JANUARY 2011

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VOLUME 3 NO. 17

RESOURCES

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Cover: LMS International

EDLETTER

Last October Nordex USA held an open house at its new assembly plant in Jonesboro, Arkansas. As Joe Brenner, vice president of production, relatesw in this month's Q&A, the turnout was the perfect antidote to the dark times brought about by the recent economic downturn. "The whole community got behind us in a way that I've never experienced before," he recalls. "Manufacturing has been decreasing, but wind is an industry that's growing, and it's bringing back jobs for individuals who didn't know when they'd be able to find work again. You could see a light in their eyes when they realized there were brighter days ahead, and it's great for us to be part of that." We're sure companies such as Vestas, ACCIONA Windpower—profiled in this issue of the magazine, with the assistance of CEO Joe Baker—and many others have enjoyed this same experience in building manufacturing facilities in the United States, and we're pleased to start off the New Year with such positive news to report.

As for our editorial lineup, Brian MacCleery of National Instruments promotes a fascinating potential energy source in "The Advent of Airborne Wind Power," describing how his company's technology is utilized to provide dynamic condition monitoring, and Jay Holman of IDC Energy Insights discusses relatively non-intrusive techniques for "Increasing Transmission Capacity." Pam Neal of the Portland Development Commission makes clear how an active manufacturing base and progressive business environment play critical roles in developing a healthy wind market in "Portland's Plan for Progress," and Jennifer Schlegel of LMS International has contributed "Beyond the Borders of Wind Energy," explaining how NREL is harnessing the company's LMS Test.Lab to perform modal testing on next-generation wind power systems. Along the same lines, Eric Leafquist of Dassault Systèmes SolidWorks points to technologies such as its 3D CAD tools as a means of achieving innovation in "Designing Better Wind Systems," and Joe Gallione of Loop Belt Industries outlines their new telescopic truck-mounted conveyor belt system for delivering concrete to tower foundations in "Providing Concrete Evidence."

I'd like to welcome two new columnists to our pages. Sven Schmidt, Ph.D., of the wind-energy program at The Pennsylvania State University, has written an excellent first installment of his technology column, and Graham Brisben—president of Professional Logistics Group—provides insights on the logistical challenges faced by the wind industry. James Hussin of Hayward Baker discusses chemical grouting for reducing soil settlement in his construction column, and Merritt Brown of Rev1 Renewables suggests regular cable maintenance in order to avoid expensive downtime.

It's a true pleasure for us to have the opportunity to learn so much from acknowledged experts while producing each issue of the magazine, and we want to hear from you as well. Let's help each other succeed in 2011! All best:

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PUBLISHED BY MEDIA SOLUTIONS, INC.
P. O. BOX 1987 • PELHAM, AL 35124
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AWEA Educational Workshop Series | Spring 2011

We strive to create and deliver educational events that capture the energy of the rapidly expanding wind market and offer necessary opportunities for organizations to learn and network with fellow wind professionals.

The revenue generated from AWEA events is used to advance the wind industry through policy analysis and promotion, to ensure wind industry interests are addressed in renewable energy legislation, to communicate the benefits of wind energy to all. ONLY AWEA puts your dollars to work advancing the wind energy industry. **Join us at our upcoming events!**

AWEA Project Performance & Reliability Workshop

January 12 – 13, 2011 ▸ San Diego, CA

AWEA Wind & Transmission Workshop

February 9 – 10, 2011 ▸ Omaha, NE

AWEA Wind Power on Capitol Hill

February 15 – 16, 2011 ▸ Washington, DC

AWEA Wind Power Project Siting Workshop

March 1 – 2, 2011 ▸ Kansas City, MO

AWEA Wind Power Supply Chain Workshop

March 24, 2011 ▸ Little Rock, AR

AWEA Wind Power Finance & Investment Workshop

April 7 – 8, 2011 ▸ New York, NY

For More Information: **www.awea.org/events**

NEW FLOOR-TYPE BORING MILL FROM MAG

MAG's new FTR 3500 floor-type horizontal boring mill (HBM) is a versatile, mid-sized job-shop machine, capable of a full 2 m reach inside parts with a ram-supported spindle. The workhorse machine tool is ideal for "heavy metal" milling, as well as precision multi-axis contouring, boring, drilling, and tapping on large parts for the construction, oil field, and wind energy industries.

The machine's collinear ram, made from ductile iron, adds a 1-meter W-axis reach to the spindle's existing 1-meter extension. It provides maximum rigidity for full-power cuts by minimizing spindle extension. The ram's 400 x 500 mm cross section is ideally sized for extended reach with rigid support to enable the machine to perform additional operations, helping to reduce time-consuming large-part setups for faster cycle times and less work-in-process. The machine's ram displacement compensation system uses a hydraulically actuated tension rod system to counteract the static loads of attachments, and control ram displacement caused by variations in ram extension and attachment weight. Like all MAG boring mills, the FTR 3500 includes W and Z-axis thermal compensation software to dynamically offset spindle growth.

The FTR 3500 is available in column heights of 2 to 5 meters (6.6 to 16.4 ft) in half-meter increments. Traveling-column design allows virtually unlimited X-axis travel for processing of large and long workpieces or multiple batch parts, while 20 m/min (787 ipm) rapid traverse rates reduce cycle times. The choice of spindle power trains includes two four-speed versions available with spindle diameters of 130 and 155 mm (5 and 6 in). Available horsepower is 56 kW (75hp). Modular design allows economical customization of the FTR 3500, along with industry's fastest machine build and delivery. The machine can be fitted with choice of travels, headstocks, spindle diameters and spindle power, controls, coolant systems, workholding and tool magazines. Front-end options include a range of indexing and rotary tables, auxiliary slides and floor plates. An optional attachment rack enables storage and quick change of contouring heads, programmable boring bars, right angle heads and more to speed production. Optional

Companies wishing to submit materials for inclusion in this section should contact Russ Willcutt at russ@windsystemsmag.com. Releases accompanied by color images will be given first consideration.

cartridge-style ram allows for a fixed attachment or attachment changing operations.

MAG is a leading machine tool and systems company serving the durable goods industry worldwide with complete manufacturing solutions. Key markets served include aerospace, automotive and truck, heavy equipment, oil and gas, rail, solar energy, wind turbine production and general machining. With manufacturing and support operations strategically located worldwide, MAG offers comprehensive lines of equipment and technologies including process development, automated assembly, turning, milling, automotive powertrain production, composites processing, maintenance, automation, and software, and core components. Go online to www.mag-ias.com.

AWEA ANNOUNCES NEW DISTRIBUTED WIND ASSOCIATION

The American Wind Energy Association (AWEA) announces the formation of the Distributed Wind Energy Association (DWEA), which will focus on advocacy and education to promote the on-site generation and consumption of distributed wind energy. The new coalition will have a national scope and will be lead by Jennifer Jenkins as executive director.

DWEA will expand the efforts of AWEA, which include producing an annual statistical report and advocating on the state and federal levels for distributed wind—small and mid-sized turbines that generate enough electricity for a home or business. DWEA also joined AWEA as an event partner in the second annual AWEA Small and Community Wind Conference and Exposition last December.

Distributed wind systems create local jobs, reduce operating expenses, protect against electric rate hikes, save fuel, and reduce pollution and energy imports. The 2009 market data showed the industry reached 100MW of installed capacity, more than $80 million in sales, and more than $250 million in private equity investment. The industry is growing at a healthy rate and business prospects are improving. This is in large part due to the industry's successful pursuit of the 30-percent federal tax credit introduced in 2009. "This group can bring additional focus to a promising sector of the wind industry that is many peoples' first encounter with wind energy," says AWEA CEO Denise Bode. "As homeowners, landowners, and small businesses look for ways to diversify their energy choices, distributed wind can be a very appealing way to obtain clean, American-made electricity."

AWEA is the national trade association of America's wind industry, with more than 2,500

member companies, including global leaders in wind power and energy development, wind turbine manufacturing, component and service suppliers. Learn more by visiting www.awea.org or www.smallandcommunitywindexpo.org.

GURIT RENUVO BLADE REPAIR SYSTEM SECURES INDUSTRY CERTIFICATION

Gurit, a leading global supplier of composite materials and technical solutions, has secured approval from one the world's leading certification bodies for its new blade repair system, RENUVO™. Launched at Husum Wind Energy 2010, it has secured Germanischer Lloyd Certification (GL). Rudolf Gerber, general manager wind energy, says that "Achieving GL certification is an important milestone in the market acceptance of this new technology, which is a key component in our strategy to reduce the cost of wind energy."

The RENUVO blade repair system offers a fresh and novel approach to the many of the practical issues that have prevented more effective and expedient maintenance programs. Addressing damage arising from production, transportation and in-field use, the RENUVO system provides the solution. A wider weather window for repair has been achieved by the working temperature range starting at +5˚C. Traditional wet laminating materials must normally be used above +15˚C as they can suffer from bi-product and handling issues. Summer- and winter-grade versions of the RENUVO MPS (Multi-Purpose System) and RENUVO PP (Prepreg) are available to cope with most conditions.

The RENUVO product range has transformed the conditions for repair by using UV light from the RENUVO lamp technology to cure materials in minutes. A spot lamp is available for simple maintenance repairs with a higher intensity product available for deeper structural repairs using RENUVO PP. Both lamps are available exclusively from Gurit. Benefits include: over 50 percent reduction in structural repair time; low odor, zero VOC resin; styrene and amine-free; extended weather window for repair from +5˚C; zero

post-cure for repair; and compatibility with all types of blade construction including prepreg, epoxy infusion, and polyester infusion. The Certificate is published on the Germanischer Lloyd Web site. Also visit www.gurit.com.

SSB SERVICE BECOMES AVAILON

SSB Service, Inc., is now Availon, Inc., following changes in the parent company, Availon GmbH. The new name derives itself from "availability" and "on," reflecting the company's commitment to being available for its customers and keeping their turbines available.

"As a global market leader, our promise of availability demands that we are always poised for response," according to CEO Ulrich Schomakers. "That means faster turnaround times, more maintenance services, greater availability of spare parts and components, more secure investments, and new turbine upgrades. Our goal as a global service provider is to be more available to our clients in every way which, in turn, improves their wind turbine productivity."

Availon remains a primary supplier of SSB Wind Systems and SSB Duradrive parts. However, the renaming denotes a clear separation from these companies. SSB Wind Systems provides electrical systems for wind turbines, and SSB Duradrive manufactures specific drive solutions. "Our new name provides better emphasis on our core offering, which is independent wind turbine maintenance services for the international market," says Schomakers.

Availon specializes in parts and services for GE and Vestas turbines, but can often service other turbine types. In addition to being a primary supplier for SSB and Duradrive parts, Availon is also an exclusive vendor for Bachmann, Leonard+Bauer, and Convertech parts. The Availon global portfolio includes spare parts supply and management, end of warranty inspections, individual turbine optimization, turbine upgrades, field services, remote monitoring, and operations and maintenance.

"Broadening the types of turbines we're able to service is one more way we can help customers," Schomakers says. "With a more expansive network, we can continue to reduce response and traveling time. We can use worldwide synergies and resources for further rapid development, while maintaining a high level of customer service. Since our formation in 2007 we have grown rapidly, but thoughtfully. Our customers appreciate our commitment, our competence and, just as importantly, our independence."

Availon, Inc., is a part of the Availon GmbH family, which has more than 170 employees worldwide with business units in the United States, Germany, the Netherlands, Spain, and Italy. Currently Availon operates throughout North America and Europe, but is expanding into other regions as well. Visit online at www.availon.com.

MORTENSON EXECUTIVE NAMED TO CANWEA BOARD

During the Canadian Wind Energy Association's (CanWEA) annual conference in Montreal recently, Brent Bergland—construction executive with Mortenson Canada Corporation—was elected as a member of the 2011-2013 board of directors. Chosen by industry peers, he was one of five newly elected directors to the 12-member board. Mortenson is the sole engineering and construction representative on the board.

"Being elected to the CanWEA board of directors amongst a group of established peers in the Canadian wind industry is great step for Mortenson," Bergland says. "I believe that it provides us the assurances Mortenson is being recognized for the role we are playing in Canada and also the benefits our collective North American wind experience brings to the CanWEA board. I am truly humbled and honored with this election."

CanWEA is the voice of Canada's wind energy industry, actively promoting the responsible and sustainable growth of wind energy on behalf of its more than 450 member companies. A national non-profit association, CanWEA serves as Canada's leading source of credible information about wind energy and its social, economic and environmental benefits.

Bergland has gained extensive wind development exposure, design management, and technical project management experience in the wind industry. He takes a wind power developer's concepts and turns them into detailed engineering and execution plans. Since the beginning of 2002 he has been fully dedicated to the wind power industry. To date, his wind power experience includes 35 projects totaling in excess of 3,500-megawatts. He has direct involvement with approximately 1,300 megawatts of wind projects that are located in five provinces throughout Canada.

"As a representative of one of the leading EPC contractors directly involved and 100-percent dedicated to the Canadian wind industry, I have the passion to be a key contributor to the CanWEA board," Bergland says. "I represent not only the role of a service provider to the industry, but bring a great appreciation for the opportunities and challenges that face our developer/owners, turbine manufacturers, regulators, policy makers, and communities."

Mortenson Canada Corporation, one of Canada's largest construction firms dedicated to renewable energy, provides efficient, quality solutions to meet the demanding needs of its customers throughout Canada. Founded in 2004, Mortenson Canada Corporation, a sister company of M.A. Mortenson, leverages the collective experience and expertise of Mortenson's Renewable Energy Groups, which has built nearly 100 wind power projects throughout North America since 1995. The company offers a complete range of services, including program management, preconstruction, engineering, EPC contracting, general contracting, and construction management. For more information visit www.mortenson.com/wind.

PORTABLE NIKON SHUTTLEPIX FOR RECORDING HIGH-RESOLUTION IMAGES

Nikon Metrology, Inc., announces the release of its new ShuttlePix P-400R digital microscope, made for inspection, observation, simple measurement, and recording of high-resolution images. For on-site analysis of samples it serves as a handheld microscope that shoots high-resolution images as quickly and easily as taking pictures with a digital camera. For stationary use, the ShuttlePix microscope interfaces seamlessly with a motorized stand. With the equipped 17-inch touchscreen monitor the user can easily control, display, measure, or print images. The microscope also connects to a standard PC or laptop running dedicated 3D image reconstruction software.

"The versatility of the ShuttlePix system means the user can bring the microscope to large samples, such as an aircraft frame, turbine casting, or pipe work that often cannot be reached with a standard microscope," says Bob Wasilesky, senior vice president of Nikon Metrology. "The unique ShuttlePix technology supports a wide range of inspection tasks in automotive, electronics, aerospace, and other industries. In combination with its imaging capabilities, it's a very versatile, extremely useful piece of equipment."

The ShuttlePix addresses the market need for an easy to use device that magnifies samples and can record and save images as digital files. Nikon combined its technological excellence in optical technology with its expertise in digital image processing technology to enable the creation of the ShuttlePix. The stand is equipped with a motorized Z, which does not require a PC for control. Operation of the stand is simple, allowing extended depth of focus (EDF) image capture with the touch of a button. ShuttlePix offers a 20x zoom with a magnification range of 20x– 400x on a 17-inch monitor, which is double that of competitors' models. For optimal lighting, the zoom head has built in four-section LED ring illumination.

Nikon Metrology offers the most complete and innovative metrology product portfolio, including state of the art vision measuring instruments complemented with optical inspection and mechanical 3D metrology solutions. These reliable and innovative products respond to the advanced inspection requirements of manufacturers

active in consumer, automotive, aerospace, electronics, medical, and other industries. Call (810) 220-4360 or go to www.nikonmetrology.com.

WIND SYSTEMS APPLIES FOR BPA WORLDWIDE MEMBERSHIP

Wind Systems magazine has applied for business publication membership in BPA Worldwide. *Wind Systems* is published by Media Solutions, Inc. BPA Worldwide will track circulation for the magazine based on business/distribution, demographics, and geographic coverage. Media Solutions will have 12 months to complete its initial circulation audit.

"The magazine's strong growth in the wind industry has made this a perfect time to apply for membership with BPA Worldwide," says David C. Cooper, publisher of *Wind Systems* and president of Media Solutions, Inc. "Embarking on this time- and capital-intensive project stands as proof of our commitment to our recipients and advertisers alike."

A not-for-profit organization since 1931, BPA Worldwide is governed by a tripartite board comprising media owners, advertising agencies, and advertisers. Headquartered in Shelton, Connecticut, BPA has the largest membership of any media-auditing organization in the world, spanning more than 20 countries. Worldwide, BPA serves over 2,500 media properties including more than 2,000 B-to-B publications and more than 600 consumer magazines and newspapers, plus events, Web sites, e-mail newsletters, databases, wireless and other advertiser-supported media. The organization has more than 2,600 advertiser and agency members.

For more information on BPA Worldwide—including the latest audit reports, membership information, and publishing and advertising industry news—go to www.bpaww.com. To learn more about *Wind Systems* visit the magazine's Web site at www.windsystemsmag.com.

BROADWIND ENERGY NAMES NEW PRESIDENT AND CEO

Broadwind Energy, Inc., announces that Peter C. Duprey has been named president and chief executive officer of the company, effective December 1. He will also serve on Broadwind's board of directors.

Duprey, 53, is a veteran of the renewable energy industry, most recently serving as chief executive officer of Acciona Energy North America. J. Cameron Drecoll, Broadwind's chief executive officer since October, 2007, is retiring, but will provide technical advice and transition support under a consulting

agreement. "Peter is the right person to lead Broadwind through the challenges and opportunities of the evolving wind energy market," according to Broadwind Chairman David P. Reiland. "He offers the vital mix of skills and renewable energy experience needed to build upon Broadwind's strategy to be the preferred provider of integrated solutions for global wind and energy customers."

Since 2006 Duprey served as president and chief executive officer at Acciona Energy North America and led Acciona Energy's dramatic growth in wind development and operations, turbine manufacturing, and solar in North America. Prior to joining Acciona he was general manager of marketing for GE Energy's wind business, and he led GE Energy's business development efforts in renewable energy, including the acquisition of Enron Wind. Duprey's early career included business development and financial management positions at Eastman Kodak and Price Waterhouse Coopers. Duprey holds a bachelor's degree in accounting and finance from Clarkson University in Potsdam, New York, and an MBA from the University of Rochester in New York.

"I'm delighted to join the Broadwind team," Duprey says. "The long-term prospects of the global wind market remain promising, and Broadwind offers customers an unmatched and unique portfolio of products and services. I look forward to working with the company's capable, dedicated employees to grow shareholder value as we meet the evolving demands of a global customer base."

"We thank Cam for his leadership in bringing the Broadwind model to life and wish him the best in his retirement," Reiland says. "Cam's passion for wind, his gearing expertise, and his commitment to Broadwind and its customers, employees, and stockholders has steered the company through this tough market. We are pleased to be able to continue to draw on Cam's experience in future months."

Based in Naperville, Illinois, Broadwind Energy provides technologically advanced high-value products and services to the U.S. wind energy industry. The company's product and service portfolio provides customers—including wind turbine manufacturers, wind farm developers and wind farm operators—with access to a broad array of wind component and service offerings. These product and service offerings include wind turbine gearing systems, wind turbine structural towers, industrial products, technical services, precision repair and engineering services, and logistics. For more information go online to www.bwen.com.

GAELECTRIC RAISES FUNDS TO BOOK U.S. TRANSMISSION CAPACITY

Renewable energy and energy storage group Gaelectric has announced that it has successfully raised $18 million to book 960 MW of transmission capacity for its wind energy developments in Montana. Gaelectric North America says the funds raised have been placed on deposit with transmission system operators, Bonneville Power Administration (BPA) and North Western Energy (NWE), to book transmission capacity on their networks with power expected to flow in the period 2014-2016.

"The funding we have announced today will enable Gaelectric to advance the development of key sites in Montana with power delivered via the Bonneville Power Administration network and NorthWestern Energy networks," according to Éamonn McGrath, president. "States like Montana, which have high quality wind regimes and that have historically confronted sizeable transmission development barriers, will now reap that value in a shorter timeframe. A recent study undertaken by E3 (Energy and Environmental Economics), experts in planning, policy, and markets in California and the West, found that of 12 states located across the U.S. western seaboard, Montana had the lowest levelized cost of energy production from wind. Furthermore, we believe the United States' pursuit of a clean renewable energy future will soon break the logjam, which will mean that the policy environment is going to catch up with wind energy developers' expectations."

Gaelectric is a group of companies founded in 2004 with assets in Europe and the U.S. Each Group company is active in different fields of renewable power generation and energy storage with experienced teams specialized in all aspects of project planning, permitting, finance, engineering, and management. Gaelectric is active in Northern Ireland, the Republic of Ireland, and North America, where it operates regional development offices. In 2006, Gaelectric North America opened its offices in Great Falls, Montana, and now employees 15 people in its overall North American operations. In Montana it has secured circa 250,000 acres under options in high wind resource areas, and has a medium term objective of bringing up to 2000MW of wind generation capacity to shovel ready stage. Learn more at www.gaelectric.ie.

NEW PRESIDENT AT NAES POWER CONTRACTORS

NAES Corporation, a broad-based provider of services to the power generation industry, announces it has hired Dale Withers to assume the role of president of NAES Power Contractors, Inc., effective January 1, 2011. NAES PC is a wholly owned subsidiary of NAES specializing in construction, maintenance, and refurbishment projects that support the energy sector in North America. NAES PC focuses its talents on several key businesses, which include fossil fuel generation; hydroelectric and renewable generation; substations, switchyards and electrical balance of plant; and spent nuclear fuel cask on-site construction. NAES PC provides

services ranging from specific contracts to long-term system-wide arrangements with all field-based projects employing AFL-CIO building trade's personnel.

Withers' background includes 40 years of experience in construction and construction management in the petroleum, chemical, and power generation industries throughout the United States, Middle East, North Africa, and South America. He was previously employed by Alliant Energy, Brown & Root, and Foster Wheeler, holding senior management positions in each. NAES, headquartered in Issaquah, Washington, is the generation industry's largest independent, third-party provider of operations and maintenance services, and also serves the industry with specialized support services, gas and steam turbine inspections, mechanical shop repairs, and the placement of technical personnel. Go online to www.naes.com.

METHODS EXPANDS ILLINOIS TECHNICAL CENTER

Methods Machine Tools, Inc.—a leading supplier of innovative machine tools, automation, and machine tool accessories—has brought Imad Tsay onboard as the new general manager of its Elgin, Illinois, Technical Center. Mike Land will be joining Tsay as the new sales manager. "We are pleased to have Imad and Mike take on management of the Elgin facility," according to Bryon Deysher, president and CEO. "Imad and Mike both bring decades of experience—Mike started out as a tool and die maker, and Imad as a service and applications engineer—and their experience and their success in machine tool sales and sales management is the reason they were chosen to lead the Elgin team."

Methods' Elgin Tech Center is being expanded in response to the company's success at IMTS last September. Methods sold over 50 machines there, including almost all of the machines on display at its booth. Application engineers and service personnel are also being added to the Elgin facility to meet the increasing demand for Methods' brands. The facility can provide complete turnkey installations and cellular automation for the full line of Methods metal cutting and EDM machine tools.

Methods Machine Tools has been a leading supplier of precision machine tools, automation, and machine tool accessories for over 50 years. For more information call (978) 443-5388, e-mail sales@methodsmachine.com, or visit www.methodsmachine.com.

INTERNATIONAL WIND MARKETING ALLIANCE LAUNCHED

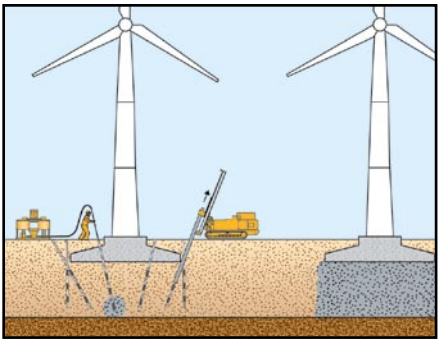
A European marketing and public relations firm and two North American companies have formed the Wind Marketing Alliance to provide branding and marketing strategies and services that connect wind energy clients to new and established markets on both continents. The companies are Lorenz Kommunikation, Grevenbroich, Germany; Fredricks Communications, West Fargo, North Dakota; and Advertising Marketing in Fargo. They

Continued on page 59 >

James Hussin
Hayward Baker, Inc.

A proven technique for stopping or reducing settlement, chemical grouting is an effective, cost-efficient alternative to complete reconstruction of the foundation system.

WIND TOWERS FOUNDED on spread footings may settle as a result of loose bearing soils either not identified during the preconstruction geotechnical exploration or remaining after inadequate subgrade preparation. Loose granular soils may also be susceptible to liquefaction during a seismic event, which may result in excessive settlement or complete foundation failure. When wind towers are founded on loose granular soils, chemical grouting may be the correct solution for providing long-term support. Chemical grouting is also commonly used to solidify granular soils beneath a structure for both underpinning and excavation support when an adjacent excavation is to take place.



Chemical grouting is a permeation grouting technique that transforms granular soils into sandstone-like masses, by permeation with a low viscosity grout. The most common permeation grout for structural applications is sodium silicate. The grout is injected under pressure through previously installed pipes. The grout permeates the soil and solidifies it into a sandstone-like mass. The grouted soil has increased strength and stiffness, and reduced permeability. Common chemical grouting applications are to underpin existing foundations, create excavation support walls, create water cutoff walls, and stabilize soils for tunneling. Chemical grouting is available as a design-build service by specialty contractors. A thorough geotechnical investigation should be performed prior to design of a chemical grouting program to help to ensure proper injection hole geometry and grout selection. The equipment is relatively small, and therefore suitable for use on sites with restricted access.

Chemical grouting uses injection pipes known as Tube-a-manchette (TAM) pipes to deliver the grout. TAM pipes are typically 2-inch diameter steel pipes with injection ports every few feet along the length of the pipe. Rubber sleeves (manchettes) cover each injection port and serve as one-way valves that open during injection and collapse onto the ports after injection. The TAM pipes are installed in boreholes in a designed pattern beneath a foundation to allow injection beneath the entire foundation footprint. Depending on site access, TAM pipe inclinations can range from vertical to horizontal to create a treatment zone. Once the TAM pipes have been inserted into the borehole, the space between the TAM pipe and borehole wall (annulus) is filled with a weak but stiff grout that seals and stabilizes the borehole and holds the TAM pipe in position. A pneumatic packer is then pushed into the TAM to a specified injection point. Rubber seals at each end of the packer are hydraulically inflated to isolate the injection port. The initial pressure of the chemical grout breaks through the annulus, permitting it access to the soil.

The volume of chemical grout needed to solidify a zone of granular soil is calculated by predicting the shape of the grout flow from the injection point determined by the subsurface conditions. In uniform granular soils, the grout typically flows radially from each port to create a spherical grouted shape. Based on a spherical flow model and the soil void ratio, the required maximum design volume can be calculated.

An effective quality control program requires that all stages be monitored and fully documented. Installation of the sleeve port pipes is monitored to ensure proper alignment. An experienced grout technician should monitor the grout manifold's optical flow meters and pressure gauges during grout injection and record the injection data for each location: pipe number, date, sleeve number and elevation, grout volume, and pressure and flow readings. A geotechnical engineer should review the data to verify the formation and stability of the grouted mass.

Chemical grouting with sodium silicate grout was first used over 100 years ago. Since then, it and many other formulations have been used to strengthen granular foundation soils for structures including bridge and tower piers, utilities, pads, and high- and low-rise buildings throughout Europe and North America. Wind tower construction can take advantage of this effective, cost-efficient alternative to complete reconstruction of the foundation system.

James Hussin is a director for Hayward Baker, Inc., the leading specialty foundation and ground improvement contractor. He can be reached at jdhussin@haywardbaker.com. Go online to www.haywardbaker.com.

Merritt Brown
Rev1 Power Services, Inc.

Protecting turbine cables is vital, and at each maintenance interval sufficient time must be given to their care in order to avoid unnecessary—and expensive—downtime.

ONE OF THE MOST COMMON findings from a wind turbine inspection is broken cable ties, which results in abrasion to cable insulation, and perhaps ultimately cable failure. These inexpensive nylon fasteners are used in nearly all wind turbines to secure power and control cables into proper position, and provide the necessary "wire management" of the structure. While their rather simplistic design makes them a likely choice for assembling a turbine cable system, fatigue, exposure to UV or extreme temperatures, and chemical degradation have a negative effect on their useful life. One broken cable tie can produce a very undesirable rub point for a critical cable, leaving the turbine at risk of looming downtime that may take weeks to recover from.

PLACEMENT IMPORTANT

In wind turbine design, there is limited space available for electrical components. Cables pass through foundations, cabinets and panels, up and down the tower, through the nacelle, from the generator, and into and out of the hub. Assembling cables through these transition points requires design considerations that understand how the cable might be affected by the operational and vibration forces of the turbine. As the dynamic response of a wind turbine structure to the imposed loads affects the rotor, the power train, and the tower, where cables are placed is just as important to how they are fastened to the structure.

Failure of wind turbine cables falls into at least five categories that include insulation damage, corkscrew deformation, jacket abrasion, jacket swelling from oils or chemicals, and shielding loss due to breaks from continuous bending. Protecting turbine cables is vital, and at each maintenance interval sufficient time must be given to replacing broken cable ties, untwisting bundles, retightening pinch blocks, and installing cable protection along sharp edges of transition points. Common errors can be avoided through education and attention to detail. Unintentional assembly techniques are a prime cause of later failures, assembling groups of cables and inadvertently exposing an adjacent cable to the sharp ratchet end of a cable tie, for example. Another oversight lies with the installation of fiber optic cable within the turbine. Industry does not recommend the use of cable ties for securing fiber optic cables due to the common tendency toward over-zealous cinching, possibly compromising performance or in severe cases causing fiber breakage due to the high level of pressure exerted on the fiber. If cable ties must be used instead of the Velcro fasteners provided by a few manufacturers for this application, care should be given to cross-tying the fiber cable to the attached bundle.

> "Recognizing the areas where cable failure is likely and taking precautions to limit damage is essential in order to minimize unexpected production downtime."

Many of us have also seen the result of a cable twist counter that didn't quite do its job. While yaw counters are typically reset upon finding excessively twisted cables, repeated occurrences are likely due to improper drip loop length that was established during construction. Ultimately leading to premature failure due to the corkscrew effect, this issue is easily recognized by deformation of the cable in this area and can only be mitigated by a controls change or reinstallation of the cable itself. During each inspection, verifying proper drip loop length is another simple maintenance activity that can increase the longevity of a turbine's life.

AVOIDING DOWNTIME

Though cable ties are one of the least expensive options for securing wind turbine cables together, replacing a cable can be one of the more expensive repairs to make if it fails due to insulation damage. Recognizing the areas where cable failure is likely and taking precautions to limit damage is essential in order to minimize unexpected production downtime. Understanding the cable installation requirements also increases the likelihood that your O&M team will continue to use sound maintenance techniques that will save time and money later.

Merritt Brown is vice president of Rev1 Renewables, an energy services company supporting wind, solar, and biomass clients worldwide. To learn more call (866) 738-1669 or go online to www.rev1renewables.com.

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Sven Schmitz, Ph.D.
Penn State Wind Energy

Penn State offers an emerging educational and research program in wind energy, and it is aiming to become a major contributor to research excellence in the U.S. wind industry.

THE UNIVERSITY PARK campus of The Pennsylvania State University is the home of emerging research and educational activities in the field of wind energy. The Commonwealth of Pennsylvania is fostering its position among the leading "wind states" in the Northeastern United States, and since 2004 has been aiming to meet 8 percent of the state's energy needs with Tier I renewables such as wind energy by 2021. Additionally, with a good local wind resource and incentives provided by the state government, there are a growing number of wind companies locating in the state. Individual researchers at Penn State started investigating wind-related topics several years ago. Faculty members from across campus interested in wind energy organized the "Pennsylvania Wind Energy Symposium: Power for the Future" in late 2008. The first fulltime faculty position in wind energy was filled this year in the Department of Aerospace Engineering. It is one of 25 new faculty positions at Penn State in energy science, engineering, and policy cosponsored by an academic department and the Penn State Institutes of Energy and the Environment. Current activities include:

Wind for Schools Program: This program (www.wind.psu.edu/wfs) is part of DOE's Wind Powering America (www.windpoweringamerica.gov) and supports wind energy education at K-12 schools across the state. Additionally, the program initiated the formation of a Penn State Wind Application Center, which focuses on wind energy education within the university as well as providing outreach to the surrounding community. The goal is to install three to five wind turbines at K-12 schools across the state while integrating wind energy activities into the curriculum, as well as promoting wind workforce development within the university. For more information contact Susan Stewart at sstewart@psu.edu.

Short Course in Wind Energy: A unique curriculum was developed for a 32-hour short course in wind energy engineering, offered for the first time this November. A total of 11 lecturers from seven departments and institutes at Penn State provided and presented the course material. Topics included wind resources, mesoscale modeling, turbine dynamics and aerodynamics, grid connection, tower design and foundation, icing on wind turbine blades, acoustics, experimental methods, drive trains, design and analysis methods, and more. Stewart, listed previously, can provide more information.

Graduate Certificate in Wind Energy Engineering: The wind industry is seeking an educated workforce, so Penn State is developing courses that will constitute the basis for a graduate certificate. This effort is led by the Department of Aerospace Engineering as part of a DOE grant. Two new courses to be offered in the spring of 2011 include a junior-level course titled "Wind Energy Engineering and Projects" and a graduate course in "Wind Turbine Aerodynamics." Another graduate course anticipated for fall 2011 is "Engineering of Wind Power Plants," which will involve all the aspects that are important to the design, operation, and maintenance of future wind power plants. Several online courses are also planned. For more information contact George Lesieutre at g-lesieutre@psu.edu.

Wind Turbine Field Test Facility: Students in the Department of Aerospace Engineering have about three years of experience with the operation and field measurements of a 3.5 kW Southwest Windpower Whisper 500 wind turbine. The field test facility is located in Penn State's Center for Sustainability (www.cfs.psu.edu). Two new small wind turbine system installations are planned in support of the Wind for Schools and Center for Sustainability programs, as well as to upgrade fielding testing. Furthermore, students are designing and manufacturing their own wind turbine blades that will soon be tested in the facility, and health monitoring studies are underway. To learn more contact Dennis McLaughlin at dkm2@engr.psu.edu.

Research in Wind Energy: Penn State offers a wealth of expertise to conduct cutting-edge research in wind energy. Close interaction between faculty in the College of Engineering, the College of Earth and Mineral Sciences, and the Applied Research Laboratory has initiated research activities transversing the areas of mesoscale modeling, wind siting over complex terrain, acoustics, icing on wind turbine blades, turbine blade interactions with the atmospheric boundary layer, composite materials, and offshore systems. Expertise in Computational Fluid Dynamics (CFD) plays an integral part in many of the current activities. For more information contact me at the phone number or e-mail address listed below.

Sven Schmitz, Ph.D., is an assistant professor in the Department of Aerospace Engineering at The Pennsylvania State University and a member of its Wind Energy program. Call (814) 863-0778, e-mail sus52@engr.psu.edu, or go to www.wind.psu.edu.

Graham Brisben
Professional Logistics Group, Inc.

U.S. wind market undulations cause ripple effects in transportation, so understanding recent history can help guide logistics planning and procurement going forward.

AS CONSULTANTS IN THE AREA of wind component logistics, we are often asked to provide a market overview for clients. The challenge, of course, is that the market is constantly changing. In order to optimize component logistics in today's environment it's useful to understand the recent history of wind component logistics in North America and how the larger wind energy market trends affect transportation.

RECENT HISTORY

The U.S. wind energy "boom" began in 2005, the first year in which new capacity installations exceeded 2,000 megawatts (MW). The industry went on to enjoy a nearly fourfold increase in annual new installations, reaching 8,366 MW added by 2008. For logistics providers, and specialized trucking carriers in particular, this rapid growth resulted in tight capacity, strong pricing power, and returns far exceeding other types of trucking. Companies paying the freight bills, usually turbine OEMs, responded by exploring mode flexibility not only to mitigate high trucking costs but also as a hedge against capacity constraints.

By 2009 approximately 35 percent of wind component miles were being handled via rail, primarily as a result of the efforts of Tier 1 OEMs—GE, Vestas, and Siemens—to leverage their outsized volumes, logistics teams, and resources in the transportation market. These sophisticated shippers were better equipped than their smaller competitors to develop the necessary processes and methods for serial use of rail and barge transportation in North America.

A turbulent period for the U.S. wind industry began in the fall of 2008 when the credit crisis caused a freeze in bank financing for wind farm projects. Quick action at the federal level brought about the DOE's Investment Tax Credit program, extending a lifeline to the industry and allowing for continued growth in installations to reach a record 10,000 MW in 2009. However, this growth was partly a mirage, reflecting the playing out of legacy Turbine Supply Agreements. It was also a case of the "rich getting richer," with Tier 1 OEMs securing much of the new growth due to their ability to provide turbine financing for developer customers.

The impact in the transportation market was immediate: An anticipated capacity crunch in trucking assets was abated, the result of numerous project cancellations coinciding with the increased use of alternative modes by the Tier 1 OEMs. The importance of this latter factor cannot be overstated, since it was the Tier 1 OEMs who had spent much of 2007 and 2008 strengthening their multimodal capabilities and executing on strategies to shift longer distance shipments to rail.

CURRENT AND FUTURE MARKETS

At November's American Wind Energy Association Fall Symposium, forecasts for 2010 and 2011 new U.S. installations were projected at about 5,000 MW each; half of 2009's new installations. These projections are validated by the transportation market conditions of 2010, which were particularly hard on specialized trucking carriers. With trailer equipment suitable for little else than wind cargoes, many carriers were been forced to sell assets and reassign qualified drivers. For trailer leasing companies, some allowed equipment to remain on lease but "under water" on payments from carriers, not unlike what has occurred with many home mortgages in the U.S.

The ailing truck sector has not necessarily benefited railroads, however, because the overcapacity situation in trucking has resulted in significant price competition. Where railroads could once consistently offer a 25-40 percent cost savings to wind component shippers vs. truck, today the modes are often equal in cost for moves of less than 800 miles. Meanwhile, within the trucking sector, dramatic swings in pricing can be seen among carriers for the same project based primarily on whose assets are utilized and whose are not at any given time. On one recent wind farm logistics project, a 100-percent cost variance was observed between the highest and lowest bidding truckers.

The upshot for wind logistics today is that it's a "buyer's market." In wind, however, price cannot be the sole driving factor, since performance—or lack thereof—can trigger significant (20+ percent) unplanned expenses in the form of truck detention and project delays. The last few years have seen robust development of multi-modal logistics options for wind using rail and barge. As such, with tightened transport price competition, the sophisticated transportation buyer can optimize wind farm supply chain projects across all modes and carriers for cost savings and delivery reliability.

Graham Brisben is president of Professional Logistics Group, Inc., which provides transportation and supply chain consulting to the global wind energy industry. Go online to www.prologisticsgroup.com.

ACCIONA WINDPOWER

By Russ Willcutt

With more than 15 years of experience in the global wind industry, this company is making a significant investment in the North American market as well.

AS PART OF A COMPANY founded more than 160 years ago, and today a leader in manufacturing cutting-edge turbines, ACCIONA Windpower is firmly rooted in the past with an eye trained toward the future. And with years of experience in the global wind industry, the company is sharing that expertise with the North-American market.

"We wanted to be involved in the largest wind market there is, and that's here in the United States," according to Joe Baker, CEO of ACCIONA Windpower, "so in 2007 we established our third turbine assembly plant in West Branch, Iowa, with the other two located in Spain."

ACCIONA is comprised of three divisions: ACCIONA Infrastructures, which was founded in Pamplona, Spain, in 1850; ACCIONA Agua, targeting water treatment and desalination; and ACCIONA Energy, which is involved in hydro, solar, and wind-farm development, construction, and operations. Housed within this division, ACCIONA Windpower designs and manufactures 1.5 and 3MW turbines for both its parent company and third-party clients. This depth and variety of corporate resources often leads to unexpected innovations.

The first and most apparent example has to do with Windpower's position within the larger Energy division, with its vast experience in the "develop-build-operate" business model, as opposed selling the wind farms it builds to another operator. "This field experience as a utility is what led to the decision to begin designing and manufacturing our own turbines," Baker says, "because we were familiar with the turbines in operation at that time and felt we could do better. That's also an advantage when we're approaching new clients, because they know we've been in their shoes and understand their concerns and the challenges they face every day."

Another benefit of this internal synergy is that it leads to fresh ideas such as the concrete towers for which ACCIONA Windpower is known. "The Infrastructure division is involved in huge construction projects all around the world, such as the Petronus Towers in Malaysia, the Ting Kay Bridge in China, and the Central Coastal Road Network in Chile, so they pour a lot of concrete. It was during a conversation with members of this division that the idea to build concrete towers for our wind turbines was born. These towers can be formed on site, which eliminates shipping time and costs while at the same time allowing us to contribute to the local economy by purchasing our materials from community businesses and putting them to work for the duration of the project."

ACCIONA Energy-North America (AENA) also paved the way for ACCIONA Windpower to enter the market by first establishing itself as an operating utility in the States as plans to build the assembly plant proceeded. With a solar farm in Nevada and four wind farms completed and in operation—EcoGrove in Illinois, Red Hills in Oklahoma, Tatanka in North and South Dakota, and Velva in North Dakota—the company's St. Lawrence Wind Farm in New York State and Dempsey Ridge in Oklahoma are currently in development. ACCIONA Windpower also has projects in the works. The AW-3000 3MW turbine is undergoing testing for ANSI certification and is drawing a great deal of attention. Already being quoted, the AW-3000 will be available in early 2012. And its AW-1500 1.5MW turbine is one of the most rugged and dependable turbines in the world, with three configurations and less than a 1-percent failure rate on major components.

Active in Spain, Australia, Poland, and seeking to establish itself in South Africa and Brazil, ACCIONA Windpower is poised for growth in North America, with its physical presence standing as proof of its commitment. "We didn't make this decision lightly," Baker says. "Years of planning went into where we would locate our facility, and we're already working toward building a domestic supply chain, which will help grow existing businesses and even help draw new ones to the area. We are also involved in a consortium of international wind-energy companies to discuss the future of the industry, because you simply can't afford to remain static in such a vibrant, innovative market. It is our goal to help establish wind as an ever-growing component of North America's renewable energy portfolio."

Go online to www.acciona-na.com.

THE ADVENT OF AIRBORNE WIND POWER

Airborne wind is on track to become a cost effective, practical, and utility scale-ready segment of the industry. National Instruments describes its role.

By Brian MacCleery

Brian MacCleery is clean energy product manager at National Instruments.
Go online to www.ni.com.

YOU MIGHT BE AN EXPERT on conventional horizontal and vertical wind turbines, but have you heard of airborne wind? If the pace of innovation in the nascent airborne wind industry is any guide, 10 years from now "airborne wind turbines" could become a household word. Why? In most of the Northern hemisphere, just a few thousand feet above our heads blows a vast untapped resource on par with some of the best ground-based wind sites in the world. Go 10 times higher into the troposphere and you'll find the highest density source of renewable energy in the world.

Harnessing high altitude airborne wind may take some major leaps, but closer to Earth airborne wind is on track to become a cost effective, practical, and utility scale-ready segment of the wind industry within the decade. Most airborne wind companies have their sights set on the "boundary layer" winds that blow a few thousand feet above ground level. Bringing utility scale airborne wind to market at those altitudes doesn't require any breakthroughs, just solid engineering work, R&D investment, and the support and guidance of the experienced ground-based wind community.

At least 30 startups and research groups around the world are busy at work to make airborne wind a reality. An abundance of commercial off the shelf (COTS) technologies and tools are enabling them to achieve a remarkable pace of innovation. Over the years their prototypes have proven the basic principles of airborne wind and grown into the tens of kilowatts. The next step for the indus-

try leaders is to prove their systems can perform reliably during long-term continuous operation in the field.

Airborne wind is in its infancy, but if it makes it off the ground it would help extend the reach of the wind industry to new locations where ground-based turbines aren't cost effective today. Makani Power, a well-funded leader in airborne wind, believes its Airborne Wind Turbine (AWT) technology can extend the developable terrestrial wind resource area by five times, to over 80 percent of the U.S. land surface. Paired with ground-based turbines, airborne wind promises to help keep the power lines humming by reducing the variability of production, and by "going vertical" to extract more energy from a given land area.

INNOVATION THROUGH ASSIMILATION

Airborne wind borrows many established technologies from the rest of the wind energy industry, sometimes even using the same type of generators, gearboxes, and grid-tied power converters. Table 1 compares similarities and differences between ground-based and airborne turbines. The main feature that makes airborne turbines different is the way they extract energy from the wind. Instead of a large steel tower structure, a tether cable anchors the system to the ground. Rather than rotating blades, specially designed airfoils sweep a path across the sky to extract energy.

This ability to sweep through a larger cross section of the sky is one of the fundamental attractions of airborne wind, enabling a modestly sized airfoil to extract large amounts of energy from the stronger, more-consistent winds found higher above ground. Like the tip of a conventional turbine blade, the airfoil flies crosswind in a circle or figure-eight pattern at many times the speed of the wind, as shown in fig. 1.

Airborne and ground-based turbines operate on much the same aerodynamic principals. Just like conventional wind energy, power production is proportional to one-half the air density times the cube of wind speed (equation 1).

$$P_o \propto \frac{1}{2}\rho_{air} \cdot v^3{}_{wind}$$

Equation 1: Like conventional turbines, the power output of an airborne turbine is proportional to the cube of wind speed.

Thus, a small increase in wind speed makes a big difference in power, since doubling wind speed yields eight times more power. Like the tip of a conventional turbine blade the airfoil wing travels at high speeds through the air, using aerodynamic lift to efficiently extract energy. At a wingspan comparable in length to a wind turbine blade, an airborne turbine can sweep a larger region of the sky to access nearly 10 times more energy. Airborne turbines can also move up or down in altitude and adjust their flight path to adjust for a wide range of wind conditions. Mechanically, airborne turbines benefit from being cushioned in a pillow of air during flight rather than being rigidly connected to the ground—however, the g-force loads caused by their fast moving patterns can put significant stress on airfoil structures and tether lines.

OPERATING AT ALTITUDE

By going up above the reach of ground-based turbines, airborne machines chase the consistent and stronger wind resource at altitude. At 2,000 feet wind speeds above 8 m/s are blowing more than 40 percent of the time at most locations in the northern hemisphere. Furthermore, power densities (kW/

m²) are on par with the world's most favorable sites for ground-based wind, as illustrated in fig. 2. Thus, airborne turbines should expand the reach of the wind industry into new regions and could be located closer to population centers.

Although boundary layer winds provide the "low hanging fruit" being chased by most companies today, the most elusive prize is found in the jet stream winds of the troposphere. At 35,000 feet, average power densities soar beyond 20 kW/m² and the total available resource is measured in thousands of terawatts (TW), hundreds of times higher than world energy demand. "From an environmental perspective, getting huge terawatt-scale renewable systems is really important," according to Ken Caldeira of the Carnegie Institution of Washington at the Airborne Wind Energy Conference 2010. "The idea that airborne wind power is of the scale to meet civilization's needs is sound. Airborne wind energy is one of the few civilization scale power generation technologies."

Caldeira is a world-renowned climate scientist who has studied the potential environmental impact of extracting civilization scale power levels from high altitude wind. His models indicate that extracting 18 TW, enough energy to satisfy world energy demand, would itself have no significant impact on climate, resulting in a negligible cooling effect of 0.04 °C. Of course, switching the world to cheap, clean, carbon-free power would certainly have a positive impact on the environment.

Harnessing high-altitude wind is a bold vision but brings with it a wide range of technical and logistical challenges, from finding tether lines that are strong and light enough to gaining Federal Aviation Administration (FAA) approval and airspace clearance. Even at boundary layer altitudes, FAA permitting questions need to be resolved. At least for now, making tropospheric wind commercially viable is likely to remain elusive. Even companies with their sights set on the troposphere plan to start at more modest heights. "At 1,000 feet wind is profitable

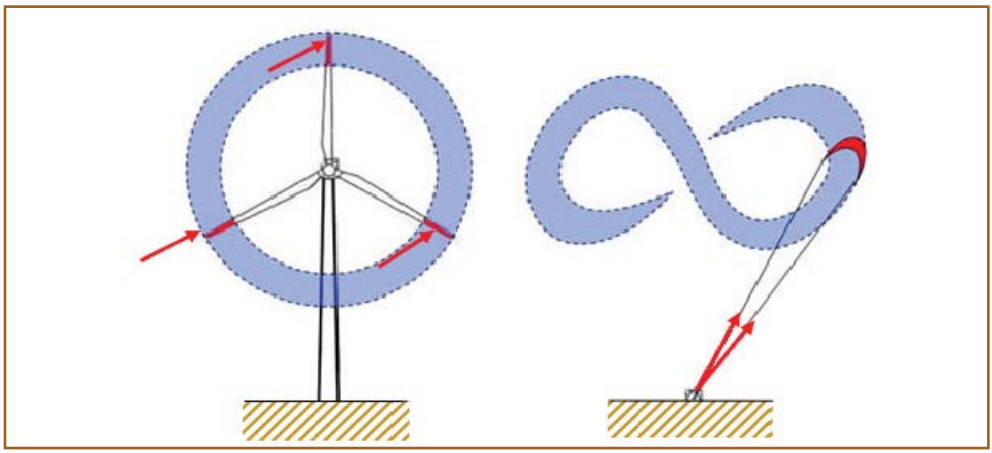


Fig. 1: Ground based turbine (left) compared to airborne turbine at right (image: KITEnergy).

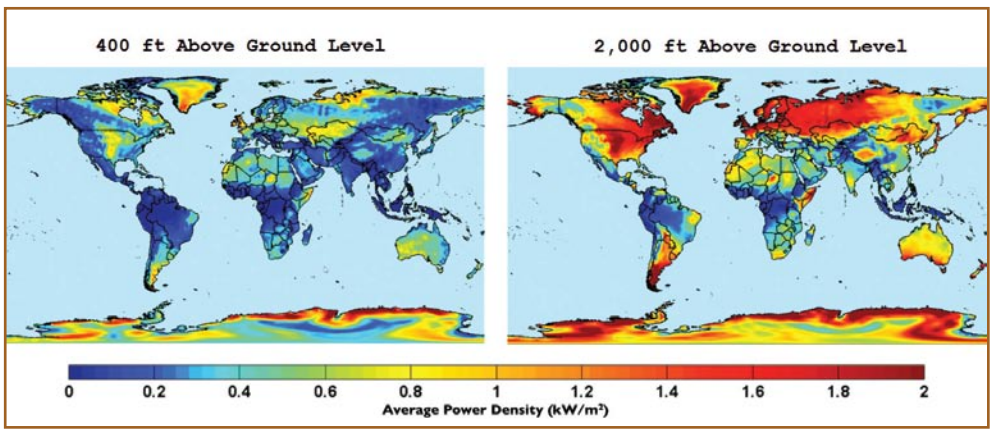


Fig. 2: Compared to 400 feet (left), at 2,000 feet (right image), most of the Northern hemisphere is suitable for wind (image: Joby Energy).

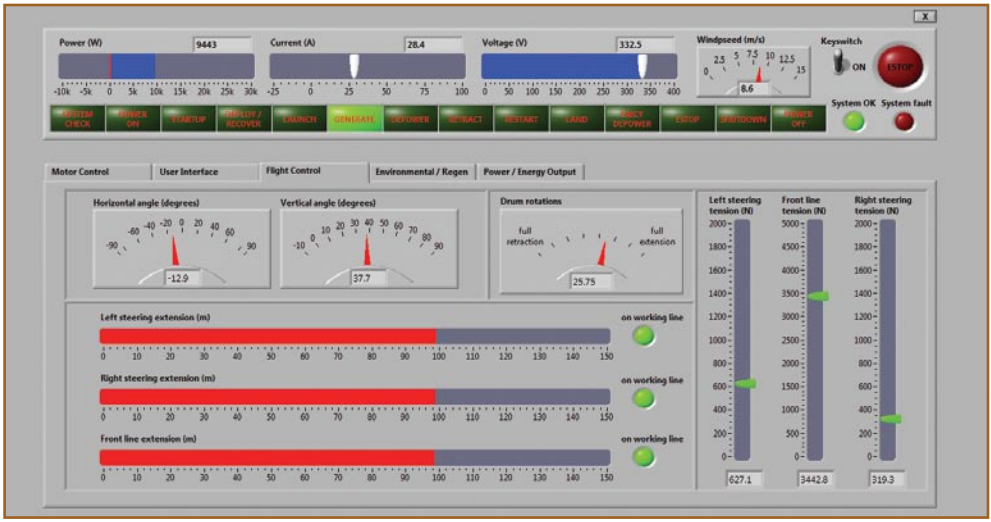


Fig. 3: A screenshot of the NI LabVIEW graphical programming software used by Windlift to control their 12 kW mobile power generation system (images: Windlift).

on 70 percent of the world," says Pierre Rivard, CEO of MAGENN Power, a company developing lighter than air generators resembling blimps that also double as floating cell phone towers.

EXPLORING THE DESIGN SPACE

Looking top down, there are three primary ways to classify airborne wind systems: 1) altitude: low, boundary layer or troposphere; 2) type of airfoil: lighter or heavier than air, rigid or flexible, drag, lift, or rotorcraft based, and; 3) generator location and type: ground or airborne, gearbox or direct drive.

Like the early days of the ground-based wind industry, researchers in airborne wind are testing every possible design choice to find out what works best. Even with computer models there's no substitute for a physical prototype. Working prototypes are also going a long way toward convincing skeptics and attracting investors. "I think people were more skeptical a few years ago, but today there are many startup companies working on this," says Archan Padmanabhan, director of business development at Joby Energy. "Over the past several years, the industry has seen many prototypes, and we've seen them growing larger into the tens of kilowatts. At Joby we started with ground-based generator designs, tested autogyro concepts, and finally moved to a winged airborne generation system with multiple rotors and power sent down the cable. Now we're exploring ways in which the wing can be structured to simplify takeoff and landing."

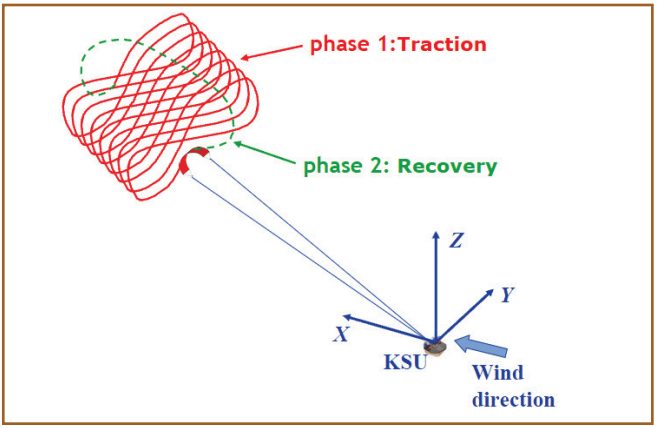


Fig. 4: KITEnergy uses a design with the generator and kite steering unit (KSU) located on the ground.

Fig. 5: The 40 kW experimental prototype, right, has been tested with tether lengths up to 3,000 ft (image: KITEnergy).

OVERCOMING TECHNICAL CHALLENGES

The idea of using a "tethered airfoil" as a way to generate power isn't new. The fundamental concepts were patented in the late 1970s and are now public domain. Lawrence Livermore National Lab researcher Miles L. Loyd pioneered the fundamental mathematical equations for airborne wind, developed computer models, and validated them with small experimental prototypes. His seminal paper, "Crosswind Kite Power," was published in the June 1980 issue of the *Journal of Energy.*

So why hasn't airborne wind reached commercial viability? The answer has to do with complexity, cost, and Moore's law. Just 10 years ago the processing, instrumentation, sensors, and control software were prohibitively expensive. Today exponential increases in embedded computing power (Moore's law), instrumentation technology, and the availability of high level, high productivity software tools and rugged embedded computing platforms enables airborne wind companies to build and test their prototypes by the dozen, using readily available COTS technology and high level software tools to shrink the time between design, prototype, and field deployment.

"Would airborne wind have been cost effective 10 years ago?" Pad-

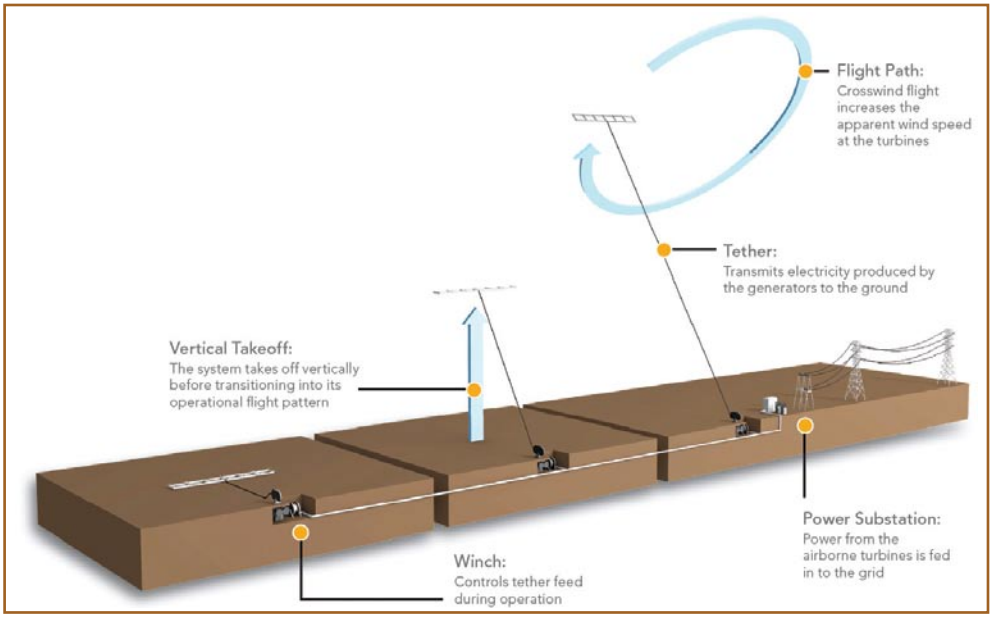


Fig. 6: Joby Energy uses an airborne generator approach capable of vertical takeoff and landing. (image: Joby Energy).

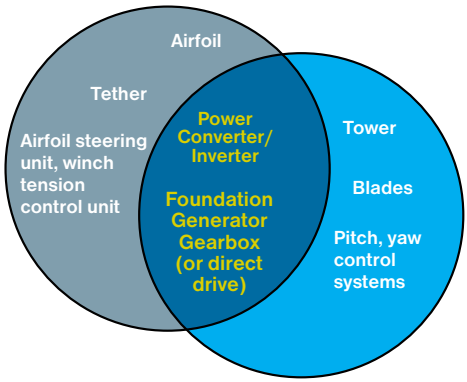


Table. 1: Airborne turbines borrow many established technologies from ground-based wind.

manabhan asks. "No. It's definitely advances in technology that make it cost effective today, from inexpensive aircraft materials to low-cost GPS sensors, autonomous flight software, and the increasing power of embedded computing. The biggest technical hurdle that's been overcome is in the area of control systems. Thanks to the aerospace industry, flight control systems have become a lot more robust than at any time before. Commercial airlines today are primarily flown on autopilot and people trust those systems—no one expects airplanes to come crashing down. The aircraft industry has a lot to offer, and we are learning from it."

Windlift, another airborne wind startup, is developing mobile airborne wind turbines that have attracted significant interest from the U.S. military because their high-power density makes them a future replacement for diesel generators and the vulnerable fuel convoys that must supply them. Windlift uses the National Instruments' LabVIEW graphical programming language and NI CompactRIO ruggedized embedded instrumentation systems for control and dynamic monitoring, as shown in the interface for their 12 kW prototype system (fig. 3). Control Design Engineer Matt Bennett explains how commercially available tools play an important role in their development. "Having a COTS real-time system is a big enabler," he says. "Actively flying the airfoil under high load is a real challenge and the NI CompactRIO system takes care of all of the signal processing and feedback control tasks required to keep the system stable. We extensively use the field programmable gate array, or FPGA, which handles tasks completely in parallel. The LabVIEW FPGA technology is indispensible. There are a lot of things it does that we couldn't do any other way."

Ground-based Generator	Airborne Generator(s)
Pros	**Pros**
• Lower cost tether cable; no need to transmit power	• Self launching; turbines supplied with power to enable vertical take-off
• Lower cost ground based generator/gearbox; can be heavy and large	• Continuous production; no need to constantly reel in and out
• Simple, low cost airfoil; steering unit can be ground based	• Small airspace requirements; fixed circular flight path
Cons	**Cons**
• Intermittent production; airfoil flown back when tether reaches maximum length	• More expensive tether; cable must transmit power
• Larger airspace requirements	• More expensive generators; must be light, high power density
• Self-launch may not be possible in low wind conditions	• Airfoil more complex; carries generators, steering unit and flight controls

Table 2: Pros and cons of airborne wind generator types.

POWER GENERATION TECHNOLOGIES

We are all familiar with the spinning blades of ground-based turbines. So how do airborne turbines generate power? Although techniques vary widely—from tethered rotorcraft to lighter than air spinning blimps—the most mundane and popular techniques leverage one of two basic principles: 1) a ground-based generator attached to the tether cable winch which produces power as the kite pulls out the cable, or; 2) a set of high speed wind-driven propellers onboard the airfoil that drive small airborne generators. Table 2 compares the pros and cons of these popular approaches.

Ground-based generator systems, like those being developed by Windlift in the U.S. and KITEnergy in Europe, produce power when the airfoil pulls a tether line. The torque and velocity of the tether cable produces electricity by spinning a generator that is attached to a rotating winch drum. As illustrated in fig. 4, there are two distinct modes of operation—the traction phase, and the recovery phase. In the traction phase the airfoil slowly pulls the tether line and electricity is produced until the maximum tether length or altitude is reached. Then the recovery phase begins, during which the airfoil is flown back while the tether cable is winched in. Recovery actually uses a small amount of power, as the generator becomes a motor drive to retract the cable. Then the process begins again.

For steering, the airfoil wirelessly transmits GPS coordinates and roll, pitch, and yaw information from an inertial measurement unit (IMU) in the air to a kite steering unit (KSU) on the ground. KITEnergy uses the National Instruments PXI platform and LabVIEW Real-Time software as the ground control unit, which acquires and processes the sensor signals and executes advanced control algorithms to command the winch motor-generator and steer the kite. "Theoretical, numerical, and experimental results so far indicate that KITEnergy technology could provide large quantities of renewable energy, available practically everywhere, at lower cost than fossil energy," according to KITEnergy founder Mario Milanese.

Other companies, such as Joby Energy and Makani Power, are pursuing airborne generator designs. In this case a number of small propeller-driven generators located on the aircraft are used for power generation, and power is sent down the tether cable to the ground. Airborne generator systems are typically more like an aircraft and less like a kite, featuring an onboard computerized autopilot system and flight control surfaces to control roll, pitch, and yaw like elevators and ailerons. A great deal of engineering effort at airborne wind companies is focused on perfecting these flight control systems and making them robust to any sort of problem, from gusting winds to actuator and sensor failures. The Makani Power system is being designed so it can even disconnect from the tether and land autonomously if needed. Any control or aerospace engineer looking for a fascinating challenge should consider working in the airborne wind industry. Figure 5 illustrates the salient features of the Joby Energy design, which is capable of vertical takeoff and landing and uses high-speed crosswind flight patterns to maximize energy output.

Not surprisingly for such a nascent segment of the wind industry, the dust has yet to settle on which design choices prove to be the most practical and cost effective. It is way too early to call this race, but my guess is that the leading contender today is a boundary layer system with a rigid airfoil that's carefully designed to maximize aerodynamic efficiency and an onboard flight control system. Airborne wind has a way to go before becoming a mature technology, but one thing is for sure—it's an exciting time. Each new prototype that takes flight helps to convince skeptics and investors alike that above-ground wind power isn't such a crazy idea. If you're a professional in the wind industry, consider lending your talents to help airborne wind get off the ground. To learn more visit the Airborne Wind Energy Consortium Web site at www.aweconsortium.org.

PROVIDING CONCRETE EVIDENCE

A new telescopic truck-mounted conveyor belt system from Loop Belt Industries easily meets the challenges of delivering concrete to tower foundation worksites. This case study provides proof.

By Joe Gallione

Joe Gallione is director of engineering and marketing at Loop Belt Industries, Inc. For more information call (630) 552-5303, e-mail jgallione@loopbeltind.com, or go to www.loopbeltind.com.

SOON TO RISE FROM THE FERTILE CORN and soybean fields of central Illinois is the White Oak Wind Energy Center, developed by Chicago based Invenergy LLC. The 150-megawatt project located northwest of Bloomington, Illinois, will include 100 General Electric 1.5 megawatt wind turbines. Invenergy has reportedly negotiated power purchase agreements (PPA's) with the Tennessee Valley Authority, a federally owned utility, to export the wind power out of state.

PLENTY OF POWER

According to Illinois Wind Power, the electric load in Illinois is primarily served by large coal and nuclear plants that use hundreds of miles of high voltage transmission lines to deliver power to users. Wind farms can easily tie into this existing infrastructure, making wind power a valuable export commodity for rural Illinois communities. Illinois electric transmission lines are part of the PJM electric grid, a regional transmission organization that serves a market of over 50 million people in 13 states. Illinois has the strongest winds in the PJM market, which is driving a massive expansion in wind energy development. Currently over 25 existing wind energy sites are operating in Illinois, adding over 2000 mega-watts of power to the states electrical grid. Additional data show that more than 30 new wind projects are in the planning stages bringing the potential

Fig. 1: The Loop Belt LB32T4 Telescopic Conveyor Belt in road transport position.

for more than 12,000 mega-watts of installed wind power capacity in the coming years.

A typical wind farm like White Oak will have the capacity to supply power to more than 40,000 homes. Projects like these will bring thousands of new jobs, tax revenues, and other forms of economic development to the area. In recent years Chicago, with its close proximity to wind sites in the Midwest, has become the home of the wind energy industry in North America. Attracted by well-developed air, rail, and auto transportation infrastructure, several of the world's largest wind energy companies have opened offices there and now call Chicago home. Illinois-based companies such as Siemens Winergy and Trinity Structural Towers are making Illinois a leader in wind component manufacturing. Fabrication companies and machine shops in Illinois represent a strong potential for turbine component manufacturing, along with other related wind energy components and services.

White Oak's wind towers will stand about 262 feet high with a blade sweep area of 274 feet. The total overall height will be 397 feet. A typical foundation for this size turbine requires over 300 cubic yards of concrete. Foundation costs have become a significant proportion of the total cost for a wind farm and can impact the overall cost of energy. Therefore, foundation design and selection of materials, along with shorter construction times, are important economic considerations. Mortenson Construction, which is headquartered in Minneapolis, Minnesota, is responsible for the design and construction of White Oak's access roads, foundations, and erection of the turbines. Mortenson has recognized that large wind turbine foundations, with their high strength concrete requirements and limited access roads, have defined the need for high-speed, long-reach concrete placement machines.

FLEXIBLE FEATURES

Suburban Chicago-based Loop Belt Industries has developed a telescopic, truck-mounted conveyor belt system that is very mobile, making it ideal for moving to and from the foundation sites on projects like White Oak. Conveyor belts have long since proven their worth on civil projects, and Loop Belt's introduction is now proving its mettle, easily taking on the challenges of delivering low-slump concrete to wind turbine foundations. The new innovative patent-pending model LB32T4 features a welded tubular steel, four-section, telescopic main boom conveyor that easily covered the entire foundation pour area with only one setup position. The LB32T4 is mounted on an International Workstar 7500 series heavy-duty chassis and features a 350 horsepower engine and twin rear transmission power take-offs, providing robust power for the machine's hydraulic functions. Loop Belt's engineers worked closely with the specialists at International to ensure the best possible chassis specification and matchup for mounting the machine. The Workstar 7500 chassis is equipped with Internationals "Diamond Logic" electronic control system, which enables communication between the vehicle components and the Loop Belt equipment to decrease downtime, improve productivity, and optimize maintenance. The Workstar 7500 low

cab height dimension is critical, and it allows the machine to be configured for road legal transport. The LB32T4 conveyor is stored over the top of the cab in road transport position and is less than the 13'-6" allowable height dimension indicated by most states bridge regulations.

The all-steel welded boom structure is fabricated from high strength structural tubing and features a highly refined design, putting the

Fig. 2: Outriggers stabilize the truck during operation.

Fig. 3: The telescopic conveyor belt carries material to the foundation site.

Fig. 4: The equipment's design allows for an aggressive pouring schedule.

strength into the critical areas while keeping the overall weight to a minimum. In fact, the LB32T4 paired up with the International 7500 chassis weighs in at less than 54,000 pounds, requiring only three axles to be road legal. The machine's lower overall weight also results in less outrigger pad reaction forces, making the machine very stabile in a variety of jobsite conditions.

Lighter weight is a big plus when maneuvering around and setting up on wind tower foundation sites. With 100 tower foundations to pour at White Oak, Mortenson knows that scheduling and equipment availability are extremely important. The LB32T4 is robustly designed for durability and reliability as well as high-speed performance.

Project Details:

Project: White Oak Wind Farm
Developer: Invenergy LLC
General Contractor: Mortenson Construction
Subcontractor: Complete Conveyor Services
Concrete Supplier: Prairie Material
Equipment: One Loop Belt LB32T4 Telescopic Conveyor Belt, a new enhanced mobile telescopic conveyor system enters the wind energy market in the summer of 2010.

Fig. 5: Concrete is loaded from the truck into the material delivery system.

The machines vital mechanical systems are well engineered and designed for ease of service and maintenance. High quality components along with excellent craftsmanship make the LB32T4 a valuable high-performance, reliable tool for the wind tower contractor. The integral 18" (457 mm) wide conveyor belt is formed into a U-trough giving it maximum concrete delivery capacity while maintaining an exceptionally clean running operation.

All of the conveyor transition points were designed to run clean and transfer material smoothly. The Loop Belt design is equipped with fully-proportional radio remote controls, so that the operator can easily direct the flow of concrete to any spot in the pour area as directed by the finishing crew. The conveyor belt speeds are also remotely controlled by the operator to match the needs of the contractor and finishing crew from as little as 1 cubic yard per hour up to a maximum pour rate in excess of 300 cubic yards per hour.

The powered feed conveyor, also equipped with fully proportional controls, is easily positioned to receive concrete simultaneously from two ready-mix trucks. Mortenson's General Superintendent Ray Bragg was impressed with Loop Belt's speed and capacity to empty an eight cubic yard ready-mix truck in only 2 minutes allowing Mortenson to maintain their aggressive foundation-pouring schedule.

DELIVERING THE GOODS

Mortenson chose Prairie Materials of Bloomington, Illinois, as their concrete supplier. After the foundation site is excavated, a "mud slab" of 2000 psi concrete is poured to provide a stable base on which to build and pour the foundation. Heavily reinforced with steel rebar, the foundations require about 300 cubic yards of 5000 psi low slump concrete. According to Tom Lombardy of Prairie Materials, the concrete is mixed stiff, with only a 4" slump making it ideal for placement with a belt conveyor.

The LB32T4 machine with its four vertically deployed hydraulic outriggers, sets up quickly in less than 10 minutes, and easily placed the stiff concrete at a rate of four cubic yards per minute. Steve Cottongin, who owns Complete Conveyor Services, operated the LB32T4 on the White Oak Project. "I'm very impressed with the performance of this machine, especially for wind turbine foundations," he says, recognizing that the designers of the new LB32T4 have paid attention to the details of this machine and designed it for ease of operation, high performance, and with the maintenance mechanic in mind. "Being an owner/operator myself, I appreciate the simplicity and ease at which this machine can be maintained."

Conveyors are not new in the construction

world and have proven their worth and can place stone and concrete with little regard to mix type. Conveyors have poured millions of yards of concrete in dams, bridges, and wind projects as well as commercial and residential projects worldwide. Loop Belt's inventors were part of the original design of the first truck mounted telescopic conveyors, and after 30 years of working on the problems with this type of equipment have designed and built a new machine that they believe is the best working truck mounted conveyor to handle mass amounts of stone and concrete fast, clean, and with pinpoint accuracy.

FUTURE DEVELOPMENTS

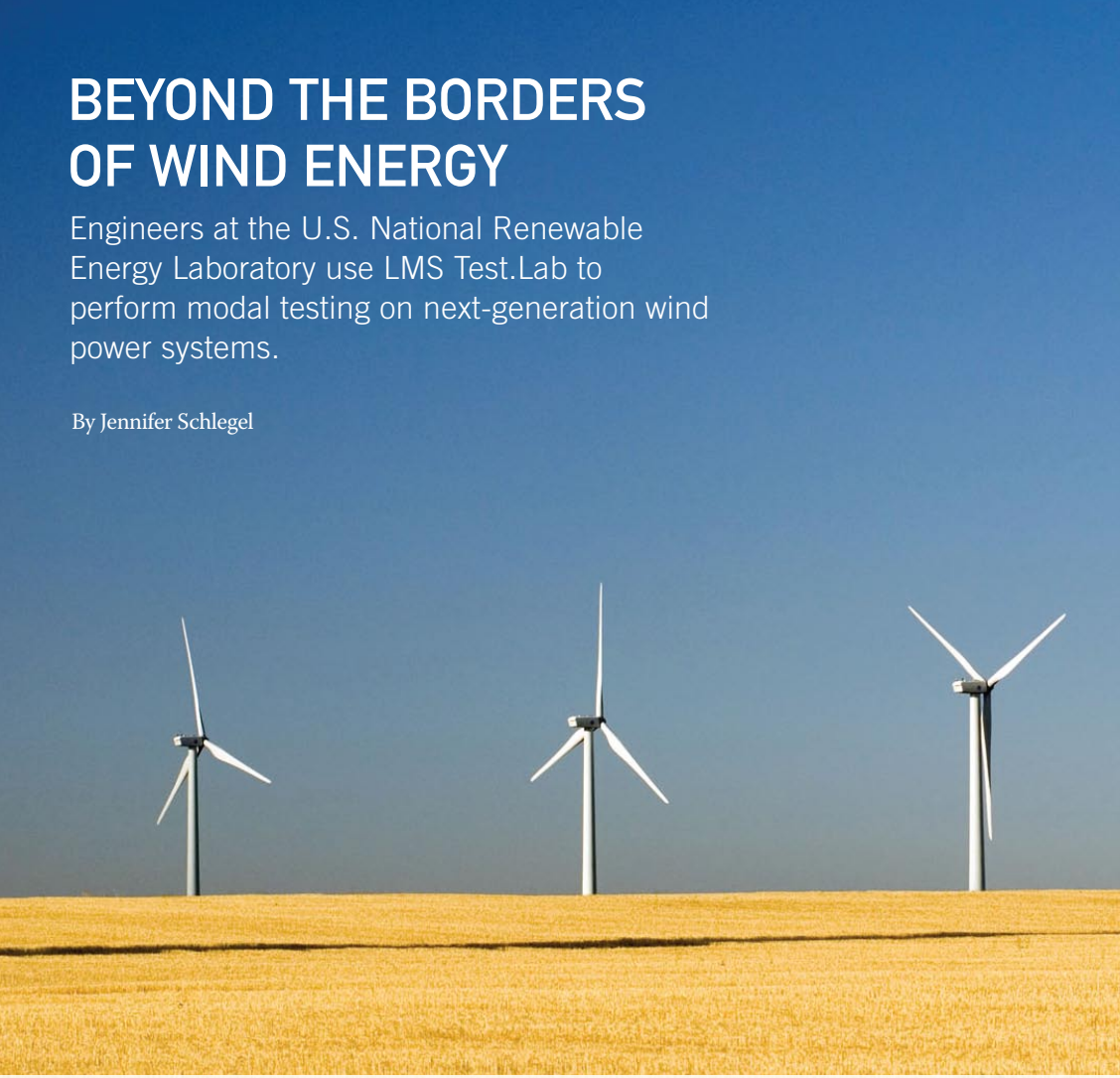
Located in Glenn Ellyn, Illinois, Loop Belt Industries is dedicated to designing and manufacturing high quality conveyor placing equipment. The company's future design plans also include the development of larger conveyors, providing additional reach and capacity for large civil projects. Along with its sister company, Illinois Conveyor Enterprises [www.ilconveyor.com], which manufactures conveyor parts and repairs/rebuilds conveyors, the company's dedicated staff is committed to advancing the role of conveyors in today's construction markets, especially wind energy.

Fig. 6: Conveyor belt speeds are remotely controlled by the operator to match the needs of the contractor and finishing crew.

BEYOND THE BORDERS OF WIND ENERGY

Engineers at the U.S. National Renewable Energy Laboratory use LMS Test.Lab to perform modal testing on next-generation wind power systems.

By Jennifer Schlegel



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ENGINEERS AT THE U.S. DEPARTMENT of Energy's National Renewable Energy Laboratory use LMS Test.Lab in performing modal testing on next-generation wind power systems destined to radically change America's energy policies in decades to come. As an inexhaustible, clean and economical way to generate electricity, wind power often tops the list of alterative energy sources for companies around the world facing volatility in fossil fuel prices, supply uncertainties and environmental issues. The "20% Wind Energy by 2030" study published by the U.S. Department of Energy (DOE) in 2008 stated that generating 20% of the country's electricity from wind power is feasible by the year 2030.

To reach this ambitious goal, efforts are being stepped up to boost U.S. wind capacity to 300 gigawatts (GW), a more than tenfold increase from present levels. In 2008 alone, the United States added more than 8 GW of new installations, bringing the nation's total wind energy capacity to more than 25 GW—the largest in the world according to the American Wind Energy Association.

Generating this much power will take more than building bigger wind turbines, however. According to DOE, the reliability and operability of turbines must improve. Also, with the number of easily accessible high-wind-speed sites dwindling, turbines that operate efficiently in low-speed sites must be developed.

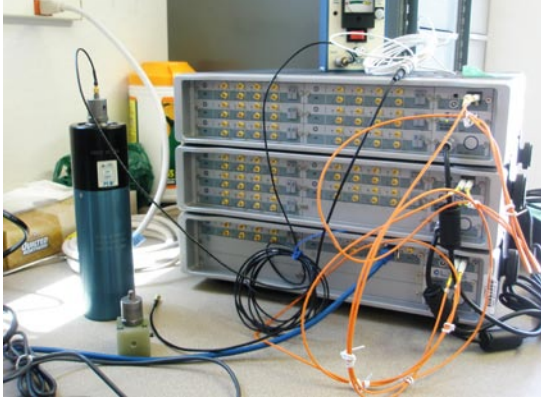

Fig. 1: The 96-channel LMS SCADAS Mobile system consists of three lightweight, battery-powered laptop-size units.

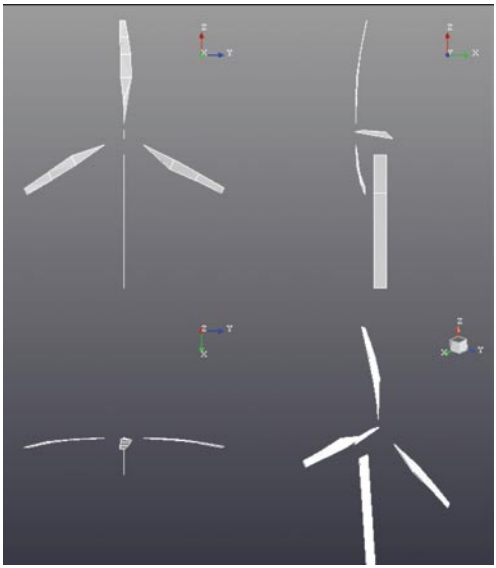

Fig. 2: Animated mode shape displays show engineers how various parts of the wind turbine structure bend, twist, and otherwise deform at resonant frequencies.

All this will require advances in designing, simulating, and testing these next-generation machines, including variable-speed drive trains and advanced controls for adjusting blade pitch to match wind conditions.

TOOLS FOR ADVANCED TESTING

Work in addressing these requirements is spearheaded by the National Renewable Energy Laboratory (NREL), DOE's primary research and development center for wind power. A key element of efforts at NREL's National Wind Technology Center (NWTC) in Golden, Colorado, is aimed at testing proposed new concepts, as well as improving existing designs, often in connection with industry partners, including wind turbine manufacturers and component suppliers.

In particular, modal testing is performed to identify resonant frequencies of the wind machine. As a nationally certified test facility, the NWTC also performs modal analysis as part of a suite of dynamic vibration tests for certifying wind turbine designs. NREL recently installed an LMS Test.Lab data acquisition and analysis system for performing these modal and vibration tests, and LMS Virtual.Lab software for correlating and updating simulation models. Measurements are made using a 96-channel LMS SCADAS Mobile system consisting of three lightweight, battery-powered, laptop-size units that are easy to carry up into a wind tur-

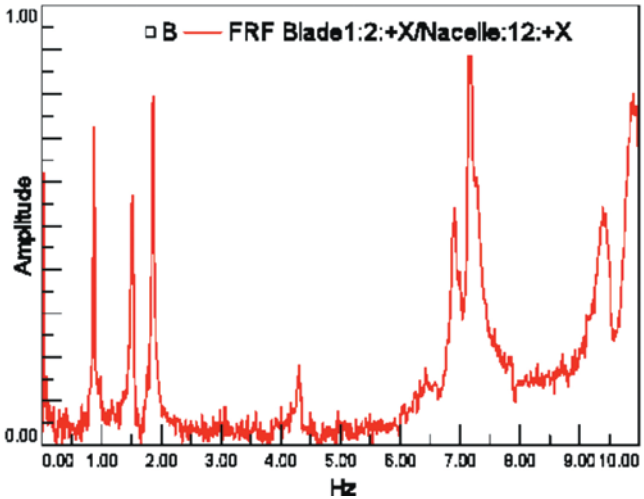

Fig. 3: Resonant modes show up as peaks on frequency response function (FRF) plots.

Fig. 4: For a modal survey, an engineer positions accelerometers on the blade of a 600-kW wind turbine with a 40-meter rotor diameter.

bine nacelle and between the NWTC and outdoor wind turbine sites. The portable units are less than a third the size and weight of the NWTC's former cumbersome UNIX-based system.

FULL MODAL SURVEY

NWTC engineers have already used the LMS system in performing a full system model survey of a specially modified three-bladed 600-kW wind turbine system known as the CART-3, which is used for advanced controls research. With its rotor fixed in a parked position accelerometers were placed on the entire structure, including points on the tower, rotor blades, gearbox, and nacelle. Blades were excited to vibrate with impact from an instrumented hammer. For other parts of the structure, hydraulic shakers were controlled by signals from the LMS SCADAS system, which measured amplitude response of the structure for various input frequencies.

According to NWTC Test Engineer Richard Osgood, one of the major advantages of using the LMS SCADAS Mobile was that it could be used as a distributed data acquisition system, with slave units on the rotor, blades, nacelle, tower, and even a remote meteorological tower to measure wind speeds—all daisy-chained together and connected by fiber-optic cables to a master unit on a truck on the ground at the base of the tower.

"This level of cost and efficiency is important in operations such as ours in which budgets are extremely tight," he says. "Also, signal loss and background electronic interference was significantly reduced with a distributed system based on fiber optics, so less time is required in correcting for these discrepancies, especially in testing variable-speed drive trains that tend to generate considerable radio-frequency noise."

Using multiple-input/multiple-output acquisition and analysis capabilities for measured signals, the LMS system created plots—including animated mode-shape displays and frequency response functions (FRFs)—identifying 10 fundamental system modes of vibration of the structure including rotor bending and twisting, blade torsion, and tower fore-aft and side-to-side bending. The LMS system also accurately identified vibration modes often difficult to predict solely through simulation, such as coupled motion between the nacelle, tower, and rotor bending.

Test engineers used LMS Virtual.Lab software to correlate field test measurements with predicted results from a dynamic simulation model developed by NREL wind researchers. Initial evaluations were performed using a Modal Assurance Criteria (MAC) matrix diagram, showing where the experimental and theoretical types of modal data aligned and where they diverged. From this comparison the test engineers were able to provide the dynamist with information confirming simulation predictions and updating simulation modes when discrepancies were found. In addition, experimental identification of the turbine's drive train frequencies was used to adjust the wind turbine

Fig. 5: An array of sensors is positioned on the turbine blade for simulation model validation study.

Fig. 6: An engineer hits a turbine blade with an instrumented hammer to excite the structure to vibrate.

controller and resolve vibration problems occurring during operation of the variable speed power electronics.

ADJUSTING SIMULATION MODELS

"For obtaining accurate predictions of turbine vibration characteristics, test-based modal analysis is critical to adjusting models for a wide range of simulation including finite element analysis, multi-body dynamics, aerodynamics, acoustics, and blade pitch control," Osgood says.

"Stiffness attributes and damping characteristics computed by LMS Test.Lab from modal data is an essential structural parameter needed as inputs to the simulation model to accurately represent structural members as flexible, rather than entirely rigid bodies," he says. "In this manner, simulations can more accurately predict the realistic bending and twisting motion of components that sometimes can lead to unacceptable deformations and instabilities."

AN INTEGRATED SYSTEM

Osgood notes that having this wide range of capabilities in a single system was an important criterion in their selection process, with LMS Test.Lab providing a fully integrated suite of tools—test setup, control, measurement, signal conditioning, result analysis, data management, and report generation—all in the portable test unit. The LMS PolyMAX feature, for example, automatically highlights resonances so engineers can visually identify natural frequencies in minutes instead of spending hours looking through raw data. With an "Active Pictures" capability, live test data in the form of interactive, animated plots can be cut-and-pasted into Microsoft Office tools like Word and PowerPoint.

Integration of these functions, plus a fast processing speed, enables NWTC engineers to see results immediately after measurements are taken instead of waiting hours or days for post-processing. This fast visualization helps engineers verify the test on the spot, see right away how the structure behaves, get a good insight into the root cause of vibration problems, and easily identify particular areas that need further investigation.

"A fully integrated system ensures that all tools we need are compatible and work together properly," according to Osgood. "If a problem arises there is only one vendor to contact, and LMS has been extremely helpful in getting our engineers up and running on the new system."

LMS TECHNOLOGY'S ROLE

"We are certainly honored for LMS technology to have a pivotal role in NREL's testing operations for advanced wind energy systems," says LMS Test Division Vice President Bruno Massa. "The selection of LMS for this critical work confirms the trust organizations have in LMS test solutions and demonstrates the effectiveness of the technology in supporting mission-critical applications in a wide range of industries around the world."

DESIGNING BETTER WIND SYSTEMS

Human creativity is magnified by today's technologies, especially in the wind industry. SolidWorks explains how 3D CAD tools facilitate wind systems development.

By Eric Leafquist

Eric Leafquist is product manager at Dassault Systèmes SolidWorks Corp. Call (800) 693-9000 or go online to www.solidworks.com.

EVER SINCE HERON OF ALEXANDRIA tapped the wind's power to operate a musical organ in the first century A.D., engineers and inventors have created imaginative mechanisms for harnessing wind power. Almost all of the ensuing systems have taken advantage of the basic blade design of a windmill, which gets its name because its primary applications until now have involved mills such as grinding mills, sawmills, and hammermills. Today, however, using the wind to turn a generator to produce clean, renewable, and sustainable electric power has become the overarching objective. No longer does the challenge in wind systems development involve how to produce wind-generated power, but how to capture as much of the wind's power as possible and convert it into electricity.

Of course, electric companies, inventors, and energy entrepreneurs want to develop power-generating wind turbines in an efficient and cost-effective manner. This is no easy task because of the range of engineering, economic, and organizational challenges that they face. Many wind systems developers are tackling the engineering difficulties involved in optimizing wind turbine development by leveraging 3D CAD technology. By using 3D computer-based design tools, designers and engineers can not only create models of new turbine designs but also simulate their performance and optimize their geometries, while using product data

management (PDM) software to streamline the entire development process.

3D CAD EASES OFFSHORE

Maximizing the energy potential of the earth's wind requires building power-generating turbines where the wind is most prevalent. One of these areas—the wind-rich oceans of the world—presents a unique set of engineering challenges that require specialized expertise. The company that developed the first wind turbine towers in 1986 is now using SolidWorks® 3D CAD tools to take on the task of laying the foundations for the burgeoning offshore wind turbine market.

With offices in Denmark and the United Kingdom, Rambøll Wind Energy—part of the Rambøll Group A/S, a global engineering consultancy with more than 8,000 employees and 200 offices worldwide—has delivered the substructures for more than 60 percent of the world's offshore wind power capacity, which amounts to more than 500 offshore wind turbine towers. Rambøll develops the infrastructure that secures the tower to the ocean floor, including piles, platforms, ladders, and boat landings. The structures, which penetrate up to 30 meters into the seabed, must withstand the constant pounding of tides, waves, and currents, in addition to the loads of the wind tower itself.

In 2007, Rambøll management decided to upgrade its existing 2D design software to a 3D CAD system. Company managers believed that by moving to a 3D CAD platform engineers could consistently and efficiently develop, communicate, and produce the high-quality, innovative designs that would enable the company to continue to grow, according to Filipe Ângelo, a structural engineer in the Esbjerg, Denmark, office.

"It took a lot of time in the previous package to output detailed drawings," Ângelo recalls. "We were interested in 3D CAD not only as a means for accelerating drawing production but also for taking advantage of improved design visualization, which we believed would make us even more competitive by optimizing the quality of our final product."

Rambøll decided to implement SolidWorks Premium design software because it is easy to use, provides greater flexibility, and improves design communications. Since implementing SolidWorks software in mid-2008, Rambøll has advanced its capacity for developing innovative wind tower designs while simultaneously increasing design accuracy by 20 percent. "SolidWorks enabled an incredible improvement in our final products in terms of detail, quality, and flexibility," Ângelo notes. "SolidWorks 3D modelling provides a robust and aesthetic overview of the model. With this simple, clean environment, it is much easier to identify design errors and correct them early in the project."

The improved quality afforded by SolidWorks helps to ensure safe, productive performance during construction and operation of the offshore wind turbine. "With SolidWorks, we can limit obstructions and discover clashes during the design phase so there are no issues when we send the turbine out to the platform," according to Mike Hallett, senior design engineer in the U.K. office.

Upgrading its development platform to the SolidWorks 3D design system has allowed Rambøll to continue its dominance in offshore wind power—a 60-percent share of the global

Fig. 2: Rambøll's structures penetrate the seabed up to 30 meters and must withstand the constant pounding of tides, waves, and currents, in addition to the loads of the wind tower itself.

market. "Innovation has helped us gain a commanding share of the offshore wind turbine market, and SolidWorks is one of the tools that help us to innovate freely," says Kai Birger Olsen, engineering director at the U.K. office. "SolidWorks enables us to produce better-quality, more-precise preliminary designs faster than our competitors. When a project comes in we can calculate the operation of up to 100 turbines in one go, analyzing many factors such as the wave loads and rapidly produce designs that take them all into consideration."

SIMULATION DRIVES INNOVATION

With a tried and tested design like a windmill, one might think that there's little potential to improve upon a fundamental design concept that has proven its effectiveness over the centuries. Yet with 3D CAD technology engineers can take the basic geometry of a wind turbine and use simulation tools to optimize it shape in a way that maximizes its ability to catch the wind and turn it into electricity.

For example, just as the angle and intensity of the sun's rays change throughout the day, wind direction and speed vary widely. Most wind turbines are stationary and constructed to face in the direction of the prevailing winds. However, the ability to adjust the perspective of turbine blades to catch the wind and compensate for sudden changes in wind speed is an innovation that can extend the lifespan and boost the efficiency of wind-based generating systems.

A pioneer in solar power, ADES (Aplicaciones De Energías Sustitutivas), set out to apply the same concept to the wind power market that has made its industry leading solar-tracking systems so successful. Like a flower chas-

Fig. 3: ADES revolutionary single-blade pendular wind turbine compensates, accumulates, and reinstates wind speed variations, preventing them from affecting the evenness of generator rotation and subsequently diminishing structural overload and power peaks caused by wind gusts.

ing the sun, the Spanish company's solar panels include autonomous tracking systems that slowly move the panel so that it remains directly aligned with the sun's rays throughout the day. ADES engineers believed that they could apply the same approach to wind turbines to not only improve the quality of power output, but also to make them last longer.

The company had used a combination of 2D and 3D design tools until 2007, when management decided to reassess ADES' design platform in anticipation of an expanded product offering, according to Fabian Riveros, technical office director. "Our entry into the wind turbine market compelled us to look at upgrading our development environment to improve our efficiency," he recalls. "We needed a single platform within which we could do all of our design work, including simulation. That way we could quickly bring breakthrough products in wind turbine design to market."

ADES chose SolidWorks Premium 3D design, SolidWorks Simulation Premium analysis, and SolidWorks Flow Simulation CFD (computational fluid dynamics) analysis software because the integrated solution satisfied all of the company's design requirements and allowed the company to cost-effectively simulate the physical performance of new design concepts.

"We particularly value the SolidWorks Simulation capabilities because we can easily analyze our designs without changing formats or modifying drawings, as we did in the past," he says. "The integration between applications provides the speed and versatility we need to create innovative products while achieving our productivity goals."

ADES engineers utilized SolidWorks design and simulation software to create the company's revolutionary single-blade pendular wind turbine. With conventional wind turbine designs, the lack of evenness in intensity and direction, as well as the continuity in wind, can damage both turbines and the electric system to which they are connected. The unique ADES pendular wind turbine employs a downwind construction shape that automatically orients itself toward the wind by means of three passive mechanical systems: a swiveling single-blade rotor, a pendulum power train, and a self-steering nacelle. The

Fig. 4: The ADES pendular wind turbine employs a downwind construction shape that automatically orients itself toward the wind by means of three passive mechanical systems: a swiveling single-blade rotor, a pendulum power train, and a self-steering nacelle.

design compensates, accumulates, and reinstates wind speed variations, preventing them from affecting the evenness of generator rotation and subsequently diminishing structural overload and power peaks caused by wind gusts. With lower stress loads, the turbine tower has a longer lifespan and requires fewer materials in its construction, thereby lowering the cost.

"The project took just six months with a team of six people," Riveros says. "Simulation was the key to helping us create this product so quickly and shorten our design cycle by 25 percent."

ADES débuted its 100 kW and 250 kW pendular wind turbines at last year's Wind Power Expo Fair in Saragossa, Spain, and is working on 1000 kW and 1600 kW turbine models. Riveros asserts that the versatility of SolidWorks design and simulation software enabled the company to cut in half the time it took to bring this revolutionary product to market. "Because of the benefits SolidWorks provides in terms of design speed, we are more competitive," Riveros says. "It allows us to come up with fast solutions and provides realistic views and animations of our design projects."

PDM ENERGIZES DEVELOPMENT

An often-overlooked aspect of efficient wind system development is effective management of the large volume of data associated with wind turbine design and production. PDM—particularly when integrated with 3D CAD design software—can also boost productivity in wind systems development, especially when an organization is operating on a large scale, like the wind tower factory at Martifer Energy Systems.

Headquartered in Portugal, Martifer comprises 120 companies across 20 countries. The global concern first implemented SolidWorks 3D CAD software at its wind tower factory in 2004. Less than five years later Martifer began a PDM implementation designed to increase efficiency across its organization, according to António Caroço, director of information systems and best practices at Martifer. "The company had grown so quickly that we needed to take our systems and processes to a completely new level," he explains. "We embarked on a huge transformation program that involved a thorough assessment of our processes, software, and systems in an effort to integrate our design work, take advantage of our diverse expertise, and generate greater efficiencies across the organization.

"Our design groups used to work in silos," Caroço goes on to say. "We wanted to standardize our software solutions and establish best practices as a strategy for encouraging our divisions to work more closely together. After exploring the product lifecycle management (PLM) concept, we ultimately decided to work with Sqédio [Integrated Technology Solutions] to further customize and expand upon our proven SolidWorks CAD and CAE solutions by adding SolidWorks Enterprise PDM software."

The implementation of SolidWorks Enterprise PDM software at the Martifer Wind Energy Systems division marked the

Fig. 5: Wind tower factory at Martifer Energy Systems.

first step in a company-wide deployment that is designed to solidify best practices and establish standardized workflows across Martifer. In addition to facilitating design revision control, promoting collaboration, and encouraging design reuse, the system has reduced the company's data storage expenses.

"We view PDM as the key data foundation of the organization and plan on replicating our initial implementation throughout Martifer," Caroço says. "SolidWorks Enterprise PDM fits our needs because it is easy to learn, requiring minimal training; uses open source code, making it easy to customize; and is integrated with our engineering systems, supporting our goals of formalizing best practices and improving efficiency."

Wind systems development has come a long way since Heron's quaint wind-powered musical instrument. For today's wind turbines to play an increasingly greater role in powering the future of renewable energy production, they need to become continually better and more efficient. As the aforementioned examples demonstrate, 3D CAD technology is helping many companies leverage design, simulation, and data management tools to make wind turbine production more efficient, innovative, and cost effective.

The future of wind power rests on developing systems that produce more energy with the same amount of wind. Wind turbines need to last longer, have fewer environmental impacts, and cost less to become an easy alternative to fossil fuels. 3D CAD tools can help today's wind systems engineers, inventors, and entrepreneurs achieve those goals and reap the full potential of wind-based energy systems.

INCREASING TRANSMISSION CAPACITY

It isn't always necessary to build new lines to add transmission capacity. IDC Energy Insights describes technologies that cause little or no visible change to the existing infrastructure.

By Jay Holman

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WIND-BASED ELECTRICITY GENERATION has enjoyed rapid growth over the past 10 years, driven by government incentives and wind's current status as the lowest cost, most scalable renewable energy option. New wind farms must be located in areas with excellent wind resources, and unfortunately these areas are often far from load centers and have weak transmission infrastructure. This creates a well-documented need for additional transmission capacity, which has been difficult to satisfy due to planning and permitting hurdles that can cause endless delays and cost escalations for new transmission projects. As solar plants increase in size, they will face increasing transmission challenges as well.

It is not always necessary to build new transmission lines to add transmission capacity, however, and technologies exist that enable increases in transmission capacity that cause little or no visible change to the existing transmission infrastructure. While no single technology will solve all transmission related challenges on its own, together these technologies will play an important role in enabling the increased penetration of renewables on the grid.

INCREASING TRANSMISSION CAPACITY

Many options exist for increasing capacity in the transmission grid, but not all options will find equal acceptance by all stakeholders. As a general rule, if a new right of way (ROW) is required for new transmission infrastructure, a smaller

ROW will meet less external resistance than a larger one. Additionally, if an existing transmission ROW can be upgraded to increase capacity with only a small increase in footprint, it will meet even less resistance. In the best-case scenario, transmission capacity can be increased in an existing ROW without expanding the footprint of either the structures or the ROW itself.

Technologies are available today to fulfill this scenario, but each one has its own unique characteristics that make it effective in some situations and ineffective in others. In those cases where all of the requirements for deploying one of these technologies are met, they can offer considerable savings in costs, time, and effort. The technologies include Dynamic Line Rating (DLR), High Temperature Low-Sag Conductors (HTLS), Voltage Uprating, and Flexible AC Transmission Systems (FACTS).

DYNAMIC LINE RATING

To avoid exceeding a transmission line's thermal constraints, most lines have established a maximum power flow level that cannot be exceeded at any time. This static thermal rating is based on the worst-case scenario with respect to environmental conditions: a hot day with full sun and a very low wind that is typically assumed to be around 2ftps. If the line's maximum power flow is exceeded under these conditions, the line could sag to the point where it would come into contact with trees, trucks, boats, or other nearby hazards.

However, power levels that would cause unacceptable sag in a transmission line under these conditions may not cause unacceptable sag on a cooler, cloudy, windy day, when the rising temperature caused by current through the line is offset by the colder operating environment and the cooling effect of the wind. Because the environmental conditions are almost never as unfavorable as those used to calculate the static thermal rating of a line, the line's true maximum capacity is underestimated the vast majority of the time.

Dynamic line rating equipment provides the true maximum capacity of the line based on current environmental conditions, effectively enabling this capacity to be used for power transmission. The amount of capacity enabled in this way can be significant. Vendors of DLR equipment estimate that an increase of 10C in the ambient temperature can increase the rating of a line by over 10 percent, and an increase from no wind to a 1mps wind blowing at a 90-degree angle to the line can increase the rating by over 40 percent. Shadows caused by clouds tend to have a smaller effect, increasing the rating by a couple percent. Rain can have a large impact on the rating as well.

DLR requires additional equipment to be added to the line and an information link to be made to the transmission control system, but it uses the existing line in the existing right of way. Some DLR technologies require the line to be taken out of service as they are installed or calibrated, which can cause disruption, particularly because the technology is often installed on lines that are very heavily loaded.

One tradeoff that must be considered when evaluating DLR and other technologies that allow increased current through existing lines is that the losses in transmission lines increase as the square of the current through them. Therefore there is a penalty for running high currents through lines, which makes "high current" technologies more attractive when those higher currents will only be required on a temporary basis, such as during periods of peak demand or when other lines fail.

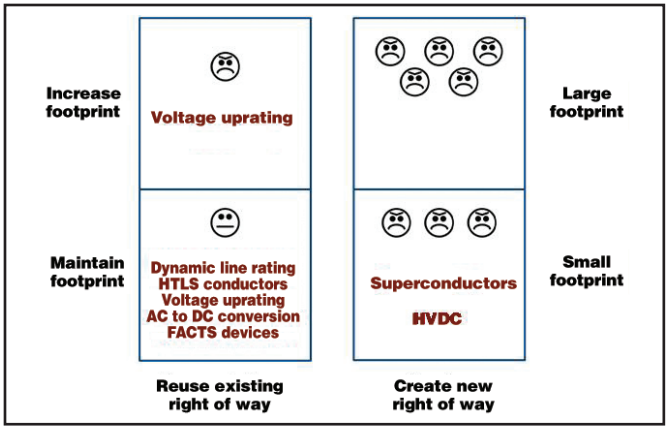

Fig. 1: Options for increasing transmission capacity.

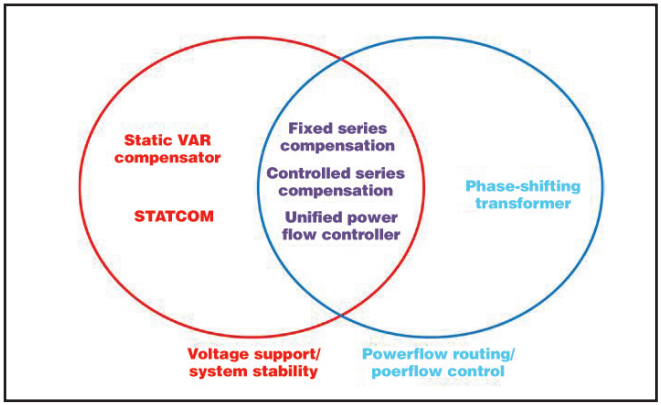

Fig. 2: Flexible AC Transmission Systems (FACTS) devices.

HIGH TEMPERATURE LOW-SAG CONDUCTORS

Another option for overcoming excessive sag caused by overheating is to reconductor existing transmission lines with high-temperature low-sag (HTLS) conductors. These conductors have special cores that, like traditional conductors, heat up when carrying large amounts of current. However, unlike traditional conductors, they do not sag nearly as much when operating at high temperatures. As a result, a traditional conductor can be replaced by an HTLS conductor with the same weight and diameter, and which uses the existing transmission towers and ROWs, for a significant increase in the line's thermal rating.

Then why not use them all the time? HTLS conductors are significantly more expensive than traditional cables (costing 1.2 to 6 times more), although when they are used to upgrade an existing line this additional cost is offset by the savings associated with reusing the same right of way and towers, and reduced (or, in some states, eliminated) permitting costs. Additionally, reconductoring does involve construction crews working on a right of way, even though the right of way itself won't be expanded. And like DLR, the advantage from HTLS conductors comes from enabling operation at higher currents, which can lead to unacceptably high losses. Newer HTLS conductors that use composite materials have a higher conductivity than conventional cables, which reduces the loss penalty at higher currents but does not eliminate it completely.

Even with those drawbacks, there are situations where HTLS conductors can play a valuable role, such as long spans over rivers that are particularly sensitive to sag. They can also improve the reliability of the grid without requiring additional lines to be added. In this case, the additional capacity enabled by the ability to carry high currents in the HTLS cable is held in reserve, allowing other lines in the area to increase their capacity. If one of those other lines fails, the HTLS cable can carry the additional load until the down line is repaired.

VOLTAGE UPRATING

Voltage uprating involves increasing the voltage of a transmission line to the next standard voltage level, which increases the power that can be transmitted through the line without increasing the current. By taking this approach, the line is not brought any closer to its thermal rating and losses are not increased.

Some transmission lines, usually those built years ago, have been overbuilt to the extent that their voltage can be increased with only relatively minor changes to the line itself (e.g., new transformers but reuse of the conductor). In this best-case scenario, an increase in the corona of the line and the line's electromagnetic field (EMF) may still require an increase in the ROW for the line, which can be very difficult to obtain. However, if those challenges do not apply or can be overcome, voltage uprating is a very attractive option for increasing the capacity of a line.

In most cases, unfortunately, voltage uprating will require a larger conductor or bundled conductors, and larger transformers, among other changes. In this case, permitting and construction crews will be required to install the new conductor and either install new towers or modify the existing towers. The one advantage of rebuilding the line in this way is that it may be possible to use a compact design or

Fig. 3: High Temperature Low-Sag (HTLS) conductors.

bundle the conductors so that the corona and EMF do not require an expanded ROW. This reduces the impact of the upgrade on the footprint of the transmission line and could make planning and permitting easier while reducing costs.

One of the challenges of voltage uprating is that it must be undertaken in relatively large steps: even if only a little more voltage is required to meet additional power flow requirements, the voltage must be increased all the way up to the next standard voltage level if voltage uprating is undertaken. While a small voltage increase may have allowed the use of the same ROW, jumping all of the way up to the next voltage level is likely to push the line beyond the existing ROW limits. As a result, voltage uprating can be an attractive option when large jumps in power are required, but other options may be preferable when only an incremental increase is needed.

FLEXIBLE AC TRANSMISSION SYSTEMS

Flexible AC Transmission System (FACTS) devices play a key role in ensuring transmission system stability and also can increase the amount of capacity available at key points in the transmission grid by routing power flows.

Static VAR compensators (SVCs) and STATCOM devices both provide dynamic reactive power to serve as voltage support to counteract changes to system voltage, including rapid changes such as those due to a line fault. The primary purpose of these devices is to improve system stability, and they do not directly increase the capacity available on a given line. However, with improved control over system stability, it is possible to run transmission lines closer to their limits, so these devices indirectly enable increased transmission capacity in the system.

Series compensation, on the other hand, can be used to increase the available capacity on a given path, although this also occurs in an indirect manner. When there is more than one path between a generator of electricity and a load, the electrical power flows preferentially through the transmission grid down the path of least impedance. Series compensation can reduce the impedance of a line, either statically or dynamically, to increase the load carried by that line and reduce the load carried by parallel paths.

Unified power flow controllers (UPFCs) and phase-shifting transformers both have the ability to directly route real power flows through the transmission network, while UPFCs have the added ability to offer voltage support through functionality similar to that of SVCs and STATCOM devices. UPFCs and phase-shifting devices can be used to route power away from lines that require additional capacity, assuming there is available capacity in a parallel line.

ACCELERATING GROWTH IN RENEWABLES

While technologies that increase transmission capacity without requiring the acquisition of new rights of way or the undertaking of major construction projects will not always meet the capacity requirements of new renewable energy projects, there are situations where they can help by reducing costs, accelerating timelines, and easing permitting burdens. These technologies provide options to developers that will enable faster growth in renewables while avoiding resistance to new projects that new transmission lines can foster.

Fig. 4: Sag in transmission lines.

PORTLAND'S PLAN FOR PROGRESS

A thriving wind-power industry isn't just a matter of geography, with a healthy manufacturing base, a progressive business environment, and economic support networks playing critical roles.

By Pam Neal

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AS AN ACTIVE PARTICIPANT in the wind industry, you've likely heard or read about the wind-related innovations taking place in and around Portland, Oregon. You may know a bit about Portland's burgeoning leadership in this arena. When you see the entire picture, however, you truly begin to appreciate the explosive wind scene in progress there.

Portland's position in the wind arena is both a strategic stance, based on the city's five-year economic development plan to build the most sustainable economy in the world, and a natural outgrowth of its particular set of attributes developed over time that make increasingly more sense for the local and regional growth of this industry.

As one of the nation's greenest cities, and a central player in the clean tech cluster economy, Portland and its partners have worked to maximize the competitive environment for local businesses. By positioning these businesses as leaders in the green economy, developing analyses and specific strategies to remove obstacles and address opportunities for growth, Portland is paving the way for big investments in wind power.

THE GREEN TALENT POOL

The first reason Portland is leading the way in the wind industry is because it hosts one of the most significant concentrations in the United States of firms in the renewable en-

Fig. 1: Construction of the PGE Biglow Canyon Wind Farm.

ergy, environmental services, recycling, and green building sectors. In particular, the city is home to a notable number of green building and wind energy firms, including the North American headquarters of both Vestas Americas and Iberdrola Renewables. Many of these companies are already developing and using wind energy resources and providing services for ongoing maintenance of wind installations.

Equally important is the growing supply of experienced employees for clean tech firms: the region has built a critical mass of knowledge, expertise, and personnel that isn't duplicated elsewhere. The Portland area's renewable energy talent clusters are 84 percent greater than similar-sized regions, and 43 percent greater for environmental services and recycling. Consequently, when clean tech and other green firms are seeking a location to form or expand their businesses, Portland lands at or near the top of the list.

MANUFACTURING STRENGTH

Portland's second strength in the wind sector comes from its strong manufacturing base, which presents plenty of opportunities to develop a regional supply chain. The city is primed to work with local companies to help them participate in that business.

Numerous metal and steel companies with a long history of providing transportation equipment products use high technology tools to produce a finished product or part or enhance manufacturing capabilities, all of which fit well with the needs of the wind industry. Such manufacturers can supply the wind industry with rotors, generators, towers, and other components needed for wind turbines. In some cases companies have already launched their new role in the supply chain.

READY FOR ACTION

Third, Portland is primed for action. Both Portland General Electric (PGE) and Pacific Power were early entrants to the wind market, giving Oregon a jump on the competition for installed wind projects, and creating new opportunities

Fig. 2: The PGE Biglow Canyon Wind Farm, with Mt. Hood in the background.

for regional manufacturing firms to provide repair and maintenance services for wind turbines. Nationally, Oregon and Washington rank fourth and fifth respectively for installed wind power.

Total installed and under construction wind capacity is more than 5,263 megawatts in Washington and Oregon, providing one of the largest installed markets in the U.S. The region's strong environmental policies, which drove early adoption of aggressive renewable portfolio standards and tax credits, have also encouraged demand.

By sourcing regionally, owners and operators can reduce transportation costs and shorten lead times for replacement parts, decreasing overall operational costs. The Northwest has competitive, established firms that can provide raw steel, fabrication of large castings, hydraulic systems, gearbox repair/services, machining capabilities, and fiberglass operations. Other opportunities include electronics, metal shredding, blasting, coatings, and heat-treating.

The Portland region's deep bench in the manufacture of highly specialized engineered metal includes EVRAZ/Oregon Steel (raw steel), Oregon Iron Works, Gunderson, and Vigor Industrial (machining, fabrication, and assembly work). Each of these firms brings existing infrastructure, an experienced labor force, and large sites and buildings, as well as accessible locations near transportation corridors linked by rail, barge, and freeway to existing markets.

BUILDING CAPACITY

The fourth reason Portland is paving the path in the wind arena is because it has put an array of tools to work on behalf of its regional wind suppliers, using partnerships, technical and financial assistance, and networking and promotion to help companies meet potential new customers and advance their specialized expertise.

PARTNERING FOR LEAN PROCESSES

For wind companies to supply original equipment manufacturers they need to understand the importance of Lean, 6 Sigma, and ISO 9000. A recent multimillion-dollar grant from the U.S. Department of Labor to the Oregon Manufacturing Extension Partnership (OMEP) addresses that need, offering workforce training and supply chain development for regional companies involved in the renewable energy sector or those interested in entering that sector. The technical assistance includes helping existing and new supplier companies incorporate lean processes into their production to improve quality and increase efficiency. Portland manufacturers receiving OMEP assistance have experienced overall productivity improvements of between 40-60 percent, resulting in increased sales, job creation and retention, and a resumption of the manufacture of previously off-shored items.

FINANCING

The City of Portland and the Portland Development Commission (PDC), as its economic development agency, work with the State of Oregon to offer competitive tax incentives that foster the growth and prosperity of manufacturing businesses. Financing programs address working capital, equipment purchase, real estate acquisition, tenant improvements, property development, and façade improvements.

CREATING CONNECTIONS

This past spring a team of Portland-Vancouver businesses and public officials attended WINDPOWER 2010, the world's largest wind power event hosted by the American Wind Energy Association (AWEA). Calling themselves "The Pacific Northwest Wind Team" the trade show group included industry leaders from eight wind supply chain companies, as well as regional economic development representatives. Collectively, the delegation showcased the region's manufacturing expertise, identified potential business opportunities, and sparked the development of a regional network for the industry. Through the WINDPOWER partnership the region's suppliers generated new sales and business leads, and gained a better understanding of how they fit in the industry.

PDC also led the way in helping the WINDPOWER show attendees access MarketLink, a service launched by the Oregon Microenterprise Network and based on economic gardening tenets, which focus on creating a nurturing environment for existing companies rather than recruiting businesses from elsewhere. MarketLink provided customized market research, competitive intelligence, and industry and sales lead generation to new suppliers who wanted to diversify into the growing wind industry but needed additional information on markets, customers, and competitors.

Fig. 3: Vigor Industrial offers marine and industrial services.

In addition to efforts such as the AWEA show, PDC facilitates monthly meetings to encourage collaborations among government, non-profit, and member associations focusing on this cluster. By coordinating efforts PDC has been able to partner, leverage, and coordinate efforts to assist the industry. Additional assistance has taken the form of "matchmaking"—inviting regional suppliers to pitch their services and capabilities to major owners/operators, including Vestas, Iberdrola, PGE, and others. These buyers have identified parts and services they prefer to source regionally, and in turn the sellers and suppliers are learning more about demand, requirements, and processes.

Connection takes place online, as well, with The Northwest Connectory, which is a recent addition to the toolkit [www.nwconnectory.com]. The Connectory is an online database that contains detailed profiles of Pacific Northwest companies in all industries at every level of the supply chain, including their capabilities, products, and services. The purpose of the tool is to link Oregon businesses to opportunities around the region via a robust, searchable, online buyer-supplier database. It's a free ser-

Fig. 4: A drill manufactured by Premier Gear, of Portland.

vice, supported by Business Oregon and PDC and managed by the Pacific Northwest Defense Coalition.

RECENT SUCCESSES

Last, leadership can only be claimed if it's backed by a positive track record, and Portland has that. Recently announced expansions by major players in the wind industry point to the growing success of Portland's strategic focus. Vestas, Iberdrola, and Moventas have all announced their commitment to expand in the metro area, strengthening the region's leadership position in wind supply and development.

- Vestas Americas is the world's largest manufacturer of wind turbines. This giant established an early stronghold in the Pacific Northwest and strong company growth has allowed it to relocate its North American headquarters to Portland's Pearl District. A former Meier & Frank warehouse is slated to become home to a new LEED-Platinum, 172,000 square-foot headquarters, with completion in 2012. The company, now staffed at 400 employees, has committed to adding 100 jobs within the next five years.
- Iberdrola Renewables has its North American headquarters and 400 employees in Portland, and it continues to expand in the city. The company recently invested in a new advanced wind energy control facility. This control center allows Iberdrola to monitor its U.S. wind turbines, wind farms, and substations. Approximately 25 full-time employees work at the control center. Iberdrola will likely add workers as the company expands its wind capacity in the United States.
- Moventas, a Finland-based supplier of wind turbine gears, is expanding its existing facility in Portland for gear service and repairs. The company will add a new assembly production line to keep up with regional growth.

With these significant investments, an array of promising new prospects for local businesses, and the region's continued commitment to its fast-growing wind industry base, Portland is a competitive business environment for wind power, worthy of participation from companies around the world.

< Continued from page 15

announced the formation of the global Wind Marketing Alliance during the HUSUM WindEnergy Trade Fair and Congress in Husum, Germany.

"The Wind Marketing Alliance brings a powerful combination of wind industry and international marketing experience to serving our clients," says Klaus Lorenz. "With our combined expertise, we can help companies build and execute strategies that are aligned and effective in the international wind energy market."

Independently, the Wind Marketing Alliance's founding organizations have worked in the wind energy industry for nearly 20 years and have represented some of the best-known companies in the world. Their experience includes manufacturers of turbines, towers, internal systems, precision gears, and specialty tools; construction, installation, and maintenance contractors; heavy-haul providers; and industry consultants. Its members also have been public relations partners to HUSUM WindEnergy in Europe since 1998 and in North America since 2008.

"Companies in Europe are anxious to enter or increase their presence in the North American market, and many companies in North America are interested in becoming their suppliers or partners," according to Martin Fredricks. "We are in an excellent position to help them grow and positively impact sales, either on one continent or both."

Lorenz adds that, through its strong networks of industry professionals, consultants, developers and trade organization leaders, the Wind Marketing Alliance also can be a facilitator for companies seeking international technology- and resource-sharing collaborations. He also said the organization intends to expand with partners in Asia, Australia, and other parts of the world where there is wind energy development. For more information go to www.windmarketingalliance.com.

NEW DELTA HARNESS FROM CAPITAL SAFETY

Capital Safety announces the launch of the latest product in the popular Delta™ harness line from DBI-SALA, which provides premium comfort and ease of use. The newest Delta full-body harness offers industry-first features such as an improved ergonomic fit and feel, lighter-weight buckles, and high-strength webbing.

Building upon the existing line's attributes, the updated Delta harness employs the patented No-Tangle™ triangle pattern, creating a frame that allows the harness to easily fall into place when donned and maintains ideal spacing of shoulder straps to eliminate rubbing and chafing. The 420-pound capacity harness features a soft, breathable interior and a comfort hip pad to help support the back and hips when carrying a heavy load.

With its durable yet lightweight Tech-Lite™ quick connect buckles, made of alloy aluminum material, Delta is fast and efficient to don, and is also built to last in even the toughest work environments. The harness features Revolver™ torso adjusters, which allow for quick adjustments and eliminate loose ends for workers, and liquid-resistant Repel™ webbing to promote comfort and prevent mold. In addition, built-in lanyard keepers holster snap hooks when not in use.

"The latest addition to the Delta line combines globally-accepted and proven safety features with industry-first upgrades that make Delta III the most comfortable and functional harness in its class," says Jerry Falk, global product director. "Representing more than two decades of research and design, the newest Delta harness will surely establish its place as an industry standard for fall protection."

For increased worker safety, the improved Delta harness offers DBI-SALA's I-Safe™ identification tag and rip-stitch impact indicator that shows if the harness has been compromised in a fall. This provides an efficient way for users to inspect, store and track the harness's integrity around the jobsite. Additionally, the dorsal D-ring patented spring-loaded design automatically stands up to ensure fast, easy and safe connections to fall arrest systems.

Capital Safety—one of the world's leading manufacturers of fall protection, confined space and rescue equipment, with 12 operating sites worldwide and a passionate commitment to quality, innovation, and safety—is home of the DBI-SALA and PROTECTA brands. All of Capital Safety's fall protection and rescue systems are backed by extensive training, knowledgeable technical assistance, and professional customer service. For more information call (800) 328-6146 or go to www.capitalsafety.com.

VESTAS RECEIVES 43 MW ORDER FOR WIND-ENERGY PROJECT IN MINNESOTA

Vestas has received an order for 24 V90-1.8 MW turbines from Oak Glen Wind Farm, LLC, for a wind project near Blooming Prairie, Minnesota. Oak Glen Wind

Farm is a subsidiary of the Minnesota Municipal Power Agency (MMPA). Avant Energy, Inc., of Minneapolis is managing the project. The contract includes delivery and commissioning of the turbines along with a five-year service and maintenance agreement. Delivery is scheduled for late summer 2011 and commissioning is expected by the end of next year.

"The V90-1.8 MW turbine is specifically designed to provide maximum power output at sites with medium wind speeds," says Martha Wyrsch, president of Vestas Americas. "Minnesota is one of the leading states for wind power, and we are excited to help create more clean, reliable energy here. This project also will result in construction jobs and long-term local maintenance positions to be hired by Vestas."

Formed in 1992, MMPA supplies electric power to its 11-member communities, all of which are located in Minnesota. MMPA is committed to renewable power production. Employee-owned Avant Energy has provided energy management services to public power utilities, universities, and large energy users for more than 20 years. This is Vestas' 12th North American deal announced in 2010, totaling 1,655 MW among four turbine types. Six Vestas customers have ordered V90-1.8 MW turbines this year for projects in the United States and Canada.

Vestas is the world leader in providing high-tech wind power systems. Since 1979, Vestas has supplied more than 41,000 wind turbines in 65 countries. Vestas sold its first wind turbine in North America in 1981 and since has supplied more than 11,000 turbines to the United States and Canada. The company's North American manufacturing operations are based in Colorado. This includes a blade factory in Windsor, a nacelle factory in Brighton, and a tower factory—the world's largest—in Pueblo. Vestas has research and development offices in Texas, Wisconsin, Massachusetts, and Colorado. Its global headquarters are in Randers, Denmark. Learn more at www.vestas.com.

NORDEX AWARDED 75 MW PROJECT IN REPEAT ORDER WITH EVERPOWER

Shortly after dedicating its new wind turbine manufacturing plant in Jonesboro, Arkansas (see Q&A in this issue), Nordex USA secured an order for a 75 MW project using N100 wind turbines from EverPower Wind Holdings, Inc. The contract includes a five-year premium maintenance and service agreement as well as the delivery, commissioning, and testing of the turbines. This is the second time EverPower has selected Nordex.

In 2009, EverPower installed 25 Nordex N90 2.5 MW high-speed wind turbines at its Highland Wind Farm, a 62.5 Megawatt project located in Cambria County, Pennsylvania. At the time it was Nordex' largest American wind project, and the first wind farm in the country using turbine generators that large. EverPower currently has advanced stage projects in New York, Ohio, Pennsylvania, and Washington totaling 600 megawatts of capacity targeted for construction within the next three years. "We are extremely pleased to be building on a solid performance record with EverPower," says Ralf

Sigrist, president and CEO of Nordex USA. "Our partnership proves that superior turbine technology makes wind power a competitive alternative to traditional fuels and can help secure the nation's electricity supply."

EverPower Wind Holdings develops, owns, and operates utility-grade wind farms and sells clean electricity generated from its farms to local utilities, which purchase this electricity for resale to individual consumers and businesses. The company has offices in New York, Pittsburgh, Portland, Oregon, and Bellefontaine, Ohio, and it is currently progressing wind farm projects in several states. EverPower is owned by its employees and the private equity firm Terra Firm, which has a range of institutional investors with the largest proportion being U.S.-based.

"We are very pleased with the possibility of installing Nordex turbines," says Jim Spencer, president and CEO of EverPower Wind Holdings. "We have been impressed with the performance and reliability of the turbines installed at the Highland Wind Farm and from previous experience expect that Nordex' next generation of turbines will have at minimum a 97 percent availability rate. We are also very excited to be the first developer to install turbines manufactured at Nordex' new Arkansas plant. It reinforces what we have been saying—wind farms create American jobs."

Currently Nordex' largest U.S. order to date—150 Megawatts/60 turbines—is being installed at BP Wind Energy's Cedar Creek wind farm in Colorado. For more information visit www.nordex-online.com.

CAPSTONE'S CROUSE NAMED TO NATIONAL ENERGY ADVISORY COMMITTEE

Capstone Turbine Corporation, the world's leading clean technology manufacturer of

microturbine energy systems, announces that U.S. Secretary of Commerce Gary Locke recently named Capstone Executive Vice President Jim Crouse to a national advisory committee that will promote U.S. exports of renewable energy and energy efficient technologies. The 29-member Renewable Energy and Energy Efficiency Advisory Committee will advise Locke on the development and implementation of programs and policies to help expand the competitiveness of the U.S. renewable energy and energy efficiency industries. Crouse and other committee members also will develop strategies to identify and expand export markets for the industries, both in the short- and long-term.

"We will work closely with the committee to help achieve President Obama's goal of making the United States a leader in the global green economy," Locke said in a press release. "U.S. companies in these critical sectors need to take full advantage of increased exporting opportunities and thus will create green jobs for Americans that are needed to sustain our economic growth."

Secretary Locke has recognized Capstone Turbine in the past. In June Capstone representatives joined him at a signing ceremony that was part of the first U.S. International Trade Mission to China under the Obama Administration. The event in Beijing recognized the distribution agreement between Capstone and Sino Clean Energy and acknowledged the companies' efforts to broaden China's use of clean-and-green microturbine technology developed in the United States. In addition, Capstone's innovative U.S.-based technology and successful exporting record led Secretary Locke to award the company the Presidential E Award for Exporting in 2009. "Jim's years of experience in the worldwide energy marketplace, and deep knowledge about decentralized energy systems will play a crucial role in advising Secretary Locke on these critical programs," according to Darren Jamison, Capstone's president and CEO.

Jamison noted last June during the announcement of the Beijing signing ceremony that "Sales of our low emission microturbines overseas rose significantly the last three years. The Commerce Department opens doors for us, provides advice and exceptional service, and assists with market assessments domestically and in Asia and Europe. With their help we've been able to broaden our network of Capstone distributors worldwide, which has led to increased sales."

Capstone products offer a clean-and-green energy solution that ensures a reliable and uninterrupted power supply, low maintenance, and controlled energy costs. Energy efficiencies can approach 90 percent, especially in combined heat and power (CHP) or combined cooling, heating and power (CCHP) applications. In CCHP applications, for example, the Capstone microturbines produce reliable electricity. At the same time, waste heat energy is captured and recycled to heat and air condition a facility via absorption cooling, thus greatly increasing system efficiencies. Learn more at www.capstoneturbine.com.

POWERGUARD ADDS RENEWABLE ENERGY VETERAN

PowerGuard Specialty Insurance Services announces that Fred Hilsendager has joined the company as vice president. He brings more than 20 years of retail and wholesale brokerage experience, as well as expertise in the design of leading-edge insurance, risk management, and warranty solutions for renewable energy companies, with a particular emphasis on the needs of wind turbine manufacturers.

As vice president Hilsendager will be responsible for working with retail brokers, project developers, alternative energy investors, and others across the country to promote and manage new business opportunities for the PowerGuard team. He will be based in Chicago, adding significant experience and depth to PowerGuard's team in the eastern United States. "Demand for PowerGuard's products and services—particularly our industry leading PowerCLIPTM warranty solution—has increased exponentially," says managing principal Mike McMullen. "Having a top alternative energy professional of Fred's caliber on the ground for us on the east coast will improve our ability to stay ahead of this demand. Fred knows our products extremely well and we are pleased and excited to welcome him to PowerGuard."

Prior to joining PowerGuard Hilsendager worked for retail broker Holmes Murphy & Associates in Chicago, where he founded and managed their Renewable Energy Division. Earlier in his career he held a range of production, account management, and underwriting positions at wholesale broker Tri-City and retail brokers Willis Group Holdings and the Hobbs Group, focusing on the needs of Fortune 500 accounts that included Merck & Co., Inc., General Electric, Ryobi, Mafco, Inc., and the New York Stock Exchange. Hilsendager holds finance and risk management degrees from Temple University in Philadelphia and can be reached at (312) 953-0293 or fhilsendager@powerguardins.com.

PowerGuard is a managing general agent and Lloyds cover holder specializing in the design and underwriting of unique insurance and risk management solutions for wind, solar, and other alternative energy companies. Its founders and principals have more than 20 years of experience providing innovative products and services to meet the rapidly evolving needs of the energy business. PowerGuard's warranty product—PowerCLIP—is the most comprehensive contractual liability coverage available to renewable energy manufactures, project developers, power generation operators, and the financial institutions and private equity firms who invest in them. For additional information visit www.powerguardins.com.

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Joe Brenner
Vice President of Production/Nordex USA

WHAT LED NORDEX TO BUILD ITS NEW MANUFACTURING FACILITY IN ARKANSAS?

There were quite a few factors to take into consideration, as you can imagine, with the most important one being proximity to regions where most of the wind activity is currently taking place in the United States. Here in Jonesboro we're very near the Mississippi River for barging, there are two railways crossing Arkansas, and the highway system provides a major transportation network, so we can ship the 2.5MW "Gamma Generation" turbines we're be building here anywhere in the country and make delivery in a matter of days. Beyond that, though, we found Jonesboro to be one of the most pro-business communities we've ever encountered. There is an existing industrial base, good schools, a strong work ethic, and overwhelming support in terms of wanting us to succeed. Even before the plant opened we developed a relationship with Arkansas State University, which implemented a workforce training program in "mechatronics," teaching a combination of electrical and mechanical skill sets that are specific to manufacturing wind turbines. We had an open house for the local community last fall, and so many people showed up to tour the facility—including Arkansas Governor Mike Beebe—that there wasn't room for another car in the parking lot. The city even made improvements like widening intersections for trucks making deliveries, and they changed the name of the road leading to our plant to Nordex Drive. Their investment is already paying off, though, since one of our existing suppliers has just announced that they're building a new plant nearby. I've been involved in manufacturing for 30 years, and I've never seen anything quite like it.

I UNDERSTAND THAT NORDEX DESIGNED THIS FACILITY FROM THE GROUND UP FOR EFFICIENCY.

That's right. The wind industry is growing in leaps and bounds, with new technologies being introduced every day, and we wanted to create a state of the art assembly process that was also flexible so that we could take advantage of these innovations. Our approach was to collaborate with Nordex wind experts in Germany, who were involved in updating their own production process. Together we developed an assembly line model, which keeps things constantly moving forward instead of being stalled in cells. This approach has allowed them to produce 15 turbines each week... a 50 percent increase, at least, from their previous maximum throughput. We sent our key managers, production engineers, and our materials management and supply chain staff to Rostock to work side by side with the experts for a couple of months, and then they came to Arkansas to assist with our startup, so there's been a great deal of collaboration within the company. We all gained a lot by working together, and I think the effort has allowed us to leapfrog ahead of the competition. Nobody else is approaching this in the same way that we are.

NOW THAT YOU'VE BEGUN PRODUCTION, WHAT DOES THE FUTURE HOLD?

Right now we're working with our existing supplier base to make sure the materials we need arrive on time and in an orderly fashion, but we're identifying local suppliers as well. The goal is for our supply chain to be 80-percent domestic within the next year, which just makes sense from a production standpoint. And that's another way we're benefiting the local economy, in addition to the workforce we're assembling. We foresee our presence in Jonesboro eventually resulting in about 700 jobs here in the community, as our suppliers gear up to handle the workload, and even though we've already invested some $42 million in this 150,000 square-foot facility, this is just the first phase. There are significant opportunities for growth in the coming years, which is exciting both for us as well as the surrounding community. We have all been infected by this incredibly positive atmosphere, and we're using that energy as one of the building blocks for our success.

Visit Nordex USA at www.nordex-online.com.