies in constant evolution, such as solar PV, onshore and offshore wind, and energy storage. The industry has earned a reputation of being forward-thinking and often initiates more modern business practices within the workplace. The renewables industry provides professionals with the chance to be involved in some of the most diverse and innovative engineering projects in the world.

For the renewables industry to truly prosper, however, energy workers with the relevant skillsets and experience will need to be mobilized to the right worksite locations. In addition, the renewables talent pools, particularly in booming sectors such as wind and solar, will need to be quickly established and retained.

WOMEN IN ENERGY GLOBAL STUDY

The Women in Energy Global Study, a recent study by NES Global Talent, a leader in engineering and technical recruitment services, found that one potential talent pool the renewables industry should vigorously tap into is female engineers. Women are changing the future of the energy industry and in order for the sector to continue to thrive, employers must promote an environment of inclusiveness and diversity within the workplace.

A total of 1,200 female professionals participated in the

Women are changing the future of the energy industry and in order for the sector to continue to thrive, employers must promote an environment of inclusiveness and diversity within the workplace. (Courtesy: NES)

online survey, which ran for one month in the second half of 2018. NES Global Talent and its research partner, Energy Jobline, then analyzed the results, identifying key trends and statistics of women in the energy sector's workforce.

The study provides breakthrough insights into the female workforce and what women look for in an employer, as well as clear data around trending subjects within the gender diversity topic, such as mentoring, "pink vs. blue jobs," flexible work schedules, and inclusiveness. The data within these themes can aid hiring managers and organizations within the renewable energy sector to successfully implement invaluable support for female professionals.

UNDERTONES OF PROMISE

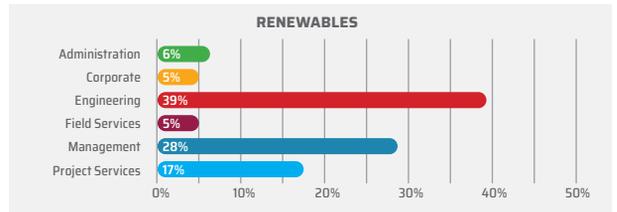
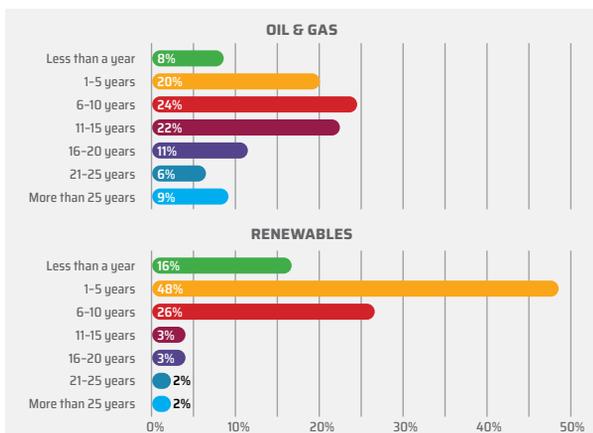
The energy sector is still behind in closing the gender gap that remains across all markets. Women in energy continue to face challenges such as male-dominated environments, a lack of work-life balance, and an absence of female mentors. As the gender diversity topic gains more momentum and more energy companies implement diversity initiatives, the study provides insight on the industry's progress to-date.

Globally, the strongest energy sector for female representation was the oil and gas sector at 85 percent. When looking at experience, the renewables sector had the best representation of women, with 63 percent of those being less than five years into their career. Additionally, more than 100,000 people work in the wind-energy field, with women making up roughly 32 percent of this figure, which has increased from 20 percent just five years ago. Thus, the renewable energy sector is currently triumphant in growing the future female workforce.

The modernistic nature of renewables, as well as its strong advantage of being environmentally-friendly, seems to be resonating with women who are in the infancy of their careers — the future leaders of the energy sector. Experienced females tend to be working in oil and gas, which will be widely due to the sector itself having had decades of activity.

The renewable energy sector is growing rapidly and is seen as a secure industry of the future. NES Global Talent's

HOW LONG HAVE YOU BEEN WORKING IN THE ENERGY INDUSTRY?



research shows that inexperienced professionals favor renewables because they see it as stable, forward-thinking, and welcoming.

FIELDS OF WORK

A common stereotype is that women who work in energy only hold support roles, such as administration and human resources. Discrediting this theory, the Women in Energy Global Study shows engineering as the most common job type at 31 percent for all energy sectors and 39 percent for renewables. This means more women are specializing in STEM subjects and qualifying in engineering fields such as wind energy. Only one-fifth of respondents claimed to specialize in "pink jobs."

Research shows the presence of women in the workplace improves perceptiveness and decision-making processes, both crucial to the renewables and wind-energy fields. A higher volume of women working in leadership roles in the energy industry will continue to pave the way for greater gender equality.

WORKING PARENTS

The gender pay gap is still a huge issue for working women, as well as the ability to achieve a healthy work-life balance. For women in energy, the common assumption that men are the big earners is counteracted, as 63 percent of survey respondents were the bread-winners in their households. This number tends to be slightly higher in oil and gas at 66 percent than in renewables at 55 percent.

Additionally, nearly half (44 percent) of those who claimed to be the primary wage earner in their family had children. The infancy of the female renewables workforce is likely to have contributed to only a third of the sector having children.

Furthermore, the U.S. contained the highest number of female professionals that were also parents at 55 percent, whereas the U.K. came in at 40 percent. The U.S. is often ahead of the game when it comes to employment change, which suggests the country is also advanced in establishing flexible working opportunities for parents.

Despite popular belief, the NES study shows that working in the energy sector fails to deter women from having children, as 30 percent of females with up to five years of experience in energy have kids. This data confirms a career in energy can offer a viable work-life balance.

COMPANY CULTURE

With a male-dominated workforce and lack of female inspi-

ration, a strong company culture should be a prime focus for renewable companies. When asked what their current company could do to be more welcoming and encouraging to women, 43 percent of respondents cited “more flexible working” and “better communication” as their top criteria. This was closely followed by “training/education” at 42 percent and “mentoring schemes” at 40 percent. Positively, nearly half of women in all energy sectors felt their company was inclusive or very inclusive, with renewables ranked at 43 percent.

OBSTACLES

The energy industry presents many workplace challenges to women, but which challenge is the most significant obstacle? If employers can address this challenge, retaining their female workforce becomes an easier task. The study’s respondents cited a lack of suitable roles at 31 percent as their biggest challenge working in the energy sector. This suggests acceptable roles are few and far between.

BENEFITS

Company benefits are an important consideration for attracting and retaining female employees into the under-skilled energy workforce. For a renewables company to improve its gender diversity, its employee benefits must match women’s needs. “Flexible working” was considered the most necessary benefit at 66 percent, closely followed by “remote access” at 60 percent. Access to female networks and enhanced maternity leave also receive strong rankings at 43 percent and 44 percent. Again, female professionals desire to achieve a healthy work-life balance, especially those with children.

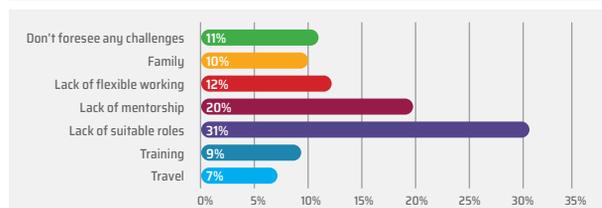
PLANNING FOR THE FUTURE

With a skills shortage looming, the industry must consider where female professionals will be in the future. The study shows a keen interest in other engineering sectors, with 55 percent of respondents stated having considered a move. Among the alternative engineering markets, construction and infrastructure had the biggest draw of female interest at 28 percent and 22 percent.

WHAT COULD YOUR COMPANY DO TO BE MORE WELCOMING AND ENCOURAGING TOWARD ITS FEMALE EMPLOYEES?



WHAT IS YOUR BIGGEST CHALLENGE WORKING IN THE ENERGY INDUSTRY?



Yet, 84 percent of women said they would encourage a female friend to pursue a career in energy. This signifies that hiring managers’ most successful means of attracting new talent will likely be referral schemes, as incentivized referrals are often an incredibly useful way of widening the candidate pool.

Additionally, 15 percent more women with children (than not) are thinking of leaving the sector, but would recommend it to a friend, suggesting the struggle to balance childcare with a career in energy could play a part in women wanting to leave the sector. Also, the lack of flexibility offered in the workplace can sometimes lead to financial strain in which women are forced to exit the market or scale back hours.

CONNECTION

To better improve the relationship between employers and employees, the study investigated the options women place the most emphasis on when considering a new role. The survey showed that women value their ‘career development’ at 31 percent over “salary” at 14 percent. “Job security” was slightly more valued, but “career development” prevails by a considerable amount.

CONCLUSION

Without a doubt, women are making a huge impact on the energy industry. Younger sectors, such as renewable energy, are rounding up the female troops to provide for the future energy workforce, while the oil and gas sector offers strength in numbers. Women want to feel welcome in an industry, and the progressive, forward-thinking renewables sector resonates with them.

A common theme among women in the renewable energy market is that they are all pioneers, working to build gender equality in a male-dominated industry. Renewable energy companies should continue to strive for inclusivity, female mentorship, equal pay and a healthy work-life balance in order to attract and retain women in the workplace. This will help ensure the sector’s advancement and long-term success within the energy industry. ✨

ABOUT THE AUTHOR

Vicki Codd is the marketing director of NES Global Talent. She is a chartered marketer and Cambridge graduate with more than 20 years of experience in B2B marketing in various sectors including IT, Telco, Financial Services, and Social Housing. Codd has been with NES since 2015.

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LUBRICATE NOW, SAVE MORE LATER

There are several factors that should be considered before choosing a lubricant for your wind turbine, such as the lubricants operational temperature range, life expectancy, and ability to withstand environmental conditions. (Courtesy: Shutterstock)



If a lubricant is not considered in a wind turbine's design phase, it is more likely to experience unexpected maintenance issues as the systems age and components wear.

By TONY DOTSON

Wind turbines have been favored in many areas because of their ability to provide communities with environmentally friendly energy. According to Machinery Lubrication, most wind turbines are reliable 98 percent of the time. When they do fail, it is often due to failed or non-existent maintenance. Wind turbines can be expensive to operate, and any operational maintenance can prove costly to energy providers. Therefore, it is critical to identify potential failure points during manufacturing to prevent these issues from arising during operation.

CONNECTORS

Several wind-turbine components should be lubricated to reduce downtime, including the circuit-breaker contacts, switch gears, slip-rings, and fusing systems that go into the turbine's electrical distribution system. Electrical connectors are the physical interface between electrical equipment, wires, cables, and electrical circuits found in the power-distribution system. Without lubricant protection, contact metals are extremely susceptible to corrosion, resulting in a loss of connectivity over time, increased downtime, and added maintenance costs. Many factors contribute to contact corrosion in wind turbines, including micromovements, oxidation, mechanical wear, moisture, and aggressive chemicals.

Fretting corrosion is one of the major mechanical forms of deterioration of electrical terminals. Fretting corrosion is the result of micromovement between the mating surfaces of electrical terminals, which wears away the surface and allows an oxide layer to form on the contact. When an oxide layer forms on the contact, it creates an insulative layer between the contacts that causes an open circuit and increases contact resistance across the terminal. This causes the connector to act like a resistor that consumes power rather than passing it through the power lines. This micro-motion can be caused by low amplitude vibrations or even by the thermal expansion and contraction of the contacts, meaning that nearly all contacts, even when stationary, are subject to fretting corrosion.

Often, lubricant experts will get the question, "But how do lubricants prevent connectivity issues when they inter-



NyoGel® 760G is silica thickened, medium viscosity, synthetic hydrocarbon grease intended for the lubrication and protection of electrical contacts. (Courtesy: Nye Lubricants)

ferre with conductivity?” This is a common myth associated with lubricants. When a lubricant is applied to a contact, it fills in the valleys of the contact surface to protect the metal from oxidation, and it is squeezed out of the asperities, allowing the current to flow.

Despite being housed within the nacelle, connectors are still affected by environmental conditions. Extreme temperatures, dirt, salt water, and moisture from humidity are a few factors that can affect connector performance within wind turbines.

Many engineers don't consider lubricants during the design phase because they operate under a common misconception that grease attracts dirt, when in fact, it does the exact opposite. Grease creates an environmental barrier on the contact surface to seal the contact and keep out the dirt, dust, and moisture. This reduces the particulates that get in between the contacts that can create contact resistance.

SLIP-RINGS

In a wind turbine, both signal and power electrical connections must be made between the rotating blade shaft and the stationary generator. This is accomplished by using a slip ring made of gold rings and gold fingers that ride along as the assembly rotates. These components should be

▾ If a lubricant is not considered in a wind turbine's design phase, it is more likely to experience unexpected maintenance issues as the systems age and components wear. ▸

lubricated to protect the interface of the sliding electrical contact surfaces to prevent oxidation and wear. However, if improperly selected, a grease can do more harm than good. Nye Lubricants was once approached by a customer after they noticed a buildup of black debris on their slip-rings. When paired with high vibration, this debris can corrode component surfaces and prevent conductivity. In this case, the OEM had been using an aerosol can to lubricate the slip rings. When lubricants are applied with an aerosol, molecules disperse in the air and can adhere to surrounding surfaces, causing contamination.

The most commonly recommended lubricant for these applications is a perfluoropolyether oil, like Nye's line of Uni-flor™ lubricants. Compared to hydrocarbon lubricants, PFPE

oils protect slip rings from debris and contamination while also creating a seal that reduces the wear on the gold rings and fingers of the slip ring.

MECHANICAL DRIVE SYSTEMS

Couplings play an important role in moving power from one shaft to another. High vibration in the nacelle makes it so that couplings are often misaligned.

While the couplings are designed to handle a degree of misalignment, designers must take extra steps to prevent additional wear between components. Lubricants designed for high-speed and high-torque applications create a stay-in-place lubricant barrier to protect the couplings from premature wear.

LUBRICATION CONSIDERATIONS

There are several factors that should be considered before choosing a lubricant for your wind turbine, such as the lubricants operational temperature range, life expectancy, and ability to withstand environmental conditions. Depending on the geographical location, a connector lubricant may need to perform in temperatures anywhere from -40 to 125°C without degrading.

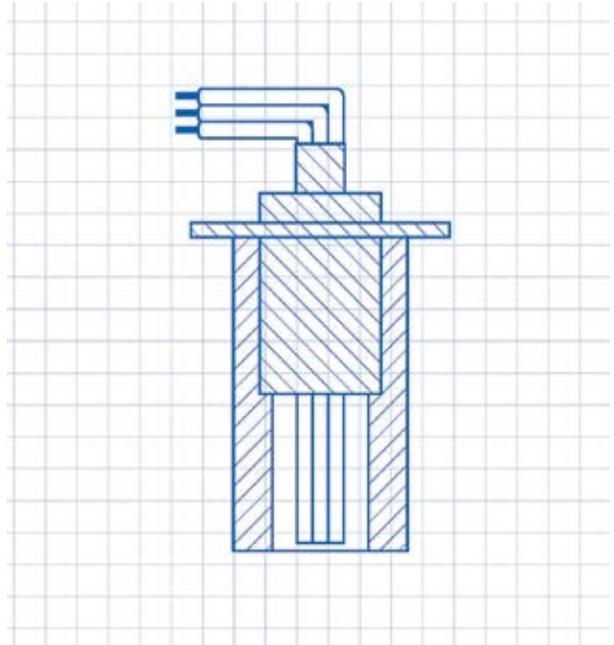
Because the average nacelle is 250 feet above ground and the costs associated with downtime can be high, energy suppliers should select appropriate lubricants that last at least three to five years before re-lubrication. Material compatibility is another factor that should be considered. For example, certain lubricants attack plastics and are not recommended for use in connectors with plastic housings or elastomeric seals. The appropriate packaging must also be selected for the lubricant to improve and optimize dispensing.

In an ideal situation, a lubricant would be considered as a key design component to prevent downtime. If a lubricant is not considered in a wind turbine's design phase, it is more likely to experience unexpected maintenance issues as the systems age and components wear. When a wind turbine does go down unexpectedly, having a reliable solution on hand is key to getting it up and running quickly, as well as preventing a reoccurrence.

Many prominent OEMs specify Nye Lubricant's synthetic greases and oils into their wind-turbine designs and have seen increased performance and protection from wear, corrosion, and, ultimately, product failure. ✈

ABOUT THE AUTHOR

Tony Dotson is the aerospace industry manager at Nye Lubricants, spearheading efforts out of the company's North Carolina office. Dotson has been an integral member of Nye for 15 years, finding lubrication solutions for the company's customers in industrial, semiconductor, vacuum, and cleanroom markets. Dotson holds a Bachelor of Science degree in Mechanical Engineering from North Carolina State University and a Master of Science in Textile Technology from the Institute of Textile Technology. He can be reached at tdotson@nyelubricants.com.



In a wind turbine, both signal and power electrical connections must be made between the rotating blade shaft and the stationary generator. This is accomplished by the use of a slip ring, like the one shown in the schematic, made of gold rings and gold fingers that ride along as the assembly rotates. (Courtesy: Nye Lubricants)

**WIND TURBINE
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CRACKING DOWN ON FOUNDATION CRACKS

Typical corrosion found on the nut and washer. (Photos courtesy: NTC Wind Energy)

During annual inspections, it's of paramount importance to inspect foundations every year for cracks as an integral part of proper turbine maintenance.

By JOSEPH W. BRUCE

We all know that the highly engineered foundation is of fundamental importance to the longevity and soundness of a wind-turbine generator. Even so, foundations are all too often overlooked during regular maintenance intervals.

Proper maintenance requires that foundations be inspected annually for cracks in the concrete and grout. Major cracks may be a result of fatigue loads, design problems, or construction errors. These problems should be taken seriously and require analysis and remedial actions. Smaller or superficial cracks can also jeopardize the integrity of the foundation if left unchecked, especially in the winter season. Water can freeze inside the fissures and expand, progressively weakening the foundation. When small cracks are found, they should be filled, if necessary, by injecting grout into them, and the surface of any cracks should be sealed to prevent further water intrusion.

LOOKING FOR PROBLEMS

Foundation anchor bolts should also be inspected for potential problems. Unprotected foundation anchor bolts will rust even before construction is complete. Light rust is not harmful, but corrosion must be kept in check. If flakes of rust slough off the face of the nut or washer — where most of the corrosion is found — then pitting of the metal is taking place, and remediation is needed. In some cases, when bolts are left to rust, the nut will seize on the rod, making it difficult to tension. In extreme cases, the nut faces and corners are compromised to the point that the nut is rounded. Severe corrosion of the washer could result in the loss of tension.

Concurrently, water travels between the threads of the rod and the nut, pooling at the bottom of the bolt sleeves and foundation. This might defy common sense. After all, those bolts are tensioned at many thousands of pounds. However, looking at a cross section of the nut and rod, there is a clear path for water to spiral down into the bolt sleeve.

The solution to the problems described is a high-quality anti-corrosion grease and bolt caps. Bolt caps protect the grease on the rod, nut, and washer, which, in turn, protects the bolt from corrosion. They also keep water from traveling under the pedestal. Bolt caps are not intended to protect the foundation anchor bolt itself; they are intended to protect the grease. Without grease, bolt caps will actually accelerate corrosion due to the inevitable condensation in the annulus of the bolt cap.

THE IMPORTANCE OF PROPER INSTALLATION

Proper installation is critical to the performance of bolt caps. When installing bolt caps, they should be firmly seated on the flange but not crushed. The seal at the flange is important to the long-term performance of the cap. A mallet

should never be used to drive caps onto the rod, as this will damage the cap. If mechanical means are necessary, use a piece of ABS pipe to drive the cap down, making light downward contact with the shoulder of the cap where it is structurally strong.

Bolt caps will expand and contract with temperature changes. Expansion results in a vacuum inside the cap, which can draw water into the annulus when water pools on the flange. To resolve this issue and allow condensation to escape, a small ventilation hole can be drilled into the side of the cap. Recently, some caps have been designed with ventilation built into them.

A good maintenance program includes pulling a few caps every year, especially on the shady side of the foundation, and inspecting the rods, nuts, and washers for proper grease coverage and corrosion problems. Any damaged or missing bolt caps should be replaced.

HIGH-QUALITY GREASE

While on the subject of grease, it is important to use a high-quality grease that is intended for this application. It should be specifically an anti-corrosion grease with a high dropping point, so it will not dissipate or “melt” off the bolt. Avoid using wax-based greases, as these products generally have a low dropping point and do not provide the corrosion protection required for long term protection. Wax-based grease also tends to string out during application, leaving strings of grease on the tower wall and flange. The grease should cover all of the exposed metal surface on the rod, nut, and washer. It is not necessary to fill the bolt cap with grease, but it should be applied to the rod, nut, and washer as you would a thick coat of paint. Special attention should be given to greasing the nut and washer, as this is the area most vulnerable to corrosion. Grease application tools are available to make the job easier, faster, and more thorough.

In a perfect world, the foundation anchor bolts would be thoroughly greased and protected with undamaged and properly installed bolt caps with no corrosion present. The reality is that we see a lot of corrosion for many reasons.



Workers mark and tension foundation anchor bolts.

Clearly the reason for the corrosion should be identified and corrected, but the corrosion itself can also be effectively mitigated. Most mechanical methods of removal, such as wire wheels, are hazardous to personnel and can damage the tower wall and flange. It is also difficult to get a wire wheel between the tower wall and the bolt. However, there are tools available to cut the heavy rust off the face of the nuts and top of the washer where most of the corrosion occurs. Chemical treatments have proven to be efficient and effective in resolving issues with light rust by converting iron-oxide or rust to a protective coating of iron-phosphate. Starting with a light coating of rust is actually desirable, since it provides for material to be converted. After treatment and once the bolts are clean and dry, they should be coated with anti-corrosion grease and capped for the renewed longevity and protection for your foundation.

LOSING TENSION

Unfortunately, foundation anchor bolts lose tension over time. Think of them as guitar strings. If the strings do not have the proper tension, the guitar does not perform the way it was meant to. It's the same with foundation anchor bolts. The foundation loads become out of balance, and fatigue within the foundation can bring expensive and potentially catastrophic results. Most of the relaxation in the rods and creep in the foundation occur early in the life of

the foundation. For that reason, it is important to perform a full re-tension after 500 hours of initial operation. After that, many operators perform full re-tensions every five years. However, it is recommended, and often required by the design engineer, to do a tension test every other year to monitor the tension. Normally, 10 percent of the foundation anchor bolts are tested at random for correct tension, both inside the tower and outside. To perform this test, the bolt is tensioned at a predetermined level, generally 10 percent below initial tension. If the nut rotates at all or lifts off of the flange as measured by a feeler gauge, it fails, and all of the bolts on that foundation should be re-tensioned.

As early projects grow older and technology advances, many owners are opting to re-power wind farms to increase power output and reduce operating costs. This is the ideal time to inspect the foundation for damage, remove the bolt caps, clean the bolts, re-tension them, and apply new grease and caps. ✎

ABOUT THE AUTHOR

Joe Bruce is the owner of NTC Wind Energy, which has been in the wind business since 1998 and focuses on creative solutions to foundation issues. Best known for their IronClad Bolt Caps, NTC Wind Energy sells and services a number of patented products while providing on-site consultation and bolt tensioning services.

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A closer look inside the stator of an onshore wind generator; the visible pressed lamination stack including vent plates, end plate. (Courtesy: Sotek)

Family owned and operated, Sotek Inc. has been a leader in the manufacturing of precision metal stampings, stator, and rotor assemblies for 35 years.

By **KENNETH CARTER** ▸ Wind Systems editor

The path that brought Sotek to the wind industry is a bit serendipitous.

The company had been a leader in the manufacturing of precision metal stampings used in large motors and generators for more than 30 years when it was introduced to wind energy about half a decade ago at a trade show.

“A lot of these shows kind of showcase the internal components of motors and generators, and at one of those shows we crossed paths with a company that needed to manufacture wind generators,” said Joe Doino, director of business development with Sotek. “We made the connection there.”

And what Sotek discovered was that the transition to wind ended up being, well, a breeze.

“The reality was, it’s very similar to the large motor and generator components that we were already making,” he said.

About the only step Sotek had to change was modifying the specific generator assembly process in order to accommodate the overall size and putting the large shafts in place, according to Doino.

“The changes we made are not wind related; it’s really just a product specific process,” he said.

CREATING STATORS & ROTORS

Now, Sotek makes stators and rotors for wind-turbine generators.

“That starts with making the tooling and stamping and the laminations that go into the stators and rotors,” Doino said. “Then we manufacture and purchase a combination of the balance of assembly, the compression and welding here in house to make completed stators and rotors just prior to insertion, whether it’s copper or magnets or whatever the customer’s next step would be, that’s as far as we currently take it for this customer.”

“We provide more or less components and services based on what each customer needs,” he said. “Using both in-house expertise and close industry partnerships to provide the most value for a customer’s project goals, we have space and expect to continue our expansion as our wind business develops, and there are new customer needs to be met. They drive our expansion.”

Specifically, the company can stamp generator laminations or segments of any diameter up to 48 inches wide, handle five-ton rotor or stator assemblies and do machine

compression to 200 tons. It also offers an interference fit shaft insertion with a dedicated 16,000 square feet under crane area that includes a manual lathe with a 48-inch cross slide swing. All the steel work is done by Sotek, which it’s been doing for more than five years. Sotek is proud to have generator components on almost 2,000 wind turbines, according to Doino.

MANY DIFFERENT MARKETS

In addition to serving the wind market, Sotek also has its hands in other industries, including hydro, rapid transit, electric drives, defense, mining, steel, and oil & gas.

Sotek is able to help customers with new OEM manufac-



Several onshore wind generator sets get final production steps. (Courtesy: Sotek)

turing, stator and rotor repair, rebuild, end-user, value-added services such as fabrication, assembly, sourcing options, and streamlining production bottlenecks and delivering products whenever or wherever they’re needed, according to Doino. The company boasts an 80,000-square-foot manufacturing and warehouse space that is stocked with more than 3 million pounds of electrical grade steel inventory, allowing Sotek to react quickly for a wide range of applications.

GROWING WIND MARKET (GROWIN’ IN THE WIND)

But Doino sees the wind market growing within Sotek’s ranks.

“We’re relatively new to this industry, but we see terrific opportunities,” he said. “There is very strong growth coming,



Two rotors and a stator await a final inspection and packaging. (Courtesy: Sotek)



As wind continues to grow, Sotek is making sure it remains heavily involved in future developments. (Courtesy: Public image)

a lot of news; the industry is bustling, and we see it as an increasingly large, key part of our future. It might be a fraction of our current business; our goal is to double or triple where we are now. We're committed to our value-added strategy and growth in wind power."

Power generators are considered Sotek's specialty, according to Doino, and the company is always striving to help its customers find the right solution to whatever challenge they may bring to the table.

"We have people that have been doing this with us for a really long time," he said. "They are making stampings, lamina-

tions, lamination stacks, cores, and these types of assemblies. With the expertise at work in our team, we can guide the customer to something that is easier to manufacture, more cost effective, and takes less time. We consult with them in these ways to improve the overall process because we do have a lot of experienced folks within our company. Some of our experts have been hands on with us from the beginning."

THE START OF SOTEK

That beginning was 35 years ago.

Sotek opened its doors in 1984 with 13 employees, when the company founder bought tool room assets from Westinghouse Electric Corporation's motor division. Sotek used the equipment to create specialty tooling and dies.

"When Westinghouse closed, the founder of the company purchased some of the equipment that they were leaving behind and began making tooling," Doino said.

It didn't take long for the company to grow, and in 1987, Sotek expanded its reach from the western New York region to the rest of the U.S. Since landing a contract for stamped armature laminations for drive motors in New York City subway cars, Sotek has concentrated its expertise into the manufacture of motors and generators.

"After a short period of time, customers we were making tooling for asked if Sotek could stamp out the parts for them as well, so the founder went out and bought a press and started stamping parts, and it kind of just took off from there," Doino said.

WIND CHALLENGES

Within the wind industry, Sotek is meeting many challenges head on, especially as the wind landscape continues to change, according to Doino.

"Things do move quickly, but as far as the manufacturing processes go, our biggest challenge is just bringing in the manufacturing that's required to service this industry better," he said. "It's more about adapting our own manufacturing footprint to the needs of the wind industry, which tends to be higher volume, larger sizes. So, we are adapting more of our capabilities to meet those larger volumes and sizes than we had worked with in the past. We have adopted robotics where they make sense; we're constantly upgrading our equipment. We have an excellent supplier network to ensure quality and value in our section of the supply chain, are competitively priced, and can plug right in logistically to our customers' processes."

As wind continues to grow, Sotek is making sure it remains heavily involved in future developments.

"We're positioning ourselves to take advantage of offshore wind as it develops, but in the meantime, we're also well established with onshore," Doino said. "We feel that's really a growth area, ideally suited to us. The push for U.S. manufacturing grows as the market develops, and that's a direction that we would like our business to grow into. We're looking to expand into it, and we're actively seeking additional opportunities that can benefit from a U.S.-made product." ✎

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Peter Walper

Managing Member ▸ Thermal Cam USA

“We started out with a drone and then realized that we could do a much better job delivering a superior data set if we started looking at the wind industry outside of the box.”

▸ What does Thermal Cam USA do for wind?

We’re a drone aerial inspection company, but our forte is that we work with large wind companies using third-party mapping software such as EdgeData and their AI analytics engine, EDDIE. EdgeData allows us to communicate with the onsite superintendent and the back-office engineers about specific issues and solve these issues quickly, economically, and safely. That communication sets us apart. Having a technology partner like BladeEdge gives us a leg up.

Most wind companies have in-house drone divisions or national contracts. Utilizing these resources at a local level for minor jobs is not economical or timely. We respond: “We’ve just had a hail storm; we think we have issues on these four towers.” Our flight talents and mapping success have given us a higher level of communication where we understand our clients’ field operations to the point we are almost a subset of their company and can solve these issues now.

▸ What is a typical day like for you at Thermal Cam USA?

Thermal Cam USA covers more markets than just wind, although wind is one of our bigger markets. We have flown turbines almost since Day One.

We fly solar, utilities, aggregates, and oilfield. We work with other software companies to supply data to solve issues or concerns these companies may have. For example, we use an exciting and cutting-edge software developed by ONDAKA. We fly a location or facility and document specific areas photographically. ONDAKA, with their AI systems, produces an augmented-reality representation of that site.

Clients can view this site and the equipment on this site, touch the computer screen of an iPad or desktop in the field or in the office and view any piece of equipment. Touching the screen on, say, a specific motor or valve results in a screen pop-up detailing motor specs, maintenance records, maintenance protocol, PPE required, safety procedures, any data you require. This data can be pre-

sent to our clients, across their different divisions, GIS, maintenance, engineering, purchasing, whoever. Mothusi Pahl, chief commercial officer, recently presented at Rice Alliances Startup Round up at OTC, with ONDAKA winning an award as one of the top 10 most promising entrepreneurial startups.

▸ What makes Thermal Cam USA unique when it comes to the wind industry?

Thermal Cam USA is in the neighborhood and open 24/7, available, now. We don’t compete against the national firms. If anything, we complement them.

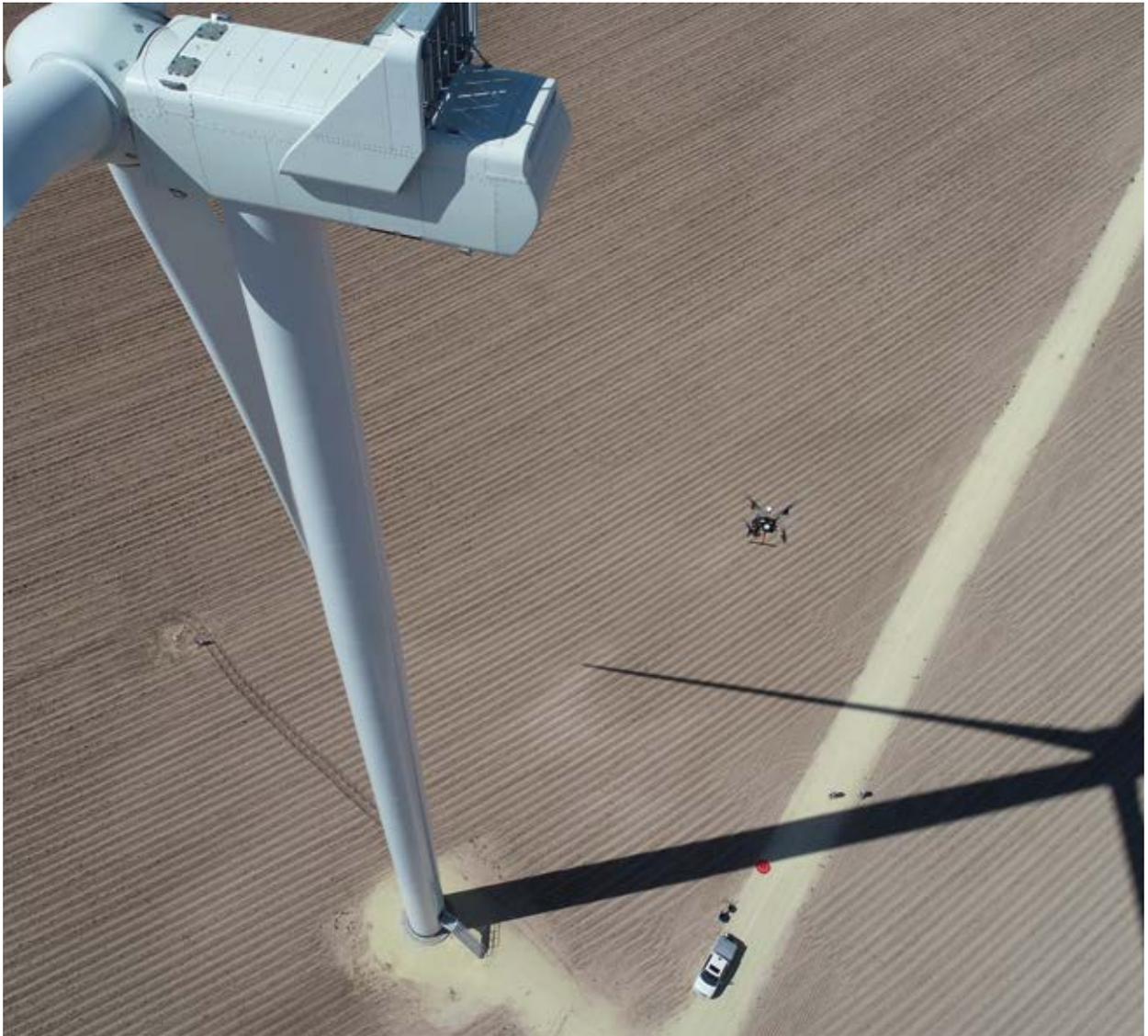
We understand the wind market and our wind clients. We know what we are doing in wind simply because the wind industry has trained us in their procedures and processes. We have also trained them in the various uses of drones.

We now have a synergy with our clients where we are growing together within the changing wind world. They call; we are there, and we deliver.

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

Sometimes the challenge is simple: “We think there are issues on these particular towers. Go fly them.” Sometimes it’s more difficult: “We think we have warranty issues or potential blade failure because we are seeing this.” By defining the scope of work where Thermal Cam USA can know exactly what data and information to bring to the table, the client can resolve these issues faster and easier within a shorter time frame.

We also like to bring more to the table than required. For example, if there is one particular blade needing specific data, we will usually fly the other two blades simply because we want a historical record of what’s going on with that particular tower. Our software allows our client



Thermal Cam USA uses cutting-edge software developed by ONDAKA. (Courtesy: Thermal Cam USA)

to access this information at any time. Knowledge like this is exponentially powerful.

► **The wind industry is constantly evolving. How is Thermal Cam USA evolving with it?**

We evolve by trying to embrace the most cutting-edge software. Thermal Cam USA, by aligning themselves with software companies, is essentially becoming beta-test partners with software and wind companies.

We started out with a drone and documenting anomalies using RGB. We realized we could do a much better job by providing an improved data set. That's what we have tried to do.

We are constantly brainstorming to bring new ideas to our clients. Perhaps we look at a blade thermally rather than optically to bring a better data set. Can we do a thermal test dynamically or statically? How can we as drone pilots collect that data more efficiently? As we scratch our heads over some

of these ideas, the wind energy people are saying OK, let's do it. The wind companies want to work with us.

► **Where do you see wind in the next 10 to 20 years, and where is Thermal Cam USA's place in that future?**

Thermal Cam USA is in the middle of the largest wind energy generation area in the U.S.

Wind energy is continuing to grow in Texas, and we will grow with it. I believe that in the next 10 to 20 years, wind will continue to lead the way in green energy. TCUSA will continue to work with wind companies and be on the cutting edge in drone inspections.

Wind has a successful network of people across the U.S. We're all learning from each other and, in my opinion, that's what makes this industry and its growth exciting. Thermal Cam USA is proud to be part of this industry. ✌

MORE INFO ► www.thermalcamusa.com



To transport the blades, ALE worked with local authorities to obtain the relevant permits but also to make adjustments to the route, such as cutting into part of a mountain to achieve the necessary turn radius. (Courtesy: ALE)

► CONSTRUCTION

Advanced route planning helps transport 61 turbines

Chile's Energy Route 2018-2022 is an initiative that hopes to bring together stakeholders in the renewable industry. Following its announcement, Spain's Acciona was contracted to build four new renewable energy projects in Chile, adding 400 MW across two solar farms and two wind farms.

One of these is the San Gabriel wind farm, in the municipality of Renaico in the region of La Araucanía.

Once completed, San Gabriel will be home to 61 wind turbines, adding 183 MW of renewable energy to the grid, with an investment of \$300 million.

To transport the components, the contractor turned to ALE. Each wind turbine was made of concrete segments, as well as a nacelle, which houses the generator; a hub, to which the blades are attached; and the blades themselves. In total, there were 976 components.

ALE was tasked with unloading the components from ships arriving into Lirquén Port near the city of Concepcion. After receiving the components, they had to be transported about 230 kilometers near to the town of Renaico.

The challenge ALE faced was navi-

gating the route from the port to the wind-farm site. The sheer size, weight, and volume of components meant that the route had to be carefully surveyed and planned.

Each nacelle weighed 105 metric tons, and each blade weighed 18 metric tons with a length of 65 meters, making the components difficult to transport on conventional trailers and under standard bridge heights.

To solve this problem, ALE surveyed the route using manual measurements as well as topographical and software simulations using AUTOCAD and AUTOTURN to evaluate tight bends.

To transport the blades, ALE worked with local authorities to obtain the relevant permits but also to

make adjustments to the route, such as cutting into part of a mountain to achieve the necessary turn radius and also temporarily shutting down a hydro-power station to relocate the transmission line. These subcontracting works were coordinated by ALE in order to make all the upgrades to the route in the time-scale necessary to achieve the schedule of the project.

The equipment ALE used ranged from 24 axle lines, three blade trailers, two low boys, and five expandable trailers to accommodate the tower sections.

ALE was able to turn around the project within three months of being appointed. This was made possible thanks to ALE's experience of delivering parts to the most remote locations around the world. Not only does this improve the cost per kWh of transporting components, it is vital to getting renewable energy projects up and running.

MORE INFO www.ale-heavylift.com

CONSTRUCTION

EDF and Masdar places 415-MW order in Saudi Arabia

A consortium formed by EDF Renewables and Masdar has placed a 415-MW order for the Dumat Al Jandal wind park in the Al Jouf region of Saudi Arabia. The project will be the country's first utility-scale wind park, showcasing the increasing competitiveness of wind energy globally.

The order is an engineering, procurement, and construction (EPC) contract for the supply and installation of 99 V150-4.2 MW wind turbines, as well as a 20-year Active Output Management 4000 (AOM 4000) service agreement for the operation and maintenance of the wind park.

The Dumat Al Jandal project was awarded to the consortium by the Re-



The order is an engineering, procurement, and construction (EPC) contract for the supply and installation of 99 V150-4.2 MW wind turbines. (Courtesy: Vestas)

newable Energy Project Development Office (REPDO) in January 2019 by the Saudi Ministry of Energy, Industry, and Mineral Resources (MEIM). Once operational, it will produce electricity under a 20-year power purchase agreement (PPA) with the Saudi Power Procurement Company (SPPC).

"I would like to thank EDF Renewables and Masdar for the strong collaboration on developing this solution where we have leveraged our extensive experience in pioneering wind markets to win the competitive auction for the country's first wind park," said Eduardo Medin, president of Vestas Mediterranean. "With our 4-MW platform's market-leading cost of energy and our expertise throughout the entire wind energy value chain, the project delivers sustainable energy and develops the region's renewable energy industry."

The order marks the first phase of Saudi Arabia's plan to install 7 GW of wind capacity within five years and 16 GW by 2030. As the global wind leader with experience from more than 80 markets, Vestas has a unique position to contribute to the realization of the country's renewable energy ambitions, which include the creation of a hub for wind energy, the installation of new wind projects, the transfer of know-how, and the development of local wind-energy capabilities.

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Together with global industry partners, Covestro has developed an innovative solution for an efficient production of rotor blades for wind-power plants. (Courtesy: Covestro)

INNOVATION

Covestro delivers first commercial order of raw materials to China

Power generation from renewable sources is a key part of the sustainability concept of Covestro and underlines its commitment to achieving the UN Sustainable Development Goals, in particular goal number 7 for renewable energy (UN-SDG 7). This applies above all to wind power, which is one of the most promising renewable energy sources due to its global availability and the technical progress already made.

This is also reflected in the development of wind-power capacity, which is seeing double-digit annual growth across the globe. China is the world's largest wind-power market with 221 GW of installed capacity at the end of 2018, according to the World Wind Energy Association.

However, cost-efficient processes for manufacturing wind-power plants are in greater demand than ever to enable further expansion and for

competing with traditional energy resources. Once in operation, the aim is for turbines to be used over a lengthy period with the lowest possible maintenance requirements.

In order to meet this challenge, Covestro has joined forces with partners and developed a polyurethane (PU) resin and a manufacturing technology, which — in conjunction with glass fiber mats and an efficient production process — enables shorter cycle times.

“This is a clear cost advantage for manufacturers,” said Dirk Soontjens, who coordinates the global wind power activities of Covestro. “Its advantage over epoxy resins used so far is that it flows more easily and ensures better wetting of the glass fiber mats used for reinforcement.”

The resin also exhibits good mechanical properties and meets many regulatory and industry performance standards.

Recently, Covestro has processed the first commercial order for use of the PU resin for production of 18 wind rotor blades with a length of 59.5 meters each, together with the respective spar caps and shear webs, all manufac-

tured by Zhuzhou Times New Material Technology (TMT), one of the largest wind-blade manufacturers in China. The blades were delivered to Envision, a leading global wind turbine technology company, and were scheduled to be installed in a wind farm in Eastern China in July 2019.

Also in Europe, Covestro collaborates with leading players of the wind-power industry and intends to commercialize its technology shortly. Besides that, Covestro operates a new wind-power laboratory in Leverkusen, which expanded its global lab capacities in Asia and Europe to support customers and innovation.

Covestro has also developed coating solutions with higher cost efficiency. For instance, protective coatings based on Pasquick® technology for steel towers as well as gel coatings for blades of wind-power plants significantly increase productivity and ensure a long lasting performance without maintenance. This is due to the fact that the use of Pasquick® requires one layer less than conventional corrosion protection, and the coatings have a lower curing time.

Besides that, waterborne topcoats

based on Bayhydur® and Bayhydrol® provide long-lasting performance with low solvent emissions. Last but not least, Covestro also offers leading edge protection for rotor blades based on products of the Desmodur® line, providing long lasting protection against abrasion.

MORE INFO www.covestro.com

► **INNOVATION**

Australian startup develops wind-farm listening device

An Australian startup that has developed an acoustic listening device for monitoring the health of wind turbines has raised AU\$850,000 to support the commercialization of its world-first product.



The Ping Monitor. (Courtesy: Rosina Possingham)

Adelaide-based company Ping Services has closed a \$650,000 seed fund round after securing an additional \$200,000 in government funding earlier this year.

The patented device, known as the Ping Monitor, uses acoustic analysis, machine learning, and the Internet of Things (IoT) to continuously detect wind-turbine blade damage.

The key piece of technology is the algorithm that can rate the health of the turbine based on its acoustic signature and monitor changes over time.

The device easily attaches to wind-turbine towers and actively listens to the blades' acoustic signature while rotating to detect blade faults such as pitting or cracks caused by lightning strikes or hail.

Its conical shape protects its microphone from rain, debris such as bird droppings, and ground-level noise.

Data collected is transferred from remote sites via low orbit nanosatellite technology.

The second-generation Ping Monitor 2.0 is scheduled for launch in August.

Ping Services CEO Matthew Stead said there are 3,800 blade failures globally every year, causing up to \$2 billion in damage.

He said the tech startup recently won its first client and was further testing the technology with some of the biggest wind-farm operators in the world.

"This technology is a game-changer for the wind-farm O&M sector, and there's a rush to see which large operator will be first out of the gate to start continuously monitoring their turbines," Stead said.

The Ping Monitor intelligent listening system is also being applied to asset monitoring in the mining, transport, and power sectors.

South Australia has emerged as the epicenter of the Australian space industry in the past 12 months. Adelaide is also home to the new Austra-



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All SHIFT 4k designs are covered with the “type and component certificate.” (Courtesy: ZF Wind Power)

lian Space Agency and dozens of space startups and major Tier 1 defense companies.

MORE INFO theleadsouthaustralia.com.au

INNOVATION

ZF Wind Power gets certificate for its SHIFT 4k platform

ZF Wind Power’s SHIFT 4k platform received a “type and component certificate” from the international classification society DNV GL, for its complete platform range.

In the past, every gearbox design had to go through a long administrative process of calculation files, validation results, and more. As of now, all SHIFT 4k designs are covered with the “type and component certificate.” Customers will profit from the certificate as it speeds up processes, thus saving time and money and boosting productivity.

As time is valuable, this certificate from DNV GL will save costs for OEMs and turbine owners. In the past, the

administrative process could take a few months and now, thanks to the platform’s certificate, the gearbox is ready to be installed immediately. Consequently, turbines or upgrades can be installed faster and thus productivity will increase.

MORE INFO www.zf.com

INNOVATION

Blade leading-edge coating protects against rain erosion

Wind-turbine blades are coated with one or more protective coatings to help them withstand the effects of erosion from rain, sand, hail, and dirt. In most cases, the full structure of the laminated reinforced blade is coated first with a standard two-component protective coating. The leading edge of the blade tip receives another special protective layer to protect against the extra risk of rain erosion. New cartridge-based dispensing technology improves the quality and reliability of this leading-edge protection layer, while mak-

ing it safer and more efficient for those conducting repairs using rope access.

Erosion is directly related to the speed that rain droplets, hail stones, and other airborne particles, (also known as rain erosion) hit the blade. Blade tips are subject to the fastest speeds because when it rains, as the blade rotates up, the falling speed of the rain adds to the blade’s tip speed, hitting the blade at a higher rate. This increased speed leads to faster rate of erosion, an effect that can be likened to sandblasting.

European wind-turbine blade standards expect blades to last 20-25 years — in reality they last from 10-15 years, and even that lifespan is impossible without a coating or some sort of leading-edge protection. In fact, an uncoated blade (also known as a blunt blade) will not last a year. Erosion effects can be seen in as little as a few weeks if there is a strong rain. Protective coatings are absolutely necessary to protect the blade’s leading edge.

Wind turbines are regularly inspected using a variety of techniques. Inspection, using drones or other methods, identifies the blades that need to be repaired and determines the type of repair necessary.

If full service of the blade is necessary, technicians remove the entire blade and repair it on the ground.

Many smaller repairs require simply renewing three to four meters of the leading-edge protection. These repairs can be quite time-consuming. Rope access is the standard method for smaller repairs. For larger repairs, a platform is maneuvered with a rope from the top of the tower.



Cartridge-based dispensing technologies reduce labor, waste, and disposal costs, while adding reliability and improving safety. (Courtesy: Sulzer)

Several different methods for coating the leading edge are used, including multi-layer coatings and specialized tapes applied over the standard coating.

New cartridge-based systems for applying protective coating to wind-turbine blade leading edges improve repair processes by replacing time consuming and inaccurate manual mixing and dosing. Using cartridges can be a huge advantage for workers performing rope repairs prevalent in minor repairs of turbine blades.

Workers either have to premix before going on the rope or mix at the point of installation — a difficult task while hanging by a rope 60 to 80 meters off the ground. These systems also increase the quality of the repairs, because, in general, 90 percent of coating failures (apart from insufficient surface preparation) are due to inaccurate mixing or dosing, a problem eliminated by using a cartridge.

For example, one system that provides extra protection and abrasion/erosion resistance on highly stressed areas like leading edges of wind turbine rotor blades is the Mankiewicz ALEXIT® BladeRep LEP 10DM. The two-component, solvent-free polyurethane product is usually applied using the cartridge-based Sulzer MIXPAC™ MixCoat™ Flex Hose Brush Protective Coating Dispensing System.

Sulzer cartridge-based dispensing systems are also used in the RELEST® Wind LEP ETU system, as well as in products made by several manufacturers of leading-edge coatings.

Cartridge-based dispensing technologies reduce labor, waste, and disposal costs, while adding reliability and improving safety. Use of new applicator-friendly cartridge-based dispensing technologies reduces manual mixing and dosing, improving repair quality, and making tricky rope work easier. For blade repairs that require application of leading-edge protective coatings, these systems are an excellent option.

MORE INFO www.sulzer.com



The Dropsafe Net is a stainless-steel mesh net engineered to securely enclose and tether overhead fixtures, mitigating the risk of them falling and threatening the safety of personnel. (Courtesy: Dropsafe)

MAINTENANCE

Formosa Offshore Wind, Dropsafe tackle dropped object risk

Dropsafe, the leading provider of Dropped Object (DO) prevention solutions, recently announced that offshore wind developer Formosa I Offshore Windfarm (FOWI) has adopted the Dropsafe Net dropped object prevention system, in a bespoke installation across the 20 Siemens Gamesa turbines at the Formosa I offshore wind farm.

Six operational turbines at Formosa I, near Miaoli, off the west coast of Taiwan, have already been equipped with the Dropsafe Net system, ahead of the remaining 14 turbines that will be installed during summer 2019.

With the construction of the 130-MW project heralding the start of rapid growth in the Taiwanese offshore wind market, there is a clear imperative to ensure that, with this growth,

comes the key health and safety lessons from the established markets. Mitigating known and established risks in the early key phases of project development and construction, and factoring in those new risks that may arise from extreme weather events, will enable the emerging Taiwanese offshore wind industry to manage costs and liabilities as it builds out its offshore wind program.

As the mature European offshore wind and oil and gas markets have shown, DOs are an ever-present, increasing threat to safe and cost-effective project development and operations in offshore wind. DOs include materials carried by personnel, lifted or carried from support vessels, or fixtures fitted to the wind turbine, such as lights, ventilation louvres, or hatches falling from height.

Failure to mitigate DO risks presents a clear threat to the safety of personnel, the integrity of equipment, financial performance, and ultimately the reputation of offshore wind firms and their high-profile stakeholders.

Due to the construction, design, and installation requirements specific to the region, the increased potential for dropped objects was identified during the design risk assessment. Dropsafe was engaged by FOWI to develop a custom system that would mitigate these risks.

Off the coast of Taiwan, where typhoons and storms are common, there is a heightened risk of fixtures and fittings becoming loose and posing a threat to on-site technicians. As such, installing robust DO prevention systems demonstrates a further commitment to “typhoon-proofing” of project infrastructure.

FOWI have taken an industry-leading approach in their adoption of DO prevention technology, setting a new safety benchmark, not only for the Taiwanese market, but also for the global offshore wind sector.

The Dropsafe Net is a stainless-steel mesh net engineered to securely enclose and tether overhead fixtures, mitigating the risk of them falling and threatening the safety of personnel. It

is an application-specific solution for a wide range of fixture types, enabling wind-energy companies to confidently improve workplace safety and minimize risks to operational integrity.

At Formosa I, a bespoke Dropsafe Net design, made of SUS 316 Japanese stainless-steel, has been installed between the external landing platform and the tower of the Siemens Gamesa SWT-6.0-154 turbines. This allows FOWI to mitigate the risk of Dropped Objects falling from the landing platform into the sea.

“With this market-first installation, Formosa Offshore Wind is rising to the challenge of preventing dropped object incidents and acting as an industry safety pioneer,” said Mike Rice, commercial director of Dropsafe. “While there is a particular emphasis on Taiwanese projects to be ‘typhoon-proof,’ there are lessons to be learned by the global offshore wind sector in terms of the approach to tackling a major safety risk.”

FOWI’s Formosa II wind farm is scheduled to complete construction in Q3 2019 and is set to maintain FOWI’s leadership position in the mitigation of DO risk.

MORE INFO www.dropsafe.com

► MAINTENANCE

TGM Wind brings back cleaning services due to customer demand

Kardie Equipment, a TGM Wind Services company, leading AWP provider, and turbine cleaner for the past decade, has relaunched its specialized wind-turbine generator cleaning service and expanded its cleaning capabilities to include more industry sectors.

TGM Wind prides itself on being the most efficient and environmentally friendly high-reach cleaning service company on the market, using the largest fleet of Bronto Skylifts in North America. With 10 years of experience providing both access and cleaning,



TGM Wind offers customers a choice between hand-washing or pressure-washing. (Courtesy: Kardie Equipment)

TGM Wind remains the industry leader and preferred cleaning provider. The company accomplishes this by offering customers a choice between hand-washing or pressure-washing, both of which provide a unique set of advantages.

The benefits of hand-washing in place of the pressure washer method are numerous and impactful. First and foremost, the hand-washing method uses significantly less water. Roughly five gallons of water are used to hand-clean a standard 90-meter wind turbine versus 30 gallons with the traditional pressure-washing method.

When hand-washing, TGM only uses the minimum amount of water required, to ensure there is no water waste, while also increasing efficiency. When cleaning with a power-washer, one usually starts at the top of the turbine, and all the water, dirt, and oil must be washed the full length down the turbine. Using the hand-wash method (and environmentally friendly soaps and solutions), TGM technicians are able to hand wipe only the top of the turbine where most of the dirt and oil stains are.

TGM Wind is leveraging its expertise as the renewables sector leader in cleaning, and now delivering the same best practices to the utility, power generation, refining, and telecommunications industries.

MORE INFO www.kardieequipment.com/tgmcleaning

► MANUFACTURING

Vestas to supply one of the world’s largest citizen-owned parks

Bürgerwindpark Reußenköge GmbH & Co. KG has placed an order for 12 V112-3.45 MW turbines for the expansion of a citizen-owned wind park in Schleswig-Holstein.

With this order, the wind park will have a total installed capacity of 210 MW with the possibility of a further expansion up to 300 MW, making it one of the world’s largest citizen-owned wind projects. The current wind park has an estimated annual production of around 600,000 MWh, which can cover the annual electricity consumption of half a million German citizens.

“This 12 V 112-3.45 MW turbine expansion is another major step to building out our citizen wind park to provide sustainable energy to the



Vestas’ V112-3.45 MW turbine. (Courtesy: Vestas)

region,” said Dirk Ketelsen, managing director Bürgerwindpark Reußenköge GmbH & Co. KG. “We started this journey in 1989 with our first turbine, and we plan to expand this citizen wind park to up to 300 MW in the coming years. With the 12 new turbines, Vestas will have provided 63 V112-turbines for this wind project.”

“We look forward to working with our long-term customer Bürgerwindpark Reußenköge GmbH & Co. KG and help them achieve maximum return on their investment over the wind-power plant’s lifetime,” said Claudia Feki, key account manager, Sales Germany North, Vestas Northern & Central Europe. “By expanding this lighthouse citizen-owned wind park in Northern Germany and choosing the V112-3.45 MW turbine, one of our top performers for high-wind sites, the size, capacity, and sustainability of this citizen-owned wind park make the people of Reußenköge role models for wind power commitment.”

The order comprises supply, installation, and commissioning of the turbines and a VestasOnline® Business SCADA solution. Wind-turbine delivery is planned to begin in the third quarter of 2020, with commissioning expected in the fourth quarter of 2020.

MORE INFO www.vestas.com

MANUFACTURING

Siemens Gamesa awarded large repowering order

Siemens Gamesa has been selected by MidAmerican Energy Company for the Rolling Hills wind power project for a total of 429.3 MW, the largest repowering order to date in North America. The company will repower the project with 163 SG 2.7-129 and 18 previously sold SWT-2.3-108 wind turbines.

Rolling Hills is in Adair, Adams, and Cass counties in Iowa and features 193 SWT-2.3-101 turbines. The



Siemens Gamesa will repower the Iowa project with 163 SG 2.7-129 and 18 previously sold SWT-2.3-108 wind turbines. (Courtesy: Siemens Gamesa)

repowering project includes replacement of the blades, hubs, and nacelles for all units and top-tower sections for the SG 2.7-129 units. Commissioning of the project is expected for late 2021.

The SG 2.7-129 turbine builds on the robust and successful 2.3-MW geared product series.

“We are excited to provide upgraded equipment and technology to the Rolling Hills project in Iowa, a national leader in the wind energy industry,” said José Antonio Miranda, CEO of Onshore Americas at Siemens Gamesa Renewable Energy. “This new project is a testament to MidAmerican Energy’s confidence in us as well as Iowa, where we have supplied them with

more than 2.6 GW. The blades will be produced right there in Iowa, and the nacelles and hubs will come from neighboring Kansas, making this a truly local project.”

Siemens Gamesa has installed more than 10,000 wind turbines in the U.S. totaling approximately 20 GW of installed capacity.

In Iowa, Siemens Gamesa has installed nearly 1,400 wind turbines for a total of almost 3.5 GW. The company has a strong footprint consisting of service, offices, and two manufacturing facilities in Fort Madison, Iowa, and Hutchinson, Kansas. ↘

MORE INFO www.siemensgamesa.com

A close-up photograph of a hand holding a Snap-on electronic torque wrench. The wrench is black with a digital display showing '90°'. The wrench is being used on a metal component that is wrapped in silver heat-resistant mesh. The background shows various mechanical parts, including pipes and wires, suggesting an industrial or automotive setting. The Snap-on logo is visible on the wrench's handle.

CROSSWINDS

THE FUTURE OF WIND

BETTER TOOLS OF THE TRADE

Electronic torque wrenches tend to offer greater accuracy than mechanical models.
(Courtesy : Snap-on)

New designs in torque and tethered tools are helping technicians do the job more safely and efficiently.

By STEVE STAEDLER

The last thing a wind technician wants to haul up a turbine is a heavy, cumbersome torque wrench to repair a hydraulic actuator out in the hub. But that's exactly what occurs often to complete the job several times a year, unless one uses a torque multiplier. This tool, which is lighter and easier to maneuver, works just as well as a traditional torque wrench to make repairs on systems such as hydraulic actuators.

Given the challenges of working in the wind industry — such as being several hundred feet off the ground and operating in tight, confined workspaces — having the right tools is critical to completing a job safely and efficiently. Fortunately, advances in the design of torque tools and tethering devices are giving technicians a helping hand when it comes to maintenance. While these innovations will never replace the deep mechanical aptitude of savvy technicians, it can make them more proficient — and that benefits everyone.

TORQUE IN ACTION

One of the more demanding jobs is repairing hydraulic actuators in the hub, which is a component that connects the three blades to the main shaft and the rest of the drive train. Formerly, the maintenance team would carry up a large hydraulic torque wrench and related accessories to remove the head seal of the actuator. But that job has been made easier, thanks to a torque multiplier.

“Anywhere there’s a high torque, confined-space situation, a torque multiplier should be close at hand,” said Mark Edmunds, product manager at Snap-on Industrial. “Not only will a torque multiplier help make sure your fasteners are properly tightened, but it will help improve a technician’s efficiency — two things that add up to increased productivity.”

Torque multipliers are particularly useful on wind farms or other remote jobsites, as they don’t require electrical or pneumatic power sources. Designed for extreme duty, they deliver very high torque output, making them well suited for two- to three-inch bolt diameter applications. Generally, a torque multiplier is ideal when a prescribed amount of torque must be applied to threaded fasteners having a diameter of one or more inches, and/or when fasteners must be accurately tightened in a work space that precludes the use of a torque wrench with a long arm length.

Edmunds said torque multipliers are ideal for extracting the ram and inspecting the bore of a hydraulic actuator. He added that using a multiplier saves time from carrying quite a few tool bags up the tower, and from a safety standpoint, it eliminates the need of running a high-pressure hydraulic unit in order to remove the head seal on the actuator.

For smaller torque applications, some companies have begun using 1/4”, 3/8”, and 1/2”-drive electronic torque wrenches. While electronic torque tools are gaining in popularity, mechanical torque wrenches are still popular

in wind power because they are relatively inexpensive, and it’s the style that many technicians grew up with. Mechanical wrenches represent an older technology, but they still perform well if the technician uses the tool correctly, stores it properly, and keeps it accurately calibrated.

According to Edmunds, electronic torque wrenches tend to offer greater accuracy than mechanical models. The chance of over-torquing is reduced with electronic wrenches, as illuminating LEDs provide operational guidance, signaling the user that he or she is approaching the targeted torque.

Data collection is another benefit of electronic torque wrenches. For each use, instant data on the exact torque applied is displayed and stored, which can be downloaded and analyzed for tracking and auditing purposes. These wrenches come with built-in calibration factors for different head lengths and adapters, and also alert the user when the wrench is due for calibration based on pre-set date and cycle count reminders.

PROPER USE

It’s difficult to obtain accurate results from either a mechanical or electronic model if the tool isn’t properly used. That’s why correct hand position on the wrench is critical.

Edmunds points out that your hand should fit squarely on the steel or plastic-covered handle. Positioning your hand on any other part of the wrench, or even just off-centered on the handle, can lead to injury and result in a false torque reading. If two hands need to be used, place one hand on top of the other. The length of a torque wrench is designed and calibrated in such a way that your hand(s) need to be properly positioned on the handle during use. Changing the location of your hand negatively affects the tool’s performance.

Other tips for safe torque wrench use include:

- ▀ Wear safety glasses.
- ▀ Always pull rather than push the wrench when applying torque.
- ▀ Never use sockets that are worn or showing signs of cracking or fatigue.
- ▀ Ensure fasteners and bolts are well cleaned and dry (thread condition actually changes the amount of torque required to achieve proper fastener tension and clamping force).
- ▀ Avoid using accessories or handle extensions unless specifically allowed by the torque wrench manufacturer.

Some tooling manufacturers offer torque training to technicians and students to become certified in all things torque. These training seminars cover understanding torque theory; learning the proper procedures for applying torque; identifying bolt hardness and metal grades/thread pitch; fastener lubrication; appropriate safety measures;



Torque multipliers are ideal for extracting the ram and inspecting the bore of a hydraulic actuator. (Courtesy : Snap-on)

and selecting the right tool for the job. Reputable manufacturers host these seminars on their customers' jobsites, while many technical schools offer them as part of their training programs.

TETHERED TOOLS

Technicians working 300 feet in the air certainly know the importance of properly tethering tools, as one dropped object can have deadly consequences. According to the Bureau of Labor Statistics, 237 people were killed by falling objects or equipment in 2017. Furthermore, the BLS reports that being struck by a falling object is the third leading cause of workplace fatalities, yet many of these accidents are completely preventable.

Tethering devices come in many shapes and sizes, but many fall short for one reason or another. Some mount in a way that limits the full use of the tool, is difficult to handle, and is an obstruction. Other tethers are only attached to some of the components of the tools, leaving other parts unsecured. Edmunds said the most common complaint of tethered devices is that they inhibit the functionality of the tool. A tool can be tethered, but if a technician refuses to use the device because it's too cumbersome, then the design fails, and the objective of a safer working environment is not reached.



Correct hand position on the wrench is critical. (Courtesy : Snap-on)

AD INDEX

Abaris Training Resources	7
American Chemical Technologies	IBC
American Gear Manufacturers Assn (AGMA)	5
Association of Equipment Manufacturers	11
AWEA (American Wind Energy Assn)	23
Aztec Bolting	29
Bachmann Electronic Corporation	17
Castrol Industries	3
Elevator Industry Work Preservation Fund	45
Hannover Fair USA	41
ITH Engineering	36
Kalamazoo Valley Community College.....	33
NTC Wind Energy.....	7,37
Stahlwille Tools LLC	55
Thermal Cam USA	55
The Timken Company	BC
TORKWORX LP.....	IFC
Wind Secure Inc.	1
<i>Wind Systems</i>	22
Worldwide Machinery Pipeline Division	47

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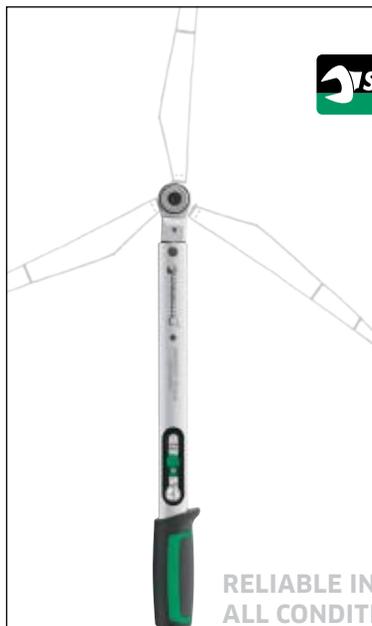
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In examining ways to make drop prevention systems better for technicians, Edmunds said the industry has studied the most common occurrence of tool drops — the transfer of a tool between storage and use. More than half of drop incidents occur during this frequent action. With most systems, in order to secure a tool, the technician must first retrieve it and then clip or attach it to a lanyard. This process involves both hands and creates the potential for dropped tools as

the technician transfers the tool from one hand to another and/or incorrectly attaches the tether.

To address this concern, Edmunds said Snap-on Industrial has developed Tools@Height; a tethering system that eliminates the additional actions normally required to secure tools. An example is a tool belt in which each tool has its own pouch or holster with a tethering device already installed. This enables the technician to simply remove

the tool, use it, and put it back into its place on the belt — all with one hand. Since every tool is already independently tethered, no device needs to be attached, which can reduce transfer-related issues and resultant drops.

An additional benefit of the Tools@Height system is the reduction of the potential for accidental falls. Safety experts agree that, to minimize such accidents, technicians working at height should maintain three points of contact: two feet on a platform and one hand on a secured infrastructure. However, when using both hands to handle tools and attach them to a tethering device, the technician loses one point of contact. The Tools@Height system allows technicians to access and use their tools while maintaining the recommended “three points” position.

New designs in torque and tethered tools are bringing about more productivity and a higher level of safety to wind farms. Today, there are more than 1,000 tools available with engineered tether points for drop prevention. By design, the systems do not interfere with functionality or productivity. As tool drop prevention systems continue to evolve, productivity and efficiencies will increase. Safety is the No. 1 objective on all wind farms, and eliminating dropped tools goes a long way toward achieving a safe work environment. ✎

ABOUT THE AUTHOR

Steve Staedler is a senior account executive at LePoidevin Marketing, a Brookfield, Wisconsin-based business-to-business consulting firm that specializes in the tooling and material handling industries. Staedler has been covering wind industry topics for more than 10 years. He can be reached at steve@lepoidevin-marketing.com; 262-754-9550.



Torque multipliers are useful on wind farms or other remote jobsites, as they don't require electrical or pneumatic power sources. (Courtesy: Snap-on)



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