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Wind Systems (ISSN 2327-2422) is published monthly by Media Solutions, Inc., 266D Yeager Parkway Pelham, AL 35124. Phone (205) 380-1573 Fax (205) 380-1580 International subscription rates: \$72.00 per year. Periodicals Postage Paid at Pelham AL and at additional mailing offices. Printed in the USA. POSTMASTER: Send address changes to *Wind Systems* magazine, P.O. Box 1210 Pelham AL 35124. Publications mail agreement No. 41395015 return undeliverable Canadian addresses to P.O. Box 503 RPO West Beaver Creek Richmond Hill, ON L4B4R6. Copyright 2006 by Media Solutions, Inc. All rights reserved.



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November 7 - 9 | Albuquerque, New Mexico, USA

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EDITOR'S DESK

AUGUST 2017

Keeping an eye on the future of wind

What's the future of wind? That question, more than any other, is more than likely always on the minds of anyone and everyone who is involved in the wind industry.

It's a question I contemplate daily, and after working with many experts in the industry whose job it is to answer that question, I can say with confidence that the future of wind looks strong.

And in this special issue of *Wind Systems*, I want to share those experts' findings with you.

Every year, *Wind Systems* publishes a special Market Outlook issue where experts and insiders offer their prognostications of the industry backed up by hard facts about where we are now.

In this issue, Hannah Hunt with AWEA offers her insights on how wind power will continue to boom in the years ahead.

Anthony Logan with MAKE consulting firm looks at the eventual PTC phase out and beyond, and how it could spur unprecedented growth.

And energy writer Lisa Cohn talks with many in the industry who say that the PTC, as well as innovation in the industry, will continue to drive growth in the wind market, including O&M and jobs.

Also as part of the Market Outlook, I offer up a story about Oklahoma and its amazing success in the industry as it has just jumped up the wind energy chart to become third in the U.S. for installed energy.

But the Market Outlook is only a part of what you'll find in this issue.

Our monthly inFocus topics feature articles on lubrication and filtration, as well as turbine foundations.

Included in that section is a company profile with ExxonMobil, in which a company official discusses its breakthroughs in synthetic lubricants specifically designed for wind turbines. And in this month's Conversation, we chat with the marketing manager with Klüber Lubrication and the strides it is making in innovative solutions that save energy and resources.

There's a lot of good news and information bundled up in this issue, so enjoy it. According to the experts, wind's future — and ours — is strong.

Thanks for reading!



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History is full of wind firsts

Courtesy of AWEA

- **1888:** Wind power is first used to generate electricity at a test lab in Cleveland, Ohio.
- **1941:** Palmer Putnam installs the world's first megawatt-sized wind turbine at Grandpa's Knob in Vermont.
- **1980:** The world's first wind farm is built at Crotched Mountain in New Hampshire, consisting of 20 turbines totaling 600 KW of installed capacity.
- **1981:** The first utility-scale wind farm is built in California.
- **1983:** Iowa passes the country's first renewable portfolio standard.

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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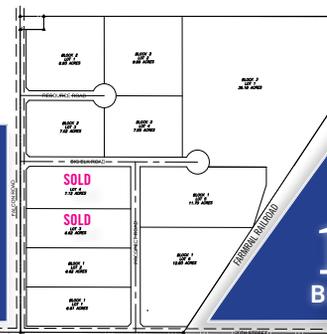
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Windsourcing.com to be sales partner for SikaCor SW-1000 RepaCor

As a result of the “RepaKorr” joint research project, Sika Germany GmbH developed SikaCor SW-1000 RepaCor. This product innovation is a revolution in the repair of corrosion damage to on- and offshore wind turbines. The solvent-free two-component coating dries four hours faster than conventional systems. The practical packaging in the form of mixing cartridges makes the product easier to process, so industrial climbers only have to carry a low weight during their repair work, thus guaranteeing complete process safety with minimal waste. Other properties of SikaCor SW-1000 RepaCor include a high level of impact and abrasion resistance. The product is impermeable and demonstrates color stability like two-component polyurethane top-coats. Surface-tolerant SikaCor SW-1000 RepaCor provides corrosion protection with only one coat, such as a first coat ex works at only 500 µm. This has been confirmed in successful tests and certification in accordance with ISO 20340.

A NEW REPAIR CONCEPT

During the “RepaKORR” research project, funded by the German Ministry for Education and Research, the material, technical, and organizational bases for an “on-site repair” concept were developed. The focus of this project was on a high-performance coating material modified to meet the key requirements of the project, with Sika Germany GmbH in charge of its development as the research part-



SikaCor SW-1000 RepaCor is applied. (Courtesy: Windsourcing.com)

ner with sole responsibility. Intensive development work resulted in the new product, SikaCor SW-1000 RepaCor, which combines all of the properties of long-lasting corrosion protection, particularly in the case of repair measures.

EXCLUSIVE SUPPLY PARTNERSHIP

As a specialist dealer for the wind-energy industry, Windsourcing.com was selected by Sika as its exclusive supply partner for the new product in the aftersales service market for the wind industry in Europe.

“We are delighted with the confidence shown in us as a qualified trade partner for the wind industry and feel that this is a great endorsement of our work”, said Seher Kaygusuz, who is responsible for business development and marketing at Windsourcing.com. “We see

ourselves not only as a sales partner but also as a business partner that can actively support the announcement of this new product on the wind energy market.”

Kaygusuz invites manufacturers and suppliers to also become part of the Windsourcing.com supply network.

“Our supply network already consists of numerous national and international supply partners for various wind turbine brands,” Kaygusuz said. “If companies offer products or services for wind turbines and would like to make their portfolio available through an experienced trade partner that specializes in the wind-energy market, we would be delighted to hear from them.”

Source: Windsourcing.com

For more information, go to www.windsourcing.com

CEE Group acquires wind farm in Brandenburg

The Hamburg private equity firm CEE continues to expand its wind-power portfolio and has acquired another German wind farm in Lüdersdorf, Brandenburg. The seller is the Danish company, European Energy A/S.

The wind farm consists of two turbines (type Vestas V112). The hub height is 140 meters; the rotor diameter is 112 meters, and the wind farm's overall capacity is 6.6 MW. The turbines, which were commissioned in May, will deliver environmentally friendly power for about 5,000 households a year.

CEE Operations, which manages the CEE Group's power-plant portfolio, is responsible for the commercial side. The seller of the wind farm is the project developer European Energy A/S, Copenhagen, from which CEE recently acquired a 27.6 MW wind farm in Brandenburg.

"The acquired turbines will ideally complement CEE's existing portfolio and underline our strategy of ongoing growth in the core German market," said Detlef Schreiber, the CEE Group's CEO. "For our investors, this means that we will continue to generate regular stable income and attractive returns."

"We are very pleased with this follow-up transaction, which we have successfully implemented with European Energy after the Vormark project," said Felicitas Hauk, investment director and responsible for projects at CEE. "A further project is also due to be completed shortly."

"With the successful implementation of the follow-up project in Lüdersdorf, we once again demonstrated our expertise in Germany as one of our core markets," said

Knud Erik Andersen, managing director and main shareholder of European Energy A/S. "In addition, the project testifies to our expertise in repowering. We are pleased to collaborate with experienced partners such as the CEE Group and also see new opportunities to cooperation in the future."

Following the acquisition of the Lüdersdorf wind farm, the CEE Group's renewable energies portfolio has grown to about 592 MW.

In 2017, CEE's energy parks should produce about 930,000 MWh of power from renewable sources. ↵

Source: CEE Group

For more information, go to www.cee-group.de



CEE Group acquires a further wind farm in Brandenburg from European Energy A/S. (Courtesy: CEE Group)



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MARKET OUTLOOK





Continuing an American Success Story

*Wind power to keep booming
in the years ahead.*

By Hannah Hunt

Over the past few years, wind, solar, and natural gas have made up nearly all new electric generating capacity in the U.S. And earlier this year, wind energy surpassed conventional hydropower to become the country's largest renewable resource, with enough installed to power 25 million homes.

But what about the years ahead? Will this American success story continue, bringing more low-cost clean energy to families and businesses across the country, while creating thousands of new well-paying jobs along the way?

A trio of new data points clearly show the answer to these questions is 'yes.'

ENCOURAGING NEWS

New data from the second quarter of 2017 indicate the wind-energy development pipeline is bigger than ever. More than 25 GW of wind capacity are under construction or in the advanced stages of development — enough to power millions of homes.

From April through June, 5 GW of new wind started construction. Of that, 3 GW came from Wyoming's Chokecherry and Sierra Madre wind farm. Once completed, it will be one of the world's largest wind projects, satisfying demand for renewable energy across the western United States.

Fortune 500 companies also committed to powering more of their operations with wind during the second quarter. Notable buyers included T-Mobile, Goldman Sachs, General Mills, Apple, and Partners HealthCare. Long past the trend stage and now

American wind power will drive more than \$85 billion in economic activity between 2017 and 2020, while wind-related employment will reach 248,000 jobs in 50 states. (Courtesy: AWEA)

firmly entrenched as an important source of market demand, thirst from corporate buyers will play an important role in wind's growth in the years to come.

Because wind's costs have fallen by two-thirds over the last seven years, buying wind helps these businesses boost bottom lines while also helping to meet internal sustainability goals.

"This pursuit of renewable energy benefits our customers and communities through cleaner air while strengthening our business through lower and more stable energy costs," said GM Chairman and CEO Mary Barra, speaking about her company's 100-percent renewable goal.

Fortune 500 companies aren't the only large energy users to recognize the benefits of wind, however. Fort Hood, one of the country's largest military bases, began powering about half of its operations from a hybrid wind solar project earlier this year.

"We need to be autonomous," said Chris Haug, a Fort Hood spokesman. "If the unfortunate thing happened and we were under attack or someone attacked our power grid, you'd certainly want Fort Hood to be able to respond."

Finally, the U.S. continued to establish offshore wind as a new ocean energy resource during the second quarter.

The Maryland Public Service Commission greenlit two projects that put the state at the forefront of U.S. offshore wind development.

The commission approved offshore renewable energy credit (OREC) contracts for 368 MW of capacity spread across two projects, proposed by U.S. Wind and a subsidiary of



New data from the second quarter of 2017 indicate the wind-energy development pipeline is bigger than ever. (Courtesy: AWEA)

Deepwater Wind. The move will allow the financing of both projects to move forward, and takes us one step closer to having a second American offshore wind farm, following Deepwater Wind's groundbreaking Block Island project off the coast of Rhode Island.

BOOM YEARS AHEAD

Second quarter data confirm the earlier findings of a Navigant Consulting report: The U.S. wind industry will see strong growth through 2020.

American wind power will drive more than \$85 billion in economic activity between 2017 and 2020, while wind-related employment will reach 248,000 jobs in 50 states. By 2020, Navigant expects 33,000 Americans will be working in wind-related factories, 114,000 Americans will be building, operating and maintaining wind turbines, and another 102,000 will have jobs supporting the industry.

Beyond job creation, wind's growth will bring enormous economic development opportunities to rural America. Land lease payments for farmers and ranchers hosting wind turbines are expected to grow from \$245 million a year to more than \$350 million by 2020, according to Navigant.

And entire communities stand to benefit from increased revenue, not just landowners. Navigant forecasts that new wind farms built over the next four years will provide \$8 billion in property-, income-, and sales-tax payments, on top of payments from the many projects already in existence.

As Washington continues to look for homegrown success stories it can promote, particularly ones hiring good-paying manufacturing jobs across the Rust Belt and investments in rural America, wind power clearly works for America.

TECHNOLOGY GAINS

Bringing 1980s wind farms into the 21st century also offers another path for wind-energy progress.

American wind power was born in the Golden State, where the first large-scale wind farms were built three decades ago. Many still generate electricity today, more than 30 years later. But through a process known as repowering, companies are starting to

replace vintage turbines with modern equipment.

Good examples of this process occurred during the second quarter of 2017. Salka LLC continues to repower the Summit wind farm in California's Altamont Pass. Just 27 modern wind turbines will replace 569 first-generation machines.

NextEra Energy Resources just broke ground on a full repowering at the Golden Hills North wind farm, replacing 283 turbines from the '80s with just 20 modern ones capable of generating significantly more electricity.

"(This) allows us to breathe new life into an old project, reduce the impact on the environment, and provide good jobs and meaningful economic benefits for the local economy," said Daryl Hart, director of development for NextEra Energy Resources.

Other companies are repowering old California projects, too. EDF Renewable Energy recently upgraded the Shiloh IV wind farm, originally built in 1989. Just 50 new turbines replaced 235 old machines while quadrupling the project's capacity to generate electricity.

Elsewhere in California, 21 modern turbines replaced 145 vintage machines at the San Geronio project in Riverside County in 2015.

Repowering helps these pioneering projects generate more electricity with increasing reliability and lower costs, all while significantly decreasing their environmental footprint. It also boosts the local economy.

"Repowering the Altamont Pass wind farm will have a profound impact on the Alameda County economy," Salka chief executive Jiddu Tapia said. "Not only will the redevelopment process create local jobs, but the energy produced at the site will provide an affordable, dependable way for the east San Francisco Bay Area to meet its expanding power needs for generations to come."

The forecast for American wind power remains strong, though, with wind staying on track to produce 10 percent of the country's electricity by 2020. That means more jobs, low-cost electricity, and economic development. Any way you look at it, wind works for America. ↵



Hannah Hunt is a senior research analyst with AWEA focused on wind-industry data and analysis, with applied GIS experience. Hunt joined AWEA in July 2014 after receiving her master's of public affairs (MPA) degree at the Indiana University School of Public and Environmental Affairs (SPEA), with previous positions at the Tennessee Valley Authority (TVA) and the Government Accountability Office (GAO).

PTC Phase-out Spurs Unprecedented Growth

The 10-year outlook for the U.S. wind industry highlights yet another boom-and-bust cycle.



The Block Island Wind Farm off the coast of Rhode Island was the first offshore wind farm in the U.S. (Courtesy: Deepwater Wind/GE)

By Anthony Logan

The global wind industry is no stranger to seizing opportunity as incentive schemes expire. In key markets, including China and Germany, installation totals ballooned in the months and years before subsidy expirations. The U.S. is no different, and the legislated phase-out of the Production Tax Credit, or PTC, will drive an unprecedented four-year installation total of nearly 40 GW from 2017 to 2020.

In a twist of irony and barring substantial policy changes, the administration of President Donald Trump, a vocal skeptic of wind energy, will oversee the largest four-year rollout of new onshore wind capacity in U.S. history — roughly 5 GW more than was installed from 2009 to 2012 under President Barack Obama’s first term.

A wind market forecast can be broadly spoken of in

terms of key drivers and barriers. Drivers supporting MAKE’s outlook include the PTC, wind’s steadily falling levelized cost of energy (LCOE), capacity retirements, state renewable portfolio standards (RPS), and increasing interest from commercial and industrial off-takers (C&I). Key barriers, by contrast, include persistently low natural gas prices, solar power’s falling LCOE, a dearth of transmission availability, and anemic growth in demand for electricity.

The Trump administration itself remains a potent wildcard for the U.S. wind industry. The president is typically hostile to wind in his public statements, but many of his signature policy proposals affect wind in unexpected ways, sometimes benefiting and hindering wind in a single stroke. The case of corporate tax reform

illustrates this duality: A sharp reduction in the corporate tax rate, in this case from 35 percent to the 15 percent preferred by the president, would reduce overall tax equity appetite and starve projects of critical funding, but if the reform encourages a broad repatriation of overseas assets, a large pool of firms with a tremendous one-time tax liability could be eager to leverage the PTC to reduce their overall tax burdens.

POLICY AND TECHNOLOGY

The sense of urgency caused by its looming phase-out is not the only characteristic of the PTC that is driving wind-installation growth. The Internal Revenue Service (IRS) provided a particularly generous guidance for the implementation of this final PTC extension, allowing developers four years to complete projects after initial qualification. This extended run time, well in excess of the typical one- or two-year completion runway in previous iterations of the PTC, mitigates the impact of the de facto cap on the U.S.' annual installation potential, which is set by the availability of project sites, engineering, procurement and construction (EPC) resources, investor appetite, and manufacturing capacity, among other variables, and allows for roughly 20 GW more wind capacity than a two-year runway would have. Additionally, the market stability engendered by a four-year runway for project installation and a four-year phase-out has created a markedly improved investment climate that would have boosted investor confidence more, but for the post-election uncertainties in tax reform and trade.

The unsubsidized LCOE of on-shore wind will continue to decrease, driven by improved turbine technology and increasing rotor diameters. LCOE, as well as the PTC, whose

passage through Congress on bipartisan terms in 2015 gives it some much-needed staying power, are generally "fixed" drivers that are not anticipated to react dramatically to likely market or political developments. The scale and pace of non-renewable capacity retirements, state RPS expansions and C&I participation in wind off-take arrangements, on the other hand, are key "variable" drivers that can fluctuate widely based on political and market conditions.

An international uproar over Trump's decision to step back from the Paris Agreement was echoed in several states, mostly those with Democratic majorities in their state legislatures. Many of these states have existing RPS programs that are nearing the end of their mandates or are modest in aim compared to more recent RPS policies enacted in oth-

er states. Amid federal abdication on climate change policy, MAKE anticipates several left-leaning or otherwise environmentally-minded states to increase their RPS mandates substantially in the near-term to provide a counterpoint to the Trump administration while avoiding unnecessary compliance costs by leveraging expiring wind and solar tax credits.

NON-RENEWABLE RETIREMENTS

The pace of non-renewable retirements is primarily dependent on plant-level economic decisions, but the administration's statements and actions carry weight in some circumstances nevertheless. In early 2016, before both the election results and the dimming prospects of Obama's Clean Power Plan (CPP), more than 80 GW of coal assets were expected to

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retire before 2026. The apparent demise of the CPP and Trump's pro-coal policy measures incentivize utilities and IPPs to slow coal retirements. While a promising number of coal retirements have been announced or reaffirmed since November, a substantial percentage of the anticipated retirement capacity will be deferred, especially facilities in Midwestern and Northeastern markets that succeed in winning at capacity auctions.

An increase in the pace of in nuclear retirements will pick up some of this slack in coal retirements. As nuclear facilities increasingly fail to win at those same capacity auctions, states are forced to either heavily subsidize nuclear generation, typically the decision when the state has an RPS or other carbon-reducing aim, or retire them ahead of license expiration. Much of the retired capacity in the PJM and MISO markets will be replaced with new gas-fired capacity, but retirements in New York and New England may translate to substantial demand for new wind capacity, given those states' commitment to reduce carbon emissions and the severe disparity between wind and nuclear capacity factors.

SYNTHETIC PPAS AND THE C&I SPACE

While contract volume from C&I off-takers has not increased as steadily as many in the industry would like, purchasing wind power, particularly through "synthetic PPAs" in markets that allow them, is an increasingly attractive option for companies. Large, power-hungry manufacturers and technology firms such as Google, Apple, and General Motors have signed several off-take deals in the past three years, and this trend is expected to continue throughout the forecast period. Much work remains, however, by utilities and so-called aggregators to court smaller power consumers, who typically desire smaller or syndicated off-take arrangements for shorter terms.

KEY BARRIERS

Among barriers to wind development, a delay in adequate transmission build out looms large. Virtually all outstanding plans for privately financed HVDC lines, which send electricity generated in the central U.S. "wind belt" toward coastal demand centers, are either delayed or have been otherwise scaled back in scope. Delays abound in other transmission projects as well; developers unable to secure off-take agreements due to lack of transmission availability can sign hedge deals to at least build projects before the PTC expiration, but such arrangements may seem disturbingly cavalier to investors in 2019 and 2020 if it becomes apparent transmission will not be able to close the gap and curtailment begins to occur in increasingly congested regions. Burgeoning utility-scale solar markets, especially in highly irradiated Texas, coupled with a drastic reduction in solar

LCOE — module costs in the U.S. have fallen more than 40 percent since the start of 2016 — will also increasingly threaten wind's market share of new capacity additions.

INSTALLATION TIMELINES

The extended four-year project completion runway under the PTC has generally led to two strategies: One, favored by developers and manufacturers on the supply side, involves reaching commercial operations as quickly as possible to mitigate political risk (border adjustment, tax reform, etc.), secure cash-in-hand and, for projects with off-takers, meet pre-established construction timelines.

On the demand-side, three types of off-takers underpin the 2017-2020 boom: Utilities, often acting on state-level RPS mandates; C&I players, especially owners of large and energy-intensive facilities in manufacturing or data storage; and financial entities, who provide hedging arrangements that are popular in deregulated electricity markets with an excellent wind resource, like the Texas Panhandle. These players generally hold to the opposite strategy, scheduling projects in 2019 and 2020 to fully leverage the IRS' extended installation runway and allow for technology evolution to aid in reducing wind energy's LCOE while hoping for better power pricing as more legacy generation assets are retired to fulfill mandates or meet expected demand projections. The investment decisions of the demand-side ultimately decide market size, but these players should be careful to consider the risks inherent in delayed project executions.

THE COMING MARKET RECALIBRATION

Installations in 2021 will be subject to the 80 percent PTC value, which keeps wind power competitive in most states, though most developers will avoid intentionally using the lower-value PTC, and utilities complying with RPS requirements are likely to focus on solar investments in 2021, the last year for that technology's full-value tax credit, which is subject to a similar phase-out to the PTC on a delayed schedule. The 60 percent and 40 percent PTC values erode the economics of new capacity additions, and MAKE does not expect either value to pencil out for most developers, leading to a severe drop in 2022 installations as the U.S. begins a transition to an "economic build" market, dependent upon LCOE competition, except for in a handful of RPS-driven markets.

In this post-PTC environment, the quality of a project's wind resource will be paramount in achieving the low LCOE required to wrest market share from new solar and natural gas generation. Developers will particularly prize projects in states with abundant land, favorable wind resources, and access to transmission given the impact those project parameters have on LCOE. What were once minor

hurdles under the PTC, such as state-level tax policies and permitting difficulties, threaten to become project-killing obstacles in the new marginal environment. In all, onshore wind installations from 2022 to 2026 will number a fraction of the 2017 to 2020 total, almost entirely confined to a handful of states in the center of the country, on land far from the largest U.S. load centers. As a result, regional transmission development, whether through successful private investment or a federal infrastructure policy, will be critical in realizing post-PTC wind power installations.

THREATS TO WATCH

The wind industry must take care to guard against what might be termed myopic oversight, in which individual players or sectors within the wind market are unaware of a threat that appears eminently obvious to other players and sectors, and vice versa. An EPC contractor, for example, may be keenly aware of a coming labor and equipment shortage, and may succeed in communicating this to a developer client, but a small regional utility drafting its integrated resource plan may be completely unaware of the coming disruption. Opportunities for such oversights abound in the next decade of wind development; notable examples include the dangers in tax reform, the lack of EPC resource availability, disruptions to the wind supply chain in the event of a trade action under Trump, and an oversupply of the U.S. electricity market in the face of anemic growth in demand for electricity.

The U.S. market is more dependent on tax equity investment than at any other point in its history, so a decline in investor interest from a sharp drop in the corporate tax rate would have outsize effects on the broader wind market. It must be noted, however, that the threat of tax reform is rapidly receding as Congressional gridlock fails to move healthcare reform legislation to the president's desk and distracts from meaningful work on taxes. If reform is delayed past 2017, Republicans are unlikely to risk such a major reform package in an election year, meaning a reform package in 2019 would take effect in 2020 and have far less impact on the accelerated depreciation benefits of new wind build. Tax equity providers will continue to be thorough to a fault in due diligence activities; as they grow more confident in these legislative odds, they should be willing to sign off on more projects scheduled for COD in 2018 and 2019.

A labor and equipment shortage is not a purely hypothetical scenario. If projects are pushed into the 2019 and 2020 timeframe en masse, many may well be abandoned as EPC resources fail to cover all desired installations. The previous U.S. installation peak, some 12 GW in 2012, required the import of equipment from Mexico and Canada. In 2020, the Mexican market alone will be larger than the combined Mexican and Canadian markets of 2012. Compounding the shortage, new installations will vie for resources with a partial-scope repowering drive aimed at extending the PTC eligibility of roughly 7 GW of existing wind farms.

The threat of a border adjustment provision in the U.S. tax code follows the fortunes of broader tax reform, but a tariff action remains a real concern: Trump has shown a pointed willingness to use trade as a negotiating tool, particularly with China over its handling of North Korea and with Mexico over his border wall proposals. Either trade action would destabilize a domestic supply chain that has grown increasingly reliant on turbine components sourced from abroad given continued price pressure and PTC instability that resulted in a series of factory closures in 2013 and 2014.

The final oversight affects the post-2020 market: If coal-fired facility operators are particularly loath to retire assets and new natural gas installations do not slow from the 8 GW annual average of the past six years, the subsidized installation booms of both wind and solar power from 2017 to 2021 will substantially oversupply the U.S. market and collapse demand in the later years of the forecast for all utility-scale generation sources, including wind.

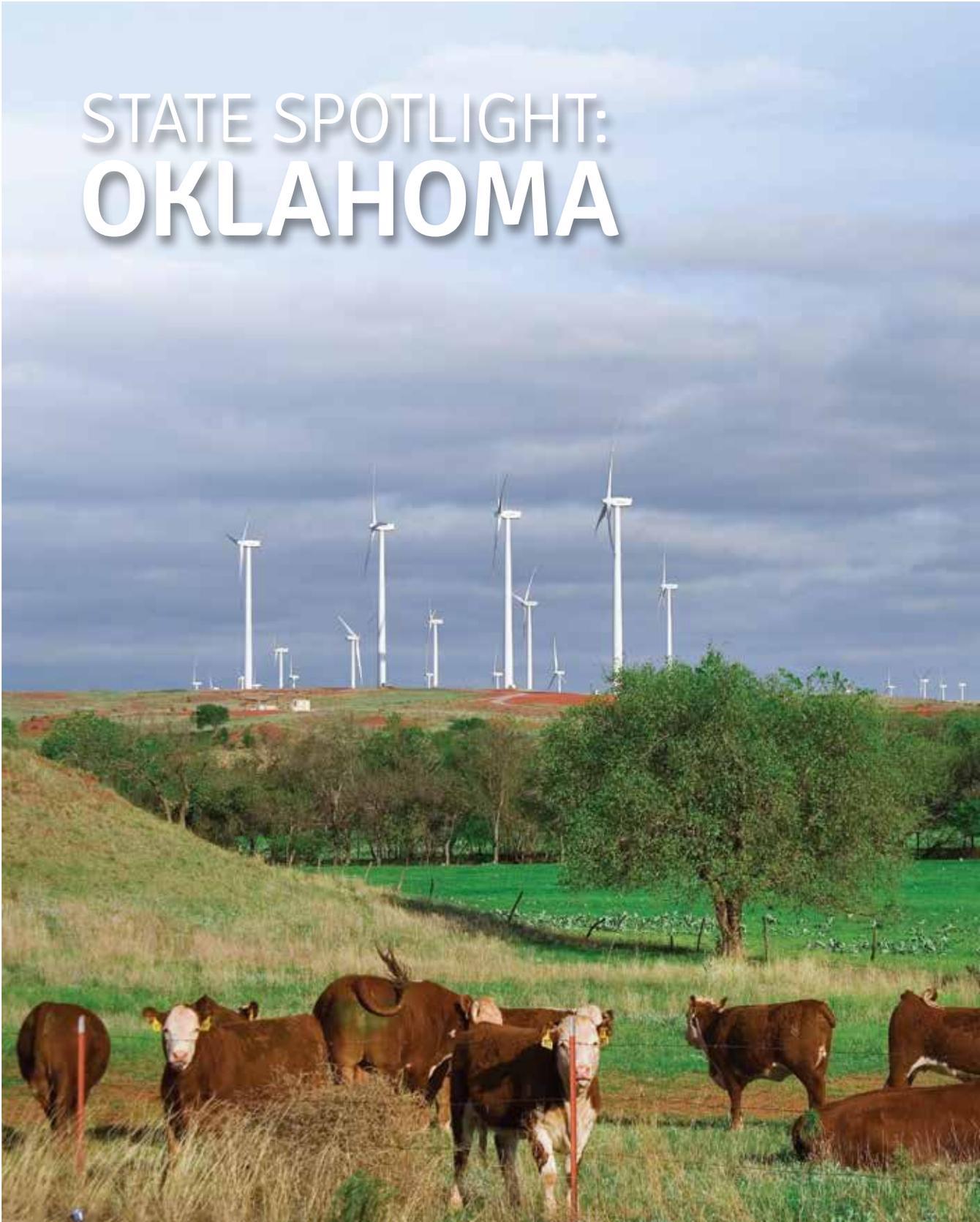
PLENTY OF OPPORTUNITY

Ultimately, the 10-year outlook highlights yet another boom-and-bust cycle for the U.S. wind industry. Still, the boom, unprecedented in scale, offers plenty of potential. The supply side is working furiously: More than enough equipment to cover the four-year outlook qualified for the full-value PTC through safe harboring turbines and turbine components; interconnection queues across the country are bloated, and developers are hunting for high-quality projects. If demand materializes, and supply is not jeopardized by external disruptions, this market looks set to make the most of a loud boom. ↪



Anthony Logan focuses on market developments, future scenarios, supply chain dynamics as well as competitive strategies across the wind power value chain in North America, Central America, and the Caribbean. He is based in MAKE's office in Chicago, Illinois.

STATE SPOTLIGHT: OKLAHOMA





Sooner, Not Later

Oklahoma's wind industry has moved to third in the nation for installed energy, as well as surpassing its renewable energy goal two years ahead of schedule.

By Kenneth Carter
Editor | Wind Systems

Oklahoma, where the wind comes sweepin' down the plain...

Renowned composers Rodgers and Hammerstein are much better known for their iconic musical numbers than being energy prognosticators, but when their first collaboration, "Oklahoma!," premiered on Broadway in 1943, no one could have foreseen their lyrics coincidentally giving a nod to the future of renewable energy in the Midwestern state.

But that wind sweepin' down the plain was exactly the inspiration state officials needed to introduce wind energy to the state.

And introduce it, it did. Since the first wind farm went online in Oklahoma in 2003, the state is now home to 6,600 MW of installed wind power, according to Michael Teague, Oklahoma secretary of Energy and Environment. Those thousands of megawatts of energy now account for more than 25 percent of Oklahoma's total electrical generation.

THIRD IN U.S.

According to the American Wind Energy Association's recent 2016 4th Quarter Report, Oklahoma jumped in the state rankings to become the third-ranked in the U.S. for installed wind energy.

"Oklahoma is historically an energy state with its natural resources," Teague said. "Being home to a top-10 wind resource in the nation, we knew it was just a matter of time before the wind industry would take off in the state. As

Since the first wind farm went online in Oklahoma in 2003, the state is now home to 6,600 MW of installed wind power. (Courtesy: Oklahoma Chamber of Commerce)



Several states in the South purchase power created from wind in Oklahoma, including Gulf Power, Georgia Power, and Alabama Power, according to cleanenergy.org. (Courtesy: Oklahoma Chamber of Commerce)

OKLAHOMA WIND FACTS

- Total installed capacity as of 1Q 2017: 6,645 MW.
- Total wind projects under construction: 1,546 MW.
- No. 2 in nation in new capacity installations in 2016: 1,416 MW.
- No. 3 in nation for installed capacity. Fifth fastest growing wind state in 2016, with 28 percent one-year growth rate in 2016
- Fourth in nation for wind electricity generation: 25.1 percent.
- No. 3 in wind generation, with 19.5 million MWh in 2016 — enough to power 1.8 million homes .
- No. 2 in nation for wind capacity factors: 42.5 percent.
- OG&E ranks eighth in the nation of utilities with wind-power ownership capacity: 449 MW.
- 8,000-9,000 wind industry jobs in the state, according to the AWEA 2016 annual report.
- 3,000 wind turbines in the ground, existing infrastructure, support existing industry.
- A leader in wind training programs through higher education and career tech systems.

with most energy markets, it just took things coming together for the right projects to be built with the interest from the state utilities to purchase the power.”

Wind in Oklahoma is expected to continue to grow, although at a slower pace than in previous years, according to Teague.

“With over a quarter of the state’s electricity coming from wind, future projects and generation will most likely work within the Southwest Power Pool, the regional transmission organization, to move wind-generated electricity to other markets,” he said.

Several states in the South purchase power created from wind in Oklahoma, including Gulf Power, Georgia Power, and Alabama Power, according to cleanenergy.org.

The Oklahoma Chamber of Commerce recently reported that wind farms should provide more than \$1 billion in local property tax revenue, proving that the financial benefits of wind can be found in every nook and cranny.

RENEWABLE ENERGY GOAL

Much of that stems from Oklahoma having already met its renewable energy goal.

“Oklahoma previously had a renewable energy goal of 15 percent renewable energy by 2015,” Teague said. “This was met two years ahead of plan.”

A lot of that extra push for wind more than likely comes from the positive support renewable energy has received from Oklahomans.

“Surveys performed in the state show that residents overwhelmingly support wind,” Teague said. “As wind continues to grow in the state, industry will need to continue the outreach and education efforts to ensure residents are well-educated on the industry.”

As a matter of fact, one such survey noted that 83 percent of Oklahomans were in favor of the state meeting its electricity needs with wind, without any education on the issue. And 91 percent were in favor of developing wind farms for electricity; a figure double that of residents who would want to see further development of coal and nuclear power.

That’s especially true in Elk City, where that Oklahoma city has seen many benefits from wind.

“The growth of wind energy in Oklahoma has led to many rural land owners, including land owned by schools, receiving significant annual royalties,” said Jim D. Mason, director of economic and community development. “A significant number of western Oklahoma schools have received enough royalties to allow them to drop off the state school funding formula. While Elk City has not reached that level, we are in the heart of the Oklahoma wind corridor on Interstate 40 and have two wind farms

fully operational and two more that are in process of being constructed within miles of our city.”

The energy created for the grid has a liberal (unpretentious) permitting process, according to Teague.

“Oklahoma has a history and is known for being a business friendly state,” he said. “That is no different when it comes to the wind industry. There is minimal permitting required at the state level. There are some siting considerations with regards to setbacks from hospitals and schools, as well as bond requirements for decommissioning. These are overseen by the state utility commission.”

WIND EDUCATION

That education is important as wind continues to supply a big part of the state’s energy needs, according to Teague.

“Not only is Oklahoma historically an energy state, we also have a strong CareerTech program,” he said. “Oklahoma is home to multiple nationally recognized wind technician training programs through our CareerTech system. This, combined with our continued growth in the market and Oklahoma being a great place to live due to our low cost of living, makes Oklahoma a prime location for wind techs and other wind-related jobs.”

The future looks bright — and windy — for Oklahoma’s wind industry with few hurdles on the horizon.

“As it relates to production, the state has had minimal challenges,” Teague said. “Wind forecasting has improved over time, and the geographic diversity of wind projects across the state has also enabled integration of the resource into the grid.”



Oklahoma is home to multiple nationally recognized wind technician training programs through its CareerTech system. (Courtesy: Oklahoma Chamber of Commerce)

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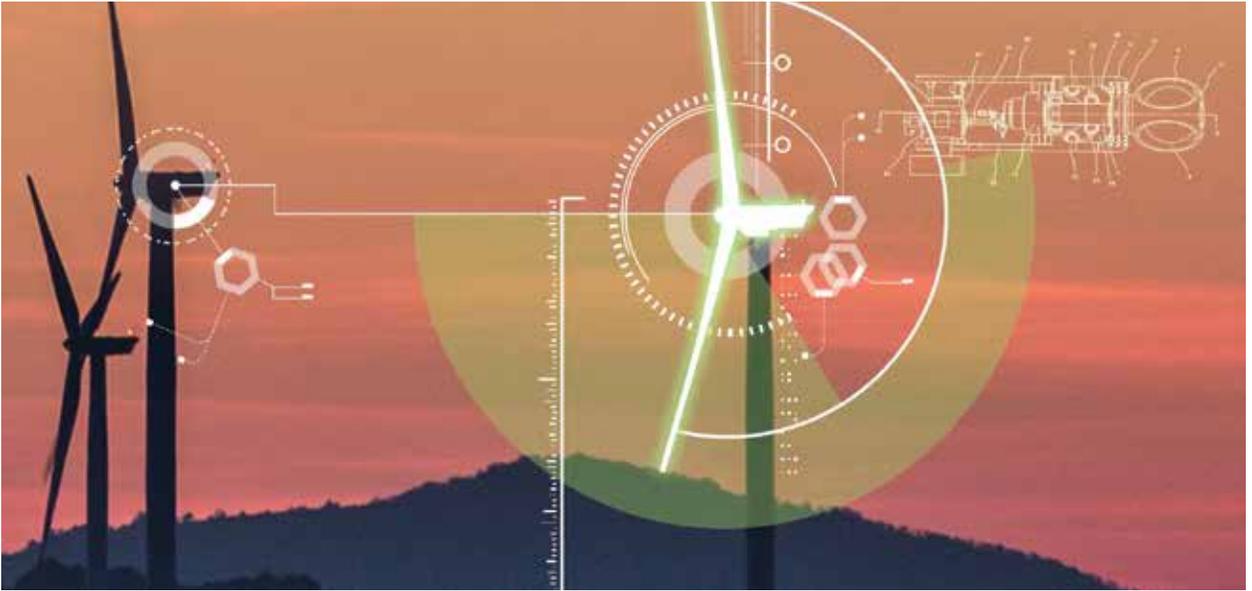
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Wind Boom to Continue

PTC and innovation expected to drive growth in wind market, O&M, and jobs.

By Lisa Cohn



At the May 2017 AWEA Wind Power Conference, the AWEA policy committee concluded that the Trump administration is not targeting renewable energy. (Courtesy: Lisa Cohn)

The wind energy market boom is expected to continue in 2017 as the federal Production Tax Credit (PTC) drives new wind-project development and boosts the already lively O&M market.

In fact, the industry has seen so much growth that “wind-turbine technician” was the fastest growing job in the U.S. last year.

The past year saw the installation of 8.2 GW from new plants. Continued high growth in 2017 is expected, with the additional installation of 7.8 GW in wind energy, said Bruce Hamilton, director of Navigant Research’s energy practice.

This year’s growth will be driven principally by developers who are accelerating wind projects in order to take advantage of PTC subsidies, which will be gradually phased out by 2020. PTC credits in 2017 will be stepped down to 80 percent of 2016 values, 60 percent in 2018, and 40 percent in 2019, Hamilton said.

In a study that Navigant conducted for AWEA, developers and OEMs were interviewed for their near-term plans and reported that many of their planned projects for the 2021-2023 timeframe are being pushed forward in order to be eligible for high PTC subsidiza-

tions, Hamilton said.

“We saw a lot of projects accelerated to qualify for the full PTC, which caused a spike in wind installations in early 2017,” said Hayden Baker, a partner at Sullivan & Worcester. “But there remains a robust pipeline for this year; we expect to see several more sizeable projects announced in the second half of 2017.”

PTC SAFE HARBOR CLAUSE

A vital component of the PTC that’s driving the boom in growth is the 5 percent safe harbor clause. Wind projects are eligible for the current-year PTC subsidy if a minimum of 5 percent of the project’s total capital cost is incurred before the end of that year, Hamilton said. Projects also must comply with the four-year rule, which says that project construction must be completed within four years after starting.

“Virtually all new projects we are seeing in the market are taking advantage of the ‘begin construction’ rules in order to capture the full, rather than the reduced, PTC amount,” said Ed Einowski, renewable energy project finance and development partner at Stoel Rives.

Because one of the largest expenses invested in a

wind project are the turbines, one of the ways to meet the 5 percent requirement is to purchase wind turbines before the end of the current calendar year. This has generated a booming market for turbines, Hamilton said. This safe harbor market was responsible for the 10 GW of turbines ordered last year, which qualified for 100 percent of the PTC that's eligible to be installed any time during the next four years. This year, Navigant predicts the turbine market will drop somewhat because purchases this year will qualify for only 80 percent of the PTC credit.

Navigant predicts the high growth of the wind market will continue for the next four years as more projects are accelerated to take advantage of the PTC. In fact, Navigant predicts that wind-energy growth will increase every year and peak in 2020, which will be the year that accelerated projects — which entered the pipeline in 2016 with a 100 percent subsidy under the PTC — will be required to be completed under the four-year rule.

Increasing state RPS requirements and improved transmission also will contribute to this increase in growth, Hamilton said. Beginning in 2020, after the PTC phases out, the growth will subside over several years. This fall-off will occur as additional projects, whose development was accelerated in order to be eligible for PTC subsidies, are completed.

However, Meghan McIver, business development associate at Apex Clean Energy, sees a rosy long-term forecast for the wind market after the PTC phase-out, especially for O&M.

"Many of the long-term projections forecast wind as the largest source of electricity in the U.S. for a number of reasons, including drastically falling costs," she said. "This means even after the PTC phases

out, wind O&M will likely continue to see new customers."

LONG-TERM GROWTH

Bruce Bailey, vice president of Renewables in UL's energy and power technologies division, said he also sees long-term growth in the wind market after the PTC has expired.

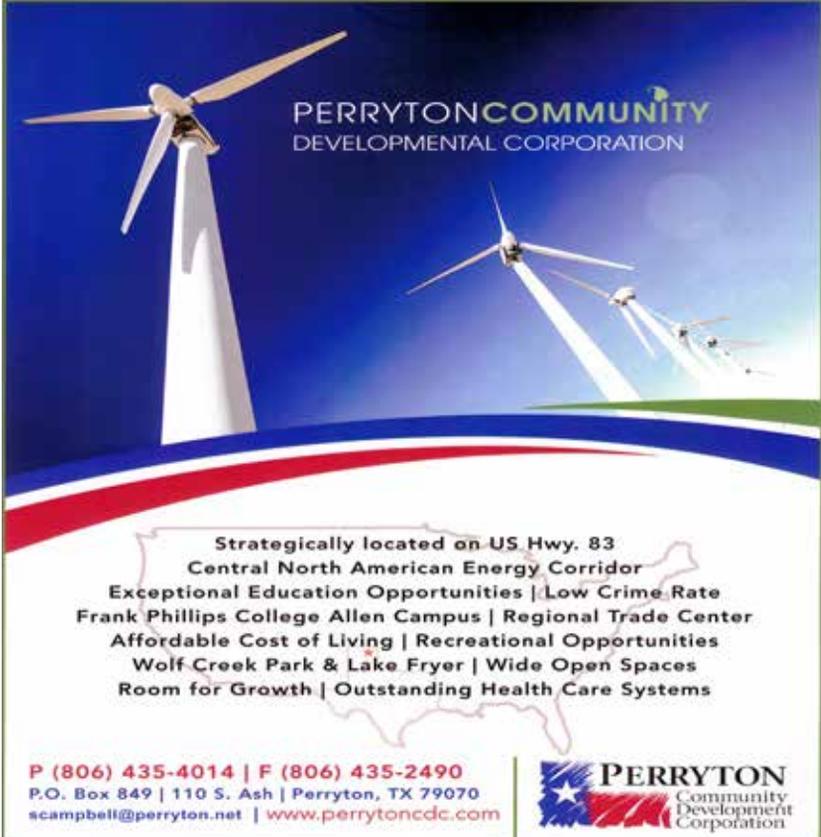
"The PTC makes wind cheaper for customers and was very important in giving wind a shot in the energy markets when the playing field wasn't level," he said. "In a world of much cheaper wind-energy prices and market acceptance, the need for the PTC to promote wind is waning."

Whether the need for the PTC is waning, many wonder how the results of the recent presidential election and the changing political landscape in Washington will affect the U.S. wind-power industry. At the May 2017 AWEA Wind Pow-

er Conference, the AWEA policy committee concluded that the new administration is not targeting renewable energy. This was confirmed by U.S. Treasury Secretary Steven Mnuchin, who, during his nomination hearing, said the current phase-out of the PTC will not change. Further, many of the predominantly windy states, which are led by Republican governors and legislators, won't want to change the timeline of the PTC phase-out because that could undermine those states' economies and jobs.

"Although the Clean Power Plan is pretty much dead, it is encouraging to see that states are already proceeding with their own policies as if those federal requirements are still in effect," Hamilton said.

However, with the elimination of the Clean Power Plan, coal-plant retirements will happen more slowly, and initially will be down by



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30 percent from what was predicted a year ago, he said.

But states are expected to pick up their activity in response to the federal government's withdrawal from the Paris Climate agreement and its killing the Clean Power Plan. Subsidies for wind-project development will increasingly come from individual state RPS requirements. Many states are raising their RPS, which will be a major force in driving wind-energy development after the PTC phase out in 2020, Hamilton said.

MORE INVESTMENT MONEY

In addition to increased attention to renewable energy at the state level, businesses are showing interest in using renewable energy sources for their electricity needs.

"In spite of the current administration, people are going for renewables," said Marlene Motyka, U.S. Global and Renewable Energy Leader for Deloitte. "Climate change and green energy have moved beyond politics; it's past the tipping point. Sixty-one percent of businesses are demanding that their company acquire a portion of their electricity from renewable sources. That won't stop regardless of what's happening on the political front."

This strong interest in renewable energy by businesses has prompted vigorous U.S. investment in wind energy.

"The administration's withdrawal from Paris and reversal on the Clean Power Plan left little doubt about the trajectory of federal policy under (President Donald) Trump, but as a practical matter those measures were not driving wind development or investment," Baker said.

"There is currently a great deal more investment money seeking wind projects than there are wind projects available," Einowski said.

While most of the explosive growth in the U.S. wind-power industry has occurred in the onshore wind market, new offshore wind markets are opening in several key states. In 2016, Massachusetts passed legislation that requires procurement of 1,600 MW offshore wind by 2030. In 2017, New York voted to approve the nation's largest offshore wind farm, a 90-MW development 30 miles southeast of Montauk. This project is part of the state's mandate to produce 50 percent of the state's electricity from renewable energy by 2030.

CONSTRUCTION AND O&M

The high growth of the wind market over the next four years will drive the creation of many new jobs in the wind-power industry. Navigant predicts employment in the wind-power field will reach 248,000 in 2020, up from 180,000 in 2017. These new jobs will be in all aspects of the wind-power industry, including manufacturing, construction, and operations and maintenance, Hamilton said.

The biggest increase in employment in the wind-power industry will be in construction and operations and maintenance, accounting for 114,000 of new jobs. O&M will see an increase of 62,000 jobs while construction jobs will increase by 84,000. Manufacturing jobs will see a somewhat smaller increase of 33,000, Hamilton said.

Navigant's wind-market forecast, prepared for AWEA, notes that the project pipeline at the beginning of 2017 was 28 percent larger than the pipeline at the beginning of 2016. As of January 2017, 9.4 GW were under construction, and 11.6 GW were in advanced development.

The employment boosts over the last year were so high that wind-turbine technician was the fastest growing profession in the country last year, according to the U.S. Department of Labor.

"Wind-turbine operations and maintenance represents a growing sector of the industry, and the future seems even brighter as companies are bringing more wind projects online before the PTC wanes," McIver said

MERGERS AND CONSOLIDATIONS

The high growth and maturation of the wind market is driving consolidations and mergers in O&M, which has traditionally been handled by independent service providers. These companies have not usually been affiliated with OEMs or the owners of wind plants. For example, during 2015-2016, Vestas acquired several independent service providers, including UpWind Technologies, as well as Availon.

"The industry overall has seen a number of buyouts of smaller operations and maintenance companies," McIver said. "These strategic partnerships broaden the offerings of various O&M providers, creating a streamlined contract and process for customers. Instead of working with different businesses for their various needs, customers are now seeing one-stop service providers."

Along with buyouts, wind-power growth is driving the creation of new business offering specialized services. One example is Strat Aero, which uses unmanned drones to perform turbine-blade maintenance inspections. Using unmanned aerial vehicles and advanced proprietary software, the company inspects up to eight turbines per day, which is significantly more turbines compared to the two-per-day of conventional manual inspection methods.

"Throughout the wind-energy industry, drones are becoming more prevalent for site and blade inspection because they offer clear views of every angle of the turbines," McIver said. "Using drones improves our effi-

ciency and enables us to better ensure the health of our turbine blades.”

R&D FOCUS

Other areas of the wind-power industry are the focus of intensive R&D efforts.

One such focus is the use of “smart” data analytics to provide more accurate forecasts of wind, allowing more wind power to be integrated into the existing power grid. This technology helps address fluctuations in wind production that create the need for backup power. When these backup sources are conventional power plants, it’s expensive and inefficient to keep these plants idling. Software developed by the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, can generate accurate forecasts of how much power to expect from a wind farm in 15-minute increments, for up to seven days, allowing more efficient utilization of backup power plants.

According to UL’s Bailey, “Everything is getting smarter, thanks to inexpensive sensors, big data and data analytics, advanced controllers. Smart means better energy productivity, longer component lifetimes, and, consequently, improved economics.”

For example, GE uses big data and analytics to help predict turbine failures and also to help decide when wind can be best used in the market, said Kimberly Brown, head of GE’s product marketing for renewable energy digital solutions.

One example is predictive monitoring, she said. This involves gathering vibration data from sensors on wind turbines.

“We can model analytics and look outward and say, based on the trends, we’re seeing potential escalation and can predict gearbox failures,” she said.

Big data also can be used to make decisions on forecasting and bidding into the market, Brown said.

TALLER TOWER CHALLENGE

In addition to big data, R&D is focused on taller towers

“The wind resource is better the higher you go, but taller towers are more expensive so you have a tradeoff,” said Daniel Laird, director, National Wind Technology Center (NWTC), NREL.

One solution is called “Hexcrete” wind turbine tow-



The use of “smart” data analytics can provide more accurate forecasts of wind, allowing more wind power to be integrated into the existing power grid. (Courtesy: Lisa Cohn)

ers. The towers are assembled from precast concrete panels and columns that are tied together on-site by cables to form hexagon-shaped cells. The cells can be stacked to form towers as high as 140 meters, said Sri Sritharan, Professor, Wilkinson Chair in Engineering, Iowa State University, College of Engineering, who is developing the product.

“Taller towers have benefits in both the wind-rich regions and regions like the Southeast where renewable energy production is fairly low,” he said. “The Hexcrete technology will facilitate the use of tall towers throughout the nation as it eliminates transportation logistics and other challenges that are associated with building them.”

Taller wind-turbine towers will be crucial in expanding wind power nationwide, enabling wind energy production in all 50 states, according to studies by the U.S. Department of Energy’s National Renewable Energy Laboratory, based in Golden, Colorado.

Overall, these R&D efforts are expected to help keep the industry competitive, even after the PTC expires.

“Renewables and wind specifically are born of innovation and change,” Brown said. “What makes it special is the industry understands the need for change and innovates change. What’s really unique is the rate of change.” ↴



Lisa Cohn is a freelance writer who specializes in energy issues. Her work has appeared in Mother Earth News, Natural Home Magazine, Horizon Air Magazine, Oregon Business, the Portland Tribune, The Oregonian, Renewable Energy World, EnergyBiz, and other publications. Visit her at www.RealEnergyWriters.com

inFOCUS

Lubrication Technologies for the Wind Farm

Finding the proper lubrication for wind turbines is essential for the best performance and longevity.

By Dayananda Raju

When wind turbines go down due to equipment failure or maintenance issues, the resulting unplanned shut-downs and time-consuming maintenance fixes can exact a heavy toll. When such incidents occur, wind farms must deal with exorbitant crane mobilization expenses, lost energy production, soaring costs per kilowatt-hour, and untimely delays in obtaining replacement parts in a burgeoning industry where demand for necessary components routinely outstrips supply. Onshore and particularly offshore, anything that can prevent a service trip will help boost overall wind-turbine return on investment (ROI).

Ultimately, the reliability of equipment stands tall as a central challenge for wind-farm operators. This challenge extends to the rolling bearings at all points in wind turbines, whose proper lubrication is essential for optimized performance and longevity.

Supplying the right lubricant in the right quantity at the right time is critical, but adhering consistently to this practice can present challenges of its own: What is the most practical way to dispense the lubricant — manually or automatically? How can over- or under-greasing be avoided? Are lubricant points difficult to reach, or are they inaccessible? Will maintenance staff be placed in harm's way?

How wind-farm operators approach

and resolve these and similar questions can make all the difference in minimizing the need and costs of maintenance and promoting reliable performance of equipment.

DELIVERY SYSTEMS

Whether grease or oil, lubricants for bearings in rotating machinery — wind turbines included — serve to prevent wear and damage between a bearing's rolling and sliding contact surfaces, reduce friction and heat generation, help protect against corrosion, and keep out contaminants.

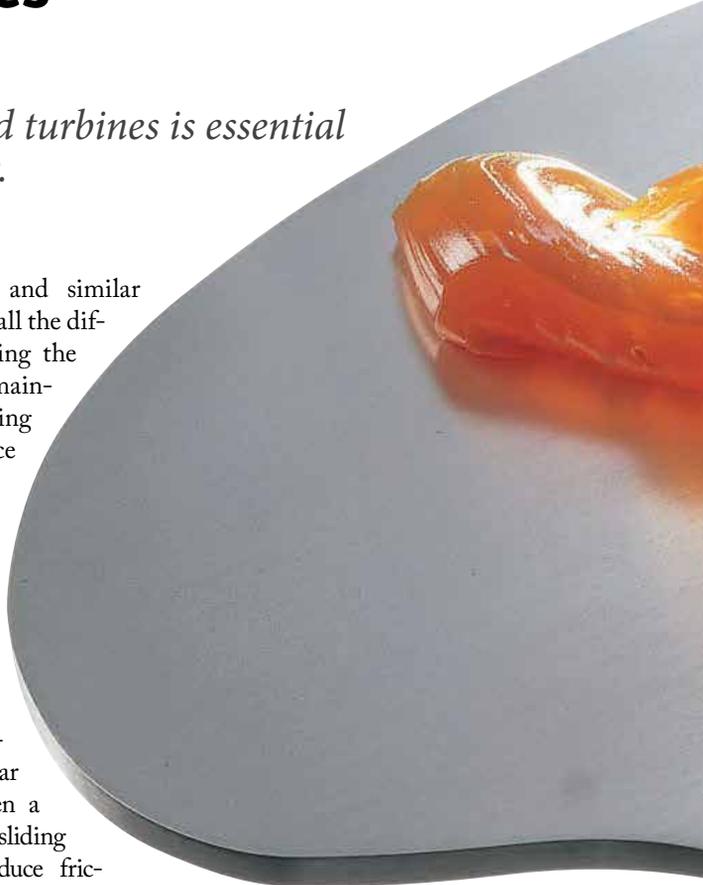
A lack of proper lubrication can bring a turbine to a standstill. Vibration, high mechanical loads, contamination, and moisture are all threats to turbine bearings. And improper lubrication certainly will take a toll on bearings: 36 percent of all premature bearing damage historically has been attributed to poor lubrication-related practices.

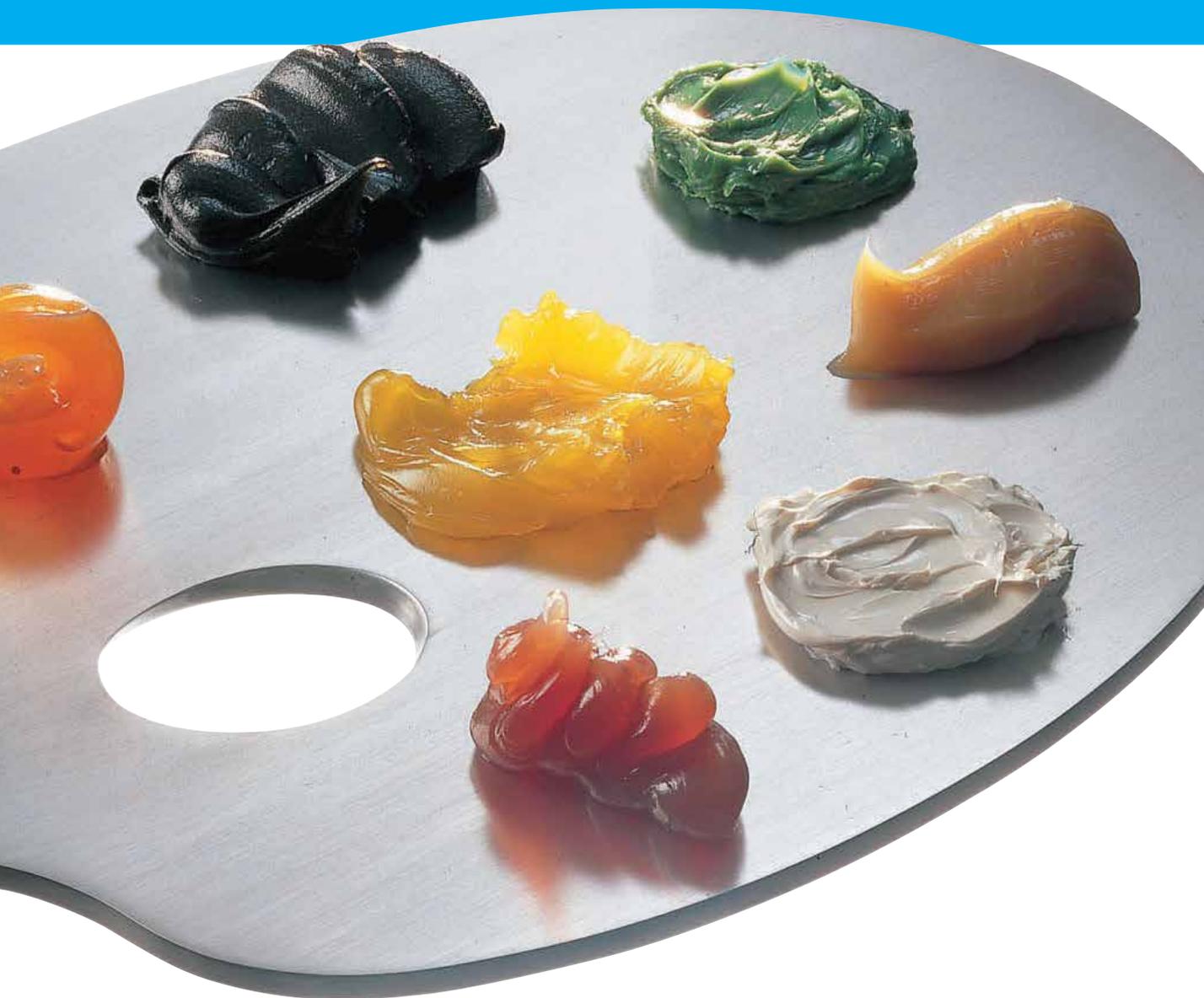
One of the most important steps on the road toward proper lubrication is deciding how to deliver lubricant effectively to all the lubrication points in a nacelle. A variety of manual-lubrication tools have been developed — some quite advanced and user-friendly — and

grease guns rank high on the list.

A recent innovation in grease guns for wind farms uses a 12-volt lithium-ion battery for maximum power and efficiency with the capability to quickly deliver grease at up to 8,000 psi (551 bar). Its three-point base keeps the tool upright for user convenience and helps prevent dirt and debris from entering the motor. The tool is relatively lightweight and ergonomically constructed to help reduce operator fatigue and allow for easy access to tight areas. Such grease guns can further allow for secure hose storage and easy threading of the grease barrel by integrating a hose holder and tube guide.

As an alternative when hoses may get





There is no “universal” one-size-fits-all lubricant solution for every application.
(Courtesy: SKF USA)

in the way, a handheld and rechargeable battery-driven grease gun combines portability with a user-friendly interface to maximize efficiency and accuracy. With such a tool, lubricant flow rates can be precisely adjusted and an integrated grease meter dispenses the proper amount of lubricant to prevent possible over- or under-greasing. A visual display assists workers by showing

battery charge level, amount of grease dispensed, pump/motor speed, and even blocked lubrication points.

But what if lubrication points are difficult and/or unsafe to access? What if too much or too little lubricant is dispensed? When manual lubrication will be impractical for these or any other reasons, single-point or fully automatic centralized lubrication systems can deliver the

ALSO IN THIS SECTION

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According to industry averages, 10 to 20 percent of the uptower time involved in servicing a turbine is spent on re-lubrication. (Courtesy: SKF USA)

goods. Systems for various locations in a wind turbine have been engineered to dispense exact and clean quantities of appropriate lubricant where and when required.

Automatic delivery of lubricant will surely lift a heavy burden from the shoulders of the maintenance staff.

According to industry averages, 10 to 20 percent of the uptower time involved in servicing a turbine is spent on re-lubrication (technicians crawling around in the cramped nacelle and hub to grease lubrication points numbering from 10 to more than 80 with several different greases in each turbine). And, in the case of conventional manual lubrication methods, over- or under-greasing (leading to potential failure) always is an unwanted possibility; lubrication intervals may be sporadic or ill timed; contaminants can inadvertently be introduced, and equipment performance may be compromised

With an automatic lubrication system, bearing life can be lengthened by delivering frequent, correct amounts of grease to each bearing. Precisely controlled amounts of lubricant — dispensed at pre-set intervals — keeps bearings coated and enables them to perform to their rated capacity.

A SYSTEMS OVERVIEW

Single-point automatic lubricators. These inject the precise and correct amounts of contaminant-free grease and often will be used for the re-lubrication of pitch bearings and other bearings in moving parts. They inherently minimize the risks of over- or under-greasing and can supply lubricant 24/7 for periods up to a year as governed by a pre-set automatic timer.

Single-line lubrication systems. In this centralized configuration, a central pump station automatically delivers lubricant through a single supply line to a lubricant metering device. Each metering device serves one lubrication point and can be adjusted to deliver the precise amount of required grease or oil. A single-line system can pump long distances and within a wide temperature range. Components in corrosion-resistant designs will especially benefit offshore applications.

Progressive lubrication systems. These dispense small measured amounts of lubricant at frequent and intermittent intervals. The grease flow created by the system's pump is proportioned by progressive metering devices and distributed to each bearing according to need. Metered quantities of lubricant are fed progressively in predetermined ratios from master feeders to the lube points. The lubricant does not leave the respective feeder until the preceding one has discharged its volume.

If a lube point does not receive any lubricant, regardless of the reason, or if a secondary feeder is blocked, the entire lubrication cycle is interrupted, and the system will



The Lincoln 20-volt PowerLuber grease gun can be used for multiple lubrication applications. (Courtesy: SKF USA)

provide a signal to alert operators to the problem. Integrated system control and monitoring is another plus for this and other centralized systems.

TIPS FOR SUCCESS

Centralized lubrication systems can be applied to all bearings at a turbine's rotor shaft, blade pitch, and azimuth positions, as well as non-rotating applications inside the turbine. Stationary systems can supply grease accurately to main shaft, generator, blade, and yaw bearings. For the rotating blade

bearings, lubrication systems can be equipped with a follower plate.

Decision-making for the most appropriate lubrication system will depend, in general, on the application and, in particular, on a range of other parameters, such as the operating conditions (variations in the operating temperature and lubricant viscosity), accuracy requirements for lubricant quantities, turbine system geometry (size, dimensions, and symmetry), and monitoring demands, among others.

When planning, installing, and subsequently implementing a centralized lubrication system inside a wind turbine, these guidelines can help:

- Determine the number of lube points.
- Choose the proper lubricant for the temperature, speed, and load conditions.
- Calculate appropriate dispense rates and quantities for the application.
- Choose pumps consistent with the type of actuation and system capacity.
- Consider monitoring as an integral requirement for the lubrication system.

After a lubrication system is up and running, measurable benefits can be realized at every turn:

- No more chances of over- or under-greasing.
- Lubricant consumption can be brought into line with requirements.
- More informed and timely lubricant purchasing decisions can be made.
- Lubrication-related breakdowns can be reduced.
- Turbine productivity, reliability, and availability can be improved.

In the case of existing equipment in the wind-turbine aftermarket, gen-



Single-point automatic lubricators inject the precise and correct amounts of contaminant-free grease and often will be used for the re-lubrication of pitch bearings and other bearings in moving parts. (Courtesy: SKF USA)

erally populated with older and/or smaller machines, operators have the option to upgrade their lubrication programs with the latest advanced technologies. It's never too late.

Regardless of application or system, close attention should always be paid to the specific type of lubricant required for the turbine main shaft, yaw, and blades. There is no "universal" one-size-fits-all lubricant solution for every application. The proper grease will provide proper lubrication whether the turbine is operating or in standstill mode, installed onshore or offshore, or in extreme temperatures or conditions.

One more guideline on the path to sustained success: partnering with a knowledgeable specialist can help in implementing the best lubrication practices for any installation, new or old. ↵



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Foam Rings and Turbine Foundations

Foam rings are still used in the grout trough of a turbine foundation to prevent the grout from making contact with the anchor bolts.



Foam rings are still predominantly used today and the process is no more sophisticated than it was at the beginning. (Courtesy: NTC Wind Energy)

By Joe Bruce

When it comes to wind-turbine foundations, it seems appropriate to reflect on the traditional way foundations have been built and how their structural integrity can be improved and, at the same time, save money and enhance safety.

One of the traditional ways foundations are built has been by using foam rings in the grout trough to prevent grout from making contact with the foundation anchor bolts. Should the grout make contact with the rods, it could interfere with tensioning by not allowing the rod to pull through the grout as it is being pulled from above. Theoretically, the foam also would prevent grout from

moving into the bolt sleeve, which spans the full depth of the pedestal and allows the rod to move within the foundation as the tower sways back-and-forth, acting like rubber bands alternatively under compression and expansion.

SAME PROCESS

Foam rings are still predominantly used today and the process is no more sophisticated than it was at the beginning. First, the bolt sleeves are sealed at the top by placing a bead of caulk around the rod within the bolt sleeve. Then, someone has to cut the foam into rings equivalent in length to the prescribed grout depth. The rings are dropped over the rods in

the grout trough and often have to be wrapped with common duct tape to keep them from splitting when the base is set. It's a throwback from the days of the backyard mechanic. It's hard to believe a multimillion-dollar machine is being built using caulk, foam pipe insulation, and duct tape.

Right now, a couple of employees are handed sharp knives and told to cut 14,000 two-inch rings (enough for 100 average foundations) by quitting time and then make sure the first aid kit is ready. After a day of cutting foam, those two-inch rings end up being long or short, either of which diminishes their functionality. Then comes the job of caulking and taping — a tedious task at best.

THE EARLY DAYS

Back in the early days, grout was poured into an open foundation, and the base was set in the grout. It was not uncommon to find the foam rings floating in the grout. Cementitious grout also was used, which, if allowed to contact the rod, would generally break away from the rods as they were pulled through the grout during tensioning. Occasionally, while setting the base on the grout-bed, the grout would push into the base-flange boltholes where it would interfere with the proper seating of the washer and nut during tensioning.

Happily, some things have changed for the better. Now high-strength, flowable epoxy grout is used, and the grout is applied with the base in place using forms. This has proven to be a superior material and method of grouting. But the superior grout also makes it that much more important that the rods be protected from contact with the grout. But, foam is still predominantly used.

The ongoing trend toward heavier and taller turbines means more grout and supporting leveling shims in the grout trough, adding to the potential for voids. Basically, the more hardware in the trough, the greater the potential for voids. Unfortunately, with the base down, it is difficult to detect those voids.

ADDING TO THE PROBLEM

The use of foam rings inadvertently adds to the problem. Each ring of foam creates a void in the grout, further reducing the overall compressive strength of the grout bed. Applying some basic math: a foam ring 2 inches tall and ½-inch thick, having an ID of 1 5/8 inch displaces 6.676 cubic inches of grout. If the grout reaches 14,000 pounds of compressive strength when cured, the loss of compressive strength in a foundation with 140 foundation anchor bolts is more than 13 million pounds or 6,500 tons. A total of 6.58 cubic feet of grout in that foundation has been displaced. Admittedly, the remaining grout is more than enough for structural integrity, and in foundation design, engineers compensate for potential grout voids. But why not eliminate as many voids as possible, increasing the quality and structural strength of the foundation?

Though the industry has an excellent record for foundation integrity, the trend is increasingly toward engineers building in design excesses to ensure their design



Grout sleeves are useful for over-wintering foundations. (Courtesy: NTC Wind Energy)

will not fail. At some point, the cost versus the benefit of these design excesses will have to be examined. If the foam rings in the foundation could be eliminated, perhaps some money could be saved by reducing the size and depth of the grout trough or by reducing the compressive strength requirements of the grout in order to have a better foundation.

IRONCLAD GROUT SLEEVE

The advent of NTC Wind Energy's patent pending IronClad Grout Sleeve addresses all of the concerns listed above. These injection-molded parts slide easily over the rods but fit tightly enough to seal around the bottom of the rod and stay in place, negating the need to caulk around the top of the bolt sleeve. At the same time, the thin walls of the polyethylene parts displace little grout. At 3 1/2 inches tall, grout sleeves are intended to project into the flange slightly, protecting the entire exposed portion of the rod and allowing the rod to easily move during tensioning. Like foam rings, grout sleeves allow the rod to move laterally within the bolt sleeve to line them up during base setting.

Grout sleeves are also useful for over-wintering foundations. By placing a ½-inch ring of caulk around each rod and installing the sleeves on top of the wet caulk, the sleeves provide a protective seal against water and mud draining into the bolt sleeve within the foundation. ↵



Joe Bruce works with J.W. Bruce & Company, LLC, dba NTC Wind Energy and has a bachelor's of science from California Polytechnic State University. Bruce joined Norm Tooman Construction — Wind Energy Division in 2001 with his father-in-law, Norm Tooman. Together, they developed and patented multiple products for wind-turbine foundation construction and corrosion protection. Their signature product is the IronClad bolt cap, which was the first bolt cap for wind-turbine foundation applications and still the most used in the industry.

PROFILE

ExxonMobil

Providing the right lubricants to ensure wind turbines keep operating smoothly and for as long as possible can be a challenge, but ExxonMobil's innovative lubrication solutions are more than up to that task.

By Kenneth Carter
Editor | Wind Systems

ExxonMobil is a company name that pops into view practically every time a commuter gets behind the wheel of a car.

There's a reason for that — it's been around for a long time.

ExxonMobil is just as well known when it comes to wind energy for much the same reason.

"ExxonMobil has been involved in the wind industry since the beginning," said Gary Hennigan, U.S. lubricants engineer for ExxonMobil. "We developed one of the first lubricants specifically formulated for wind-turbine gearboxes. And, today, our lubricants protect more than 40,000 wind turbines around the world — we're supporting wind-turbine operators in virtually every market where the wind industry is active."

Over the past few decades, ExxonMobil has worked with some of the world's leading manufacturers of wind turbines, gears, and bearings through its Equipment Builder Group to gain insight into key wind-turbine equipment trends.

"This insight has enabled us to continuously develop new and advanced lubricant technologies to protect turbine components in even the harshest operating conditions," Hennigan said.



ExxonMobil works closely with OEMs and operators to understand the specific operating demands for their equipment so it can develop advanced lubrication solutions that can enhance wind-turbine reliability, performance, and productivity. (Photos courtesy: ExxonMobil)

ExxonMobil

Headquarters:
Spring, Texas

Website:
mobil.com/wind

INNOVATIVE LUBRICATION SOLUTIONS

Because of that, ExxonMobil develops innovative lubrication solutions in order to help operators meet their

equipment and business goals.

"The quality of our products has always been a key to our success, and it remains a defining characteristic of how we support operators across many different industries," Hennigan said. "This means working closely with OEMs and operators to understand the specific operating demands for their equipment so that we can develop advanced lubrication solutions that can enhance the reliability, performance, and productivity of this equipment. We want to help operators keep their equipment running

for as long as possible without the need for unscheduled maintenance.”

Proper lubrication is critical for the inner workings of a turbine, so longer lasting lubricants can translate into equipment failure being reduced dramatically and potentially prevented altogether, extending the performance of a turbine even longer.

“Everyone in the wind industry knows that equipment reliability is critical to their success, profitability, and operational safety. They’d likely all agree that production loss from unexpected equipment downtime can be catastrophic,” Hennigan said. “Here’s where we come in.”

SPECIFIC FORMULATION

ExxonMobil has a specific lubricant formulation strategy that enables it to develop the industry’s most advanced synthetic lubricants, according to Hennigan.

For wind, specifically, ExxonMobil has developed novel lubricants and synthetic oils that include its newest synthetic oil, Mobil SHC Gear 320 WT.

The Mobil SHC Gear 320 WT synthetic gear oil is a good example of how the company’s formulation philosophy dovetails into a better product.

“It is our most advanced synthetic wind-turbine gear oil, designed to protect equipment from common issues such as scuffing, micropitting fatigue, and rust and corrosion,” he said. “It also ensures proper protection at extreme high temperatures and good pumpability at low temperatures.”

LASTS LONGER

And one of the most important aspects of the synthetic oil’s formulation is that it lasts years longer than most conventional lubricants, according to Hennigan.



A wind-turbine gearbox operates in uniquely severe conditions. These include heights of up to 350 feet above the ground, heavy and varying loads from strong winds, and exposure to contaminants such as saltwater in an offshore environment.

“It’s been proven to perform reliably for up to seven years at the very least, which is 40 percent longer than most conventional lubricants on the market today,” he said. “This performance is backed by an industry-leading seven-year warranty, which covers both the oil and the components the oil protects.”

It practically goes without saying that longer oil life translates into better wind-turbine performance, which reduces O&M costs over the life of the equipment as well as enhancing worker safety. With wind-turbine technicians having to work 300 meters above the ground, safety among wind farms is always a paramount issue.

“By extending oil life by 40 percent over conventional lubricants, we can help operators reduce how often they have to change their oil, potentially even eliminating an entire service cycle over the standard 20-year life of an average wind turbine,” Hennigan said. “That means more turbine uptime, less money spent servicing the equipment, and reduced worker exposure.”

In addition to the Mobil SHC Gear 320 WT, ExxonMobil has also launched two other synthetic greases:

- **Mobil SHC Grease 460 WT:** This grease is specially formulated to lubricate wind-turbine yaw, pitch, and main bearings. It has become the first fill product of choice for many wind-turbine builders and component suppliers. It has proven outstanding performance in more than 10,000 wind turbines worldwide. Compared to conventional greases, Mobil SHC Grease 460 WT delivers longer grease life, enhanced false brinelling protection and bearing life, wide temperature range of application, and the potential for improved mechanical efficiency.
- **Mobil SHC Grease 102 WT:** This grease is scientifically engineered to meet or exceed the demanding requirements for severe wind-turbine pitch and yaw applications at extreme temperatures ranging from 120 degrees C down to as low as minus-50 degrees C.

TECHNICAL SERVICES

To help with educating its clients about the value of its products, ExxonMobil offers technical services such as Mobil Serv Lubricant Analysis, which utilizes the latest used oil analysis (UOA) technology to keep lubricants performing properly and to monitor equipment condition in real time.

“Almost all operators are familiar with UOA, which is a tool that enables them to monitor real-time lubricant performance, so they can identify and address potential equipment performance challenges before they become a serious issue,” Hennigan said.

Mobil Serv Lubricant Analysis transforms the UOA process to help improve equipment and operational productivity. It streamlines the entire process, from initial sample gathering to final reporting, using a mobile-enabled platform that eliminates the need for paperwork. Operators use QR-coded scan-and-go bottles to easily deliver used oil samples to ExxonMobil’s oil analysis laboratory. Once these samples are analyzed, customers can access the results and customized equipment recommendations on their mobile or tablet device, according to Hennigan.

“The launch of this service builds on ExxonMobil’s long tradition of providing leading UOA services to companies around the world, and it’s yet another tool to help wind operators enhance their lubrication program,” he said.

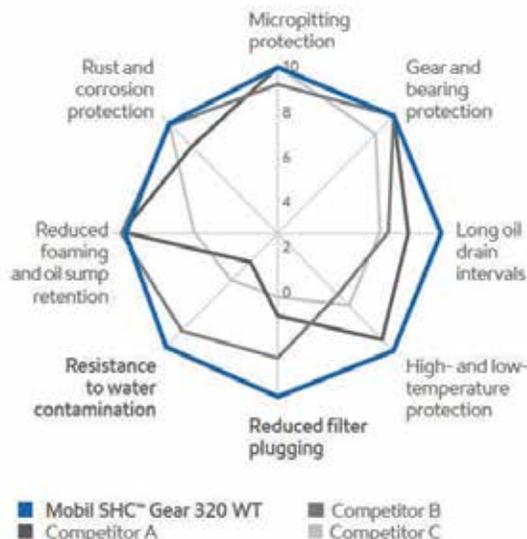
PERFORMANCE CHALLENGES

Along with making sure its customer have the right lubrication for the right job, ExxonMobil is committed to making sure OEMs understand performance challenges common to today’s wind industry.

“One of those challenges is white etching cracking (WEC), which are sub-surface bearing failures occurring under fatigue load that are reported to cause 80 percent of wind-turbine high speed bearing failures,” Hennigan said. “There are many factors that contribute to the formation of WEC, but we partnered with Schaeffler, a leading bearing manufacturer, to better understand the role that lubricants play in causing WEC.”

ExxonMobil discovered that metal-based additives, such as zinc phosphate and/or a combination of over-based calcium and sodium, increased the sub-surface stress and enhanced hydrogen diffusion below the contact point, causing WEC formation, he said.

“In short, they’re one contributor to the problem,” Hennigan said. “During this research, we also confirmed that Mobil SHC Gear 320 WT, our newest gear oil, can help operators rule out one of WEC’s key suspects. Because of its metal-free formulation, Mobil SHC Gear 320 WT is



This chart compares the performance of Mobil SHC Gear 320 WT synthetic gear oil against other synthetic oils available on the market today. ExxonMobil’s balanced formulation approach enables superior performance across a wide range of important characteristics.

scientifically proven to not contribute to WEC. So, while lubricants cannot prevent WEC formation altogether, using the right lubricants can help eliminate one of the causes of WEC.”

DELIVERING LONG LUBRICANT LIFE

The products and services ExxonMobil offers are all focused on providing wind operators with the same benefit — delivering long lubricant life to help maximize equipment uptime and productivity.

“It’s important because when it comes to long-term lubricant performance, there has been increased focus on trying some less effective strategies,” Hennigan said. “I’m talking about mitigation strategies like top treating. To conduct top treating, operators use oil analysis to identify when an oil’s additives start to deplete and then re-additize that oil with the addition of after-market additive packages.”

But Hennigan said that approach is much like putting on a Band-Aid and doesn’t compensate for good formulation.

“I liken it to baking,” he said. “If you want to bake the best cake possible, then you need to use high-quality ingredients and ensure that all the needed ingredients are included in the cake mix at the right ratios before it is baked. You’ll be able to taste their quality in the final product, and poor quality ingredients will not result in a tasty cake. And, most importantly, once the cake is baked, you cannot go back and add ingredients



Wind-turbine equipment is often also located in remote areas that experience extreme temperatures. As a result, gearboxes can be required to operate in temperatures ranging from 120 degrees C to minus-50 degrees C.

without further ruining the cake. Say, for example, that you forgot to include vanilla extract. Trying to add vanilla flavoring to an already baked cake would not be possible, and even if you tried to douse the cake in extract, it would result in an uneven distribution of flavor.”

Hennigan said these same principles apply to an oil’s formulation. Additive top treating may introduce new contaminants that could affect equipment performance. Top treating also increases how often operators need to interact with equipment. While it may not be as invasive as flushing and changing an oil, it can increase the potential for safety issues.

LUBRICATION’S IMPACT

Hennigan noted a case study that showed the impact that lubrication can have on enhancing wind-turbine reliability and operator profitability.

“One West Virginia-based wind farm operated 44 wind turbines equipped with Flender gearboxes,” he said. “These turbines operated in a four-season climate, meaning they were exposed to regular rain, snow, and extreme high and low temperatures. While the turbines were operating just fine, the operator’s maintenance team wanted to see if there was an opportunity to reduce service interval frequency and enhance productivity.”

After a thorough inspection, ExxonMobil engineers recommended the company convert its gearboxes to one of its synthetic lubricants, as well as implement routine Mobil Serv Lubricant Analysis to monitor both lubricant and equipment condition.

“After making the switch, the company was able to extend its oil drain intervals to more than 49,000 hours — more than twice the industry average — while maintaining excellent gear condition,” Hennigan said. “These benefits helped generate company-estimated annual savings of \$176,000.”

CHALLENGING TASK

Maintaining high wind-turbine reliability is no easy task. These machines operate in uniquely severe conditions. The gearboxes operate up to 350 feet above the ground and face conditions such as heavy and varying loads from strong winds, extreme temperatures ranging from 120 degrees C to minus-50 degrees C, and exposure to contaminants such as salt water in an offshore environment.

“That’s why proper lubrication plays a critical role,” Hennigan said. “By using longer-lasting lubricants, you can reduce and potentially prevent wind-turbine equipment failures while extending the turbine’s performance even longer.”

CONVERSATION

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“Klüber supplies lubricants that provide superior protection.”

Tell us about Klüber and its core philosophy.

Klüber Lubrication offers tribological solutions for customers within nearly all branches of industry, notwithstanding a specific focus on wind energy.

Our customers include manufacturers of components, machines, and systems as well as companies using such equipment for production and processing activities.

The development and manufacture of lubricants to fulfill our customers' requirements has led to a portfolio of approximately 2,000 different products.

By matching competent R&D with customer-oriented consulting and services, our global teams have established Klüber Lubrication as a reputable partner to industry and trade.

With over 80 years of experience, numerous professional certifications, and world-class testing facilities, we are the leading partner for speciality lubricants.

Klüber Lubrication was founded during 1929 by Theodor Klüber, and the worldwide headquarters is still located in Munich, Germany. Our 2,100 employees represent more than 30 countries and work in local contact with customers and partners.

Klüber Lubrication has been a



brand of the Freudenberg Group since 1966. Freudenberg, headquartered in Weinheim, Germany, was founded over 160 years ago by Carl Johann Freudenberg. Freudenberg is a family-owned company with an international focus.

Our vision is to be appreciated for our values by providing superior quality and customer value along with innovative solutions that save energy and resources.

What are your duties with Klüber?

I am the market manager for wind energy throughout the USA and Canada, and a member of a global business unit that focuses on products plus services for the wind market.

What does Klüber do for the wind industry?

Wind turbines and their components are exposed to dynamic conditions that include high loads, vibrations, moisture, contamination, and extreme variances in temperatures. In addition, the maintenance of wind turbines is an arduous task and may be performed after relatively long intervals of time.

Selecting the right lubricants for initial lubrication of components as well as re-lubrication during operation is paramount. After all is designed, manufactured, and assembled, the lubricants must ensure efficiency, facilitate reliable operation, and protect expensive machine elements. Oil, grease, pastes, and coatings are utilized to maximize the output of wind-power plants. The major lubrication points are gearboxes, yaw rings, main bearings, generator bearings, hydraulic systems, and pitch bearings.

Klüber supplies lubricants that provide superior protection of mechanical and electrical components. The products withstand long service intervals, resist corrosion, protect against variable loads, suppress false brinelling, and stay functional over a wide range of temperatures. For manufacturers and operators, these characteristics mean reliable operation and substantial re-lubrication intervals. We coop-

“

With over 80 years of experience, numerous professional certifications, and world-class testing facilities, we are the leading partner for speciality lubricants.

”

erate closely with OEMs and end-users to push the technical limits of machines and increase the output of power. Lubricants play a major role for a minor investment.

What Klüber products have advanced or improved wind?

We have created high-performance lubricants (oil, grease, and pastes) that improve the functionalities, efficiencies, and lives of major components (electrical and mechanical) within wind turbines. Our Klüberplex and Klübersynth family of products are industry standards.

What sets Klüber apart when it comes to wind?

Klüber Lubrication models the conditions around mechanical and electrical components then builds the

best lubricants for the given conditions. After successful implementation, we offer consultations and finish goods to prospective customers. Alternatively, Klüber is well-suited toward developing custom solutions in partnership with manufacturers and end-users.

Different types of lubricants are often needed for different types of bearings in a turbine. How does Klüber approach a wind-industry customer?

We design and test a wide range of conditions to understand the interfaces of each tribological system, then build lubricants to perform effectively under extreme conditions. In regards to product range and support, Klüber Lubrication is ideally positioned to be a global partner with a full range of solutions (lubricants) as well as a dedicated business unit (teams) for services and consultations. ↘



Klüber Lubrication models the conditions around mechanical and electrical components then builds the best lubricants for the given conditions. (Courtesy: Klüber Lubrication)

MAINTENANCE

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

3M™ Fall Protection launches Trade-In, Trade-Up program



To help safety managers stay ahead of the curve with their safety equipment, 3M Fall Protection has launched the 3M Fall Protection Trade-in, Trade-up program. (Courtesy: 3M)

For safety professionals, keeping workers safe means providing them with effective, dependable equipment while staying compliant with changing safety standards and regulations. For workers at height, 3M™ Fall Protection designs safety equipment to meet the strictest industry standards, as is the case with its DBI-SALA® and Protecta® fall protection products. To help safety managers stay ahead of the curve with their safety equipment, 3M Fall Protection has launched the 3M Fall Protection Trade-in, Trade-up program. Workers and safety managers can trade-in qualifying fall protection equipment and trade-up for more than 170 products from the 3M Fall Protection line as well as receive cash rebates.

“No matter the current standard or safety requirement, workers must be free to start every work day with the peace of mind that comes from knowing they are protected with top-of-the-line equipment designed for their safety and comfort,” said Andrew P. Johnson, marketing manager for U.S. 3M Fall Protection. “The Trade-in, Trade-up program was created to help make the most current safety equipment even more accessible to work-

ers. We want everyone to benefit from equipment that brings the latest safety technology to workers at height.”

To participate, workers and safety managers start by identifying fall protection products they want to trade in or trade up, pick their new 3M Fall Protection products offered within the program, place an order with a 3M authorized distributor, and register their purchase at go.3M.com/FPtradein to initiate the rebate.

“For safety managers, a key incentive to participating is the option to trade in any brand of lanyard with non-3,600 pound gated hooks for 3M’s ANSI-rated 3,600 pound gated hooks,” said Ray Mann, technical services for 3M Fall Protection. “In January of this year, OSHA released a new regulation requiring gated hooks and carabiners to be proof tested to 3,600 pounds in all directions (1910.140(c)(8)). 3M Fall Protection snap hooks and carabiners comply with the requirements of this new OSHA regulation.” ↵

Source: 3M

For more information, go to go.3M.com/FPtradein.

Two-year crew transfer vessel extension announced on offshore project

CWind, a leading provider of services to the offshore wind industry, recently announced that Dong Energy, one of the key energy groups in Northern Europe, has granted CWind a two-year extension to its existing three-year crew transfer vessel contract at the West of Duddon Sands Offshore Wind Farm in the Irish Sea.

CWind, the offshore power-focused business of Global Marine Group (GMG), will provide vessels for Operations & Maintenance (O&M) to the 108-turbine West of Duddon Sands site, including a summer campaign to ensure the site remains operating at peak performance throughout the busier summer months. The contract extension builds on CWind's solid track record over the first three years of the project.

"This extension to our contract with Dong Energy is a fantastic achievement that reflects the great service we consistently deliver to customers," said Lee Andrews, managing director at CWind. "Winning a contract from a paper-based submission, as we did three years ago, is one thing, but securing an extension demonstrates our actual on-site performance levels and customer satisfaction. We have delivered on service and exceeded expectations in many areas, and we are determined to do the same over the next two years, relying on our can-do attitude and resourceful approach."

"The turbines at West of Duddon Sands, which produce enough clean electricity to power up to 340,000 homes each year, are maintained by hard-working technicians journeying out to sea each day," said Steven Clarke, head of West of Duddon Sands Operations. "The crew vessels CWind have provided over the last three years have had a high utilization factor, and we very much look forward to continuing our work together."

Three of the CWind's 18-strong fleet of crew transfer vessels (CTVs) have been dedicated to the project, comprising a pair of 19-meter resin-infused multi-purpose catamarans (MPCs) and one small water-plane area twin hull (SWATH) vessel. The robust and lightweight composite construction of the CTVs has proved to deliver fuel efficiencies and significant CO2 emission savings.

The MPC19 catamarans use a modular three-section-pod comprising a wheelhouse, accommodation pod, and porch module to provide enhanced deck space options and excellent operational flexibility. The catamarans can handle tasks ranging from passenger transfer, generator management, refuelling, and food deliveries, as well as straightforward accommodation duties.

For technicians who face a tough commute and need to arrive on site ready to work, the SWATH hull form is designed to cut through waves rather than ride over them, dramatically improving transit comfort, even in rough seas. Motions are approximately a quarter of those of conventional catamarans.



A CTV returns from a wind-farm operation. (Courtesy: CWind)

Importantly, CWind's services on site are fully integrated within the whole West of Duddon Sands wind-farm team. Strong relationships built with marine coordinators, site teams, technicians, and other contractors, established over the first three years of this contract, plus the two prior to that with the company's involvement in the site's construction phase, will make for efficient service provision moving forward. ↘

Source: CWind

For more information, go to www.cwind.global

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LiDAR wind buoys to be used in China



The Fraunhofer IWES LiDAR buoy has already been used multiple times for offshore measuring. (Courtesy: Fraunhofer IWES)

Titan Technologies Corporation has ordered two Fraunhofer IWES LiDAR measuring buoys for the surveying of the Zhangpu and Changle offshore wind farms planned for off the coast of China's Fujian province. This will be the first time a floating LiDAR system will be used for offshore wind measurements in China. The buoys will be used to precisely measure the wind conditions in the designated locations so as to allow precise calculation of the wind farm's electricity yield. China Three Gorges Corporation (CTG) owns the projected wind farms.

Many business hubs are close to the coast in China. This, coupled with the state's expansion targets, is stimulating the constant growth of the offshore wind energy sector in China. CTG received the contract to build two wind farms with a capacity of 4 GW altogether and wants to obtain precise measurements of the conditions on-site using Fraunhofer IWES LiDAR buoy technology. Titan Technologies Corporation

has been engaged by CTG to perform the measurements. The company will also be completing the installation work, servicing, and data evaluation.

"We have been working with Fraunhofer for years and appreciate their proven, highly deployable solutions for complex operational conditions. Paving the way for CTG's vision of reliable offshore wind energy for China is an exciting and honorable assignment to which we contribute years of wind energy experience," said John Feng, chairman, Titan Technologies Corporation.

By providing comprehensive feedback on the buoy's performance under the specific operation conditions found in China, Titan contributes to Fraunhofer's sound understanding of the requirements of varying environmental loads, e.g. typhoons.

"We welcome the order from Titan Technologies Corp. and believe that CTG's decision to use two Fraunhofer

IWES LiDAR buoys could set an example in China,” said Bernhard Lange, head of Wind Farm Planning and Operation at Fraunhofer.

The Fraunhofer IWES LiDAR buoy has already been used multiple times for offshore measuring, most recently off the Scottish coast for the projected Firth of Forth wind farm. It measures wind speed up to 200 meters above the surface of the water. The buoy not only passed the Carbon Trust tests for floating LiDAR devices, but surpassed the requirements for accuracy and availability. The buoy’s durability is evident in its robust build with double-encapsulated LiDAR and redundant power supply.

Fraunhofer IWES researchers developed not only the design but also the correction algorithm, which eliminates buoy movements from the measurements. This algorithm guarantees an extremely precise measurement, even in strong seas, delivering data that are as reliable as those collected with a fixed met mast.

Fraunhofer is the leading organization for applied research in Europe. It encompasses 66 institutes and research facilities in locations throughout Germany. It employs almost 24,000 people and has an annual research budget of 2 billion euros. Industry contracts and public research projects account for 70 percent of Fraunhofer’s budget. Fraunhofer has branches in Europe, North America, and South America pursuing international projects. Titan Technologies Co., Ltd., incorporated in 2009, is a system integrator, solution provider, and smart manufacturer. The company is principally engaged in smart manufacturing through products, services, and technology that enables its customers to conduct manufacturing in a cleaner, safer, more reliable, and efficient way. ↴

Source: Fraunhofer IWES

For more information, go to www.iwes.fraunhofer.de/en.html

New wind-power generator uses direct drive and solar for added efficiencies

A new design for wind-power generators uses a conical vortex that moves air through the unit with as little interference as possible, reducing heat and improving efficiency.

The cowl-housed design addresses many of the problems of the wind turbines of today — height requirements, whoosh noise, high maintenance costs, downtime for maintenance, high-wind and low-wind downtime, and limited access to transmission lines — to name just a few. The design also eliminates the weight, drag, and maintenance of a transmission and drive chain since it uses direct drive.

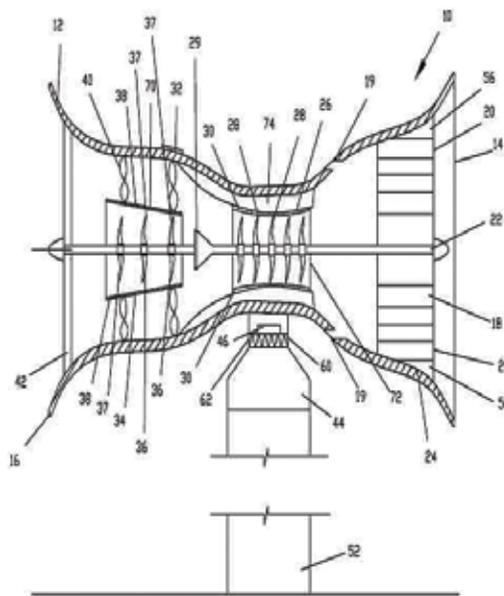
Taking advantage of a second renewable energy source, the patented design uses solar cells to provide power when wind speed is too low or too high. Unlike conventional wind turbines, the technology covered by this patent is scalable, so units can be manufactured in various sizes and generating capabilities. In addition to industrial, commercial, and residential applications, this design is ideal for providing power to charge electric vehicles.

U.S. Patent No. 8,269,368 for a “Wind and Solar Electric Generator” is exclusively represented by leading patent brokerage firm IPOfferings LLC.

“The ’368 patent represents what is absolutely the next generation in wind turbines,” said Alec Schibanoff, vice president of IPOfferings. “Its patented direct-drive design eliminates the cost, drag, and maintenance of the transmissions and drive chains that current generation of wind turbines use to transmit power from the blades to the actual power-generation unit. The question people ask when they see a brilliant invention is always the same: Why didn’t someone think of this before? It is amazing that the wind-power industry has not considered direct-drive design in their wind-power generation units.” ↴

Source: IPOfferings

For information, contact IPOfferings at patents@IPOfferings.com



This figure from the patent shows how the blades in the turbine are essentially the armatures of the dynamo. According to IPOfferings, this design eliminates the need for a transmission and drive chain, and that dramatically reduces weight and drag, as well as both assembly and maintenance costs. (Courtesy: IP Offerings)

MANUFACTURING

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

Siemens Gamesa to supply 752 MW to Dong Energy in the Netherlands



The Horns Rev 2 wind farm off the coast of Denmark was inaugurated by Dong in 2009. (Courtesy: Dong Energy A/S)

Siemens Gamesa and Dong Energy have signed an agreement* for the supply of 94 8-MW turbines (752 MW) at the Borssele 1 and 2 offshore wind power plant being developed in Dutch waters. The contract additionally includes maintenance of the turbines.

The wind-power plant will be 22 kilometers from the coast of the Dutch province of Zeeland with a water depth of 14 to 38 meters and will cover an area of 128.3 square kilometers.

The nacelles for this project will be assembled in Siemens Gamesa's new factory in Cuxhaven, Germany. The blades for the Borssele 1 and 2 projects will be produced in Hull, England.

"We are pleased that Dong Energy has selected Siemens Gamesa for the Borssele 1 and 2 offshore wind-power plants in the Dutch part of the North Sea," said Michael Hannibal, CEO Offshore at Siemens Gamesa. "The advanced model of our proven direct drive offshore wind-turbine platform and our advanced services will leverage the energy output of this lighthouse project and help to move offshore wind into the energy mainstream in Europe."

The 8-MW turbine is based on the existing Siemens Gamesa offshore direct drive platform, which has an excellent track record. More than 200 direct-drive wind turbines in the 6- to 8-MW class already have been installed and commissioned in offshore wind farms.

The energy production of one Siemens Gamesa 8-MW machine is sufficient to supply about 8,000 European households with electricity. The power supplied from the 752-MW Borssele 1 and 2 projects will cover the annual electricity consumption of close to 1 million households.

Siemens Gamesa and Dong Energy have collaborated on several offshore wind farms including London Array, West of Duddon Sands and Westermost Rough in the United Kingdom, the Anholt project in Denmark, as well as Borkum Riffgrund 1 and Gode Wind 1 and 2 in German waters.

**These contracts are still subject to notice of effectiveness by Dong. ↴*

Source: Siemens Gamesa

For more information, go to www.gamesacorp.com

Vestas gets U.S. orders totaling 432 MW

UNDISCLOSED PROJECT

Vestas has received a firm and unconditional order in the U.S. for 60 MW of V110-2.0 MW turbines for an undisclosed project. The project, which includes previously purchased PTC components, has a total size of 66 MW and consists of 30 turbines. The order includes supply and commissioning of the turbines as well as a multi-year Active Output Management 5000 (AOM5000) service agreement, a full-scope service package designed to maximize uptime and energy production. Delivery is expected to begin in the third quarter of 2017, with commissioning planned for the fourth quarter.

“Each turbine manufactured in this order will support 30 full-time jobs over its lifetime,” said Chris Brown, president of Vestas’ sales and service division in the United States and Canada. “These turbines will be produced at our Colorado factories, generating economic benefits across a diverse and domestic American supply chain and supporting long-term jobs in Colorado and the project community.”

MIDAMERICAN ENERGY COMPANY

With reference to Vestas Wind Systems A/S’ company announcement in June, Vestas has received a firm and unconditional order from MidAmerican Energy Company, a subsidiary of Berkshire Hathaway Energy, for 170 V110-2.0 MW turbines for the Wind XI project. The order includes previously purchased PTC-qualifying components.

The turbines will be manufactured at Vestas’ Colorado factories and delivered in the second quarter 2018. The order includes supply and commissioning of the wind turbines, as well as a five-year Active Output Management 5000 (AOM5000) service agreement, Vestas’ full-scope service package maximizing



A Vestas V110-2.0 MW turbine. (Courtesy: Vestas)

uptime and energy production.

“The historic Wind XI project will deliver clean, low-cost wind energy to MidAmerican Energy’s customers and communities while enhancing the reliability and resiliency of the grid. Hundreds of millions of dollars in economic benefits, including landowner lease payments, tax payments, and long-term secure jobs, will be generated to support the manufacturing, construction and operation of this project,” Brown said.

MidAmerican Energy is the largest regulated utility owner of wind energy in the U.S. When fully operational, the Wind XI project will ensure the utility generates 85 percent of its retail energy load from wind. The Wind XI project consists of multiple sites in Iowa that will be placed into service between 2017 and 2019. Potential future order intake under overall agreement linked to the Wind XI project is expected to occur as partial deliveries under the master agreement, and will be announced firm and unconditional consistent with Vestas’ order announcement policy.

COPENHAGEN WIND PROJECT

EDF Renewable Energy orders V110-2.0 MW turbines for the Copenhagen

Wind Project in upstate New York.

The firm and unconditional order comprises supply of the wind turbines as well as a 10-year Active Output Management (AOM) 5000 service agreement, a full-scope service package to maximize uptime and performance, and energy production. The project, which includes previously purchased PTC components, has a size of 80 MW and consists of 40 turbines. Turbine nacelles, blades, and towers will be produced at Vestas’ Colorado factories with delivery expected to begin in the third quarter of 2018. ↘

Source: Vestas

For more information, go to www.vestas.com

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CONSTRUCTION

BOP/EPC • Project Status • Siting • Equipment • Project Due Diligence • Services

RES to construct Copenhagen Wind Project in New York

Renewable Energy Systems (RES), a leader in the development, engineering, construction, and operations of wind, solar, transmission, and energy storage projects in the Americas, recently announced it was awarded the balance of a plant construction contract for the Copenhagen Wind Project developed and owned by EDF Renewable Energy, a subsidiary of EDF Energies Nouvelles. The project is in Jefferson and Lewis counties in upstate New York. RES was selected for balance of plant construction through a competitive third party bidding process.

Notice to proceed was awarded on May 24, 2017, and construction will begin on the 80 MW project in August 2017. It is scheduled for completion in November 2018. The Copenhagen Wind Project will use 40 Vestas V110 2.0MW turbines. RES will also construct an approximate 9-mile, 115kV transmission line, terminating at a newly constructed substation along an existing National Grid-owned transmission line.

“Copenhagen will be RES’ first wind project constructed in the state of New York, and we are pleased to be contributing to the economic benefits this project will provide to the community,” said Jason Zingerman, vice president of construction for RES in the Americas. “This project is another step forward toward our goal of a low-carbon future for all, and adds to our proud track record of working alongside EDF Renewable Energy.”

“We are pleased to be working with RES to construct EDF RE’s



The Copenhagen Wind Project will use 40 Vestas V110 2.0MW turbines such as the one pictured here. (Courtesy: Vestas)

first project in New York,” said Ryan Pfaff, executive vice president at EDF RE. “Copenhagen Wind is yet another great example of how wind power provides an economic boost to rural America through the creation of local jobs, tax base, and recurring landowner lease payments, and we look forward to partnering with the local community in Lewis and Jefferson counties to make the project a success.”

“National Grid is pleased to partner with Renewable Energy Systems on the Copenhagen Wind Project,” said Brian Gemmell, National Grid vice president of FERC Strategy and Performance. “We are committed to supporting innovative solutions that harness energy from alternative energy sources and help to achieve the company’s

clean-energy goals. National Grid is excited to play a leadership role to drive a cleaner, greener energy future to promote New York’s renewable energy target of 50 percent renewables by 2030.”

During peak construction, Copenhagen will support 120 jobs to bring the benefits of renewable energy to upstate New York. This project will offset 177,000 metric tons of CO2 emissions annually (as per the Environmental Protection Agency GHG calculator), which is equivalent to the greenhouse gas emissions from 37,500 passenger vehicles driven over the course of one year. ↴

Source: Renewable Energy Systems

For more information, go to www.res-group.com/en

Dong Energy to construct 12 MW of offshore wind energy off Virginia coast

As part of its ongoing commitment to bring cleaner energy to its customers, Dominion Energy Virginia is moving forward on the mid-Atlantic's first offshore wind project in a federal lease area.

Dominion has signed an agreement and strategic partnership with Dong Energy of Denmark, a global leader in offshore wind development, to build two 6-MW turbines off the coast of Virginia Beach. The two companies will now begin refining agreements for engineering, procurement, and construction. Dominion Energy remains the sole owner of the project.

Engineering and development work on the newly named Coastal Virginia Offshore Wind project is expected to begin immediately by Dong Energy to support the targeted installation by the end of 2020.

The timing for construction depends on many factors such as weather and protected species migration patterns.

The project is an important first step toward offshore wind development for Virginia and the United States. It would be only the second offshore wind project in the nation and the first owned by an electric utility company. Along with clean energy, it will provide Dominion Energy with valuable experience in managing offshore wind resources.

ENERGY LEADER

"Virginia is now positioned to be a leader in developing more renewable energy thanks to the Commonwealth's committed leadership and Dong's unrivaled expertise in building offshore wind farms," said Thomas F. Farrell II, Dominion Energy's chairman, president, and chief executive officer. "While we have faced many technological challenges and even more doubters as we advanced this project, we have been steadfast in our commitment to our customers and the communities we serve."

"Today marks the first step in what I expect to be the deployment of hundreds of wind turbines off Virginia's coast that will further diversify our energy production portfolio, create thousands of jobs, and reduce carbon emissions in the Commonwealth," said Gov. Terry McAuliffe. "Hampton Roads has the ideal port assets and talented workforce to attract and house the offshore wind business supply chain to support not only Virginia's commercial wind area, but also wind farms under development in Massachusetts, New York, and Maryland. Today's announcement advances our efforts to build a new Virginia economy that is cleaner, stronger, and more diverse."

"Dong Energy is the energy supplier in Europe that

has come the farthest in the transition to renewable energy, and we are excited to bring our expertise to America," said Samuel Leupold, executive vice president and CEO of Wind Power at Dong Energy.

"This project will provide us vital experience in constructing an offshore wind project in the United States, and serve as a stepping stone to a larger commercial-scale partnership between our companies in the future. We see the tremendous potential in the Mid-Atlantic for emission-free, renewable wind generation, and we are excited to help the Commonwealth in reaping the benefits of wind power," he said.

PHASE-ONE DEVELOPMENT

This phase-one development of two wind turbines will be built approximately 27 miles off the coast of Virginia Beach on a 2,135-acre site leased by the Virginia Department of Mines, Minerals and Energy.

The project opens the door to long-term commercial wind development. It will provide the critical operational, weather, and environmental experience needed for large-scale development in the adjacent 112,800-acre site leased by Dominion Energy from the Bureau of Ocean Energy Management (BOEM).

Full deployment could generate up to 2,000 megawatts of energy – enough to power half a million homes.

The two companies have signed a memorandum of understanding, which gives Dong Energy exclusive rights to discuss a strategic partnership with Dominion Energy about developing the commercial site based on successful deployment of the initial test turbines.

The project continues what previously was called the Virginia Offshore Wind Technology Assessment Project (VOWTAP). Dominion Energy began work on the project in 2011 as part of a Department of Energy grant to develop and test new wind technologies that could lower the cost and withstand hurricanes.

During that time, key achievements were made to advance the project including: Approval of the Research Activities Plan by BOEM and environmental studies, which included avian and bat surveys, as well as assessments of ocean currents, archeological conditions, and whale migration patterns. ↴

Source: Business Network of Offshore Wind

For more information, go to www.bizmdosw.org



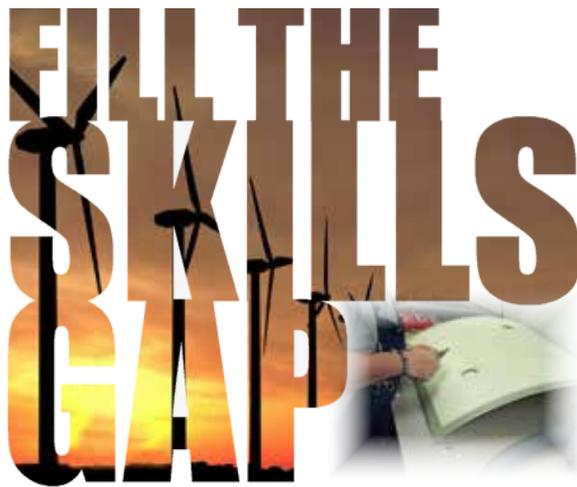
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Published by Media Solutions, Inc.
P. O. Box 1987 • Pelham, AL 35124
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Taking Care of Business

Brief Relief's products help field workers answer the call of nature properly.

By Kenneth Carter
Editor | Wind Systems

What happens when you're on someone else's massive property, in the middle of nowhere, 300 feet above the ground, and nature calls?

It's not something a lot of workers may think about — until they have to think about it.

Thankfully, Brief Relief is a company that has put a great deal of thought into this leg-crossing predicament, and it has come up with a few solutions.

"We're a manufacturer of a field restroom system, mostly designed for mobile work crews, anyone working outside who find themselves with the lack of a proper restroom facility," said Pete Lindemann, Brief Relief's national sales manager.

More often than not, outside workers often run the risk of using unapproved containers, which can cause legal problems and public relations nightmares.

To stop those problems in their tracks, the company has made the Brief Relief system.

"Our most popular product is called Brief Relief," Lindemann said. "It's a disposable urinal pouch."

The Brief Relief is basically a bag with a wide opening containing a mix of polymers and enzymes in the bottom similar to a disposable diaper.

"The polymers draw the water out of the urine and help break it down, so it's treated waste," Lindemann said. "It gels instantly, so it's treated in a gelled state, and you can simply close it up and dispose of it in any trash receptacle, just like a dispos-



Brief Relief is a disposable urinal pouch.
(Courtesy: Brief Relief)

able diaper. And now it's legal to throw away."

The products offered by Brief Relief have been well received by industries that have workers out in the field, and it's been a natural progression to introduce the wind industry to this useful product, according to Lindemann.

"We started off with telecom companies, and built on from there to electric utilities, gas utilities, the military, construction companies, anybody who works outside," he said. "We had a few accounts, and we knew reading about wind power, how much it was growing over the last couple of years."

At the recent AWEA WIND-POWER show in Anaheim, Brief Relief received a lot of interest, Lindemann said.

"In the past, what we had gathered was that techs were bringing up empty bottles to take care of waste, because you're not going to climb down from 200 feet up, and they thought it was a great product they could stick in their pocket and take it up there and then come down at the end of the day with

the used bags," he said.

But wind technicians aren't the only ones who find the product useful. Landowners where wind farms are built also find Brief Relief's products a way to keep their property clean.

"The actual land owners of the wind farms don't want anything left behind," Lindemann said. "We call them white flowers (loose pieces of toilet paper stuck in the field)."

And if additional privacy is an issue, Brief Relief also offers quickly deployed shelters, which, when used in tandem with Brief Relief's Disposa-John Portable Restroom Bags, allow for the proper disposal of solid waste, according to Lindemann.

"We do have a privacy shelter, which is a nice all-enclosed system that integrates a tent," he said. "You can erect the shelter in about two minutes and take it down in the same amount of time."

Ease of use as well as the ease of erecting it often makes it a better choice to the standard portables found at parks and concert venues, according to Lindemann.

"Portables are good as a long-term solution," he said. "The biggest cost of a portable is relocating it, having it brought out and serviced. With our product, you can deploy it yourself. You can put everything in a dufflebag, and deploy it anywhere you want. It's been to the base camp at Mount Everest. It's been all over the world. So if you have a short duration job or a job that is hard to get to, you can deploy our system quite easily. It's a much cleaner, much more hygienic environment." ↴

For more information, go to briefrelief.com

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