

Giving Wind Direction

WIND SYSTEMS

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Walk into any big-box store this time of year and you'll be met with row after row of wide-ruled notebooks, scented magic markers, and endless varieties of file folders.

School will soon be back in session, and the shelves are stocked. As a self-proclaimed "pen geek," this sparks a lot of fond memories.

It's a lot different now, though. Parents have to follow the supply list to the letter. Every year teachers mandate a new exotic, impossible-to-find item, sending parents on a grail quest to every retailer in a 100-mile radius.

In other words, when August rolls around, the rush is on. Families embark on an all-out sprint to get everything on the list by a hard-and-fast deadline — the first day of school. It's no easy task, and it's compounded by rising supply costs, class fees, club dues, and a new wardrobe.

To ease this burden, a handful of states have sales tax holidays, during which back-to-school items are exempt from state and local sales tax. While these holidays do help families stretch their dollars a bit further, they're just a temporary reprieve. These expenses don't go away on the second day of school.

We can relate to that situation in the wind energy industry. On what has seemingly become an annual basis, we rush to complete projects prior to our own hard-and-fast deadline. And every once in a while, the federal government steps in and grants us a temporary incentive.

While we're genuinely grateful, it's often difficult to mask our frustration and discouragement. These arise

not because we're spoiled children looking for a hand-out, but because we've repeatedly exhibited our gratitude by taking full advantage of the opportunity to build a clean, sustainable energy future for our nation.

Parents willingly sacrifice their time and spare no effort or expense to ensure their children are afforded every chance at a bright, successful future. But they don't need more items added to the supply list.

As parents raising this industry into its bright, successful future, let's continue to push for a long-term federal incentive policy for wind energy. Anything less is just sending us rushing for that new item on the list.

At the beginning of 2014, *Wind Systems* launched a re-design of its content and format, from which we've had nothing but positive response. The only thing we didn't change was our logo. Honestly, we didn't want it be too much of a shock to our loyal readers.

With *Wind Systems* now in its sixth year, we've decided to make the jump to a bolder, simpler, more sophisticated logo. It's kind of like our first day back to school — only we're making the jump from eighth grade to high school.

Thanks for reading!



A handwritten signature in black ink, which appears to read "Stephen Sisk". The signature is stylized and fluid.

Stephen Sisk, editor
Wind Systems magazine
editor@windssystemsmag.com
(800) 366-2185 ext. 209

Contributors

Walter Christmas is an instructor of Wind Energy Technology at Ecotech Institute in Aurora, Colorado. He is also an assistant instructor for Technical Rescue Systems of Fort Collins, Colorado.



Udo Zillmann is the founder and managing partner of Daidalos Capital GmbH, a fund management company that specialized in investing in airborne wind energy companies since 2010 and is currently raising its second special airborne wind energy fund. Mr. Zillmann is author of "Financing Strategies of AWE Companies" in the book "Airborne Wind Energy" (Springer, 2013) and a regular speaker on

airborne wind energy. Mr. Zillmann holds degrees in law and business.

From our Archives

AN AUTOMATED APPROACH TO BLADE MANUFACTURING

Increased throughput, quality, and efficiency are just a few of the benefits to be realized when taking a robotic approach to manufacturing blades for wind turbines.



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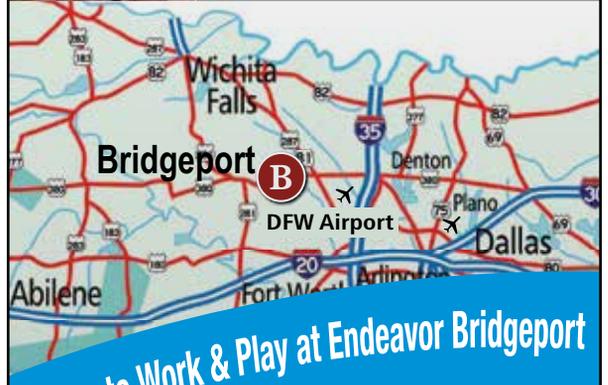


A NEW DIRECTION FOR TURBINE GEARING

Sandvik Coromant reports on tooling developments that are driving progress in cutting gears for wind-power components.



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U.S. WIND ENERGY SEES CONTINUED GROWTH IN 2Q

AWEA chief re-states need for PTC renewal for industry stability

With 1,661 MW of newly installed wind turbines coming online during the second quarter of 2015 and more than 13,600 MW under construction, American wind power continues to increase its contribution to the U.S. electric power grid. The approval in May of Florida's first purchase of wind energy, from a wind project in Oklahoma, added to the growing trend of Southeastern states purchasing wind power, as did the recent announcement of the first utility-scale wind farm to be built in North Carolina.

Building on that momentum, Congress also took a step in the right direction on July 21 when the U.S. Senate Finance Committee voted 23-3 to extend the primary federal tax incentives for growing renewable energy as part of a larger tax policy extension bill.

"With a near-record amount of wind capacity under construction, this looks to be a strong year for American wind power," said Tom Kiernan, CEO of the American Wind Energy Association. "However, to create longer term stability for the industry the full Senate and the House of Representatives must move quickly to extend the PTC and ITC. Hence the overwhelming bipartisan vote by the Senate Finance Committee ... to extend the PTC and ITC is good news for the 73,000 Americans employed by the wind power industry."

The federal renewable energy Production Tax Credit (PTC), which has the option to be taken as an Investment Tax Credit (ITC) instead, is the primary federal tax incentive for wind energy. This incentive has helped drive more than \$100 billion in private investment in the U.S. since 2008, and has been instrumental in allowing the industry to lower costs by more than 50 percent in the last five years.

AWEA's Second Quarter 2015 Market Report released July 22 shows 1,994 MW were installed during the first half of 2015. While that figure more than doubles installations during the same time period last year, it is still well below the pace set in 2012, when the U.S. industry installed more than 2,900 MW in the first half of the year and eventually provided 42 percent of all new U.S. electric generating capacity at year's end.

Looking forward, more than 100 wind projects are

under construction in 24 states, representing more than 13,600 MW of total wind capacity and over \$20 billion worth of private investment. The majority of new wind construction activity is in Texas, with Oklahoma, Kansas, Iowa, and North Dakota also benefiting from large amounts of new investment.

"This was the strongest second quarter ever for wind and we continue to see robust activity in the industry. However, uncertainty around federal tax policy clouds the outlook for new growth and could result in the industry being forced off another cliff," said Hannah Hunt, Research Analyst for AWEA.

There are now 67,870 MW of installed wind capacity in the U.S. and over 49,000 wind turbines online. Texas continues to lead the nation with over 15,000 MW of installed wind capacity, and California now has over 6,000 MW of installed capacity.

NEW TRENDS AS INDUSTRY GROWS

The Florida-based utility Gulf Power and the Arkansas Electric Cooperative Corp. signed power purchase agreements (PPA) for 180 MW and 108 MW of wind in the second quarter, respectively, building on the trend of Southeastern utilities choosing to purchase wind energy.

These announcements are paired with recent news in July that construction will begin on the first commercial-scale wind farm in North Carolina. At 208 MW, the announced project will be far larger than any other in the Southeast, and the first utility-scale project in the region since 2004. Once online, it will bring the total number of states with utility-scale wind projects to 40. Technological advances, primarily the use of taller wind turbine towers and longer blades to reach higher quality wind resources, are opening up all regions of the country to wind project development. The Southeast has long been a center of wind industry manufacturing, and these recent developments bring even more benefits to the region.

In total, utilities signed over 800 MW of new PPAs for wind power in the second quarter of 2015, building on the roughly 12,000 MW of power purchase agreements signed since the beginning of 2013.

Successful U.S. companies and other non-traditional purchasers are also increasingly turning to

wind energy as a source of clean, stably-priced energy. Amazon Web Services (AWS) will purchase the output of the recently-announced North Carolina wind project. In announcing the agreement, Jerry Hunter, vice president of infrastructure at Amazon, stated that the company encourages policymakers to “extend the tax incentives” for renewable energy projects:

“This agreement, and those previously in place, puts AWS on track to surpass our goal of 40 percent renewable energy globally by the end of 2016. We’re far from being done. We’ll continue pursuing projects that deliver clean energy to the various energy grids that serve AWS data centers, we’ll continue working with our power providers to increase their renewable energy quotient, and we’ll continue to strongly encourage our partners in government to extend the tax incentives that make it more viable for renewable projects to get off the ground.”

The second quarter also saw the commissioning of two utility-scale wind projects with corporate purchaser investment. Both a 98 MW wind farm in Illinois owned by IKEA and a 211 MW Texas wind farm invested in by Mars, Inc. are now online

and will be providing low-cost wind power to satisfy the companies’ high energy demands.

Facebook also made news in the second quarter when it announced its new data center in Texas would purchase the output of a 200 MW wind plant. Tom Furlong, vice president of infrastructure for Facebook had the following comments on the announcement:

“[The data center] will be powered by 100% renewable energy, thanks to the 200 MW of new wind energy we helped bring to the Texas grid as part of this deal. Thanks to our continued focus on efficiency and our investments in renewables in recent years, the carbon impact of one person’s use of Facebook for an entire year is the same as the carbon impact of a medium latte.”

Hewlett Packard also announced this week that it plans to power its Texas data centers with wind power, signing a 112 MW PPA for the energy output from a planned wind farm in the state.

These companies and traditional utilities have explained that they are attracted by wind energy’s unique lack of fuel cost, which builds a more balanced energy portfolio that protects against increases in the price of other fuels. ↴

— Source: AWEA

GROWN-UP WIND INDUSTRY PRESSES ITS CASE AHEAD OF COP21

Cost reduction and innovation among EWEA 2015 discussion topics

As the world’s attention turns towards the landmark COP21 climate negotiations in Paris later this year, the wind industry is in a confident mood; global wind power installations are growing at the fastest pace ever.

A fundamental shift is underway as maturing technology and falling costs are ensuring that wind energy is becoming increasingly competitive with fossil fuels around the world and in many cases, the more economical option for investors.

As a result, wind energy is now the power source of choice for a diverse and growing set of blue-chip companies, ranging from tech giants such as Google and Apple, to automotive heavyweights including General Motors and Renault Nissan.

When Google announced as early as 2007 that the company was going carbon neutral, it included “invest in and use renewable energy sources” as one of its three basic strategies for cutting emissions. Since investing in its first wind farm in 2010, the company has built up a portfolio of three power purchase agreements (PPA) in Europe and nine in total across the world.

Some corporations, notably IKEA and LEGO, have directly invested in offsite wind farm ownership. LEGO has a commitment to source 100 percent renewable energy by 2020 and recently set an intermediate milestone goal of becoming carbon positive in 2016.

Cost reductions, power purchase agreements, corporate transitions and innovative technologies are just a few of the signs that wind energy has staked its claim as a dominant force in the global energy race.

These are all key issues that EWEA will look at when the association goes to Paris in November for its 2015 annual event.

EWEA will present an international platform for the wind energy industry in Paris to showcase and demonstrate the sector’s latest products and services. The event features a broad conference program, unrivaled networking opportunities and an extensive exhibition.

Malgosia Bartosik, acting CEO of EWEA, said:



Courtesy of EWEA

“Scaling up wind power is crucial to combating climate change. In 2015 the EWEA Annual Event will take place in Paris two weeks before world leaders meet to discuss climate negotiations at the UN Summit in the French Capital. Where better to show the strength of the wind industry!”

Numerous developments of significance in the European market are converging to make this year’s EWEA Annual Event the place to be for new business: European utilities are making a strategic shift towards renewables, the offshore market is booming with 26.4 GW of consented offshore projects in the pipeline, and the focus on efficiency and innovation is translating into new business opportunities for U.S. wind technology and maintenance companies.

On a global level, wind energy is seeing a surge in large markets outside of Europe. In 2014, wind energy was the largest power source in

the US and Brazil, while China has ramped up its production steadily, accounting for over more than 40 percent of global installations last year.

GWEC reports that installed global wind power capacity had grown to 370 GW at the end of 2014, with annual installations exceeding 50 GW for the first time. This means that wind power capacity will soon overtake the world’s nuclear fleet.

The best wind projects around the world — for example in the Texas panhandle in the U.S. — are already consistently delivering electricity for \$0.05 per kWh without outside financial support. This means onshore wind is easily within the same cost range, and often even lower, as that of fossil fuel generated electricity. When externalities such as the cost of air quality and climate change are factored in, wind in Europe is cheaper than gas, nuclear or coal generation.

Onshore wind is firmly established as one of the lowest-cost sources of electricity available. The global average levelized cost of energy [LCOE] has fallen by around 10 percent since 2010, while turbine prices have fallen by around 30 percent since 2009, with prices in China — the world’s biggest wind power market — having fallen by as much as 35 percent.

The wind sector will continue delivering for corporations, governments and citizens who want affordable, carbon-free and secure electricity supplies. Support from policymakers and large commercial end-users have increased growth opportunities but this also entails important responsibilities for the wind sector to help deliver renewable capacity and lead the way in tackling climate change.

For more information visit www.ewe.org/annual2015. ↴

— Source: EWEA

CANWEA ANNOUNCES PROGRAM SESSION TOPICS FOR 2015 EVENT

Canadian wind industry's annual event to be held October 5-7 in Toronto

The Canadian Wind Energy Association (CanWEA) and Hannover Fairs (Canada), Inc. recently announce the 31st CanWEA Annual Conference and Exhibition 2015 program session themes. Every year, CanWEA's conference sessions focus on a wide range of topics of interest for wind energy professionals from around the world. The 31st CanWEA Annual Conference and Exhibition will be held at the Metro Toronto Convention Center in Toronto, Canada from October 5-7.

The event will host approximately 1,500 delegates and more than 150 exhibitors from more than 13 countries. Additionally, event attendees will see the latest wind energy solutions from the world's leading equipment and solutions providers, such as EDF EN Canada, Enbridge Inc., ENERCON, GDF SUEZ Canada Inc., GE Power & Water, Siemens, Vestas and more.

"Canadian wind energy enjoyed record breaking years in 2013 and 2014, and we are on track to maintain this momentum in 2015 and 2016," said Robert Hornung, CanWEA president. "With more than 10 GW of installed wind

energy capacity, enough to power 3 million average Canadian homes, Canada is one of the world's top wind energy producers. Visitors to our 31st CanWEA Annual Conference and Exhibition will come together to share insights, to find new business contacts and to discuss key wind energy issues facing Canada and its provinces going forward."

CONFERENCE SESSION HIGHLIGHTS

The conference will include multiple educational sessions and a variety of notable speakers. Keynote speakers such as Ontario Energy Minister, the Hon. Bob Chiarelli, and Ontario Minister of the Environment and Climate Change, the Hon. Glen Murray, have been invited to speak.

This year's program will address a variety of wind energy challenges and offer solutions, such as:

- **Realizing Wind Energy's Potential in Ontario – Today's Successes and Tomorrow's Opportunities**

Speakers will showcase the economic benefits of wind energy for communities across Ontario. Several leading wind energy companies will preview case studies of wind

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WoWE 2014 Rudd Mayer Fellows

(L-R): Michelle Montague (WoWE Board);
Kalie Brunton, Tanzila Ahmed, Allie Brown,
Kaitlyn Bunker, Melissa Showers, Huiyi Zhang,
Kristen Graf (WoWE Staff)



Spring 2014 WoWE Board Meeting

(Back Row L-R): Trudy Forsyth, Karen Conover,
Jan Blomstrann, Michelle Montague, Jennifer Martin,
and Julia Dalger (Front Row L-R): Kristen Graf,
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energy's positive impact on their regions from creating new jobs to creating new sources of income. During this session, CanWEA also will release the results of a new study on the economic benefits of wind energy in Ontario, highlighting the success the wind sector has enjoyed in Ontario to date. A panel discussion will wrap up this opening session with a provocative discussion among experts from the electricity and environmental sectors who will share insights and perspectives on increasing the role that wind energy plays in the province.

- ***The Status of Wind Energy in Canada's Major Markets***

CanWEA's regional directors will provide an update on markets in British Columbia, Alberta, Saskatchewan, Ontario and Quebec. During this session, attendees will gain wind energy updates specific to their region.

- ***Operations and Maintenance — An Asset Managers Perspective***

Canada's growing wind fleet means more attention is being paid to issues related to the operation and maintenance of wind farms. During the session, asset managers will speak about their challenges and how to overcome them.

- ***Cost of Wind — The Lowest Cost Power Around... But for How Long?***

Via an interactive panel format, this session will feature four presentations that explore four key factors that will determine wind's current and future cost and competitiveness relative to other sources of generation, including pure energy cost, technology evolution, value to the grid and financing. The session will explore how all four factors are set to affect the cost competitiveness of wind.

- ***Renewable Energy's Role in Combating Climate Change in Canada***

The session will start with internationally focused keynote presentations about the role Canada should play during the Paris climate change talks. The session will then cover Ontario's next steps in regards to climate change and the role renewables, such as wind energy, will play in decarbonizing Canada's energy supply.

CANWEA AWARDS BANQUET

The annual CanWEA Awards Banquet recognizes individuals and groups who have contributed significantly to the advancement of wind energy in Canada.

The annual banquet recognizes and awards Individual and Group Leadership.

CanWEA also presents the Matt Holder Community Connection Award for responsible and sustainable development within a community; the Friend of Wind Award for outstanding community level contributions by individuals or groups not employed by the wind energy industry; the R.J. Templin Award to an individual or organization that has undertaken scientific, technical, engineering or policy research and development work that has significantly advanced the wind energy industry in Canada and the Wind Energy Project Award to a CanWEA Member for a Canadian wind energy project that has demonstrated an exceptional commitment to responsible and sustainable development in all phases of the project.

During the 2015 event, Women in Renewable Energy (WiRE) will also present the Wind Power Woman of Distinction Award.

INNOVATION ZONE — NEW FORMAT

The annual Innovation Zone at CanWEA provides a showcase for cutting edge technologies in partnership with the research community and industry leaders. This year's Innovation Zone is divided into four strategic areas: Research & Science, Electric Vehicles, Innovative Technologies (featuring battery storage, smart grid technology, cold weather climate solutions, hybrid systems & remote applications) and the Learning Center for exhibitor presentations.

"Wind energy is an exciting industry in Canada and the world over," said Larry Turner, CEO of Hannover Fairs (Canada), the subsidiary of trade event organizer Deutsche Messe and CanWEA exhibition partner. "Continued and growing support for CanWEA's annual event comes from leaders in the global wind energy community."

For more information about CanWEA 2015, visit the conference web site at <http://windenergyevent.ca/>. ✎

SENATE COMMITTEE MOVES TO EXTEND PTC AND ITC

Finance Committee's 23-3 vote signifies bipartisan support of tax incentives

The American wind energy industry in July praised members of the U.S. Senate Finance Committee for voting overwhelmingly to extend over 50 tax policies through 2016, including the renewable energy Production Tax Credit (PTC) and Investment Tax Credit (ITC) that incentivize the building of more U.S. wind farms.

The committee on a final vote of 23-3 reported out a "tax extenders" bill preserving language that allows wind farms to qualify so long as they start construction while the tax credits are in place.

Those credits expired at the start of this year, again throwing the future of American wind energy into doubt once projects currently under construction are completed.

"This is a big step in the right direction," said Tom Kiernan, CEO of the American Wind Energy Association (AWEA). The federal PTC and ITC are predominant drivers of new wind farm development, and have helped lower the cost of American wind power by more than half over the last five years, while making the U.S. number one in the world in wind energy production.

During the hearing, Senate Finance Committee Chairman Orrin Hatch (R-UT) regularly acknowledged the strong sense of bipartisan support for renewing the tax extenders package. Sens. Pat Toomey (R-PA), Dan Coats (R-IN), and Rob Portman (R-OH) withdrew amendments opposing the PTC, while Sen. Michael Bennett (D-CO) made the senators aware of the tremendous amounts of economic benefits and jobs wind power has created in Colorado.

In 2013, after the renewable energy tax credits were allowed to expire even briefly, installations of new wind farms fell 92 percent, causing a loss of 30,000 jobs across the industry that year. After Congress renewed the

PTC, the U.S. wind energy industry added 23,000 jobs the following year, bringing the total to 73,000 at the end of 2014.

Wind energy brings taxes and other revenues to rural communities, benefiting county and local services, schools, and health care and public safety facilities. With over 98 percent of all wind farms on private land, wind energy projects already deliver an additional \$195 million a year in lease payments to landowners.

Earlier in the week, Sen. Chuck Grassley (R-IA) penned an op-ed renewing his call for Congress to extend the tax credits, saying they "bring certainty to investment that helps boost development, sustainability and expansion of homegrown renewable energy," and that "the facts show that bringing stability and certainty

to clean energy policy is good for the economy and the environment. Championing renewable energy that's engineered by human ingenuity and produced by human hands builds upon America's centuries-long promise of prosperity."

Today, more than 70 percent of congressional districts contain operating wind turbines, wind-related factories, or both, according to industry data.

In June this year, proposed legislation threatened to eliminate the PTC. That led to 85 companies sending a letter to Congress to protest the bill saying if passed, the bill would "take away an effective, business tax incentive that creates jobs, drives rural economic development and reduces energy costs for Americans across the country."

— Source: AWEA

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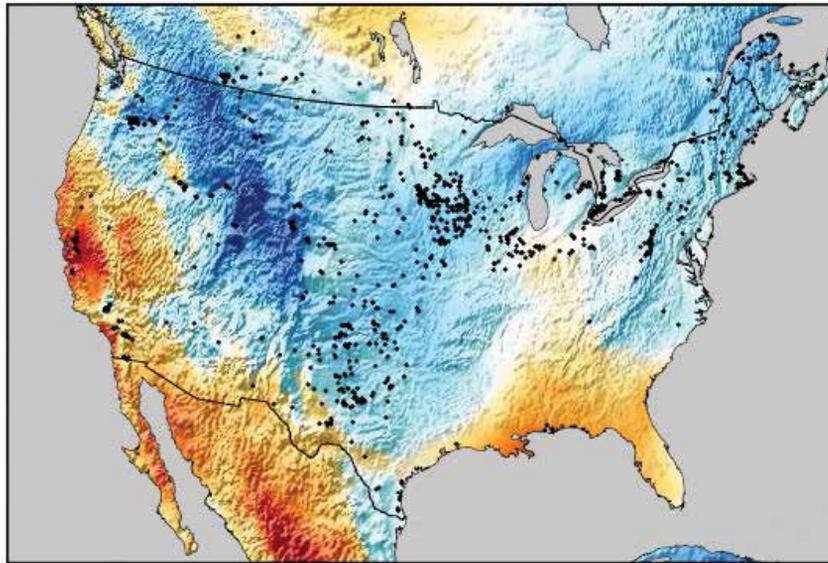
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VAISALA PREDICTS LOW U.S. WIND PRODUCTION IN Q4

Enduring El Niño causing lower than average wind speeds in many regions

VAISALA

U.S. Wind Performance Forecast Q4 2015



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Departure from normal
Below Neutral Above

After the record low wind anomalies that challenged many project operators in the United States in the beginning of the year, wind energy performance is expected to remain below normal in most regions into the final quarter of 2015. This is due to a persistent El Niño that is forecast to remain in effect throughout the end of the year.

The prediction was released today by Vaisala, a global leader in environmental and industrial measurement, based on its analysis of historic and forecast deviations from average wind conditions across North America.

The wind forecast anticipates that power producers in the Northeast, Northwest, and much of the U.S. wind belt will see below average wind

speeds in Q4 2015. While the El Niño pattern largely has a negative impact, particularly along the Rocky Mountains, it will have a positive impact in some areas with significant wind generation.

The Southwest, Southeast, Indiana, and southern Texas are all expected to see above normal wind speeds. California is an especially bright spot with a high likelihood of elevated wind speeds, which should signal a return to smooth profitability for investors following the lows of the last six months.

Vaisala has been following the evolution of North American wind anomalies in particular detail since the release of its Q1 study revealing 40-year record low wind speeds. The

low wind event caused significant reductions in generation for utilities and project owners, a number of whom reported expected shortfalls in quarterly and annual wind production.

In the first quarter of the year, wind production in southern California fell to just 64% of 2014 levels, recovering somewhat in the second quarter to 80% of 2014 levels. Texas wind production was 93% of 2014 levels over the first half of the year. However, it is important to bear in mind that year-over-year nameplate wind capacity increased in Texas by 10%, meaning actual production was much lower in 2015 than in 2014 given the number of plants in operation.

Since the end of Q1, wind speeds west of the Rocky Mountains have

remained lower than average, though to a much lesser extreme, while an area from Texas northward to the Hudson Bay saw wind speeds 10-20% above normal in May. In June, widespread low wind speeds returned with most areas west of the Mississippi River seeing below normal conditions. Rocky Mountain states and central and northern California were especially hard hit with wind speeds roughly 20% below normal.

Large-scale anomalies such as this can lead to cash flow fluctuations that threaten profitability and the perception of wind energy as a low-risk investment proposition. For capital providers seeking stable returns through YieldCo structures in the U.S. market, this Q1 and Q2 underperformance serves as a strong reminder to better diversify portfolios by geography and technology to account for the underlying variability of the climate.

As wind power operations continue to expand across North America, placing recent performance in a long-term context and monitoring production against resource availability will become increasingly critical to portfolio profitability and investor reporting.

“For managing portfolio risk, it is imperative to have a detailed understanding of how over or underperformance at each of your project sites fits within the historical record,” said Dr. Jim McCaa, Manager of Advanced Applications at Vaisala. “As acquisition and merger activity increases, the industry also needs to start thinking strategically about the variability of the assets they are looking to buy and how they fit within the existing portfolio.”

As mentioned above, Vaisala’s forecast is based on the wide agreement of the atmospheric research community and all the major global weather models that the current El Niño climate signal will continue through the end of the year. The forecast was created using an ensemble approach blending mesoscale model predictions with three of the leading reanalysis datasets, each representing 35 years of climate data.

For further information, please download Vaisala’s 2015 U.S. Wind Performance Maps, which include the Q4 forecast as well as details on wind conditions experienced from January through June across the country.

Vaisala is an expert in wind measurement, project assessment, and energy forecasting. For more information on the range of services offered by Vaisala to the renewable energy sector, please visit www.vaisala.com/energy. ↘

HP TO POWER TEXAS DATA CENTERS WITH WIND

Tech giant signs 12-year, 112-MW PPA with SunEdison

The American wind energy industry in July praised members of the U.S. Senate Finance Committee for voting overwhelmingly to extend over 50 tax policies through 2016, including the renewable energy Production Tax Credit (PTC) and Investment Tax Credit (ITC) that incentivize the building of more U.S. wind farms. The committee on a final vote of 23-3 reported out a “tax extenders” bill preserving language that allows wind farms to qualify so long as they start construction while the tax credits are in place.

Those credits expired at the start of this year, again throwing the future of American wind energy into doubt once projects currently under construction are completed.

“This is a big step in the right direction,” said Tom Kiernan, CEO of the American Wind Energy Association (AWEA). “We applaud the committee’s vote because it recognizes that the vast majority of American voters support these policies and want them continued. We urge the full Senate and the House of Representatives to follow the Senate Finance Committee’s bipartisan lead,

and quickly pass this tax extenders package, which will continue to grow American jobs and heavy manufacturing, and support rural economic growth.”

The federal PTC and ITC are predominant drivers of new wind farm development, and have helped lower the cost of American wind power by more than half over the last five years, while making the U.S. number one in the world in wind energy production.

During the hearing, Senate Finance Committee Chairman Orrin Hatch (R-UT) regularly acknowledged the strong sense of bipartisan support for renewing the tax extenders package. Sens. Pat Toomey (R-PA), Dan Coats (R-IN), and Rob Portman (R-OH) withdrew amendments opposing the PTC, while Sen. Michael Bennett (D-CO) made the senators aware of the tremendous amounts of economic benefits and jobs wind power has created in Colorado.

In 2013, after the renewable energy tax credits were allowed to expire even briefly, installations of new wind farms fell 92 percent, causing a loss of 30,000 jobs across the industry that year. After Congress

renewed the PTC, the U.S. wind energy industry added 23,000 jobs the following year, bringing the total to 73,000 at the end of 2014.

Wind energy brings taxes and other revenues to rural communities, benefiting county and local services, schools, and health care and public safety facilities. With over 98 percent of all wind farms on private land, wind energy projects already deliver an additional \$195 million a year in lease payments to landowners.

Earlier in the week, Sen. Chuck Grassley (R-IA) penned an op-ed renewing his call for Congress to extend the tax credits, saying they “bring certainty to investment that helps boost development, sustainability and expansion of homegrown renewable energy,” and that “the facts show that bringing stability and certainty to clean energy policy is good for the economy and the environment. Championing renewable energy that’s engineered by human ingenuity and produced by human hands builds upon America’s centuries-long promise of prosperity.”

Today, more than 70 percent of congressional districts contain operating wind turbines, wind-related factories, or both, according to industry data.

In June this year, proposed legislation threatened to eliminate the PTC. That led to 85 companies sending a letter to Congress to protest the bill saying if passed, the bill would “take away an effective, business tax incentive that creates jobs, drives rural economic development and reduces energy costs for Americans across the country.” ↵

— Source: HP

AMAZON WEB SERVICES TO BUILD 208-MW PROJECT IN SOUTHEAST

North Carolina’s first utility-scale wind farm will power cloud data centers

Amazon Web Services, Inc. (AWS), an Amazon.com company, recently announced that it has contracted with Iberdrola Renewables, LLC to construct and operate a 208-MW wind farm in Perquimans and Pasquotank counties, North Carolina, called the Amazon Wind Farm US East. This new wind farm is expected to start generating approximately 670,000 MWh of wind energy annually starting December 2016 — or enough to power more than 61,000 U.S. homes in a year. When completed, it will be the first utility-scale wind farm in the state of North Carolina, with the energy generated delivered into the electrical grid that supplies both current and future AWS Cloud data centers.

In November 2014, AWS shared its long-term commitment to achieve 100 percent renewable energy usage for the global AWS infrastructure footprint. In April 2015, AWS announced that approximately 25 percent of the power consumed by its global infrastructure was from renewable energy sources with a goal of increasing that percentage to at least 40 percent by the end of 2016. As part of its renewable energy push, AWS is continuously working on ways to increase the energy efficiency of its facilities and equipment. Additionally, the company continues to launch projects that increase the availability of renewable energy resources on the electrical grids that supply power to current and future AWS Cloud data centers in Virginia and Ohio.

Together with Amazon Wind Farm US East announced today, Amazon’s renewable projects will be responsible for delivering more than 1.3 million MWh of additional renewable energy into electric grids across the central and eastern U.S., or roughly the equivalent amount of energy required to power 122,000 U.S. homes.

“This agreement, and those previously in place, puts AWS on track to surpass our goal of 40 percent renewable energy globally by the end of 2016,” said Jerry Hunter, Vice President of Infrastructure at Amazon Web Services. “We’re far from being done. We’ll continue pursuing projects that deliver clean energy to the various energy grids that serve AWS data centers, we’ll continue working with our power providers to increase their renewable energy quotient, and we’ll continue to strongly encourage our partners in government to extend the tax incentives that make it more viable for renewable projects to get off the ground.”

“As a leading Internet platform and cloud services provider, Amazon continues to invest in renewable energy by supporting this wind farm in our great state,” said North Carolina Governor Pat McCrory. “This kind of collaboration between Amazon and Iberdrola Renewables promotes North Carolina’s continued economic growth and highlights the importance of supporting the ongoing expansion of the technology sector in our state.”

— Source: Amazon Web Services

UK TO REMAIN TOP OFFSHORE WIND POWER MARKET BY 2025

Offshore capacity to exceed 23 GW, according to GlobalData



The UK will remain the leading offshore wind power market globally by 2025, with its installed capacity increasing from 4.5 GW in 2014 to 23.2 GW by the end of the forecast period, representing an impressive Compound Annual Growth Rate (CAGR) of 30.5 percent, according to research and consulting firm GlobalData.

The company's latest report states that the UK accounted for a significant 51.3 percent share of global offshore capacity in 2014. Denmark and Germany followed, with respective shares of 14.5 percent and 11.9 percent.

According to Harshavardhan Reddy Nagatham, GlobalData's Analyst covering Power, the UK and Denmark's shares are expected to decrease to 30.6 percent and 4.4 percent, respectively, by the end of 2025, mainly due to other countries, such as the U.S. and China, increasing their market presence over the forecast period. Germany's share will grow to 16.1 percent by the end of 2025.

The UK's installed offshore wind power capacity increased from 0.4 GW in 2007 to 4.5 GW in 2014, at a CAGR of 22.3 percent, driven primarily by strong policy support and aggressive targets.

While these factors are currently driving the market, there is more uncertainty following the UK environment minister's calls for a reduction in offshore wind sector costs. However, industry leaders have urged the minister

to provide more clarity on long-term offshore wind power support to improve project investment.

"The UK government is aiming to achieve 18 GW of offshore wind capacity installations by 2020, based on the roadmap laid out by the Department of Energy & Climate Change (DECC)," Nagatham said. "To incentivize project development, it is looking to reduce the generation cost by 30 percent to £100 (approximately \$152) per megawatt hour.

"Despite the higher costs of offshore wind compared to onshore, the government continues to support the former with contracts for difference, with the aim of achieving lower generation costs in the long term and the 18 GW installation target."

The analyst concludes that the UK possesses the largest offshore wind resources in Europe, with the North and Irish Seas providing high-potential areas for offshore wind farm developers.

Siemens remained the UK's leading offshore wind market player in 2014, boasting a 76.2 percent share of the country's cumulative capacity. Vestas was a distant second, with 19.9 percent, followed by Senvion and Samsung with 3.8 percent and 0.2 percent, respectively.

— Source: GlobalData

WIND ENERGY: A LONG-TERM PASSION

NREL's 91-year-old senior engineer still actively involved following an established career in wind research

By Ernie Tucker



Three afternoons a week, 91-year-old Palmer Carlin comes into the Energy Department's National Wind Technology Center (NWTC) at the National Renewable Energy Laboratory (NREL), and begins having fun. That's where the senior engineer fields questions from the public, often from would-be inventors convinced they have the next big renewable energy breakthrough.

"Across the U.S., there are inventors, students, small businesses, and entrepreneurs with wind-related questions who continuously shower emails and voicemails on all of us here at the wind site," said Carlin, a dapper man with a sweep of silver hair at his jacket collar.

Carlin said he imagines that the typical inventor's scenario begins when a retired machinist goes out to a garage workshop at the suggestion of an exasperated spouse. "Then the guy invents some sort of wind machine and calls me up," he said with a laugh.

He recalled being contacted by a person who was convinced he had a major discovery. After discussing the details of the invention with the modern-day Da Vinci, Carlin paused, and then asked the man if the invention really ran on wind energy. No, the man said. Palmer realized the concept was a perpetual-motion machine. "I said, 'Well, I only talk about things that need wind.'"

This is something he has been doing since the early

1990s, and these exchanges work well for him, as he catalogues each call and files the record. "Having made some technical contributions at the NWTC in the past, I am pleased that a niche has developed for me in which my task is responding to these inquiries that my fellow workers forward to me," he said.

Now, the recent release of the Energy Department's Wind Vision Report has added an important tool in his arsenal. "This will become an excellent information source for me as well as my callers," he said.

EARLIER TIMES AND EARLIER TRIES

The Energy Department report is a far cry from the early days of modern wind energy research, when things were, well, up in the air. Carlin built an early prototype turbine while at the University of Colorado (CU) Boulder as an electrical engineering professor — a gizmo that had magnets around the outside. "It never worked very well," Carlin said simply. Despite his own visions, he never dreamed he would see the giant megawatt-scale turbines towering 90 meters or more — or the widespread acceptance that is chronicled in the Wind Vision Report.

Back in the fall of 1977, he began a three-semester leave from his professorship to help in the creation of what was the Wind Energy Test Site in the buffer zone adjacent



to the Rocky Flats Atomic Energy Installation. He remembers that a couple of trailers were the only things on the site, and he would travel with other early pioneers to work with developers of small 10- and 20-kilowatt machines. But Carlin was not merely an observer.

Eventually, the lure of NREL (then known as the Solar Energy Research Institute, or SERI) proved too strong, and he retired from CU and joined SERI in 1986. As the organization pushed for wind's future, Carlin's role was perhaps a bit more complex than he lets on. Colleagues heap praise on him. "We worked together in the 1970s to set up the small wind systems research efforts here at what was then the Rocky Flats Small Wind Systems Test Center," NREL Research Fellow Bob Thresher said.

Thresher also noted that Carlin consulted with the staff on electrical systems analysis. "He authored some of the seminal analysis papers on variable speed technology and collaborated with many small wind companies of that era on the development of variable speed electrical topologies."

DIFFERENT TIMES ON CAMPUS

Times were different when Carlin was younger, and the nation was in the middle of World War II. After growing up in the 1920s on a prairie farm in Wiley, Colorado, where he tinkered with spare engine parts, he

arrived on the CU Boulder campus in 1942 as part of the second class ever of CU's Naval Reserve Officer Training Corps. The group often started the day performing "calijumpic" exercises at dawn before getting cleaned up and dressed in uniform for class. Gas and food were rationed; travel was a luxury because nobody had a car. Carlin's student days weren't focused on wind research, though he was interested in electrical engineering — but it was the overall campus experience that had the most impact.

"It was educational for me, meeting new people from all over," he said. After all, his high school graduation class had only 19 members, including several who were later killed in service. When he graduated with his electrical engineering degree in 1945, the war was ending — but he still had about 18 months of service. He was selected to go to the Navy Yards in New York City. "There I was at Times Square — I'd come from a small town to New York, by way of Boulder."

Eventually, Carlin returned to CU to pursue a master's degree and Ph.D. — but he was fueled by a new interest in physics. He began teaching physics to undergrads. "The atom bomb had happened, so all at once, it was interesting to go into particle physics," he said. And as he pursued his doctoral degree in 1955, he was involved in several of the major historic scientific events of the day.

One was a form of research that required wire. Lots and lots of wire. Carlin was part of a project to monitor seismic activity, which involved setting up three monitors in Boulder, two miles apart, unspooling wire along fence lines and even to a barn. The goal was to detect motion from distant earthquakes or atomic tests. The project successfully noted at least one such U.S. test. Another time, on the evening of October 4, 1957, he heard that the Russians had launched a satellite, so he and his colleagues hurriedly went to test a long-range radar system they were studying. "Sputnik happened to be going over, and we could basically look out into space, and the radar could see it," he said—and noted it was one of the very first sightings that happened "just by accident."

Not everything happened by accident, of course. Carlin's work with the NREL low-speed, direct-coupled wind turbine resulted in several reports and papers, including "Some Analysis of Energy Production from the NWTC Variable Speed Test Bed," which was awarded Best Conference Paper at the 1997 American Society of Mechanical Engineers Wind Energy Symposium.

Through the years, wind energy has also remained a passion. "It's supposed to be the 'in' thing, and it's fun in itself," he said. When asked how long he'll keep coming to work from his Boulder home, Carlin paused, and then said: "I'm having too good a time out here. I'm very pleased I worked at NREL. Everyone here is working because they are doing something they are proud of.

"Whenever I hear people talking about global warming, I feel proud. We're trying to keep the planet's temperature down. Wind is one way to do that," he said.

Learn more about wind research at the National Wind Technology Center (NWTC) by visiting www.nrel.gov/nwtc. ↴

— Source: *National Renewable Energy Laboratory*

REACHING NEW HEIGHTS

Could wind drones be the next evolution in wind power generation?

By Udo Zillmann

Drones will eventually be “as ubiquitous as pigeons,” London-based futurist Liam Young recently predicted. They are omnipresent already. Only five years ago drones belonged to the realm of the military, unaffordable for anyone else. Today, they are for hobbyists and even kids. Drones arrived in our lives and conquered the extreme ends of the market for technical goods. They proved to provide the best value for both, defense budgets and pocket money. Now the race is on to fill the gap in the middle: startups, corporates and analysts try to find the most promising commercial applications for drones. That is quite a challenge since drones can be used for a surprising variety of tasks. Much media attention was paid to Amazons’, Google’s and DHL’s announcement of using delivery drones. Others see the future for drones in surveillance, detecting fires, cracks in pipelines or illegal wood logging. They can also monitor farmland in detail for precision farming. Autonomous solar powered drones can also be used to hover at high altitude over an area for months to provide wireless communication similar to a satellite. Facebook and Google have invested in startup companies in this field. But there are other disruptive uses for drone technology which the current debate is largely unaware of.

One example is Elon Musk and his SpaceX company. He

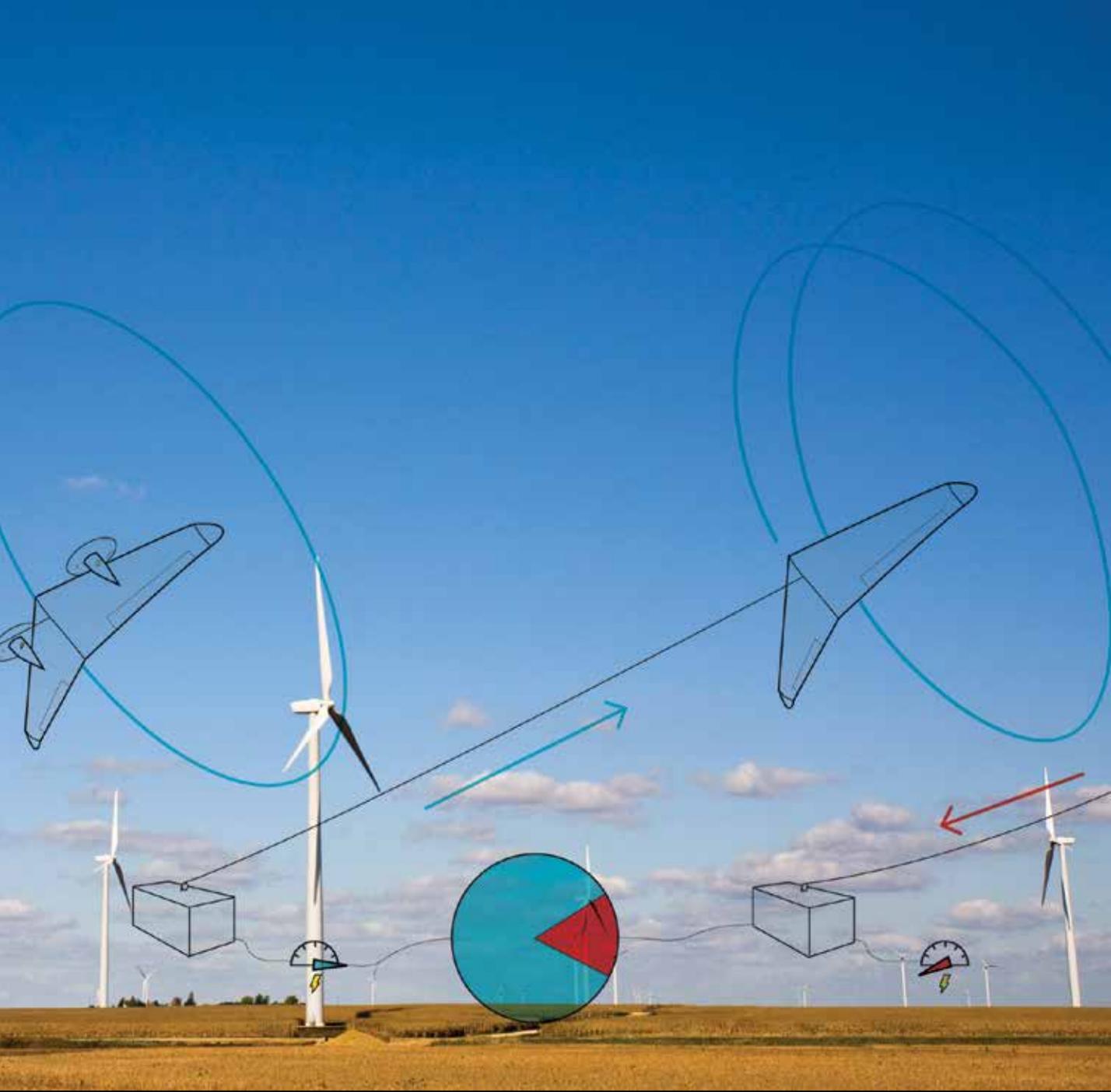
is working at landing and later reusing Falcon rockets after they have delivered their payload into space. It is impossible for a pilot to control a precision upright landing of a rocket that literally falls out of the sky. Only cutting-edge drone technology can do the job. If the rocket was to be recycled it would lower the flight costs from the cost of building a rocket to the cost of refueling it. That is \$200,000 instead of \$55 million.¹ The business potential for the “rocket drone” would be enormous.

Or take Miles Loyd. In the energy crises of the late 1970s Miles Loyd worked as an engineer at Lawrence Livermore National Laboratory. He attempted to build the best wind generator imaginable.

He had the radical idea of building it without a tower, only using a flying wing connected to the ground by a tether, much like a kite. He calculated the expected energy output of his “flying wind generator”. Based on the formula he first established – today known as Loyd’s Formula – he found that a wing with the size, weight and aerodynamics of a standard plane wing of the 1970s could produce 6.7 MW of power. Even larger wings with an output of 45 MW seemed feasible. To put this into perspective: even today, 35 years later, the average wind turbine is still below 3 MW and the largest existing prototype has 8 MW. Loyd obtained a patent² and published an article³ on this new technology.



And here the story ends. He could not convince investors to finance his flying wind generator, because he had no solution for one problem: how to control the flying wing without a pilot? Today, we have a technology that lets us control flying objects without a pilot. It is called: drones. If we can apply this new technology to Loyd’s old formula we can build a new type of drone: the wind drone.



WIND DRONE TECHNOLOGY

How exactly does a wind drone work? There is a great resemblance to kite surfers. Kite surfers use a kite and a tether to pull a surfer through the water. The same mechanism can be used to generate electricity. The tethered kite or wing is connected to a drum and a generator on the ground and the tether is wound around the drum. The wing tears

at the tether and turns the drum to generate electricity. Once the tether is fully unwound, the wing nosedives and the tether is quickly reeled in. Then the cycle starts again. This up-and-down motion inspired the name “yo-yo” type wind drone (Fig. 1).

Google X, overseen by Sergey Brin, is working on a different wind drone in its Makani⁴ project. Google’s approach is to use little

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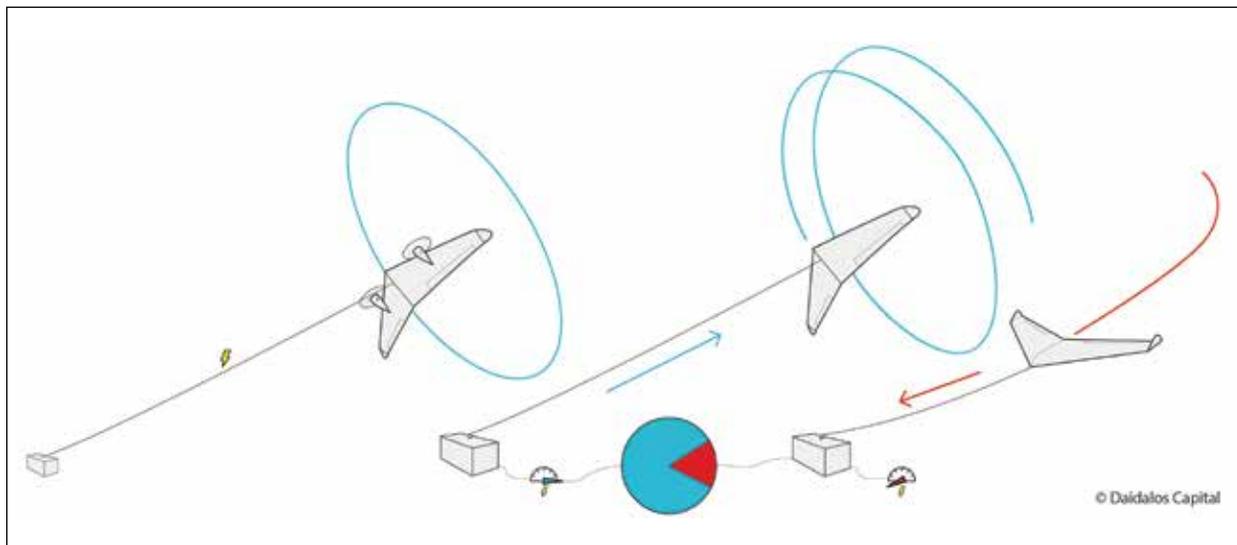


Figure 1: Illustration of wind drone technology.

propellers (mini wind turbines) and generators directly mounted on the wing where they produce electricity. An electric cable is woven into the tether and transfers the electricity to the ground. In 2013 Makani presented a working prototype. They already built their first scaled up product with 600 kW output and announced that it will fly in 2015.

Google will be the first team to show a wind drone with power outputs comparable to today's wind turbines. But they are not the only ones who have realized that drone technology is ripe to take on Loyd's formula. Companies including 3M, ABB, Alstom, E.ON, Honeywell, Statkraft and Softbank have conducted research on wind drones and/or financed one of the dozens of airborne wind energy startups worldwide. Some of the prototypes use soft wings resembling a surf kite or a paraglider, others use hard wings like the wing of an airplane. The designs also differ in many other details. A dominant design has not yet emerged. But irrespective of their final design, wind drones share three characteristics that could turn them into the killer

application for drone technology: they will disrupt their market, they will be one of the first autonomous drone applications to be market ready and they will have the largest market of all drone applications.

DISRUPTING THE MARKET

Producing wind energy is not a new idea and we already have a tried and trusted device for this task: the wind turbine. Wind drones will have to offer significant advantages over wind turbines to conquer this market. Airborne wind energy companies claim that wind drones can be built at half the price of wind turbines. In addition, they claim that downtimes for wind drones will be significantly lower and wind drones therefore produce twice as much energy with the same rated power. According to their calculations energy from wind drones could therefore be available at just one quarter of the price of energy produced by wind turbines. But are such claims realistic?

COSTS

Can you manufacture wind drones more cheaply than wind turbines?

The capital costs of a wind turbine which make up the bulk of the total costs of wind energy are the following (see Figure 2).⁵

The structural elements, the tower, the blades, the foundation and the rotor hub make up half of the total capital costs of wind turbines. Material requirements are extremely high: Up to 700 tons of steel for the tower,⁶ another 100 tons of steel for the rotor hub,⁷ up to 100 tons of glass-fiber reinforced plastic for the blades,⁸ and up to 4,000 tons of concrete for the foundation.

Wind drones lack these massive structures. The tower is replaced by a thin tether. A wind drone with the power of the largest existing wind turbine (8 MW) requires a tether that is 2.5 inches/6 cm thick and would weigh less than one ton.⁹ Only minimal foundations are required and the wings can be much lighter requiring only 1 to 10 percent of the material of the blades of a wind turbine.¹⁰ The Google Makani 600 kW wing weighs below 2 tons including the tether and generators on board.¹¹ A comparable 600 kW wind turbine weighs between 50 and 100 tons without foundation.

The required components for power generation are cheap in comparison: the costs for the electricity producing generator amount to less than 3 percent of total costs. Certainly, wind drones will need more and better sensors, processors and other control components, but these cost much less than the saved materials.

STOP BUILDING LEVER ARMS

How can a wind drone save half the costs of a wind turbine? It is all about physics. A basic construction principle in engineering is to avoid a 90-degree force on an unsupported lever arm whenever possible. Large bridges are therefore supported by arches, columns, or suspension tethers. If parts cannot be supported they have to be made as short as possible.

Wind turbine engineers have done the opposite. Rightfully wanting to build ever larger and more efficient wind turbines they worked to increase the height of the towers and the length of the blades. Both are lever arms in a 90 degree angle to the wind force and they are not supported. Wind engineers would love to tether the tower and the blades. But it is not possible. The wind can blow from all directions, so the rotor has to be able to rotate around the tower and the blades have to spin freely. Nonetheless, wind engineers have excelled in building ever larger wind turbines. They hold the record for building the longest unsupported lever arms in the world. Undoubtedly a great achievement, but one that does not help saving material. The tether of a drone can be 1,000 times lighter than the tower of a turbine simply because it avoids lever arms.

UNLEASH THE DRONES

A simple physical fact cuts costs in half. Can other physical facts dou-

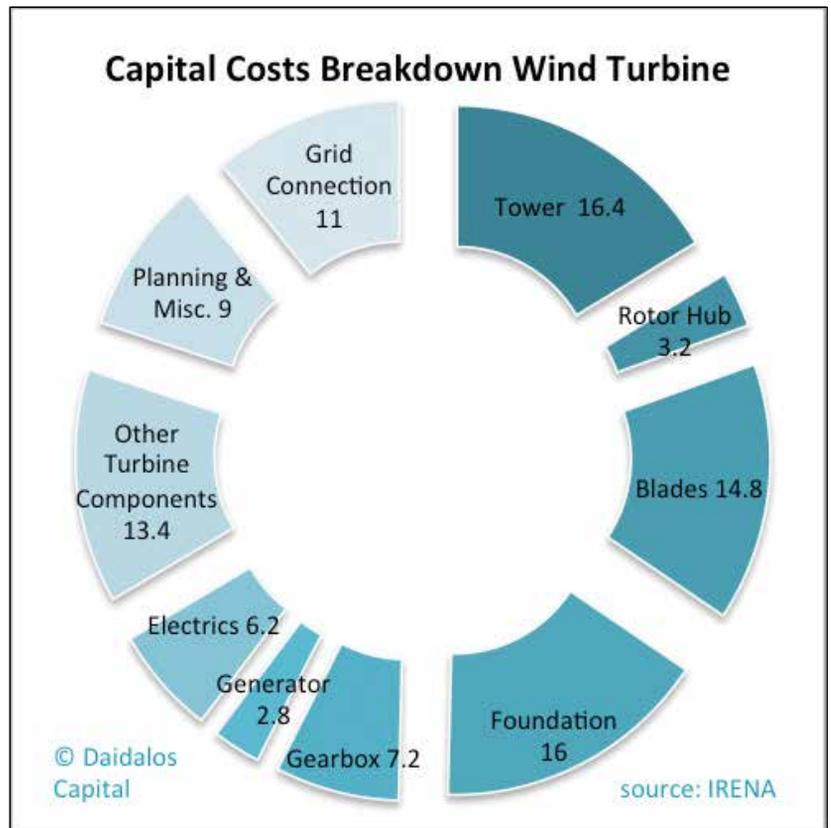


Figure 2: Capital costs breakdown of wind turbines.

ble the output? Since wind drones are not restricted by lever arms they can fly higher. They easily reach altitudes twice as high as normal wind towers (300 m/1,000 ft. instead of 150 m/500 ft.). Physical facts: on average the wind speed increases with altitude; higher wind speed means more wind power; wind power increases with the cube of the wind speed. Double the wind speed therefore means wind power multiplied by eight (2^3).

Altogether these physical facts lead to the conclusion that there is no such thing as a “bad location” for wind drones. Wind drones only know good and excellent wind sites. They will find enough wind at almost any site.

The impact of height differences can easily be illustrated by using wind data of Dresden, Germany (See Figure 3).¹² At the altitude

of wind turbines it is a very poor wind location. Not even with the support of the generous German feed-in tariffs does it allow economic energy generation. At wind drone altitude, the wind speed is 60 percent higher (grey columns). This does not sound spectacular, but due to the cubed relationship between wind speed and power the available wind power almost quadruples (blue columns).

At this altitude Dresden becomes an extremely windy place with a wind force only matched by few wind turbine locations such as coasts, mountains or offshore locations. The world’s largest offshore wind park London Array, has a comparable average wind speed of 9.2 m/s at 100-meter hub height.¹³ The reason is simple. Obstacles on land like forests, hills and buildings slow the wind down. Offshore winds partly owe their

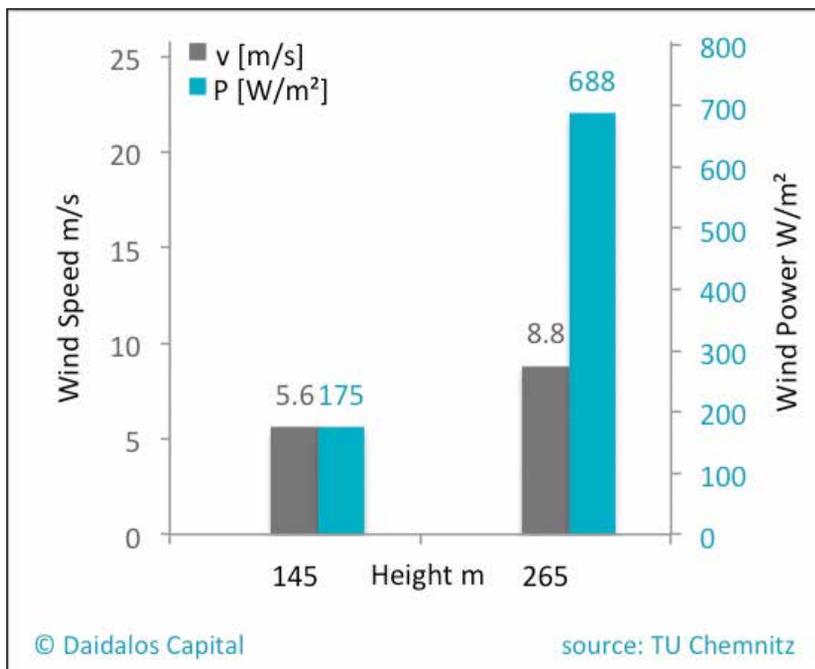


Figure 3: Wind data of Dresden, Germany, forest site.

strength to the lack of obstacles. The same applies to high altitude winds: no obstacles to slow them down.

In addition, offshore or high altitude winds are steadier and therefore a more reliable source of electricity. Offshore wind turbines run at full capacity more often. Their idle periods per year are much shorter. Their so-called capacity factor is higher. They are therefore better suited to provide base load electricity. On average the output of offshore turbines is twice as high as that of onshore turbines with the same rated capacity.¹⁴ But since offshore turbines cost two to three times as much as onshore turbines, the advantage is quickly outweighed. Offshore wind energy is still more costly than onshore wind.¹⁵ According to research conducted by E.ON, Germany's largest utility, offshore wind drones can boost offshore wind turbines' high yields by another 50 percent. They can run at full capacity 70 percent per annum.¹⁶

In summary, wind drones have lower production costs, they can access much stronger high altitude winds and therefore run at full capacity for greater amounts of time. The estimate of many airborne wind energy startups seems realistic: electricity for a quarter of the price of today's wind energy.

Google shares this belief in the cost-cutting power of wind drones. Google calculated that less than 16 percent of all the onshore U.S. sites are suitable for economic wind energy production with wind turbines. For wind drones this figure more than quadruples. 66 percent of the United States become viable.¹⁷

The higher capacity factor does not only lower the price, it also increases quality. The intermittency of most renewable energy sources causes a lot of concerns. Electricity grid operators face the challenge of matching the fluctuating production of renewables with demand. Current scenarios foresee the necessity to invest billions into stronger grids and

energy storage. If wind drones can produce with a capacity factor of 70 percent as envisaged by E.ON, they could replace coal, nuclear and gas power plants without the necessity of massive new investments in grid and storage. Grid and distribution costs already make up for the greater part of our electricity bills. The high quality of wind drone power could become a decisive factor, even more important than its low cost.

TIME TO MARKET

The first wind drone prototypes are in operation. But when will they be market ready? Soon. Sooner than many other autonomous drones. The reasons: simplicity, safety, and the law.

ROUND AND ROUND WE GO

Various drones have various tasks which vary in difficulty. Wind drones are the ones with the easy job. They fly the same simple pattern, say a circle, over the same space over and over and over again. Conventional wisdom has it that robots and drones will first get into the dull, dirty and dangerous jobs. Sorry, wind drones, we cannot get you dirty and dangerous, but when it comes to dullness it is hard to beat your job.

Flying the same patterns over the same area means that the sensors know exactly what to expect, that the software has to know only a few flight patterns, and that the only variation can come from different weather, namely changes in wind speed and direction. And if the wind drone has to land for inspection or due to extreme weather, the landing site is also always nearby.

SAFETY (MAKES THEM) FIRST

No matter how simple a task, something can always go wrong and in case of flying objects the result can be a crash. To be a com-

mercial success, every drone will have to prove that it is safe.

In the beginning wind drones will only be installed in controlled areas in the countryside, or over the sea, where unauthorized access is not allowed. If the public cannot access the flight area, the public cannot be harmed. This is the simplest recipe for safety. Amazon on the other hand might find it difficult to deliver its parcel to your doorstep while keeping a safe distance from people.

Wind drones also have a built-in safety feature that is unique to drones: They are kept constantly on the leash, pardon, tether. So even if all controls go out of control, wind drones can only crash within the area of the tether and will not do any harm outside.

Stationary operation and the strictly defined flight area of wind drones not only increase safety on the ground but also in the air. Wind drone parks can be included in air maps and turned into no-flight zones for low flying air traffic, just as wind parks are today. Air regulators have already honored the additional safety and special features of wind drones. A draft decree of the European airspace authority EASA has an exemption for wind drones (and other drones on the tether) allowing them to fly higher than other drones without the same restrictions.¹⁸ And under the new EASA “concept of drone operation”¹⁹ the degree of regulation will depend on a specific risk assessment for each use of drones. In case of operation in segregated areas, where drones do not pose a risk to the public, the operator might even approve its own risk assessment. Airspace regulators worldwide are currently working on regulation for drones. They will mostly use comparable flexible concepts, since applying existing strict regulation standards for

manned aviation to drones would choke off the respective national drone industry without any safety benefits. So wind drones are not only safer in practice, but this additional safety in the air and on the ground will lead to much lighter regulations. This will make them faster, easier and cheaper to build than other more hazardous and therefore stricter regulated free flying drones or aircraft.

What is true for drones is also true for autonomous cars. Many believe that autonomous cars will become commercial reality in a few years. This is not true. Fully autonomous cars have long ago hit the market. They have been available for purchase since 2008. Where? At your local Caterpillar²⁰ or Komatsu²¹ dealer, specialized in mining equipment. More and more mines are equipped with fully autonomous haul trucks, which transport rocks and minerals within the mine. Have the engineers at Caterpillar and Komatsu outclassed their counterparts at Google, GM, Tesla, BMW, Volvo, Toyota, Audi, Mercedes by launching their product a decade earlier? Not quite. Haul trucks perform limited and well defined repetitive tasks. They operate stationary in mines, which are controlled distant places with no access for the public. There is little or no regulation on their development and use. The conclusion for drones is obvious.

HUGE MARKET

The strongest argument for wind drones is their potential market: it is huge.

To begin with, the global wind turbine market is a large market. Its volume amounted to \$80 billion in 2013.²² Its growth rate averaged 25 percent per year over the last decade²³ and the market will continue to grow strongly. But wind drones are not limited to the

existing market for wind turbines. A look at the top 20 global companies with the largest revenue as compiled by the Fortune Global 500 list²⁴ illustrates their full market potential:

Energy is big business. But wind energy is still minuscule and accounts for less than 1 percent of total global energy use.²⁵ This will change. And it is mostly a question of competitiveness. Onshore wind turbines are on the brink of becoming competitive with coal and natural gas. This so called grid-parity has been reached in some regions. It means that wind energy is already the cheapest source of electricity even without subsidies. Add wind drones’ potential to slash these costs to one quarter, add steadier production and add their ability to be deployed almost anywhere.

This means that wind drones cannot only compete with wind turbines in their niche but will become the cheapest source of electricity. Cheaper than coal, gas, nuclear and hydro power.

And since electric cars are on the rise, the electricity produced by wind drones will be able to play in the energy major league and compete with oil as a transportation fuel. And oil will have a hard time competing, even at the current “cheap” oil prices. Taking into account the inefficiencies of the combustion engine, oil at \$60 per barrel is still a more expensive source of power for a car than the electricity produced by today’s wind turbines. Based on the analysis above, oil would have to sell at a quarter of that price, below \$15 per barrel to compete with wind drone energy on a pure cost of fuel basis.

The digital revolution has disrupted many markets, created vast riches and young billionaires. But we have to bear in mind that the digital revolution has only taken

place in very limited markets so far. The so-called digital giants Google and Facebook — and many others — are all competing for a share of the online advertising market. This market has a total global volume of \$150 billion.²⁶ Compare this to the annual average \$2 trillion investment into energy supply required in the next 20 years according to the International Energy Agency.²⁷ Compare this to the \$3.4 trillion revenue that the 11 largest energy companies on the Fortune Global 500 list share. Or compare it to the total global energy market that is assumed to have a size of \$6 trillion to \$10 trillion. This is a difference in market size that could come close to a factor of 100. We cannot imagine what it will look like when the drones the digital revolution created take on the largest market of the world, the energy market.

WORLD CHANGING

We have illustrated how the laws of physics in combination with sensors, chips and smart algorithms can replace the tons of steel and concrete wind turbines are made of. This can make wind drone power cheaper than electricity from fossil fuels. Their ability to harvest stronger winds higher up in the air gives wind drones the potential to provide power where it is needed irrespective of the existing wind resource. Cost-effective electricity made by wind drones could even provide the basis for the clean synthetic fuels of the future. And this fuel could be available at less than today's oil price.

A lack of wind will no longer be a problem. We have seen how the wind resource dramatically increases by doubling the altitude. But this is only the first humble hop of wind drones into the air. Once these altitudes are mastered,

it will be tempting to gradually go higher, until they reach the jet stream at 10 km/33,000 ft. Before, many technical and legal problems will have to be solved. But it will be attempted. The wind resources at this altitude are simply too enticing. The median energy density over New York at this height is more than 10 kW/m²²⁸ of which about 5 kW/m² can be used.²⁹ The total energy consumption per person in the U.S. amounts to 10.5 kW. This includes all electricity use, heating, car and aviation fuels, and even industrial energy consumption.³⁰ This means that harvesting wind in an area of 2m² (22 sq.-ft.) per person, the size of an open front door, could on average provide all our energy. If 10 wind turbines with today's dimensions were installed in that altitude over New York, they could have the same rated power as an average nuclear power plant, over 1 GW.³¹ High-altitude wind energy is not only an extremely concentrated source of energy, it is also abundant. It can provide about 100 times of today's global energy consumption.³² High altitude wind energy could allow us to live a greener lifestyle without the need to reduce our use of energy. For the energy sector this could mean nothing less than finally solving the conflict between economy and ecology.

Burning fossil fuels started the industrial revolution. It enabled the advances of mankind in the last 200 years. Without fossil fuels feeding 7 billion people on this planet would be impossible. But fossil fuels also destroy and pollute nature, poison our cities and homes and cause an ever more dangerous climate change. Furthermore, our reliance on fossil fuels leads to unjustified wealth and power imbalances, to wars over their control and to undemocratic regimes.

When mankind started to burn fossil fuels it made a huge leap forward. When it stops to burn fossil fuels, it will make another big step towards a better world. Drones will help to bring this day much closer than most of us believe today. ↵

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MANUFACTURING VERSUS REMANUFACTURING: A TECHNICIAN'S PERSPECTIVE

Not all wind energy students plan to climb towers for a living. Fortunately, there are plenty of career opportunities for Ecotech Institute grads that don't require them to leave the safety and security of terra firma. Two options that I discuss at length in the classroom are jobs in manufacturing of turbines and components as well as remanufacturing.

TURBINE AND COMPONENT MANUFACTURING

If you were to follow Colorado news regarding turbine manufacturing employment in the wind industry, you might think that employees are all hired and laid off routinely as they ride the waves of the on-again/off-again Production Tax Credit and the turbine sales that spike every time it is renewed. For a young, unmarried technician with little more than a car payment and some student loans, this rollercoaster is nothing to worry about. But for the rest of us, the impression of a lack of job security may dissuade us from considering employment options in turbine manufacturing. In actuality, we may be doing ourselves and our careers a major disservice by steering our careers clear of the factories, however. After all, we cannot ignore how impressive the numbers look for wind turbine manufacturing employment.

- Up to 7,000 jobs in Colorado are credited to the wind industry, the vast majority of them in the manufacturing and supply chain sector.
- Vestas Colorado manufacturing facilities employ around 3,000 people.
- Vestas plans to add 600 more

Colorado employees for manufacturing.

- More than one quarter of U.S. wind energy jobs are in manufacturing.
- More than 500 supply chain/manufacturing facilities are spread out amongst 43 states.

Clearly, the occasional news headlines announcing a few hundred layoffs look more like a small market correction than a true crash. Since mid-2013, Vestas, under the leadership of Anders Runevad, has implemented efficiency measures and restructuring that has turned the company around to show healthy growth and profits. Rather than sell a Pueblo, Colorado tower factory, the Pueblo facility is operating at full throttle building tower sections to meet high demand. Sales are booming as our industry enjoys the residual effects of the most recent Production Tax Credit for safe-harbored development projects. Will a new PTC for 2015 keep the party rolling? We certainly hope so!

COMPARED TO REMANUFACTURING

Mention "remanufacturing" in a group of uptower technicians and you're likely to receive comments that might be better suited to describe rebuilt and counterfeit electronics from Asia. For reasons of propriety, most remanufacturing facilities are not openly discussed. Therefore, their virtues are quietly extolled by a handful of discrete advocates. Original equipment manufacturers (OEMs) might set them up in nondescript warehouses with small lettering on one door to ensure UPS and FedEx know where to find them.



By *Walter Christmas*
Ecotech Institute

Press releases are almost unheard of, and tours for outsiders are often forbidden.

Why is such careful discretion regarding remanufacturing a common practice in our industry? OEM representatives will never utter the word "recall", but this is essentially what most remanufacturing projects are all about. While OEM sales departments fight for market share in America, arguably the world's largest potential market for turbine sales, the last thing they need is for would-be customers to learn about serial gearbox, generator, or blade issues. Warranted or not, turbine downtime is costly. OEM asset managers carefully dance around the topic in discussions with customers to explain why a crane will be visiting several turbines over the next few weeks. Engineers

scramble to resolve the serial issues quickly and quietly. Process work instructions (PWI's) are drafted and revised as technicians and engineers collaborate to develop cost-effective solutions.

When skillfully managed, the outcome of such projects can be a wealth of knowledge regarding failure modes of components. Brand new techniques are often developed on the fly with astonishing results. In fact, this author has seen components roll out of a remanufacturing facility that are better than factory new! Performance increases beyond customer expectations can draw attention that OEMs may not appreciate. An overexposed successful recall program might gain so much positive attention that the OEM must alter their dialogue and call it something like a "Component Upgrade Program." Soon, customers will want to know why only some of their warranted turbines are receiving this upgrade.

Secrecy is a necessary aspect of many remanufacturing projects. Loose lips sink ships; OEMs can lose millions if the public perception is not carefully controlled. So proud, accomplished technicians and engineers that deserve to brag about saving the day must quietly lurk in the shadows.

It should be noted that not all remanufacturing is provided by OEMs, and therefore they do not all have to operate under a shroud of secrecy. Shermco Industries rebuilds motors and generators in addition to many other services. Gearbox Express provides better-than-factory gearboxes built from OEM cores. As long as representatives from these companies aren't sharing damaging or otherwise proprietary OEM information, they benefit by singing their praises from the rooftops. It's clear what they have to offer, and nobody needs to apologize for it.

SIDE-BY-SIDE COMPARISON

Manufacturing and remanufacturing are options for our students who do not wish to climb turbines. But how would an entry-level job applicant choose between these options?

From a technician's perspective, manufacturing and remanufacturing share a few things in common.

- They both involve an assembly process, which is obvious.
- They both tend to be located in or near cities as opposed to wind farm jobs, which are usually at least an hour from the nearest city if not several hours.
- Beefy overhead cranes offer safety and versatility in material handling that a turbine's gantry crane cannot offer.
- Access for engineers is easier to manage than an uptower visit.
- Tools do not have to be transported and lifted uptower, nor are they limited in size and power.
- Specialist technicians trained in the PWI's are not usually required to travel for their job.
- Overtime is often expected and/or offered to technicians in both types of facilities.

How do manufacturing and remanufacturing differ from a technician's perspective?

- Bolting new components together to build a new turbine or component doesn't require deep knowledge of how a wind turbine functions, but helping to diagnose a failure mode in a component does.
- Disassembly of a failed or deteriorating component is very messy work requiring endless house-keeping, whereas a factory floor is often kept nearly spotless with little effort.

- Manufacturing a turbine exposes technicians to the opportunity to learn about all of the components rather than a single one that happens to be prone to failure.
- Manufacturing technicians might spend their entire day performing one small task on an assembly line. A remanufacturing technician will likely be responsible for solving problems that look different with every component that passes through their station.
- Manufacturing technicians might be laid off when sales slump. Remanufacturing technicians might be laid off when a recall program has been completed but is not at the mercy of the PTC.
- Manufacturing technicians often work with a large team of managers in a facility and therefore have ample opportunity to be recognized and promoted for their skill and dedication. Remanufacturing technicians tend to be part of a much smaller team with far fewer managers, but they become specialists in a particular component.

WELL-ROUNDED APPROACH

There are no rules forbidding a technician from migrating back and forth between manufacturing and remanufacturing. In fact, this practice can help a wind energy worker avoid the unemployment line during the dips in the roller-coaster ride that is the PTC. The knowledge base to be gained from such two-sided experience can be leveraged to propel a technician to quick promotions and raises as he or she would quickly prove to be too valuable to lose regardless of the current state of industry subsidies like the PTC. ↵

VESTAS RECEIVES 429 MW OF ORDERS FROM SUNEDISON

Developer's projects in Texas and Maine to be powered by 3.3 MW platform



Courtesy of Vestas Wind Systems A/S

SunEdison, Inc. has placed two firm and unconditional orders with Vestas totaling 429 MW for wind farm projects in the United States. Vestas will supply 83 V117-3.3 MW turbines (274 MW) for a wind power plant in Texas, as well as 47 V112-3.3 MW turbines (155 MW) to power the Bingham wind power plant in Somerset County, Maine.

The total capacity of the Texas project, including equipment previously purchased from Vestas, will be 300 MW. With an installation and commissioning expected in 2015, the Texas installation will be the largest V117-3.3 MW project in the world.

The Texas order is a call-off from the Master Supply Agreement announced between Vestas and SunEdison in December 2014 for multiple U.S. projects, the potential of which totals approximately 600 MW. With today's order, Vestas has announced contracts against that agreement representing 334 MW. Likewise, the Maine order is a call-off from a similar Master Supply Agreement agreed upon in December 2013 between Vestas and First Wind, which SunEdison acquired this year. This MSA for multiple U.S. projects has a potential totaling up to 718 MW. With the Maine order, Vestas has announced orders against that agreement representing 453 MW.

To date, Vestas has secured more than 9 GW of orders for the 3 MW turbine platform globally.

Both projects include supply and commissioning of the wind turbines as well as a 10-year Active Output Management (AOM) 5000 service agreement designed to maximize energy production.

"We're pleased to move forward with this project and to further our relationship with Vestas," Paul Gaynor, SunEdison's executive vice president for Europe, Americas, and MENA said regarding the Texas order. "We look forward to installing Vestas' V117-3.3 MW turbines in Texas. The Vestas turbines we have at other projects around the country have performed well and we expect this project to enjoy similar success."

"Our 3 MW turbine platform is proving its versatility across a variety of North American

wind regimes, and we are starting to see much broader deployment across the wind belt,” said Chris Brown, president of Vestas’ sales and service division in the U.S. and Canada. “This project will be its first deployment in the important Texas market, where the combination of a robust design, outstanding grid support, and a large rotor make this turbine the best choice to minimize the cost of energy throughout the

life of the project. We’re very happy to add this latest agreement to our growing strategic relationship with SunEdison.”

108 MW SUPPLY ORDER RECEIVED FOR U.S. PROJECT

Vestas has also entered an agreement to supply turbines totaling 108 MW for a project in the U.S. Vestas will provide 54 of its V110-2.0 MW model wind turbines for the project.

The customer, project name, and location were not disclosed at the request of the customer. Turbine delivery is expected for the third quarter of 2016, with commissioning set for the following quarter. The contract includes supply and commissioning of the wind turbines, as well as a five-year customized Active Output Management service agreement. ↗

— Source: Vestas

GAMESA CHOSEN AS TURBINE SUPPLIER FOR NC WIND FARM PROJECT

OEM will supply 208 MW for Iberdrola’s Amazon Wind Farm U.S. East

Gamesa recently announced that Iberdrola Renewables has placed a firm order for Gamesa to supply 208 MW for the Amazon Wind Farm U.S. East in North Carolina.

Under the terms of the agreement, Gamesa will provide supply, transportation, construction supervision, technical guidance and commissioning of these 104 G114-2.0 MW turbines at the Amazon Wind Farm US East, located in Perquimans and Pasquotank counties, North Carolina. Turbine deliveries are expected to begin in Q2 of 2016, with the project to be commissioned before the end of 2016.

This project is the first utility-scale wind farm in North Carolina. The power generated by the wind farm, enough to power more than 61,000 US homes, will be supplied exclusively to an Amazon data center.

“This agreement reinforces Gamesa’s presence in the United States and strengthens the long-standing relationship we have with Iberdrola Renewables globally and in North America,” said Gamesa’s CEO in the US, Borja Negro. He added: “This large order for our G114-2.0 MW, one of our most competitive models, was possible thanks to our technological leadership, our local know-how and our credibility with our customers.”

The order is the largest order placed to date in the U.S. for the G114-2.0 MW, which is designed to yield more power, at lower cost, at low and medium wind speed sites. Gamesa has already signed orders for the supply of close to 1,500 MW in markets as diverse as Sweden, Uruguay, the US, Poland and Brazil.

With this order, Gamesa will have supplied approximately 2,300 MW of installed capacity to Iberdrola Renewables in the United States. Gamesa has a long and substantial presence in the United States, where it has installed more than 4,000 MW.

— Source: Gamesa



SIEMENS RECEIVES 402-MW ORDER FOR GERMAN OFFSHORE PROJECT

Deal includes record 15-year service and maintenance agreement



Siemens will supply, install and commission 67 of its 6-MW direct drive offshore wind turbines with a total capacity of 402 MW at the Veja Mate Offshore wind power plant in the German North Sea. Veja Mate Offshore Project GmbH, a company owned by Highland Group Holdings Ltd, Copenhagen Infrastructure II, a fund managed by Copenhagen Infrastructure Partners and Siemens Financial Services (SFS) have now come to a final investment decision. This confirms the collaboration that had been started with a public signing at the EWEA Offshore trade show in Copenhagen in March. Also included is a 15-year service and maintenance agreement, representing the largest ever wind service order for Siemens in Germany and the second largest globally.

Siemens will provide a highly advanced offshore service logistics concept, tailored specifically for far-shore projects such as Veja Mate that uses both helicopters and a specially designed, purpose-built service operation vessel (SOV). It will be the fifth SOV to be deployed by Siemens in European waters. To ensure increased energy production this concept allows maintenance work to be carried out at almost all times irrespective of the weather conditions or wave height.

The project in German Waters is located in the North Sea northwest of Borkum island at 115 km from the shore. It will be installed at water depths ranging from 39 to 41 meters. With average wind speeds of more than 10 meters per second at a hub height of 80 meters

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above sea level, the site offers excellent conditions for a high energy yield. Grid access will be provided by BorWin2, a HVDC grid connection also built by Siemens. BorWin 2 was handed over to operator TenneT early this year and is already in commercial operation. Its 800 megawatts capacity encompasses the grid connection for both Veja Mate and also the Global Tech I offshore wind farms.

The financing is being provided through a combination of equity and debt, with SFS working in partnership with Highland Capital Group and Copenhagen Infrastructure Partners in the multi-source project financing structure. SFS is investing a substantial amount as equity and thus contributes a notable piece to the overall project funding. ↵

— Source: Siemens

NORDEX TO INSTALL 10-MW TURNKEY WIND FARM IN FRANCE

Nordex SE has received a new order via its project development division in France. The customer is Saméole and the manufacturer will be installing four Gamma N100/2500 turbines for its Ondefontaine wind farm. The order includes the delivery of the turbines, their turnkey installation and long term service for the wind farm. In addition, Nordex developed the project in close collaboration with its customer Saméole.

Ondefontaine is situated near the north-west coast of France in the Basse-Normandie region, an area with a moderate amount of forest cover.

Nordex started construction work on the project in June and it is due to be connected to the grid in May 2016. Following commissioning, the manufacturer will support the wind farm for a period of 10 years on the basis of a premium service agreement. The turbines are able to supply more than 6,500 households with green electricity.

Nordex has more than 10 years of experience in developing wind projects in France. Saméole similarly has a strong local presence, and is able to contribute a lot of knowledge about the region to the project. The developer currently runs nine wind farms in France.

— Source: Nordex



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PRODUCT

WINDTALKER COLD WEATHER TURBINE CONTROL ANEMOMETER



Nor-Cal Controls is releasing a new product which will increase efficiency and reduce costs to wind project owners and operators. The WindTalker-1000 is an innovative smart relay device designed to allow any existing sensor to integrate seamlessly into an existing wind turbine control platform, no matter the age, type or communication characteristics of the Programmable Logic Controller (PLC). Nor-Cal Controls partnered with Lufft, manufacturer of the VENTUS ultrasonic wind sensor, to provide a state of the art, turnkey wind sensor replacement solution resistant to the elements as well as time.

The need for a device like this arose from discussions with countless wind turbine operators and owners. Wind sensors are required for each wind turbine installed in order to correctly point the turbine into the wind. The turbine's wind sensor only affects optimal performance of the turbine, but is a safety measure as well. As the sensors age, they often need replacing. Not only are mechanical wind sensors prone to repair and replacement, but they also require regular calibrations, costing time and money. Often, owners are not able to choose a sensor appropriate to their

installation because of the limitations of communication with the PLC. The WindTalker-1000 removes these barriers.

Traditional wind sensors can be liable to mechanical break down and require periodic repair and/or replacement. This is due to moving mechanical parts such as traditional cups and vanes. Mechanical parts sometimes accumulate rust, scale or other substances that can impede movement. In cold climates ice or rime is likely to build up on a sensor causing breakdown or highly inaccurate readings.

The WindTalker-1000 solution combines the intelligence of a smart relay device with the robustness of the VENTUS wind sensor. The result is a wind sensing system that is a direct replacement to older, end-of-life sensors, providing the end user with a highly accurate, maintenance free system that will far exceed previous operable lifetimes of older technology sensors.

Nor-Cal Controls, located in Diamond Springs, CA, is a fast growing company founded in 2005 by Robert Lopez that offers complete automation solutions for the power generation industry.

— Source: Lufft USA

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GE PLANS WIND EDUCATION CENTER IN CHINA

Site to offer technical and safety training for Chinese wind market



GE has announced that it will build a new wind education center in Shenyang, China. The approximately 500-square-meter facility will be built on the same campus as GE's current manufacturing operation in Shenyang. Located in the largest city of Liaoning Province, the new education center will offer a variety of training courses intended for GE field personnel, customer technicians, subcontractors, and other external stakeholders.

"As our business continues to grow globally, we're proud to be investing in the future of the Chinese wind industry," said Anne McEntee, president and CEO of GE's renewable energy business. "We are fully committed to this important region, and the addition of more local, technical training will help our customers continue delivering high-quality, reliable power to China in the years ahead."

Courses offered at the wind education center in Shenyang will focus on topics like wind turbine maintenance, troubleshooting and environmental health and safety (EHS). EHS training at the new center will adhere to common standards set by the Global Wind Organization (GWO). The center will also offer some non-technical skills training courses including sessions on leadership, strategy and career development.

Construction of the wind education center is scheduled to begin later this year, and the facility is expected to open in early 2016.

— Source: GE

Maintenance Profile

Avanti Wind Systems

For more than three decades, these wind energy pioneers have remained true to their core mission — safe work in wind turbines

By Stephen Sisk

Wind energy is a natural breeding ground for high-tech startups seeking to lend their technological expertise to an industry continually seeking to optimize operations to lower costs. In an industry this young, the long-term pioneers are becoming increasingly difficult to find.

Bucking that trend is Avanti Wind Systems, which for more than 30 years has been serving the global wind energy industry by providing its broad portfolio of wind turbine ascent products, tower internals, fall protection, and personal protective equipment, as well as inspection, certification, and training services.

The company has embraced technology and innovation in the development of its products and services throughout those three decades, but is determined not to do at the expense of its primary, underscoring mission: Safe Work in Wind Turbines.

That's not to say that Avanti wasn't a startup itself. It was ... 130 years ago. The company was founded in 1885 in Copenhagen, Denmark, as a producer of wooden ladders. While the company still produces ladders today, its evolution and entry into the wind energy industry began in the 1980s as a supplier of aluminum ladders.

Expanding its wind energy industry portfolio, the company has since introduced its lines of fall protection systems, service lifts, and climb assist products.

SERVICE LIFTS & CLIMB ASSIST

Avanti offers several different service lift solutions based on technologies that are commonly preferred in the wind industry. Those include a





wire-guided system, a ladder-guided system, and a rack-and-pinion system. The trio of offerings allow for choice of configurations to meet customer needs.

“Depending on the layout inside of the tower, there may be one system that is preferred over another system,” said Kent Pedersen, general manager for Avanti Wind Systems. “So we offer the three most commonly used technologies in the wind industry.”

According to the company, service lifts are generally accepted as the safest method for technicians to ascend and descend a wind tower. Using service lifts nearly eliminates the safety risks that technicians would face through climbing.

Additionally, service lifts also contribute to overall operational efficiency by increasing the number of ascents allowed over traditional ascent methods.

“We’re hearing from our customer base that repetitive climbing is a concern,” Pedersen said. “Another concern is tension among service technicians operating in a safe work environment where you’re not putting your body through strenuous situations, either during very cold weather or during very warm weather.”

Some sites only allow a certain number of daily climbs into the tower for each technician, depending on the tower height and other factors, Pedersen said.

“With a service lift there really is no limitation to how many towers you can enter each day,” Pedersen said. “thereby providing a safe work environment as well as an efficient work environment with a focus of keeping the uptime or the availability as high as possible.”

Avanti also offers a climb assist system, which works in conjunction with traditional climbing methods. This system utilizes a rope on an endless loop stretching the length of the ladder and controlled by a motor. As the technician starts to climb, a control box senses and adjusts to the user’s climbing speed.

TOWER INTERNALS

Beyond tower ascent, the company is also heavily involved in supplying wind turbine owners with necessary

components used on the interior of wind turbine towers. As a means of 'one-stop shopping,' these components are increasingly being supplied as master tower internals kit sets containing components from ladders and fabricator platforms all the way down to zip ties and decals, and often include up to 2,000 line items. In recent years, Avanti has established factories in both the U.S. and China in order to produce its wind turbine tower internals. The company has sold more than 500 of its tower internals kit sets to date in the U.S. alone.

INSPECTION & CERTIFICATION

Drawing on the company's long-standing expertise in the design, manufacture, and implementation of service lifts, ladders, and other safety equipment, Avanti's safety services and inspection division offers turnkey installation, inspection, and certification of wind turbine tower safety components and systems.

These services help ensure that a wind farm owner's tower safety systems and components are properly installed and maintained primarily for personnel safety, and also in accordance with jurisdictional regulations.

Avanti recently introduced an inspection and certification program aimed at wind farm operators that provides a simple, comprehensive program for tower maintenance and regulation compliance. Known as Avanti ONE, the program carries the 'one-stop shop' philosophy of its tower internals kit sets over to tower inspection and maintenance.

The goal of the program, which according to the company "includes inspection, maintenance/repair, and certification of up to 18 different safety components typically found in a wind tower," is to maximize turbine availability by performing a comprehensive set of inspection, certification, and maintenance functions at once, thus reducing turbine downtime required by visits from multiple contractors.

"Avanti ONE is similar to our tower internals kits in that it's a one-stop shop program," Pedersen said. "It's an all-encompassing safety inspection and

certification that would only interrupt the turbine one time when we walk in there and hereby saving the customers both mobilization of multiple contractors as well as additional uptime for their turbine."

Among the components or functions covered in the Avanti ONE program are: service lift and guard rail compliance, tower stairs, ladders, fall arrest, anchor points, fire extinguishers, emergency lighting, rescue kits, first aid stations, cabling, grounding systems, edge protection, door filters, and chain hoists.

In contracting with wind farm operators for these services, the company can schedule Avanti ONE during a season of low wind to further reduce adverse effects on production yield. Additionally, many owners may choose to schedule Avanti ONE services prior to their turbines' end-of-warranty period to ensure safe operations prior to taking over service from the OEM.

TRAINING & E-LEARNING

Avanti's commitment to safety goes beyond providing the equipment used to create a safe work environment. The company also provides safety training to ensure that a wind farm owner's employees or contractors have the knowledge and ability to safely operate Avanti's product line. Additionally, the company offers courses on health and safety, first aid, fall protection, rescue and evacuation, and fire precautions.

"We have trainers on staff," Pedersen said. "They go out and provide training, not just in North America, but all over the world. We offer different types of training programs in addition to how to install, operate, troubleshoot and evacuate Avanti's own products."

A recent addition to Avanti's training portfolio is a unique platform called Avanti E-Learning. Developed and offered in conjunction with Virtual Lab, the program allows participants to take training courses from anywhere in the world, avoiding excess travel and associated costs.

The E-Learning program combines online instruction with a realistic, 3-D Personal Computer Simulation that uses interactive gaming technology

to provide a hands-on learning experience without actually being at a turbine site.

"The E-Learning is a way for our customers and users to obtain necessary training," Pedersen said. "Instead of going out on site to a wind farm where they have to pay mobilization, demobilization, and interrupt the turbines' availability, the site can now instruct technicians to ensure that they have all this training taken care of before they show up at the site."

Trainees can take advantage of the E-learning platform wherever they have access to a desktop or laptop computer — from their home, office, or even a hotel room. All the user has to do is log in to the system, pay the course fee, and begin the training. E-Learning courses closely mirror the training that the student would receive through site-based training courses.

"The difference is that the online training is what we call 'consequence training,'" Pedersen said. "As the user is taking a test, any mistakes that are made carry consequences. For example, if you don't attach to your fall protection system, then you end up falling off the ladder, which could happen in real life."

In the event that a trainee fails one of the tests on the E-Learning platform, he is presented with a different set of questions upon re-taking the test. This safeguards against memorization and preserves the integrity of the learning experience, considering the critical nature of personal safety.

Advances in wind turbine technology, most notably increasing tower heights, are paving the way for the wind energy industry to expand into geographical regions that were once not even considered. Avanti Wind Systems is poised to parallel the evolution of the industry as it has for the past three decades — carrying out its mission of Safe Work in Wind Towers up every step along the way.

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GETTING TO GRIPS WITH WIND LIDAR TECHNOLOGY

Although remote sensing has gained widespread acceptance, misconceptions still exist

By Evan Osler



Photos courtesy of Renewable NRC Systems

Today, more than 1,000 wind Lidars of all types are being used globally for wind energy applications alone — a number that has roughly doubled in the past three years. As a general trend, Lidars have been adopted quite rapidly by the wind energy industry. We estimate that at least 80 percent of large wind farm developers and operators in North America are now utilizing wind Lidars within their businesses. Despite the maturation and widespread use of this technology in the wind sector, however, we continue to hear numerous misconceptions about it.

SELECTING THE RIGHT LIDAR TECHNOLOGY

Lidars are used for a variety of purposes, including commercial wind resource assessment, power performance testing, turbine output optimization, and calibration of wind forecast and turbine wake models.

Selecting the right remote sensing tool (ground-based, nacelle-mounted, vertically profiling, 3D scanning, etc.) depends on the particular type of application and benefits that are needed. There are a host of remote sensing products available to the wind energy industry today; they are

not interchangeable, and they serve a wide range of applications at a variety of price points. For instance, Lidar and Sodar are fundamentally different technologies, and industry acceptance of Lidar specifically seems more than ever to be weighted towards particular Lidar types and brands rather than to all such devices for sale with “Lidar” in their name. The lesson, as always, is to do your own research and consult unbiased, independent experts when considering the acquisition of a Lidar system for wind energy purposes.

Lidars are not a substitute for met



masts — It is important to know that ground-based Lidars can rarely reduce the duration of a pre-construction wind resource assessment (WRA) campaign, and they should not be expected to replace met towers in WRA any time soon. Lidars are deployed in concert with met towers as a means to reduce vertical (shear) and horizontal (topographic) measurement and resulting energy estimation uncertainty. Met towers still provide an economical (especially in the Americas), well-understood, and widely trusted measurement method with built-in redundancies, while Lidars are easy to relocate within projects and between projects. Both met towers and Lidars have unique advantages that make them likely to serve as

complements for years to come.

Power performance testing — With regard to power performance testing, some Lidars have proven to be very useful. Forthcoming revisions to the IEC 61400-12-1 standard on power performance testing will codify the use of remote sensors for this purpose for the first time, as a complement to short masts in simple terrain sites for the calculation of rotor equivalent wind speed (REWS). That said, Lidars are already being used in many power performance tests — some of them contractually based and others for operational assessment purposes only. Many savvy wind farm operators have discovered that operational power curve testing is a worthwhile and cheap investment

compared to undertaking a formal IEC test, and it may yield similar if not more valuable results.

Decreasing fatigue loads — Contrary to general belief, the majority of nacelle-mounted Lidars installed today are not actually used to control the turbines they are installed on. Many turbine OEMs are expected to incorporate Lidar technology into future turbine designs to decrease fatigue loading and therefore drive large reductions in material costs. Permanent installation of Lidars on already operating turbines for control purposes, however, may not deliver as much benefit. The primary benefits of retrofitted nacelle Lidars are realized within a short period of installation: accurate turbine performance



assessment and the detection and correction of suboptimal settings in yaw, pitch, etc.

A COST-EFFICIENT SOLUTION TO LOWER THE COE

Lidar systems are nowadays available at a wide range of price points. Generally speaking, there is a good correlation between Lidar price and level of performance and industry acceptance. Even the most expensive Lidars will provide a highly positive return-on-investment if they are used smartly, and the ROI will often be a lot quicker than for lower cost systems due to greater capabilities and higher industry acceptance. When the cost of purchasing tall met towers is considered along with the cost of relocating them multiple times, the purchase of a highly accurate and robust Lidar system (located either on the ground or a turbine nacelle) appears as a very sound investment by comparison. Plain and simple, Lidars allow the wind energy industry to understand, characterize, and harness its own fuel source with more certainty and intelligence than ever before. Used properly, they also lessen the overall cost of wind farm

development and operation.

Bankability — Certain ground-based Lidars are fully “bankable” for pre-construction wind resource assessments, with independently assessed measurement uncertainties on par with those of industry-standard, calibrated cup anemometry. It is important to assess the relative bankability of a specific Lidar system rather than assume that all systems are equivalent in this regard. Furthermore, bankable data can only be collected when the Lidar is used in a proper manner, following best practice guidelines. Just as a met tower with improper placement or configuration will provide low quality data, so will a Lidar sited or configured incorrectly.

ROBUST AND EASY TO DEPLOY

Low power consumption — Ground-based Lidars have often been wrongly accused of consuming a lot of power. Many assume that they require bulky, fossil fuel-burning, off-grid power supplies with high maintenance and refueling costs. However, ground-based Lidars like the WINDCUBE v2 actually consume very little power most of

the time (45 W nominal), and they are relatively easy to power off-grid with PV panels and batteries alone.

In very cold and/or cloudy environments, different solutions might be recommended including propane fuel cell power, which operates quietly and very efficiently. That said, our customers have deployed WINDCUBEs as far north as central Ontario, Canada, on 100 percent PV solutions with good success. This is not to say that all ground-based Lidars have low power consumption and can be practically powered by PV. It is important to consider the potential power supply sizing and cost as part of the overall cost of ownership of a ground-based Lidar, as even small differences in power consumption can lead to large differences in power supply system design, service, or refueling intervals.

A high-end technology designed for the outdoors — While wind Lidars are highly technical systems as a general rule, most are actually quite easy to use and only a day or less of training is required to convert a new user into a highly competent one. This is not to say that all Lidars are easy to use; there are exceptions to every rule, and in this case, the exceptions are generally older vintage systems and newer systems that scan in three dimensions. 3D Scanning Lidars have unlocked amazing new potential in wind measurement, but they also require significant expertise on the hardware and data analysis side.

In addition, commercial Lidars are fairly robust devices, no less so than other ruggedized, high-end electronics designed to work outdoors. We advise our customers to treat their wind Lidars like expensive digital cameras — with proper care, but without fear. ✎

— Source: Renewable NRG Systems

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BNSF LOGISTICS ACQUIRES TRANSPORTATION TECHNOLOGY SERVICES

Multi-modal service provider broadens wind fixtures portfolio and rail capabilities



Transportation Technology Services

BNSF Logistics, LLC, an international multi-modal logistics service provider, recently announced its acquisition of Transportation Technology Services, a widely recognized leader in engineering and logistics services focused on rail solutions for over-dimensional cargoes with particular expertise and market presence in the wind energy industry. The transaction follows other wind energy investments, including BNSFL's Blade RunnerSM technology investments, which are research and development efforts focused on the emerging longer dimensional aspects of the wind energy market. Since its founding in 2001 as a rail engineering company,

TTS has evolved to become a highly respected provider of specialty services ranging from railcar design to loading, inspection and management of complex project cargo shipments.

"TTS's engineering and design capabilities, extensive wind fixtures, and rail transload locations coupled with their talent, and market expertise in industrial products are a perfect fit for our broader expansion into the industrial products sector that handles freight of all sizes. When combined with our existing multi-modal and transload capabilities, BNSFL becomes a leader in North America in multi-modal capacity and ability for

the Industrial Products sector," said BNSFL president Ray Greer. "The innovation and value we will be able to bring to our customers just increased significantly."

Currently managing a fleet of nearly 2,000 rail cars for various clients, of which 1,200 are equipped with patented fixtures designed to handle wind turbine components including blades, tower sections and nacelles, TTS is a significant addition to the more than 9,700 rail shipments BNSF Logistics currently manages. With the ongoing development of BNSFL's Blade Runner technology to handle ever lengthening turbine blades via ocean and rail, the com-



bined company will have an extensive and flexible fleet of wind component handling systems in North America. Between the two companies, BNSFL and TTS have collectively developed and managed nearly 50 unique project cargo transload sites across the U.S. over the past six years.

Scott Landrum, TTS's founder and president added, "The TTS team is excited to have the resources and support of BNSF Logistics and their team to enable us to expand further in offering our customers the best solutions and greatest value for managing complex shipping needs anywhere in the world."

TTS will become the U.S. Rail, Project Cargo and Engineering Services division for BNSFL. The combined unit will have extensive capacity, hundreds of years of combined practical experience and strong relationships and credibility with the major players in Wind Energy, Power Generation, Oil & Gas, Heavy Machinery and the EPC and Manufacturing communities.

BNSF Logistics' stated vision is: To be a premier, global, multi-modal logistics services and solutions provider serving North American clients here and around the world. The company has been moving forward, developing organically and through acquisition to achieve that vision. TTS's strong competencies, industry standing and customer confidence in wind energy logistics, rail services for over-dimensional and project cargo, as well as their deep engineering and design capabilities address organizational and service portfolio needs within BNSF Logistics. With a dozen engineers and

design specialists on staff and a field services team of similar size, TTS has strong expertise in areas that are critical to effectively planning and executing over-dimensional freight movements by rail.

Scott Landrum and John Dalman, TTS's General Manager, are continuing with the new organization in key senior leadership roles with the new Rail, Project Cargo and Engineering services division of BNSF Logistics. The company is well-positioned with existing staff, and also expects to support the current growth trend by making additional hires in the months ahead. Additional terms and conditions of the transaction are not being disclosed. ✎

— Source: BNSF Logistics

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GIVING WIND DIRECTION

David C. Cooper
Publisher
david@msimktg.com
ext. 200

Chad Morrison
Associate Publisher
chad@msimktg.com
ext. 202

EDITORIAL DEPARTMENT

Stephen Sisk
Editor
editor@windssystemsmag.com
ext. 209

Anna Claire Howard
Associate Editor
annaclaire@windssystemsmag.com
ext. 204

SALES DEPARTMENT

Glenn Raglin
National Sales Manager
glenn@windssystemsmag.com
ext. 204

Mike Barker
Regional Sales Manager
mike@windssystemsmag.com
ext. 203

Tom McNulty
Regional Sales Manager
tom@windssystemsmag.com

CIRCULATION DEPARTMENT

Teresa Cooper
Manager
info@windssystemsmag.com
ext. 201

Kassie Boggan
Coordinator
kassie@msimktg.com
ext. 207

Jamie Willett
Assistant

DESIGN DEPARTMENT

Shane Bell
Creative Director
design@windssystemsmag.com
ext. 206

Michele Hall
Graphic Designer
michele@windssystemsmag.com
ext. 211

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P. O. BOX 1987 • PELHAM, AL 35124
(800) 366-2185 • (205) 380-1580 FAX

David C. Cooper
President
david@msimktg.com
ext. 200

Chad Morrison
Vice President
chad@msimktg.com
ext. 202

Teresa Cooper
Operations Director
info@msimktg.com
ext. 201

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NO, NOT THAT BAT SIGNAL!

UMass Amherst team developing blade-mounted ultrasonic warning device to alert bats to potential danger



USFWS/Ann Froschauer/CC BY 2.0

A team of researchers from the University of Massachusetts Amherst and Texas A&M University is developing a blade-mounted, ultrasonic whistle for wind turbines that will protect bats by warning them to stay away.

The UMass team will focus on designing and manufacturing of a whistle-like device based on a bat larynx, powered by air flowing over the wind turbine blade. Researchers plan to test the whistle design on bats and create a series of devices that can effectively induce a flight avoidance response for at-risk bat species. Ultimately, the goal is to provide a reliable, cost-effective means of alerting bats to the presence of moving turbine blades as a way to lower bat mortality at wind facilities and reduce regulatory uncertainty for wind facility developers.

The project is funded by a \$250,000 grant from the U.S. De-

partment of Energy's Office of Energy Efficiency & Renewable Energy and a \$62,500 grant from the Massachusetts Clean Energy Center.

As air flows over the wind turbine blade, the device will produce a deterrence signal. The project will address the challenge of deterring bats across the entire wind-turbine rotor and test whether a pulsed noise, similar to a bat call, can act as an effective warning.

At UMass Amherst, Paul R. Sievert, environmental conservation, will direct the project. Yahya Modarres-Sadeghi, UMass Amherst professor of mechanical and industrial engineering, and collaborator Michael Smotherman, biology, from Texas A&M University, will oversee activities in their respective programs.

Also at UMass Amherst, Elizabeth Dumont, biology, and Matthew Lackner, mechanical and industrial engineering, will serve advisory

roles in connection with bat larynx modeling and whistle placement, respectively. Other members of the research team are UMass Amherst graduate student fellows Zara Dowling and Daniel Carlson who are part of the Integrative Graduate Education and Research Traineeship (IGERT) program.

These whistle devices require no external power source, should require little maintenance and will be small and cost-effective, the UMass Amherst team says. It is expected that because of the small size of these devices, they can be placed at intervals along the turbine blade.

This and other DOE funded projects are designed to remove barriers to wind power deployment and increase the acceptance of wind power technologies by addressing siting and environmental issues.

— Source: University of Massachusetts Amherst



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