



Thanks to technology advances and new schools of thought, owners and operators no longer have to choose.

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On the cover: A specialized technician utilizes rope access to inspect and repair a wind turbine blade. Source: MAKE Consulting



Mark Del Franco

Breaking Through

Every so often, an item stands out among the daily news cycle as if to shout, “Pay attention. This is important.” No, I’m not talking about a project win or even a construction update. I’m referring to last month’s announcement by the Southwest Power Pool (SPP) that wind energy had surpassed 50% wind penetration – measured by the amount of total load served by wind at a given time.

On Feb. 12 at 4:30 a.m., wind served 52.1% of the regional transmission operator’s (RTO) load, marking the first time in recorded history that any North American operator served 50% of the load with wind.

Let that stat sink in for a moment. Wind energy was the primary “fuel” serving the public’s energy needs. Veteran industry watchers will recall that 10 years ago, attaining even 25% wind penetration was considered crazy. But 50%? That’s truly mind-blowing.

“This is amazing,” notes Paul Zackin, president at Zackin Publications, which publishes *North American Windpower*. “When we first started *NAW* [in 2004], many were sure that the sky would fall when wind reached 10 percent. Where there is a will, there is a way.”

SPP says the record numbers were made possible because of its geographic diversity and robust transmission system. The RTO’s footprint covers more than 550,000 square miles, from the Canadian border in Montana and North Dakota in the north, to parts of New Mexico, Texas and Louisiana to the south.

Where there is a will, there is a way.

The RTO notes that the proliferation of wind power in the SPP region has grown significantly over the last decade. As recently as the early 2000s, SPP’s generating fleet included less than 400 MW of wind, and for years, wind was reported in the “other” category in SPP’s fuel mix data. Now, wind is the third most prevalent fuel source in the SPP region: It made up approximately 15% of the organization’s generating capacity in 2016 (behind only natural gas and coal).

SPP says it has approved the construction of more than \$10 billion in high-voltage transmission infrastructure over the last decade. Much of it has been built in the Midwest to connect rural, isolated wind farms to population centers hundreds of miles away.

Perhaps more impressive is this: “It’s not even our ceiling,” notes Bruce Rew, SPP’s director of operations. “We continue to study even higher levels of renewable, variable generation as part of our plans to maintain a reliable and economic grid of the future.”

Again, where there is a will, there is a way. 

Send your news items to
mdelfranco@nawindpower.com

MICHAEL BATES Publisher & Vice President
bates@nawindpower.com

MARK DEL FRANCO Associate Publisher
(203) 262-4670, ext. 283
mdelfranco@nawindpower.com

BETSY LILLIAN
JOSEPH BEBON Associate Editors
LAUREN TYLER

AMANDA FAVA Editorial Assistant

DAWN S. HOWE Creative Director

ANGEL L. HERNÁNDEZ Graphic Artist

SANDRA MINCK Production Coordinator

CHERYL SAMIDE Office Manager

DAMASE CARON Information Systems Manager

Advertising Sales Mark Del Franco

mdelfranco@nawindpower.com
(800) 325-6745, ext. 283



PAUL ZACKIN President
pzackin@nawindpower.com



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Oil Sands Workers Ready For Renewables Shift



A row of Vestas wind turbines located west of Pincher Creek, Alberta. Photo courtesy of Bryan Passifiume/the Canadian Wind Energy Association

During his six-year tenure working in Alberta's oil sands, Lliam Hildebrand found that one topic in particular – renewable energy, of all things – always made its way into conversation.

Unemployment in the oil sector was growing, and many environmentally conscious tradespeople struggled to justify their working in a carbon-intensive industry that contributes to climate change and its effects.

Realizing that his co-workers shared the same concerns, Hildebrand conceived Iron & Earth, a national initiative to retrain tradespeople working in the fossil fuel industry to transition into the renewables sector.

“The formation of Iron & Earth came about over many lunchroom conversations in the oil sands,” Hildebrand recounts. “My co-workers and I wanted to see renewable energy technologies incorporated more significantly into our work scope, so we decided to do something about it.”

According to Hildebrand, the organization directly benefits oil sands workers by connecting them with information, training opportunities and stakeholders in the renewable energy sector.

“We also provide a platform for workers to advocate for renewable energy jobs,” he adds.

In addition to expanding tradespeople's current scope of work, the initiative also aims to retrain those who were laid off following the global drop in oil prices, which, according to the

Canadian Association of Petroleum Producers, led to the loss of more than 100,000 jobs overall in 2015.

Currently, Iron & Earth boasts more than 450 members from various trades, including boilermakers, like Hildebrand; electricians; ironworkers; pipe fitters; laborers; and more.

Although the initiative's first focus was directed to the solar industry – aiming to retrain 1,000 out-of-work oil sands workers to install solar panels in Alberta – its members see potential for work in other areas, including wind power.

“Solar PV is isolated to electricians for training, but technologies like wind, biofuels, biomass and geothermal utilize a broader range of industrial trades utilized in the oil sands,” says Hildebrand.

“This work will help the wind industry by putting a face to the workers benefiting from the industry and building broader support for renewable energy development,” he says. “And, the province of Alberta will benefit by having a renewable energy workforce ready to meet the demands of an emerging industry.”

This past November, Iron & Earth publicly introduced its plan to put words into action. Titled the Workers' Climate Plan, the report “describes how Canada can become a leader in renewable energy, and a net exporter of renewable energy products, services and technology, by harnessing the industrial trade skills of current energy sector workers.”

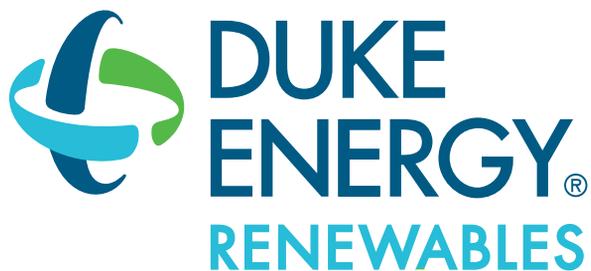
Notably, many of these workers in the building trades either

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already have the basic skills necessary for renewables work or have transferable skills that would enable a smooth transition.

According to the plan, “The compatibility or near compatibility of existing skills with renewables is extensive: Electricians are needed to develop and install solar panels; welders are needed to build wind turbines; drillers and drilling engineers are needed to locate and maintain geothermal wells; and so on.”

The Workers’ Climate Plan includes analysis of more than 1,000 survey responses detailing tradespeople’s experiences working in the energy sector, opinions on the shift to renewables, and concerns about the economy and climate change.

Citing comments from several trade technicians, the report highlights the general consensus that workers would welcome a shift to clean, alternative energy – on both a personal and a professional level.

“I care deeply about the environment and feel that the future needs to be renewable energy. I also fundamentally believe in a just transition for oil sands workers,” comments one trade worker.

“Canada needs to pivot away from all electricity generation with a high-carbon footprint to green electricity. As an electrician, I am prepared to be trained and work within the clean energy sector,” says Daniel Lee, construction electrician.

Looking at the numbers, the survey found that 63% of

respondents said they could transition to renewables projects “directly with some training,” and 16% said they could transition without any additional training at all.

What’s more, 59% of energy sector workers reported they were even willing to take a pay cut to transition to renewable energy.

To make this a reality, Iron & Earth is calling on the government to provide funding for the necessary training programs and to promote job opportunities that support a low-carbon economy.

“We have had a lot of positive meetings with the government of Alberta and the government of Canada, and we are working to secure grants for preliminary demonstration projects and training programs,” Hildebrand says. “Many unions in Canada are very supportive of renewable energy, and we are hopeful that Canada’s building trades will develop a strong position in favor of these emerging technologies.”

All that being said, the oil sands have been a key industry for the Canadian economy for years, and Iron & Earth members realize that many will rely on these jobs in the future.

As such, the initiative says its goal is not to shut down the oil sands but to “see they are managed more sustainably, while developing our renewable energy resources more ambitiously.”

In an effort to extend into the wind industry, Iron & Earth signed a memorandum of understanding (MOU) with wind energy company Beothuk Energy Inc. (BEI) in July 2016 to facilitate the apprenticeships and re-training necessary for oil and gas workers to transition into the offshore wind sector.

According to a company release, BEI proposed six offshore wind farms in Atlantic Canada with a combined 4,000+ MW of installed capacity. Under the MOU, the company plans to create approximately 10 jobs for each megawatt produced.

The group aims to keep growing in numbers and across provinces, having already expanded outside of Alberta to include a Newfoundland chapter. With a strong wind energy potential – one of the strongest in any jurisdiction in North America – Newfoundland and Labrador is particularly well-suited to benefit from this shift away from fossil fuels and to the renewables market.

Hildebrand is optimistic about the future of Iron & Earth, noting that the group’s trade skills can help the world meet climate targets and approach net-zero by 2050.

– Lauren Tyler

Mich. Utility Launches Renewables Program

Detroit-based utility DTE Energy has announced MIGreenPower, a new program that will allow customers to buy power from Michigan wind and solar farms starting in April.

“Until now, customers who wanted to use more renewable energy were limited to installing their own solar panels or other renewable equipment at their homes or businesses – which requires a significant initial investment,” explains Irene Dimitry, vice president of business planning and development at DTE Energy. “We also know that customers who rent apartments or live in condos may be unable to make any alterations to the exterior structure of the homes they live in. MIGreenPower is designed to address customer demand for a more flexible and affordable alternative.”

Energy for the program will be sourced from local DTE projects, including the Pinnebog Wind Project in Huron County and three solar arrays located in Detroit and Lapeer. By subscribing to MIGreenPower, customers can elect to increase the amount of renewable energy they use in 5% increments, up to 100%.

Participation in the program is voluntary and open to all of DTE’s 2.2 million full-service business and residential electric customers. According to the utility, customers who want to participate in MIGreenPower will see a slight increase in their monthly bills depending on the level of renewable energy they select.

The utility notes Selfridge Air National Guard Base, located in southeast Michigan, has already expressed interest in being one of the program’s early adopters.

“We are looking carefully at this program,” comments Brigadier General John Slocum, the base commander. “We think it can provide us with a means to meet our sustainability goals efficiently and economically. We are excited to know that DTE is bringing this type of opportunity to its customers in Michigan.”

Move Over, Hydro: Wind Is No. 1

Here’s to another solid quarter for U.S. wind power: According to the American Wind Energy Association’s (AWEA) freshly released fourth-quarter report, the sector just had its second-strongest quarter ever for newly installed capacity.

In addition, wind has now surpassed hydropower dams to become the largest source of renewable electric capacity in the U.S., AWEA has announced.

Stakeholders from General Motors (GM) and the

U.S. wind energy industry met to mark the milestones and release AWEA's "Fourth Quarter 2016 U.S. Wind Industry Market Report" at GM's Arlington, Texas, assembly plant – which will soon be 100% powered by wind.

"American wind power is now the No. 1 source of renewable capacity, thanks to more than 100,000 wind workers across all 50 states," says Tom Kiernan, AWEA's CEO. "Growing this made-in-the-U.S.A. clean energy resource helps rural communities pay for new roads, bridges and schools, while bringing back manufacturing jobs to the Rust Belt. With our two-thirds cost reduction over the last seven years, household brands like General Motors, Walmart and more are buying low-cost wind energy to cut costs and power their businesses. American wind power is on track to double our output over the next five years and supply 10 percent of U.S. electricity by 2020."

At the close of 2016, the American wind fleet totaled 82,183 MW, which is enough to power 24 million average American homes. Specifically, there are now more than 52,000 individual wind turbines in 41 states, plus Guam and Puerto Rico.

GM's Arlington plant, which produces over 1,000 SUVs a day, is currently 50% powered by wind energy. However, start-

ing in 2018, it will be GM's first plant to have all of its electricity needs met with wind energy. The company purchases energy from two Texas wind farms, RES' Cactus Flats in Concho County and EDPR's Los Mirasoles Wind Farm in Edinburg.

To that end, notes AWEA, non-utility purchasers – such as GM, Microsoft and the U.S. Department of Defense – represented 39% of wind purchased through long-term contracts in 2016 for a total of 1,574 MW. Notably, more than half of that capacity is located in Texas.

On the jobs front, according to the report, the wind industry now employs 25,000 Americans at more than 500 factories in 43 states (including 40 wind manufacturing facilities in Texas alone). In 2016, at least seven companies across the U.S. expanded existing manufacturing facilities to meet growing orders, and GRI Renewable Industries opened a

new tower facility in Amarillo, Texas. Citing a recent U.S. Department of Energy report, AWEA says a total of more than 100,000 American workers now manufacture, construct and maintain the U.S. wind turbine fleet.

As for new growth in the fourth quarter of 2016, 6,478 MW of wind was installed – representing the second-strongest quarter on record, says AWEA.

For the year, wind developers added 8,203 MW of wind



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power capacity, representing more than \$13.8 billion in new investment. With 99% of wind projects located in rural areas, much of this investment is flowing to communities that need it most, the association notes.

Specifically, rural and Rust Belt America are among the greatest beneficiaries of wind development. Wind projects in these areas often become the largest contributors to the property tax base – in turn, helping to improve schools, roads and other public services. Of the \$13.8 billion invested by the U.S. wind industry last year, \$10.5 billion was invested in low-income counties, according to the report.

AWEA points out that wind is also a new drought-resistant cash crop for farmers and ranchers who host turbines on their land. Nationwide, wind projects provide private landowners with more than \$245 million in land lease payments annually. In particular, Texas landowners receive more than \$60 million of that.

“Wind power isn’t a red or blue industry; it’s red, white and blue,” says Kiernan. “Low-cost, home-grown wind energy is something we can all agree on. States like Texas and Iowa are leading the way in terms of wind turbines and wind jobs.”

According to AWEA, Texas is the undisputed leader in wind energy: It has approximately three times more wind generating capacity than any other state and hosts nearly a quarter of American wind jobs.

Texas, continuing to expand its wind industry, became the first state to pass 20,000 MW of wind capacity last year (which is roughly one-fourth of national capacity).

And more wind is on the way in Texas: Even with the 1,790 MW installed in the fourth quarter of 2016, there is still 5,401 MW under construction and another 1,288 MW in advanced development.

“With more wind energy production and more wind workers than any other state, if you want to know how wind works for America, just ask a Texan,” quips Kiernan.

The report says a key part of the success story in Texas has been a strong backbone of transmission infrastructure, including the Competitive Renewable Energy Zone transmission lines. Looking ahead, transmission projects, such as Pattern Development’s proposed Southern Cross Transmission Project, will allow the state to benefit by exporting its abundant wind energy to customers in the Southeast.

AWEA notes that wind growth is now spreading up from Texas into the Plains states and across the Midwest; in fact, 89% of newly completed capacity in 2016 was found in these states.

Notably, the U.S. offshore wind industry also launched in the fourth quarter of 2016 when the 30 MW Block Island Wind Farm, located off the coast of Rhode Island, was commissioned. Gulf Island Fabrication in Louisiana manufactured

Con Edison Unveils New Rebranding

Consolidated Edison Inc. has established a new holding company, Con Edison Clean Energy Businesses Inc., which brings together Con Edison Solutions, Con Edison Development and Con Edison Energy.

Through the three main subsidiaries, the business develops, owns and operates renewable and energy infrastructure assets and provides energy-related products and services to wholesale and retail customers.

Along with its subsidiaries, the new holding company is headquartered in Valhalla, N.Y.

For all three companies, Mark Noyes serves as president and CEO. In addition, James J. Dixon has been appointed senior vice president and chief operating officer of the three businesses. Joseph Oates will serve as chairman of the board of Con Edison Clean Energy Businesses.

“The energy industry is one of the most dynamic and complex components of our national economy,” says Oates. “Success in the energy sector requires extraordinary insight and expertise. With their talent and experience, Mark Noyes and Jim Dixon will lead our team of skilled professionals so that our clean energy businesses achieve their fullest potential.”

the foundations for the project – reflecting a broader opportunity for oil and gas suppliers to earn additional business in offshore wind, AWEA points out.

Now that the generating capacity of U.S. wind turbines stands at over 82,000 MW – greater than the 80,000 MW of hydropower generating capacity – wind is now the fourth-largest source of U.S. generating capacity (behind gas, coal and nuclear), the report concludes.

Put It In The Books: GE Posts Record Year

It was a very good year: In 2016, GE Renewable Energy secured a record 7 GW of onshore wind orders, representing a 19% increase from 2015.

The company previously announced that its onshore wind business booked over \$3 billion of orders in the fourth quarter alone; this was due, in part, to a strong market in the U.S. – especially for GE’s 2 MW platform, the company says.

In total, GE Renewable Energy secured agreements in 19 countries last year. For first-time orders, the company also booked deals in Greece and Saudi Arabia.

“We are thrilled with the customer response to investments the onshore wind team made in developing new products and solutions, especially in the U.S., where our new platform is contributing ~75 percent of our orders in 2016,” comments Jérôme Péresse, president and

CEO of GE Renewable Energy.

GE’s onshore wind installed base now stands at nearly 57 GW of global capacity.



URI Undertakes Unique Study On Block Island

The U.S. Bureau of Ocean Energy Management (BOEM) has contracted the University of Rhode Island (URI) to document the effects of Deepwater Wind's Block Island Wind Farm on recreation and tourism in Rhode Island.

The two-year project is expected to yield the first-available empirical data on the effects of a U.S. offshore wind farm on coastal recreation and tourism; a suite of indicators that can be used to assess the potential effects of future offshore wind energy projects throughout the U.S.; and a recommended subset of indicators that can be used to monitor the effects of the wind farm on Rhode Island's recreation and tourism activities going forward.

These three products will help BOEM plan for the installation and management of future offshore wind energy projects in federal waters.

URI is supporting the project through the work of the Coastal Resources Center, which is dedicated to advancing coastal management worldwide; Rhode Island Sea Grant, one of 33 programs in the National Sea Grant college network working to enhance long-term economic development and responsible use of coastal and marine resources; the Department of Marine Affairs, which is part of URI's College of Environment and Life Sciences; and the Harrington School of Communication and Media, which is within URI's College of Arts & Sciences.

"This project will build upon BOEM's completed and ongoing studies seeking to characterize the effects of offshore wind on recreation and tourism activities," explains Amy Stillings, a BOEM industry economist from the Office of Renewable Energy Programs.

Rhode Island Sea Grant says an advisory committee – made up of local industry and community representatives,



Block Island, R.I.

regulators, and social scientists – will ensure that the indicators are both rigorous and realistic and respond to the needs and issues of communities and stakeholders.

The 30 MW Block Island Wind Farm, the U.S.' first operational offshore wind project, came online in December 2016 and is now delivering power to the grid.

Russian Nuclear Corp. Wants In On Wind Power

With a goal of developing wind power in Russia, ROSATOM, the country's national nuclear corporation, has approved a partnership between daughter company OTEK and Dutch wind company Lagerwey.

The partners plan to establish a joint venture this year on the implementation of wind power in Russia. Last year, VETRO SGC, a subsidiary of OTEK, won a bid for 610 MW of wind projects. According to ROSATOM, the new partnership will facilitate the transfer of critical technologies required to establish the production of wind turbines in Russia – with a localization requirement of no less than 65%.

"Here we speak of the formation of [an] entirely new industry in Russia," says Kirill Komarov, deputy director general of ROSATOM. He says the corporation has a goal of not only building wind projects, but also developing a "regulatory system, personnel training system, production localization, certification [and] R&D system" for wind power.

"The basis of the future energy balance is based on low-carbon technologies like nuclear power and renewables combined," Komarov continues. "The decision to diversify our market proposal in low-carbon energy is a reasonable follow-up to the overall business development of ROSATOM. Moreover, it corresponds to the government 2017-2025 strategy aimed at shifting to the sustainable 'green' development model."

The firm says it has evaluated the capacity of the domestic wind energy market: By 2024, wind power generation capacity could amount to up to 3.6 GWh, with an annual turnover of approximately \$1.6 billion. ROSATOM plans to build 610 MW of wind farms from 2018-2020, while localizing the production of components. **ENR**

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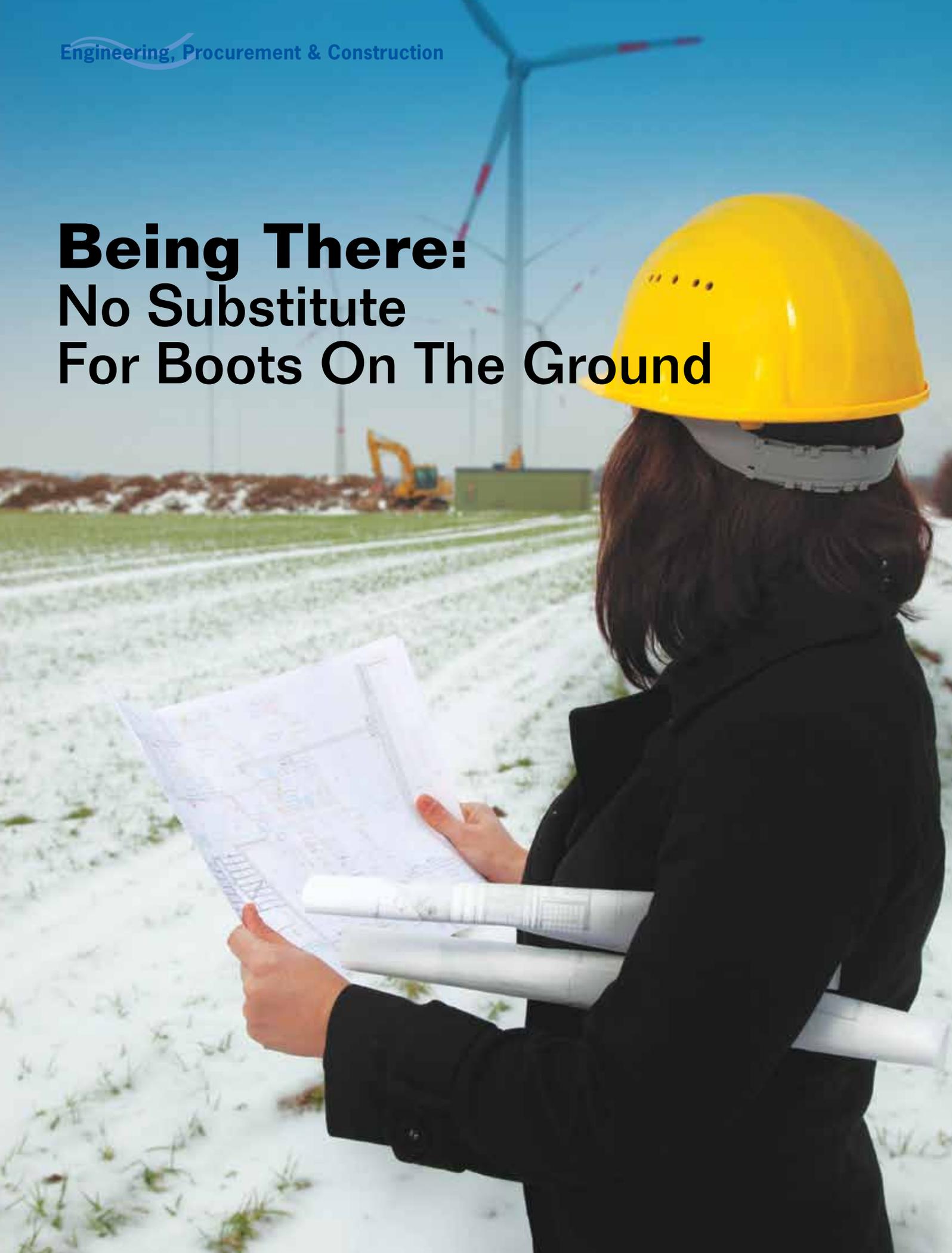
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Being There: No Substitute For Boots On The Ground



Under an engineering, procurement and construction (EPC) arrangement, contractors are responsible for designing and building a wind farm. This means the service provider procures the materials and designs and builds the project, while also absorbing all of the risks – meaning the contractor is ultimately responsible for the project’s design flaws, inaccuracies or general missteps.

Therefore, it is not surprising to learn that many service providers often go to great lengths to ensure wind farms operate successfully. Such actions can take many forms, including visiting the location early in the process. Call it value engineering, the latest buzzwords for a subset of the wind industry accustomed to delivering large projects on time and under budget.

With so much riding on the project’s success, service providers rely on site visits – and institutional knowledge – to get the job done.

By Mark Del Franco

“Site visits by the EPC can allow them to assess the most effective way to deliver the construction solution that sometimes cannot be evaluated by reviewing drawings,” explains Greg Duke, senior director of business development at construction service provider Infrastructure & Energy Alternatives.

Rob Lee, vice president of construction at Wanzek Construction, agrees. The ability to plan a project, he says, aligns directly with how many of the details you know about the physical project site – along with everything that it entails.

“Site visits are crucial to understanding topography, the existing utilities and infrastructure, meeting the landowners, and talking to local businesses,” Lee explains, noting there isn’t one singular example demonstrating the importance of site visits. “That’s how important they are to delivering a well-planned and executed project.”

At the end of last year, Lee recalled assisting a client with some work on a large project in Texas. At this point, Wanzek had not been awarded the full project but assisted with a few small-scope items to get the project rolling to ensure production tax credit compliance.

“During these activities, the Wanzek team on-site developed a system of taking copious notes and communicating them to the estimating team,” he says. “This resulted in numerous value engineering solutions that were developed and proposed to the client.”

A proactive approach of valuating the project site early on, Lee says, will eventually result in a “large reduction in project cost and schedule,” giving the construction service provider an advantage when the full project is released for bid.

Although EPCs encourage initial collaboration with geotechnical engineers and geophysical scientists through which the design engineers gain early knowledge of preliminary design parameters, those site visits can uncover subtle opportunities for cost savings, says Jason Zingerman, senior vice president of construction for RES Americas.

For example, Zingerman says that a targeted subsurface investigation – which can detect risks, allowing for the team

to make swift design adjustments and avoid unnecessary costs – is often critical to maintaining the project’s financial health and viability. And that’s precisely what happened during a recent road review. After RES reviewed the site in person, Zingerman says RES notified the third-party engineer that it could reduce site grading requirements, which yielded cost savings for the client.

Of course, project success isn’t solely dependent on site visits alone. Engineering is also critical for success.

“Engineering uncovers many items that one cannot see with the naked eye on a site visit,” Wanzek’s Lee explains, noting that engineering and site visits are two separate but equally important pieces to the puzzle. From geotechnical engineering, to final Issues for Construction Drawings, the engineering process plays a pivotal role in every aspect of the

project – from cable sizing, to thickness of roads, to selection of equipment.

“The engineering process takes all known inputs, including the soil conditions, interconnect agreement and turbine technical specs, and brings a conceptual project in the development stages to a constructible project,” he says. “Adding in the valuable information learned on the site visit with the engineering, and we are able to provide value engineering options that positively affect the cost of the project or the cost of operating the wind farm after the date of commercial operation – or, preferably, both.”

Some developers use a third-party engineer to design the project, which is then bid out to balance of plant (BOP) contractors that build what the engineer designs. The more sophisticated owner-operators like to go the BOP route, as they can squeeze as much fat out of the process as possible and lower the overall costs. That said, an EPC approach provides for a much faster process and allows for better cooperation between the engineering and construction disciplines throughout the design and costing process.

Adds RES’ Zingerman, “EPCs are more likely to actively design a project with constructability cost control taken into account than third-party engineers. Having a full EPC involved allows for directly related lessons learned to be considered, thus improving odds of successful construction process and lowest price for both the EPC and project owner.”

However, there is one caveat about EPCs, notes Jay Haley, mechanical engineer and partner at EAPC Wind Energy, a full-service design consulting firm.

“EPC contractors can and do add value based on their experience and ability to streamline the design and construction process,” he says. “This can result in lowering of costs and shortening of schedules. There is a risk that the best interests of the owner may not be served in the cost-cutting process, so it is typical and recommended to have an owner’s engineer involved to look out for the owner’s interests in the project.” 

Why Oklahoma Nuisance Lawsuit Deserves Your Attention

The litigation represents similar cases brought by landowners opposing wind projects. Here's what you should know.

By **Becky Diffen**

Oklahoma's robust wind resource, in conjunction with the state's production tax credit (PTC), has inspired the construction of nearly 6 GW of wind projects over the past decade in the state.

Despite the fact that wind energy projects bring great economic benefits to the rural communities in which they are located, local opponents of these projects have occasionally sought to fight them, and sometimes, they have done so through the courts. Nationwide, there have been few reported decisions dealing with an opponent's efforts to stop development of a wind project. But more recently, significant case law is beginning to develop, as nuisance and permitting cases related to wind energy are becoming more common.

A recent example of wind opponents trying to disrupt development of a wind project under a nuisance law theory is the Oklahoma case of *Terra Walker v. Kingfisher Wind*. The Walker litigation represents one of a rising number of wind nuisance cases, generally initiated by "not in my backyard" landowners who do not want to look at nearby turbines.

Ten years ago, there was only one case in West Virginia and a handful in Texas dealing with nuisance claims against utility-scale wind projects. Since then, the *Rankin v. FPL Energy* case in Texas has become the most commonly cited case. In *Rankin*, a Texas appellate court held that aesthetic impact is not admissible as evidence of a nuisance. Most states take the same approach to aesthetic impact and do not allow nuisance claims to move forward when they are based solely on an individual's preference against looking at wind turbines. A valid nuisance claim requires a substantial interference with the plaintiffs' use and enjoyment of their property. As a result, opponents of



Diffen

wind projects have had to become creative in submitting evidence as to why and how wind farms may create a nuisance. Nuisance claims in general are very fact-specific, but thus far, most plaintiffs have failed to provide concrete, objective evidence of impacts that would qualify a wind farm as a nuisance.

The Walker court's opinion on nuisance law provides some additional guidance on nuisance cases. In this case, neighboring landowners opposed the Kingfisher Wind project in Kingfisher and Canadian Counties, Okla.

In Walker, the Oklahoma Wind Action Association and seven individual landowner plaintiffs sought to enjoin Kingfisher Wind LLC from the construction and subsequent operation of a wind farm under theories of anticipatory nuisance and anticipatory trespass. The plaintiffs' claim for anticipatory trespass did not survive a motion to dismiss, the court finding the claim to be "too speculative" to support a plausible claim. As support for their anticipatory nuisance claim, the plaintiffs alleged that the 149 turbines would cause adverse health effects, emit noise, cause "shadow flicker" and destroy the natural landscape.

The plaintiffs supported these allegations with two expert opinions – one from a radiologist opining on potential medical impacts resulting from the wind project and one from an acoustical engineer opining on the potential impacts from sound coming from the wind project – and sought a 1.72-mile





setback of the project from their properties.

The plaintiffs' evidence focused almost entirely on adverse health effects caused by "shadow flicker" and sound from the turbines, as well as the aesthetic annoyance caused by the project generally. Despite the fact that the plaintiffs had a full opportunity to take discovery and present expert opinion on the potential impacts of the wind project, the court determined that the plaintiffs failed to make the requisite showing of likely harm – a reasonable probability that an injury would occur beyond mere speculation – and substantial interference with the use and enjoyment of the plaintiffs' property was not found.

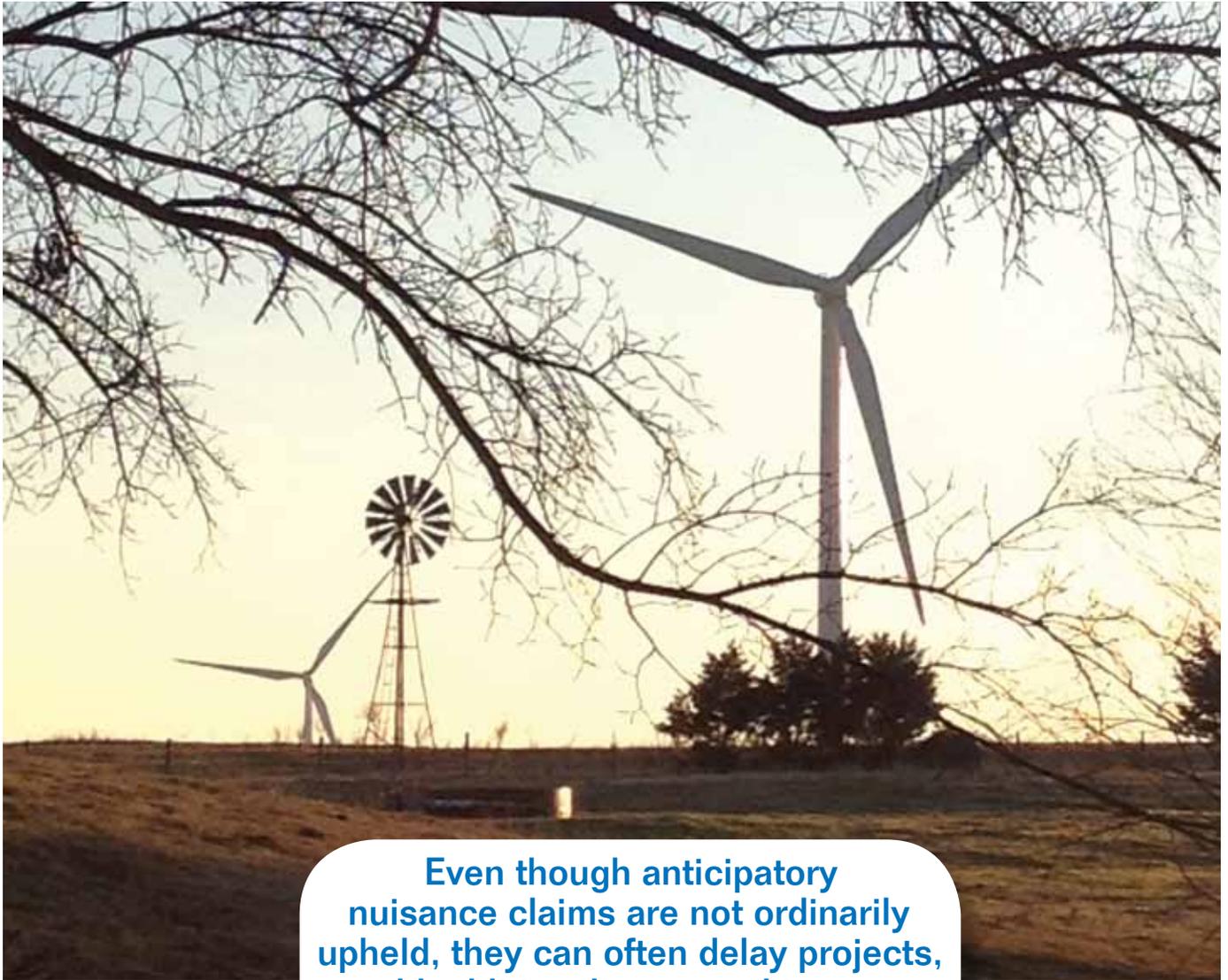
Moreover, already hesitant to grant extraordinary relief in any case, the court declined to do so not only because the plaintiffs failed to demonstrate likely harm, but also because the balance of the hardships between the parties could not be viewed as favoring the plaintiffs, given the massive costs already expended in the then-operational project. The court suggested that this was due, in part, to the plaintiffs' related

failure to request a preliminary injunction before or during construction.

In support of their anticipatory nuisance claim, the Walker plaintiffs relied "almost entirely on asserted adverse health effects and annoyance."

This is generally a common tactic among nuisance plaintiffs, who attempt to rely on generalized scientific studies or scientific work of questionable validity to assert potential health effects associated with various alleged nuisance conditions. Nuisance plaintiffs may rely on such health effects evidence both to support claims for injunctive relief and to support often unbounded demands for compensatory damages for the "annoyance" allegedly caused by such health effects. In opposing summary judgment on their anticipatory nuisance claim, the Walker plaintiffs presented the opinions of two experts concerning alleged health effects caused by wind farms.

Like in many other cases, these experts failed to tailor



Even though anticipatory nuisance claims are not ordinarily upheld, they can often delay projects, add additional costs and impact project financing.

their opinions to the facts of the Walker case. Instead, the two experts provided generalized opinions concerning plaintiffs who lived within a particular geographic radius of the wind farm that did not include examinations of any plaintiffs, review of their medical records or any investigation specific to the actual wind farm at issue. As a result, the Walker court found the harm alleged by the plaintiffs to be “speculative at best” and granted summary judgment in favor of the defendant. The decision highlights the important role that experts play in supporting nuisance claims and keeps the door open for defendants to fight nuisance claims as speculative where plaintiffs’ experts fail to tailor their work to the facts of the case or rest on generic opinions applicable to wide classes of individuals.

The Walker opinion is in line with recent decisions in several other states where landowners have attempted to claim that neighboring wind farms are a nuisance. These cases are important for the wind industry, as well as the energy industry as a whole. Even though anticipatory nuisance claims are not ordinarily upheld, they can often delay projects, add additional costs and impact project financing, particularly where the plaintiff seeks a preliminary injunction before the project begins in earnest. And, of course, courts may entertain nui-

sance cases once the project is in operations where actual proof of injury can be shown.

Historically, the doctrines of anticipatory nuisance and trespass, although long recognized, have been seldom utilized. In recent years, however, the plaintiffs’ bar has discovered that such anticipatory suits are potentially a powerful weapon, not only because they might prevent development from going forward at all, but also because such cases can impact project financing and slow construction.

As a result, industry players have been served with more and more such suits over the past few years in an attempt by opponents and their counsels to normalize this tactic. These nuisance suits have posed a threat to several industries, including the wind generation industry and companies involved in oil and gas drilling, and many in these industries are rightly concerned about this strategy to block development. Litigation of this sort can make it very difficult for a project to obtain tax equity or debt financing unless the sponsor is willing to indemnify the investor and has the credit support to back up that indemnification. In many cases, it is difficult for a sponsor to take such a risk.

Even if the developer ultimately wins the litigation, delays

in financing could lead to the project missing key construction deadlines, as well as deadlines related to PTC qualification or power purchase agreement-guaranteed completion dates. The costs of litigation can also significantly affect the economics of a project. Even if the plaintiffs know their case may ultimately be unsuccessful, many hope that a nuisance case might be enough to convince a developer to look elsewhere due to the cost and delays. The ruling in the Walker case should help encourage investors that frivolous suits of this nature represent less of a threat to successful wind farm completion than previously appreciated.

The Walker court joined a number of other courts that have rejected the anticipatory nuisance tactic. The Walker decision is important because successful prosecution and injunction of an anticipatory nuisance and trespass case could legitimize this tactic and potentially lead to a much bigger industry problem. Thus far, defendants have been able to largely defeat these claims, and the hope for developers is that plaintiffs will soon abandon this misguided tool. The Walker decision is another step in that direction.

If the plaintiffs had been successful in the Walker litigation, lenders and investors likely would have increased the level of scrutiny on wind projects, particularly when project facilities were to be located near residential uses of non-participating landowners; and developers would have incurred additional project costs related to either leasing more land than would normally be necessary for a project and/or obtaining

easements from non-participating landowners in order to create buffers around projects so as to avoid nuisance claims.

Ultimately, what can a wind project do to avoid issues with nuisance? One hope is that, as case law such as Walker continues to develop, it will make it easier for developers to have the cases dismissed quickly. If a project is built and approved in an area with zoning ordinances, that would give some additional protection against nuisance claims. Developers should also strive to gain local support for the project, even from landowners who will not have turbines on their property. Community outreach and an understanding of the economic impact of wind farms on property taxes and job creation will help gain support and may dissuade opponents from filing claims. Gaining the support of county judges and other local officials may also have an impact.

In the end, however, where neighboring landowners are intent on trying to impede development of a project under a nuisance theory, project proponents can look to a growing body of case law rejecting plaintiffs' claims for nuisance where the evidence fails to suggest a reasonable probability that an actual injury will occur. *SVP*

Becky Diffen is an attorney with McGuireWoods' energy industry team. She can be reached at bdiffen@mcguirewoods.com. Other McGuireWoods attorneys who contributed to this article include partners Trent Taylor, Marvin Rogers, Jay Hughes, Tennille Checkovich and Jonathan Blank.



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Know Your Failure Modes

Condition monitoring systems can help address this through early and reliable fault detection – provided you know what the system is telling you.

By Jesse Graeter & Becki Meadows

As the wind industry evolves into larger turbines installed in more remote locations, the operations and maintenance (O&M) costs, as well as the cost of downtime, have increased. This presents a unique set of challenges in the effort to continue reducing the levelized cost of energy. The effective use of condition monitoring systems (CMS) can help address this through early and reliable fault detection.

When deciding which CMS technology to purchase, it is essential to know your drivetrain's failure mode and understand the strengths and weaknesses of each CMS technology. This also applies to existing hardware and maintenance methods, such as borescope inspections, lubrication sample analysis and SCADA analysis. The table shown in Figure 1 is a good starting point for generating a CMS capability matrix for a specific gearbox model and CMS hardware brand. A good understanding of the service history of the specific gearbox model can also be helpful in deciding the best choice in CMS monitoring method. It is also suggested that one create a summary chart of the borescope inspection access for each gear and bearing in a turbine's drivetrain.

It is also important to determine how quickly a specific component can progress to failure. Each type of failure mode has a different rate of progression. Main bearings rotate slowly and can operate for months or even years after a severe failure is detected (e.g., macropitting). Gear tooth failures can be very sudden, as a crack can grow large enough to liberate a tooth in a matter of seconds.

Wear debris sensor

There are multiple sensor technologies within the category of wear debris sensors. To be clear, these are not for monitoring the health of the gear oil, but rather, they are for detecting specific gearbox failure modes.

One of the most common sensors in the wind industry is termed a particle counter, which typically uses an inductive coil sensing method. There are also optical style sensors that can be referred to as particle counters or oil cleanliness sensors, depending on their particle size resolution. The simplest type is the chip detector, consisting of a magnetic head that switches state when ferrous particles have accumulated. The sensor mounting method within the gearbox lubrication system can vary across wear debris sensors. The full-flow, or inline, mounting is in the primary lubrication return line prior to the filter.

Other sensors can detect smaller particles more consistently when mounted in a partial-flow configuration, also referred to as offline or kidney loop. In addition to cost, there are many factors to be considered when outfitting a gearbox with a wear debris sensor: particle size detection, turbine interfacing, analysis requirements, false-positive track record, and the ability to distinguish between ferrous and non-ferrous metallic particles.

The CMS capability matrix in Figure 1 summarizes how wear debris sensors are effective in detecting specific gearbox failure modes, such as bearing spalling, in which debris is produced over a series of months. They are less effective for early-stage crack detection when fine cracks do not generate significant debris.

Here, vibration will provide the earliest warning if the analysis work is done well. Wear debris detectors are not capable of monitoring grease-lubricated components or detecting failures outside of the gearbox, such as broken blade bolts, main bearing damage or generator issues (e.g., bearing failures or loose stator wedges).

When setting alarm limits for wear debris sensors, it is important to understand not only your failure mode, but also the detection behavior of your sensor. Typical alarm criteria are the following: i) total cumulative count; ii) daily maximum;

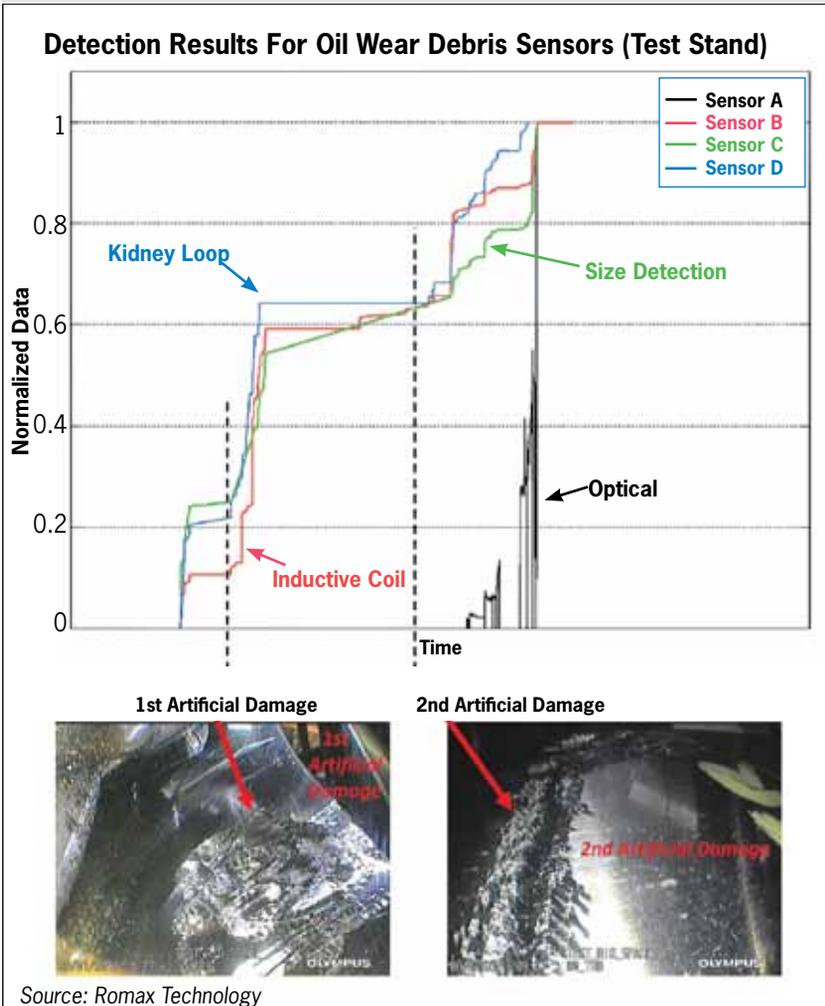
Figure 1: A CMS Capability Matrix is a valuable tool in reliability engineering, especially when customized for a specific turbine's drivetrain and CMS sensor manufacturer.

Method	Main bearings	Planet stage tooth	Planet bearings	Parallel stage tooth	Parallel stage bearings	Generator bearing	Generator stator wedge	Blade imbalance	Tower or foundation
 Vibration Analysis	Excellent	Excellent	Moderate	Excellent	Excellent	Excellent - avoid false alarms	Possible - analysis difficult	Excellent	Possible - analysis difficult
 Wear Debris Sensor	N/A (unless oil lubricated)	Moderate	Moderate	Moderate	Moderate	N/A	N/A	N/A	N/A
 Lubricant Analysis	Moderate - inconsistent	Moderate - inconsistent	Moderate - inconsistent	Moderate - inconsistent	Moderate - inconsistent	Moderate / sampling difficult	N/A	N/A	N/A
 SCADA Analysis	Poor / late warning	Poor	Poor	Poor	Moderate - select bearings only	Moderate / late warning	N/A	N/A	N/A

↑
RETROFIT
COST

Source: Romax Technology

Figure 2: Test results for different sensor technologies when introducing artificial damage to a bearing's outer raceway.



and iii) increase in slope (rate). Alarms can be tailored to specific gearboxes based on familiarity with failure modes (e.g., gear tooth inclusions, planet bearing macropitting and spline wear).

In the back-to-back sensor testing on Romax Insight's roller bearing test rig, each sensor responded differently to the introduction of debris-generating defects. Artificial damage was introduced first as a 4 mm isolated macropit feature, followed later by a larger damage extending the entire bearing raceway.

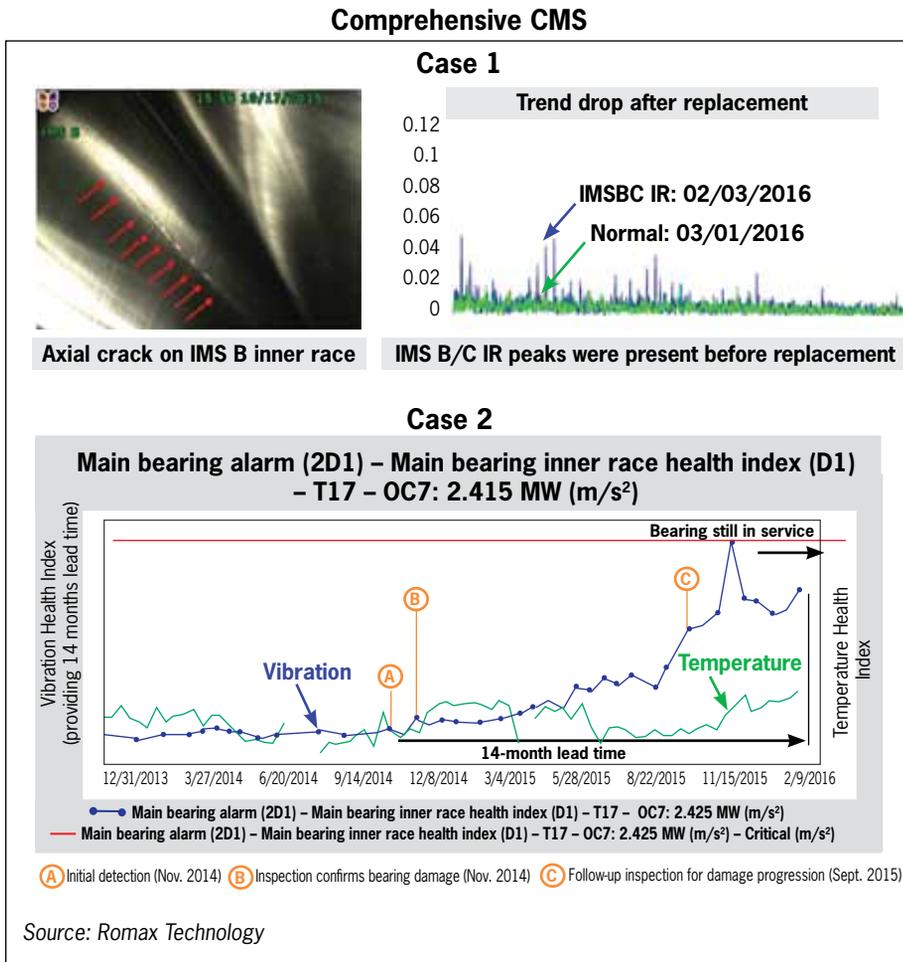
Figure 2 summarizes the results of the test. For example, Sensor C (Green) detected only 200 um ferrous particles, while Sensor B (Blue) detected as small as 25 um but only in a portion of the oil flow (kidney loop). Some sensors report the ISO 4406 cleanliness code or may not report cumulative particle count, such as Sensor A (Black), which must be interpreted differently, especially when setting alarm criteria.

By using a wear sensor or low-cost chip detector in combination with vibration-based CMS, a very thorough coverage will be obtained.

Maintenance tools

Considering again the CMS capability matrix (Figure 1), there is the obvious strategy of combining multiple CMS methods. A look at the planet bearing column shows how vibration monitoring is effective across all drivetrain components but is graded moderate for planet bearings. These failures require a lot of expertise to be effective (e.g., rotating frame, sampling methods, accelerometer placement and advanced analysis

Figure 3: CASE 1 – Early-stage axis cracking detected by vibration analysis and targeted inspection. CASE 2 – Combining vibration, SCADA and borescope inspection allows for better forecasting and prioritization of main bearing maintenance and repairs.



methods). The spalling planet bearing often passes under the radar of sophisticated vibration monitoring systems unless they are well configured and the monitoring engineers know their failure’s vibration behavior. Field service companies are advancing the capabilities of up-tower gearbox repairs to include planetary stage rebuilds, and insurers in North America are beginning to offer different terms for CMS-equipped turbines. Both of these industry trends can change the significance of early detection of planet bearing damage. The most comprehensive monitoring of planet bearings would utilize three CMS methods: a wear debris sensor, or low-cost chip detector; a vibration system; and targeted borescope inspections.

Let’s consider the two example cases of comprehensive CMS in Figure 3, Case 1.

An effective method is using vibration analysis to perform a targeted borescope inspection. A comprehensive inspection of a couple of gears or bearings has a higher likelihood of discovery of early-stage damage than a blanket inspection due to access and time constraints. When vibration analysis points to a problem at a certain location, a focused inspection can then take place. An example of this involved vibration analysis detecting an inner race defect on a bearing previously considered

inaccessible with a borescope. Armed with this fleet-wide vibration warning, the inspection team developed a method of removing gearbox covers to gain borescope access and successfully discovered multiple bearings with early-stage axial cracks that were able to be repaired up-tower.

Case 2: Many wind farm owners are only aware of main bearing failures after SCADA temperature alarms alert them of the issue, which usually corresponds to the final stages of bearing deterioration. At this stage, the gearbox may be receiving damage due to the main shaft shifting backward as a result of roller/raceway wear, subjecting the gearbox to damaging thrust loads. Combining SCADA temperature data with vibration data and grease analysis gives owners a more comprehensive toolset to detect main bearing damage and degrading lubrication conditions early on. With this information, repair costs can be better forecasted, prioritized and ultimately reduced through minimizing downtime and sharing the cost of crane mobilization with other planned repairs. Figure 3 provides a case study in which advanced vibration fault detection algorithms provided more than one year’s warning on a main bearing failure when the first debris dents appeared on the inner race.

The effective use of CMS can significantly reduce wind plant O&M costs and increase availability. However, for a fleet containing varying gearbox models, a

one-size-fits-all approach may not be the most cost-effective. A good understanding of the failure mode and service history of the specific gearbox model can be helpful in deciding the best choice in CMS hardware and health monitoring methods.

The cost of CMS methods varies greatly, which makes return on investment calculations all the more challenging. The end users have been demanding lower-cost CMS, and the industry is beginning to respond. Vibration equipment is starting to employ technology similar to that of a smartphone rather than a desktop computer. When considering wear debris sensors, an affordable alternative to the particle counter is a chip detector that simply indicates when debris has accumulated on a magnet within the gearbox lubrication system. A chip detector in combination with an affordable vibration monitoring system provides excellent detectability of the critical failure modes across the major components in a wind turbine. **SNP**

Jesse Graeter is lead technical engineer and Becki Meadows is consulting engineer at Romax Technology. They can be reached at jesse.graeter@romaxtech.com and becki.meadows@romaxtech.com.

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Canada's Westward Wind Movement Needs **Saskatchewan To Take Hold**

The province represents an important new market for the future of the country's wind industry.

By Robert Hornung



Saskatchewan can expect to lock in some of the lowest prices for wind energy ever seen in Canada as the province takes the first step in its ambitious plan to see wind energy make up 30% of total generating capacity by 2030 – up from 5% today.

SaskPower, the province's government-owned utility, is starting with a request for proposals (RFP) for up to 200 MW of wind energy in 2017. Winning projects will be offered 25-year power purchase agreements by the end of the year and are expected to come online by April 2020. The utility has also laid out a tentative schedule for future procurement, planning nine solicitations totaling 1,700 MW dating out to 2030.

Saskatchewan's planned wind expansion is part of a broader strategy that will see renewable energy sources make up 50% of generating capacity within 15 years. This is double current levels and represents a major shift for the province. What's especially significant, though, is that SaskPower is pursuing this strategy because it sees wind energy as a low-cost, low-carbon solution to the challenges it faces.

SaskPower has seen 20% demand growth over the past five years and is projecting load to increase another 13% over the



Hornung

next five, while much of its generation fleet, built between 1960 and 1985, is reaching the end of its useful life. The utility is at a turning point, and by turning to cleaner sources of power, such as wind, it stands to gain on a number of fronts.

Dramatically increasing the role of wind and other renewables on its grid will reduce electricity sector greenhouse-gas emissions in the province by 40% from 2005 levels by 2030 – making a significant contribution to provincial efforts to address climate change.

For SaskPower and the Saskatchewan government, however, the most compelling reasons for more wind energy are economic.

Industry panelists at the Canadian Wind Energy Association's (CanWEA) annual conference in November 2016 predicted prices in the 2017 RFP will likely hit C\$50/MWh-C\$60/MWh, lower than the most recent competitive wind energy procurements in Ontario and Quebec, which resulted in contracts in the C\$60/MWh-C\$70/MWh range. The fact that Saskatchewan has some of Canada's best wind resources is one factor; SaskPower's approach to procurement is another.

Developers can see the long-term goal, and that gives them the confidence they need to invest in a pipeline of projects that can compete to deliver wind energy at the best-possible price.



Pent-up industry interest in the province, which last contracted for wind capacity in 2012, virtually ensures an intensely competitive process. Investor interest is so strong that the utility has limited proponents to two bids each in the 2017 RFP. Finally, Saskatchewan's measured and predictable approach to adding new capacity positions it to benefit from continued declines in the cost of wind energy in the coming decade.

For the Saskatchewan government, wind's benefits extend beyond ratepayer value. The province's economy is built on natural resources such as petroleum, potash, agriculture and forestry, and wind energy is a way to diversify that economic base by capitalizing on another natural asset – one that is not exposed to wide swings and slumps in commodity pricing. When Saskatchewan government officials talk about wind, they talk about jobs, rural economic development, new industrial expertise and technological innovation.

Wind and other renewable energy projects are also a strong fit with another key government priority: creating economic development opportunities for Saskatchewan's First Nations. Aboriginal engagement and participation is likely to be a key

of operating wind and another 207 MW under contract to be built. It expects to have at least 2,100 MW online by the end of 2030, supplying about 20% of the province's electricity demand compared with the 3% it contributes today.

CanWEA's Pan-Canadian Wind Integration Study, released last year, confirms that Saskatchewan's targets are realistic and achievable. The study found no operational barriers to achieving 35% wind energy penetration nationwide by 2025, and importantly for Saskatchewan, it showed the significant role the province's excellent wind resource – with an average site capacity factor estimated to be 37% – can play in reaching that mark. When it comes to Saskatchewan, the analysis found the province's power grid could actually accommodate up to 4,400 MW of wind by 2025, which is enough to supply half of the forecast electricity demand. New interconnections with Manitoba and North Dakota would be required, but that would boost net electricity exports from the province by as much as 5.1 TWh a year, resulting in tens of millions of dollars of additional revenue for the province and paying back the cost of the lines within five years.



part of SaskPower's bid evaluation criteria, and the groundwork is already being laid for the kinds of effective partnerships between developers and First Nations communities already seen in markets such as Ontario and Quebec. The non-profit First Nations Power Authority, created in 2011 to help generate opportunities for Aboriginal-led power projects in the province, brought industry and indigenous groups together at its largest-ever energy forum in Saskatoon in November 2016.

Saskatchewan's commitment to a tenfold increase in installed wind capacity within 14 years illustrates how the cost-competitiveness and economic benefits of wind energy are transcending politics in Canada. Although the Saskatchewan Party has opted out of Canada's recently crafted Pan-Canadian Climate Change Plan because of its opposition to a carbon tax, it has embraced wind energy as a key element of its own climate strategy and a critical part to an affordable and reliable grid in the future. The province currently has 221 MW

To help ensure that Saskatchewan is successful in meeting its objectives, the wind energy industry has been actively engaging with the provincial environment ministry on its recently released wildlife siting guidelines for wind energy projects to ensure the implementation of results-based requirements that balance protection of environment and wildlife with reliable access to strong wind sites with good transmission access. Similarly, CanWEA and the Saskatchewan Ministry of Environment are collaborating to address uncertainty about acceptable mitigation strategies and encourage more clarity on the treatment of sound, health and post-construction monitoring requirements.

The good news is that the ministry has committed to taking an evidence-based approach to wind project siting and plans to work with the industry after the 2017 RFP to evaluate how its wildlife guidelines affected project viability and economics, with a view to determining if further evolution in the guidelines is required.

Building on the strong public support wind energy enjoys in Saskatchewan will also be critical to meeting the province's long-term goals. A poll of Saskatchewan residents commissioned by CanWEA in 2015 found not only that wind was their top choice for new electricity supply, but also that more than three-quarters of those surveyed felt more should be done to encourage its development in the province. Significantly, that support was high across all demographics, whether it was voting intention, age group, or urban and rural residency.

When it comes to evaluating bids, SaskPower has made it clear that local support and engagement on the ground in host communities is what counts. It wants companies that have successfully developed a utility-scale wind project and can demonstrate a community engagement history, as well as that have specific plans for their Saskatchewan sites. With clarity around SaskPower's expectations and evaluation criteria, the wind industry will be ready and able to bring forward the best-possible projects, not just in terms of cost, but also when it comes to meeting community expectations through their operating life.

There's no doubt that Saskatchewan represents an impor-



tant new market for Canada's wind energy industry, and the commitment it has made to new wind energy development also represents a significant opportunity for the province. Taking advantage of an abundant – but underutilized – natural resource will help diversify and bolster Saskatchewan's economy, bringing new investment and jobs into the province. By leading the transition to a cleaner, affordable and modern grid, wind energy will make a critical contribution to Saskatchewan's inevitable transition to a low-carbon economy.

As an industry, and as CanWEA, we are committed to working with the government and with SaskPower to ensure Saskatchewan meets and exceeds its wind energy targets in the most effective and efficient way possible. **SVP**

Robert Hornung is president of the Canadian Wind Energy Association. He can be reached at roberthornung@canwea.ca.

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Wind Farm Signals *Saskatchewan Trend*



The Morse wind farm came online at the end of 2015.

Photo courtesy of Algonquin Power Utilities Corp.

Algonquin Power & Utilities' 23 MW Morse wind farm exemplifies how future projects will get done in the province.

By Mark Del Franco

Algonquin Power & Utilities Corp.'s (APUC) 23 MW Morse wind farm, which achieved commercial operation in December 2015, is the latest wind farm in Saskatchewan to produce power.

The C\$81 million wind farm, which APUC purchased from Kineticator Renewables Inc., possesses many attractive attributes, according to a spokesperson from Oakville, Ontario-based APUC, an independent power producer (IPP) with nearly 1 GW of wind holdings, ranging in size from 16.5 MW to 200 MW. The location's strong wind resource and uncomplicated terrain were key factors in the siting decision. Additionally, good access to transmission also weighed heavily in the decision, as the project connects to a recently constructed 138 kV substation owned by SaskPower, the government-owned utility.

Ten Siemens direct-drive SWT 2.3 MW 113 turbines, comprising 55-meter blades, are perched on 79.5-meter towers throughout the site's 1,120 acres. The project is expected to generate 104 GWh of energy per year. The manufacturer also landed a 10-year service and maintenance agreement, and Signal Energy provided construction services at the site. According to APUC, the only notable aspect of construction was the fact that the wind turbines were delivered and erected during the winter months. However, at one point, a period of uncharacteristic warm weather hampered some construction activities, notes APUC. Nonetheless, the construction of the wind project was uneventful.

Another notable aspect of the wind farm is the nature of its long-term power contract with SaskPower. The utility awarded Morse a power purchase agreement (PPA) in May 2010 under its Green Options Partners Program (GOPP). Upon SaskPower's approval and execution of the PPA, Kineticator assigned the PPA to Algonquin Power Co., APUC's renewable energy subsidiary. In a subsequent GOPP lottery, Algonquin secured another 5 MW PPA, which was awarded in June 2011. According to SaskPower, Morse will earn C\$104.02/MWh for the first full year of operations, with an annual escalation provision of 2% over its 20-year term.

According to an APUC spokesperson, the IPP plans to explore "all options" across the province for additional wind development opportunities. APUC did clarify one thing, how-

Ten Siemens direct-drive wind turbines power the Morse wind farm.

Photo courtesy of Algonquin Power Utilities Corp.



ever: “At this time, we have no plans to add on to the Morse wind facility.”

At 23 MW, Morse is among the smallest in APUC’s portfolio. And its nameplate brings Saskatchewan’s total installed wind capacity to 221 MW, according to the Canadian Wind Energy Association (CanWEA). Nonetheless, the smallish Morse wind farm exemplifies the growing importance of IPPs in Saskatchewan and how future wind projects will get built.

Building cost-competitive projects

The Morse wind farm, along with projects in Saskatchewan’s development pipeline, will benefit from great timing, seeing as the province is now prioritizing renewable energy, such as wind. (For more on the provincial wind market, see “Canada’s Westward Wind Movement Needs Saskatchewan To Take Hold” on page 22.)

Looking at wind power specifically, SaskPower’s target calls for 30% of its generating capacity to come from wind power by 2030, which will add approximately 1,600 MW of installed capacity above and beyond that which has already been contracted and/or constructed.

Saskatchewan planned wind expansion as part of a broader strategy that will see renewable energy sources make up 50% of generating capacity within 15 years. This is double the current levels and represents a major shift for the province, notes CanWEA. It is expected that the entire 1,600 MW of new wind

forecasted by SaskPower to be built by 2030 will be sourced through PPAs with IPPs - therefore, a huge opportunity for wind developers such as APUC.

What’s more, explains Evan Wilson, CanWEA’s regional director for the Prairies, is that the local municipalities will benefit from economic development opportunities from project construction. And the province will benefit from having projects that are “economical,” Wilson says.

“The people of Saskatchewan can expect competitive prices because the IPPs are sharpening their pencils with these projects,” he says, adding that IPP-led projects will be cost-competitive because the developers are on the ground and they know the ins and outs of the projects.

“They know the area and its costs and risks.”

Wilson expects the next five procurements will each total 200 MW for wind farms to be built in the 2020-2025 time frame. “Our hope is that the IPPs build all of the wind farms,” he says.

And SaskPower has already laid out a tentative schedule for future procurement, planning nine solicitations totaling 1,700 MW dating out to 2030. This is expected to begin with a request for proposals (RFP) for up to 200 MW of wind energy expected later this year. According to CanWEA, the winning projects will be offered under 25-year power purchase agreements by the end of the year and are expected to come online by April 2020. **ENR**

Managing Risk While Improving Operating Performance

A number of options have emerged to assist owners and operators.

By Aaron Barr

Wind energy asset owners are continually examining the cost-effectiveness of their chosen services strategies and exploring options to reduce cost, manage risk and improve the profitability of their fleets. As the industry has matured, a plethora of servicing strategies, tactics and long-term technology investments have emerged to accelerate asset owners' business performance.

Conservative groups, such as regulated utilities, institutional investors and community-owned wind plants, often pursue a lower-risk approach to operations and maintenance (O&M). The options are expensive "full wrap" service agreements from turbine original equipment manufacturers (OEMs). These agreements provide a single expenditure that can be planned with confidence and guarantee limited exposure to the risk of unplanned expenses. Although public utilities do not often find themselves in financial difficulty, they abhor risk and may be willing to pay a premium to mitigate their exposure to major component failure.

Independent power providers (IPPs) represent the other end of the risk-tolerance spectrum and may opt to begin self-performing after the date of commissioning and begin retaining responsibility and risk for all unscheduled maintenance costs. In addition, these IPP groups may be more likely to explore upgrades and retrofits and foster a diverse aftermarket supply chain that may present a lower-cost option than OEMs' parts and services.

Self-performing O&M allows asset owners more freedom to optimize the cost performance of their fleets, while also remaining flexible enough to involve turbine OEMs or independent service providers (ISPs) for project-based maintenance support. The added risk of self-performing due to major component failure is becoming better understood as fleets mature.

The migration toward self-performance has fostered increased fragmentation within the industry and has given rise to split-scope service arrangements, also known as a hybrid O&M strategy. This is strongly motivated by the trend of asset owners performing routine O&M in-house and, thus, assuming the risk for planned and unplanned maintenance. There are many

elements of O&M that asset owners do not have the technical, specialist repair or procurement tools to perform, so they must rely upon the strengths of the OEM and ISP communities. This "hybrid" strategy helps provide flexibility, gives the asset owner control of risk and leverages the strengths of different O&M business models. This trend has led to rapid evolution and fragmentation of service offerings by ISPs and OEMs.

Some large asset owners have used the experience gained on their own fleets to perform O&M services as third parties to other asset owners.

These owner-backed third-party service options are attractive to other owners for many reasons. The asset owner parent provides a strong balance sheet that provides assurance that the service provider will be a lasting partner. Owner-backed third parties may leverage their internal procurement groups, remote monitoring and administrative support functions to help reduce cost and risk for other owners. Many owners have developed these third-party arms via acquisitions of established ISPs, including Duke, EDF, EnBW and Statkraft. These acquisitions create the fastest path to self-performing excellence, while also gaining access to a larger installed base for growing scale economies.

Some owners, such as Invenenergy and TerraGen, began providing services as third parties via wind project sales by continuing to maintain the projects under new ownership. Other owners have developed their third-party options organically, including E.ON, NRG, Prokon and Enertrag.

In response to the increasing fragmentation in the industry, turbine OEMs and third parties are increasingly deploying an "a-la-carte menu" of service offerings, with many service contracts bundling elements together to meet the cost and risk preferences of a maturing asset owner population. There are still many O&M contracts signed with OEMs that provide full-service coverage, but many of these agreements have risk limitations, incentive sharing mechanisms or O&M segments that are negotiated individually.

Many turbine OEMs have reached the practical limits of bringing their own lost fleets back under service, so they have turned to targeting other OEMs' equipment as a method to expand their services revenue base – also known as multi-vendor servicing. This was clearly the motivation behind Vestas' acquisitions of Upwind and Availon, as these companies have significant experience servicing the GE, Gamesa and Clipper fleets in the U.S. and Europe. Similarly, the alliance between Siemens and Duke Energy Renewable Services is a less equity-

intensive method for Siemens to gain insight and experience with the non-Siemens fleet. GE, Gamesa and Suzlon have also made efforts to service other OEMs' equipment, with varying degrees of success.

The multi-vendor business model faces some significant challenges over the long term. Foremost is the technical difficulty of servicing and troubleshooting unfamiliar technology. Developing advanced services or diagnosing reliability issues becomes very difficult without access to design documentation or proprietary controls. Spare parts supply may become a lasting barrier for multi-vendor servicing, as turbine OEMs may be hesitant to supply proprietary parts to a competitor or may impose higher prices than an ISP or owner would face.

New approaches as assets approach end of life

A whopping 90% of the U.S. fleet is less than 10 years old, with a significant portion of the market between five and 10 years old, due to the installation boom that occurred from 2008-2010. As these turbines transition to the second half of their useful life, asset owners will need to creatively address maintenance issues and risk.

Looking forward to 2025, more than 45% of the U.S. operating fleet will be greater than 10 years old, despite years of solid new installations. Many of these aging sites will be considered for "repowering" upgrades in light of the new IRS guidance on production tax credit (PTC) renewal or may be decommissioned in favor of higher-capacity-factor turbines.

In 2016, the IRS issued guidance that will allow for existing wind plants to qualify for an additional 10 years of the PTC if 80% of the fair market value of the turbines is retrofitted. These aging projects create an opportunity to realize substantial returns from increased energy production, while also deploying significantly less capital than a new project. NextEra has announced plans to spend over \$2 billion-\$2.5 billion between 2017 and 2020 on the partial repowering of its aging fleet, and other large owners are expected to follow suit. These "partial repowering" upgrades present some substantial technical challenges. Upgrading the rotor on a GE 1.5 with a 2005-2007 vintage involves replacing the rotor and drivetrain components and possibly the entire nacelle, converter and controls. The impact on the turbine foundations remains the biggest unknown, as this will likely not be within the scope of the upgrade and must accommodate the increase in loads. Capital component refurbishment firms will certainly feel the impact, as a large portion of



the aging fleet will be prematurely retrofitted and will no longer require replacement drivetrain parts.

The oldest turbines in the fleet will soon be considered for full repowering by decommissioning the turbines and replacing them with larger, more productive units. Many of these farms will operate under a “run-to-failure” strategy, in which some turbines that experience failures that are too expensive to repair will be cannibalized for parts to keep the rest of the wind plant operating. Spare parts availability for these legacy turbines is a significant barrier, as many of the OEMs either are no longer in business or no longer stock spare part inventory for legacy fleets. Other asset owners will choose to invest in life-extension programs to extend the design life of their wind plants beyond the typical 20 years. These retrofit programs can be very expensive but may provide a more cost-effective return than decommissioning and new construction.

Asset owners looking to guard against the high cost of capital component failure

As fleets age, the risk of major component failure begins to escalate. Gearboxes, generators, blades, pitch bearings and other major components require the deployment of a large crane to replace, so many asset owners are investigating options to reduce their exposure to these high-cost repairs. Three primary strategies are being employed: reducing the cost of failure, postponing failure, and anticipating and planning for failure.

A number of options have emerged to reduce the cost of the repairs or replacements for when large components fail. The number of gearbox up-tower repair companies has grown, and asset owners are increasingly comfortable with this repair. MAKE expects that approximately 55%-60% of all gearbox repairs will be performed up-tower in the future. The most common up-tower gearbox repair is exchange of the high-speed stage, while the intermediate stage up-tower repair is also gaining adopters. Generators have long been a reliability nuisance for the wind industry, and efforts are expanding to repair problems up-tower.

Up-tower generator bearing replacements have become nearly a routine maintenance item. Shaft damage, insulation degradation, wye ring failures, generator wedge problems and winding failures are very difficult to access and repair reliably up-tower, but MAKE anticipates that companies will pursue up-tower repairs and fixtures to address specific generator issues. Proactively performing these repairs up-tower can help to eliminate the need for deploying a large crane for gearbox or generator replacement.

For the large operations that must be completed down-tower, there are a number of innovative tower crane technologies being developed to save the cost of crane deployment. Liftra has developed a self-hoisting crane that can be installed and removed in a single day and realize substantial savings for specific turbine types. Gamesa, Vestas and GE have also devoted significant research and development to develop self-hoisting cranes as a method to lower or eliminate crane deployment costs.

Large fleets and the need for replacement parts have also given rise to a robust market for refurbished or rebuilt gearboxes and generators. Many of these major corrective parts are rebuilt from previously used gearbox components by replacing or updating only the parts that have experienced significant damage. This has increased the supply of aftermarket gearbox and generator cores that would otherwise be scrap metal.

Owners are looking to postpone the onset of failure by deploying reliability upgrades to major components, including improved bearings, advanced lubrication and load-limiting sensors. Auto-lubrication systems have also been deployed regularly in the aftermarket to ensure that bearings and components are receiving proper lubrication to delay reliability issues. Some owners have even chosen to de-rate select turbines when major component failure is imminent in order to postpone failure for a larger major corrective repair campaign or scheduled crane deployment.

The most proactive asset owners are seeking to minimize risk by anticipating and planning for major component failure. These owners are investing in condition monitoring systems (CMS) that are often based on drivetrain vibration or oil particulate counting. These systems and the associated analysis allow asset owners to predict a looming failure and schedule an appropriate response.

The capital budgets of asset owners for upgrades and retrofits have been the primary limitation to investing in CMS systems or other advanced asset management tools. There are a number of innovative technical and commercial approaches that are emerging to address this financial hurdle. Many companies are now able to deploy mobile CMS that are installed on the turbines for a period of weeks to months rather than permanently. With careful installation, these systems are able to detect any emerging reliability issues at a fraction of the cost of a permanent solution. The commercial auxiliary to this is the lease program that some CMS providers are starting to contemplate. These lease arrangements help to spread out the cost of a CMS system over many years, while also providing permanent monitoring to anticipate drivetrain failure.

Advanced inspection methods are already being used to help reduce labor requirements and quickly determine the condition of critical components. Drones have been deployed by many large asset owners on a demonstration basis in order to streamline blade inspections and inform proper repairs.

On the technology horizon, mobile technology, advanced inspection techniques, digital cloning and automated asset management systems are being developed to address problems before they lead to significant downtime or energy loss. CMS, advanced wind measurements, advanced inspection tools and load sensors are being paired with complex analysis tools to model the loads on the turbine, monitor for failures and anticipate the need for future maintenance. **SVP**

Aaron Barr is senior consultant at MAKE Consulting. He is responsible for monitoring global wind turbine technology trends and strategic impacts. He lends technical expertise to provide technology forecasts, economic trade-off analysis, market assessments and due diligence projects. He can be reached at ab@consultmake.com.



Maine State Sen. Opposes Offshore Wind Floater



State Sen. Dana Dow, R-Maine, has proposed a bill to prevent an offshore wind test area from being built near Maine’s Monhegan Island, which the lawmaker calls a “place of rugged beauty” that is “free from commercial development and the distractions of modern life.”

A consortium including the University of Maine is developing the 12 MW New England Aqua Ventus floating offshore wind pilot project, which has received U.S. Department of Energy funding. The project, to be situated off Monhegan Island, is a floating offshore wind farm with two 6 MW direct-drive turbines to be installed on concrete, semi-submersible foundations.

Specifically, L.R.1613, “An Act To Protect Monhegan Island,” would prohibit the placement of the turbines within 10 miles of the Monhegan Lobster Conservation Area.

In 2009, the Maine Department of Conservation designated the wind site as one of three wind energy test areas off the coast of the state. According to Maine Aqua Ventus GP LLC, the sites were selected following “extensive analysis and outreach efforts by state officials” and included input from “local/federal officials, fishermen and residents.”

In a press release, Dow argues that the bill is necessary to “protect the area’s economy and culture.” The senator says the remote island is regularly visited by “many of America’s foremost artists,” as well as a “large number of seasonal residents and visitors.”

In addition, Dow claims the legislation is critical for the protection of “migratory birds that use the island as an important landfall along the North Atlantic Flyway.”

“Mainers would never allow a massive wind turbine experiment to be placed within a short distance from the top of Mount Katahdin or near the shores of Acadia National Park because these are special places – and so is Monhegan Island,” he says.

“Having said this, I firmly believe that the final decision rests with the permanent residents of the island, who need to determine the merits of this bill. I believe the need is to finally settle this issue so that outside interests will know whether they can build this project or move onto a different area.”

The senator adds that he will be “available to Monhegan residents to help resolve this issue.”

Fallin Proposes Wind Tax, Wants To End State PTC

In her newly laid out budget proposal for the state, Gov. Mary Fallin, R-Okla., is proposing a new tax on wind power, as well as an acceleration of the phaseout of the state production tax credit (PTC).

According to the budget plan, the Oklahoma governor wants to roll out a \$0.005/kWh tax on wind produced in the state, which is home to, for example, Exelon’s 198 MW Bluestem wind project.

The Sierra Club estimates that this tax increase would raise the cost of wind energy by a whopping 25% (based on current rates).

“This would kill Oklahoma jobs, punish Oklahoma electricity

customers and send a strong message to the business community that Oklahoma is closed for investment,” Johnson Bridgwater, director of the Oklahoma chapter of the Sierra Club, says in a statement. “If Oklahoma does pass a new 25 percent tax on wind energy production, I assure you we will lose billions of dollars in investments, along with all the jobs these investments represent, to states like Texas, Colorado and Kansas.”

In the budget proposal, Fallin claims the wind industry was “incentivized sufficiently to now be a major player in the Oklahoma energy industry.” However, she says the industry is also a “major winner of now-unnecessary incentives,” referring to the PTC.

In fiscal year (FY) 2017, the governor says the “ad valorem exemption for manufacturing of wind energy costs Oklahomans \$40 million.”

The proposal adds, “Assuming no changes in current law, it is estimated that the claims paid over the next 15 years [through FY 2032] will average \$60 million a year for a total of \$840 million.”

“If the governor wants to raise new revenues and add additional taxes to our electric bills,” Bridgwater continues, “it makes much more sense to tax out-of-state coal that we

import from states like Wyoming for electricity production here in Oklahoma. It is counterproductive to tax clean energy produced right here in Oklahoma, rather than energy that we import from other states.”

In conclusion, Bridgwater calls on Fallin to “withdraw her misguided proposal.”

“If she doesn’t, I will work tirelessly with ratepayers and businesses to hold members of the legislature accountable to defeat the governor’s proposal.”

In Wyoming, the state’s House Revenue Committee axed a proposal that would have raised wind taxes by \$4/MWh.

Congressman Proposes Killing EPA

A newly elected congressman is seeking to completely abolish the U.S. Environmental Protection Agency (EPA): Yes, indeed, under H.R.861, the agency would be no more.

U.S. Rep. Matt Gaetz, R-Fla., proposed the bill on Feb. 3. The text of the legislation has yet to be published, but H.R.861 simply states that it would “terminate” the EPA. Gaetz, a freshman congressman, was sworn in as a member of the U.S. House of Representatives on Jan. 3.

The Huffington Post reports that Gaetz, in an email to legislators who could potentially co-sponsor the bill with him, said he wanted to “take back our legislative power from the EPA,” which is an “extraordinary offender” of causing U.S. citizens to be “drowning in rules and regulations promulgated by unelected bureaucrats.” He added that the legislation would terminate the “abusive and costly agency” by the end of 2018 and, thus, “allow our state and local government partners to implement responsible policies in the interim.”

The legislation has now garnered the support of co-sponsors Rep. Thomas Massie, R-Ky.; Rep. Steven M. Palazzo, R-Miss.; and Rep. Barry Loudermilk, R-Ga.

In response to the proposed bill, Melinda Pierce, legislative director of the Sierra Club, says in a statement, “Congressional Republicans have finally pulled back the curtain and revealed their true agenda: completely eliminating the Environmental Protection Agency and dismantling everything it does to protect our air, our water and the health of American families.

“This bill would do nothing less than put the lives of thousands upon thousands of Americans at risk. After decades of trying smoke-and-mirror tactics to break the EPA, this bill finally makes things explicit and puts them in the clear light of day.”

Notably, in all likelihood, according to a Business Insider report, the legislation would not become a reality. The report cites Gaetz’s political inexperience; a prerequisite of repealing several other laws in which the EPA has “specific environmental responsibilities”; and already existing Republican support for President Donald Trump’s plan for the agency, which Trump recently chose (in a controversial decision) Oklahoma Attorney General Scott Pruitt to lead.

The Sierra Club’s Pierce maintains that the “American people will not stand for this egregious overreach” and that “Congressional Republicans should expect their town halls to remain full, their phone lines to remain jammed and their lives [to] remain difficult if they continue to recklessly put the profits of polluters ahead of the needs of their own constituents.”



Bill Would Simplify Public Land Use Process

A bipartisan bill that would work toward an “all of the above” energy strategy by simplifying the permitting process for renewable energy projects on public lands has been introduced in Congress by a number of U.S. senators.

U.S. Sens. Dean Heller, R-Nev.; Martin Heinrich, D-N.M.; Jim Risch, R-Idaho; Jon Tester, D-Mon.; Cory Gardner, R-Colo.; Michael Bennet, D-Co.; Steve Daines, R-Mon.; and Tom Udall, D-N.M., have rolled out S.282, the “Public Lands Renewable Energy Development Act.”

According to a press release from Heller, the act would streamline the review of solar, wind and geothermal projects on public lands, as well as establish a U.S. Department of the Interior program focused on making the permitting process more efficient.

The legislation would also create a revenue-sharing system to aid local communities that are home to potential projects and help mitigate the impact construction could have on the land, water and wildlife.

Heller says he has long advocated for reforms to renewable energy permitting and energy production revenue sharing. In the 111th Congress, he introduced similar legislation entitled the “Clean Energy, Community Investment, and Wildlife Conservation Act” in the U.S. House, and he teamed up with a bipartisan group of senators on previous iterations of the Public Lands Renewable Energy Development Act in the 112th, 113th and 114th Congresses. Last Congress, the bill passed the U.S. Senate – the first time the legislation passed either body of Congress, according to the senator.

Jon Goldin-Dubois, president of Western Resource Advocates, says in a statement that the conservation group applauds the senators for “showing that the West can advance clean energy, protect western landscapes and support our local communities.” **WPA**

Duke's First Okla. Project Produces Power

Duke Energy Renewables' large-scale Frontier Windpower Project is now delivering power in Oklahoma.

The wind facility, located in Kay County, became operational in late December 2016. At 200 MW, the wind farm increases Duke Energy Renewables' U.S. wind capacity to 2.3 GW.

Amshore US Wind provided development support for the project, and Wanzek Construction was the contractor. In addition, Vestas supplied 61 V126-3.3 MW wind turbines. One blade on these machines measures 203 feet, and the height (from the tower base to the blade tip) totals 492 feet, says Duke Energy Renewables.

"We had several 'firsts' with the Frontier project," notes Rob Caldwell, president of Duke Energy Renewables and



Distributed Energy Technology. "It was our first wind project in Oklahoma, and it was the first time Vestas' extra-large, 126-meter rotors were deployed in the U.S.

"We also formed a unique partnership with Blackwell Industrial Authority for our operations and maintenance building," he adds. "A project of this scale was made possible by the overwhelming support of the community,

landowners, vendors, and our customer, City Utilities."

Missouri's City Utilities of Springfield (CU) is purchasing the power from the project under a 22-year agreement.

"Providing a long-term renewable source of power generation in this changing market is critical to the future of our utility," says Scott Miller, general manager of CU.

Minn. Agency Signs Up For More Wind Energy

The Minnesota Municipal Power Agency (MMPA) has expanded its portfolio of renewable resources to include power from the Black Oak Getty Wind Farm, a 78 MW project located in Stearns County, Minn.

MMPA signed a long-term contract with Sempra U.S. Gas & Power for the output of the wind farm. The project, comprising 39 turbines, entered commercial operations in December 2016.

MMPA provides wholesale electricity to its member communities, which, in turn, deliver and sell that electricity to the residential and business customers in their communities. The agency is made up of municipal utilities in Anoka, Arlington, Brownston, Buffalo, Chaska, East Grand Forks, Elk River,

Le Sueur, North St. Paul, Olivia, Shakopee and Winthrop.

The agency's renewable energy portfolio also includes 44 MW of wind energy from the Oak Glen Wind Farm, 8 MW of bioenergy from Hometown BioEnergy and renewable energy purchases from other utilities.

"MMPA's renewable energy investments support the agency's ability to deliver competitively priced power to its members," comments Oncu Er, vice president of planning for Avant Energy, MMPA's management partner. "In addition, a portion of these renewable resources help us meet the Minnesota renewable energy standard, which requires 25 percent of the agency's energy to come from renewable sources by 2025."

Senvion Completes Community Project

Senvion has announced the completion of what it says is Quebec's first 100% community-owned wind farm, the Pierre-De Saurel wind project.

The Pierre-De Saurel wind farm is located on the lands of Yamaska, Saint-Aime and Saint-Robert. The project is set to bring in over C\$200 in local revenue, including for the regional county municipality and the local farmers on whose lands the project is installed.

The project features 12 Senvion MM92 cold-climate-version turbines. With a total capacity of 24.6 MW, the project will power nearly 6,000 households in the region, says the manufacturer.

"The commissioning of Pierre-De Saurel was faster than usual," notes Helmut Herold, CEO of Senvion North America. He adds that the project is a "great example of how communities can generate income, as well as renewable energy."

Frédéric Tremblay, executive director of the Pierre-De Saurel wind farm, adds, "We are looking forward to generating

a substantial financial return for our community during the next 20 years."

To date, Senvion has a footprint of more than 1.4 GW in Canada. The company started its Canadian operations out of Montreal in 2009 and has since installed over 600 wind turbines in the country.

E.ON Adds To Client List

D. E. Shaw Renewable Investments LLC has tapped E.ON Energy Services (EES) to provide site management and balance-of-plant services for wind projects in the Pacific Northwest.

The contract includes the 45 MW Power County site, located in Idaho, and 50 MW of aggregated sites near Huntington, Ore.

"With the addition of these sites, E.ON Energy Services now manages more than 1,400 MW of third-party sites to go along with its own 3,000 MW portfolio," says Keith Day, president of EES.

Day adds that the company operates wind farms in 12 states and with five independent system operators. **ENR**

Maryland Prepares Offshore Wind Push

Maryland's offshore wind opportunity has not been in recent news. Activities in other states, such as Massachusetts, Rhode Island and New York, overshadowed the procedural advancement of the Maryland Offshore Wind Renewable Energy Credit (OREC), an up-to \$1.9 billion financing mechanism to be awarded by the Public Service Commission.

US Wind and Skipjack Energy LLC, a subsidiary of Deepwater Wind, are the two developers competing to be awarded the OREC financing. Both have submitted viable projects, and they are currently under review.

US Wind is planning to install 187 total turbines in 20 meters to 30 meters of water over approximately 80,000 acres. A substation will collect the energy from the turbines and transmit the electricity to the shore using underwater cables. The nameplate's 750 MW of power will meet 100% of Maryland's offshore wind renewable energy goals, and it is anticipated to come online in early 2020.

For its part, Deepwater Wind says its 120 MW Skipjack Wind Farm will spin off of Maryland's eastern shore using America's most innovative wind turbines. The project will help the state meet its clean energy and emission-reduction goals in an affordable way, and it's the right size for Maryland as it enters America's growing offshore wind industry.

A decision to award the OREC will be made May 17.

The buildup of the OREC award throughout this spring is newsworthy, as it will demonstrate the first successful publicly supported finance mechanism for offshore wind in the U.S. To date, there have been two power contracts awarded for the sale of U.S. offshore wind generation. Deepwater Wind owns both of them under long-term power purchase agreements with a utility off-taker.

On Jan. 9, US Wind organized the third meeting within its offshore wind information series in Salisbury, Md. Following opening remarks, the Business Network for Offshore Wind was invited to report on the state of the industry and provided the following points:

- The U.S. offshore wind market is here to stay and grow.



Tyler

There are very few new offshore wind lease areas in Europe, and the developers, along with the supply-chain businesses, are seeking new markets. Asia and the U.S. are strong contenders; however, the U.S. market provides new opportunities at a scale that will help drive down costs globally.

• Maryland can expect significant job impacts from offshore wind. The highest-profile job opportunities arise from the domestic production of the primary components, such as foundations, transition pieces, blades and cables. The production of the large and heavy primary components requires a port, such as Baltimore, with good deepwater access. By meeting with secondary and tertiary supply-chain businesses in Europe, the Network recently learned the importance of understanding the dynamic and necessities of the industry. Secondary and tertiary suppliers that are involved in providing products such as scaffolding, coatings, ladders, fastenings, hydraulics, concrete and electrical components – companies that are to be found on the eastern shore in Maryland – could be called upon at any time during installation, as well as over the 25-year operations and maintenance lifetime of the project. Intracompany relationships and trust are vital in the formation of the offshore wind supply chains.

Case studies of European businesses entering the offshore wind supply chain often have an underlying story line of the companies being called into the industry because of a pressing need or a recommendation made by an established supply-chain member. Intracompany relationships and trust are essential. Interfacing with developers, original equipment manufacturers and other supply-chain members to feature and remind colleagues of businesses' capabilities remains key to becoming part of the emerging U.S. supply chain. Equally important is the need to stay engaged in understanding the changes in the offshore wind industry as it seeks to become more efficient, with lower costs. The changes bring opportunities that are opening for new players. **■**

Ross Tyler is strategy and development advisor for the Business Network for Offshore Wind. He can be reached at ross@bizmdosw.org.

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