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WIND BLADE SAFETY: THE TRUE COST OF QUALITY

No single inspection or one-time procedure guarantees blade safety; what protects workers, communities, and assets is the accumulated effect of thousands of quality decisions made throughout the blade's life.

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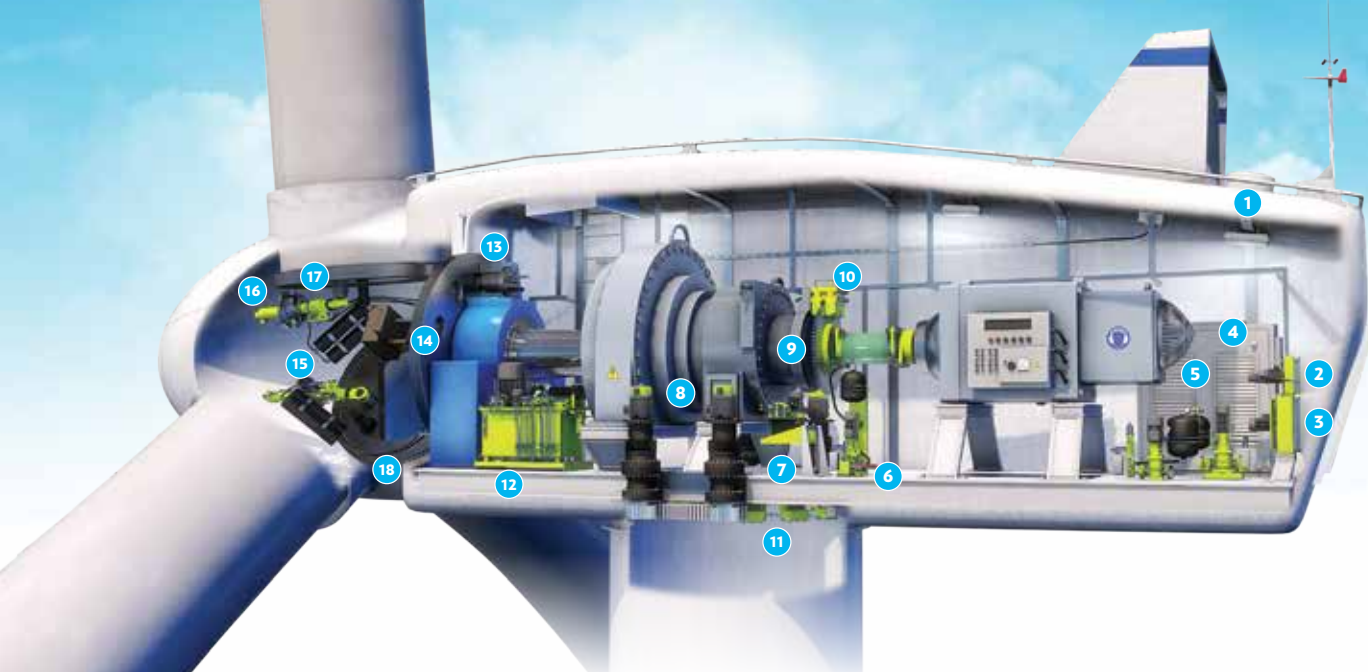
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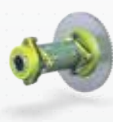
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Wind is still going strong

There has been concern — and rightfully so — among renewables companies that support on the federal level has fluctuated.

But from reports I've seen, renewables — and wind — aren't going anywhere. In fact, they are still a strong contender in the mix for an independent U.S. energy future.

At CLEANPOWER 2025 in May, I heard reports throughout the three-day conference that more than supported that goal.

Part of that goal was part of the renewables' all-of-the-above energy plan, meaning it will take a mix of all sources of energy production to help create an independent energy future.

This month's Crosswinds looks at some of those statistics told through some of the key speakers at CLEANPOWER. For example, ACP's John Hensley said that the U.S. consumes about 4,300 TW/h of electricity annually, but in just a decade, that number is going to skyrocket to 5,139 TW/h. That's another 900 TW/h of new electricity. That's like adding two more Texas to our grid. That's a lot of energy that's going to have

to come from somewhere.

So, take heart in the thought that renewables in general, and wind in particular, aren't going anywhere. To all who have spent years developing ways to harness power from the wind, that statement seems more than obvious.

That's great news for wind and all renewables. That steady growth in renewables also means that the products and services needed to get those turbines built and spinning are more important than ever.

In addition to an overview of CLEANPOWER, our July issue takes a closer look at some of these topics: safety and cables.

Our lead inFocus article from CICNDT's Brett Davis and Jeremy Heinks looks at wind turbine blade safety and what the true cost of quality amounts to.

And make sure you check out our Conversation with Castrol's David DiNunzio. He discusses the fascinating results of a two-year field study that tested long-term lubricants in a real-world situation. The results are quite fascinating and will help OEMs as they make decisions for their assets.

You'll discover that and much more in this issue. I hope you find it informative, and please feel free to send me any feedback about what you'd like to see in future issues. I'm always looking for contributors and good article ideas.

Thanks for reading!



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Clean energy pipeline grows to \$328 Billion

From American Clean Power

The American Clean Power Association (ACP) recently released its Q1 2025 Clean Power Quarterly Market Report, showing continued strong private sector investment in domestic energy production. U.S. developers installed 7.4 GW of utility-scale solar, wind, and storage capacity in the first quarter, marking the second-strongest start to a year on record and demonstrating strong market-driven demand for reliable, affordable domestic energy resources.

The industry's growth is particularly strong in Republican-leaning states, where domestic manufacturing and energy production has created nearly 650,000 direct and indirect jobs and generates \$3.4 billion in annual tax revenue and payments to landowners in rural communities.

KEY HIGHLIGHTS

▾ **Total Installed Capacity:** U.S. clean power capacity reached 320-plus GW in Q1 2025, enough to power nearly 80 million American homes.

▾ **Strong Q1 Installations:** 7.4 GW of new capacity came online, making it the second-strongest Q1 on record. The 115 project phases that came online in Q1 total \$10 billion of private investment into the U.S. energy infrastructure.

▾ **Record-Breaking Storage Growth:** Battery storage capacity surpassed 30 GW nationwide, representing a 65% increase year-over-year, with Q1 2025 setting a new first-quarter record at 1,602 MW.

▾ **Robust Project Pipeline:** The development pipeline grew 12 percent year-over-year to reach 184,418 MW, with storage and wind pipelines growing 57 percent and 24 percent respectively. This represents \$328 billion in project investment if everything in the pipeline is built. (Projects under construction or in advance stages of development (pipeline) are typically fully permitted projects. The growth of the pipeline does not signal any advances in the volume of projects receiving permits.)

▾ **Technology Mix:** Q1 additions included 4,459 MW of utility-scale solar, 1,602 MW of storage, and 1,327 MW of land-based wind.



American Clean Power is the voice of companies from across the clean-power sector that are powering America's future. For more information, go to www.cleanpower.org

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Shoreline Wind has entered the onshore wind market with a full-scale planning, construction and O&M platform. (Courtesy: Shoreline Wind)

Shoreline Wind enters onshore wind market with multi-tiered plan

Shoreline Wind has entered the onshore wind market with a full-scale planning, construction and O&M platform — unlocking an era of smarter, more resilient growth for global wind developers, operators, and service providers. With a proven offshore wind platform, powering some of the world's most complex offshore projects, Shoreline now brings its simulation-first approach to the onshore wind market, supporting developers, operators, and service providers to design, build, and operate more cost-efficient and low-risk projects.

The onshore wind sector is moving beyond the initial “gold rush” era of rapid expansion. Developers now face a complex combination of rising turbine and financing costs, tighter margins, and critical skill shortages. Regulatory, environmental, and community-specific requirements also vary by region, often leading to fragmented planning and inefficient execution. At the same time, intermittent generation, curtailment risk, and grid access limitations are creating an added layer of uncertainty that conventional planning tools struggle to handle.

“We’re bringing the full power of Shoreline’s simulation and resource management capabilities to the onshore wind market to support onshore’s evolution,” said Ole-Erik Endrerud, founder and chief product officer (CPO) at Shoreline Wind. “In today’s low-margin environment, the sector can no longer rely on speed alone — it must build smarter, plan better, and operate with more efficiency and precision.”

Shoreline’s onshore market entry aims to unlock these gains — by bringing greater precision, visibility, and collaboration to every phase of the project lifecycle. Shoreline’s Platform is powered by its proprietary Artificial Intelligence software, Shoresim AI, capable of delivering detailed and adaptive work orders, real-time operational insights, sensitivity analyses, optimizations, and forecasts.

It also optimizes project-specific constraints such as crew and resource availability, modal logistics, and environmental permits, generating efficiencies and reductions in operational expenditure (OPEX). Multi-scenario evaluation tools provide transparency for decision-makers under regulatory and investor scrutiny. Portfolio-level resource planning ensures optimal use of teams and equipment across multiple concurrent projects.

Shoreline’s onshore technology is already being used by RENOVA, a leading Japanese developer. In Japan, Shoreline’s simulations helped mitigate tidal and transport challenges, while in the Philippines, it streamlined logistics for a remote and complex site, unlocking efficiencies before ground was broken.

These capabilities come at a critical inflection point. Changes to policy tailwinds such as the Inflation Reduction Act in the U.S., repowering initiatives in Germany and Central Europe, and rapid buildout in LATAM are underpinning the expansion of the onshore wind market but adding far greater execution risk.

“Digital tools that integrate development, construction, and operations are no longer optional in the onshore market,” Endrerud said. “They are essential to navigating a market shifting from a boom period to one of disciplined, resilient, and efficient performance. By simulating and optimizing each phase of development, from turbine delivery logistics to repowering upgrades, we’re excited to start helping onshore developers and operators safeguard budgets and respond dynamically to complex changes in the market.”

MORE INFO www.shorelinewind.com

American Clean Power predicts 575,000 jobs

The American Clean Power Association released its State of Clean Energy Man-

ufacturing in America report, showing a sustainable ripple effect across states and economic sectors. The clean-power manufacturing sector contributes \$18 billion to the U.S. GDP annually, spurs \$33 billion in domestic spending annually, and supports 122,000 American jobs across the country.

If all announced manufacturing facilities become operational, clean-power manufacturing is projected to support more than 575,000 jobs and contribute \$86 billion annually to GDP by 2030.

“Surging clean energy deployment is creating new manufacturing facilities across the country,” said Jason Grumet, CEO of ACP. “This success will create hundreds of thousands of jobs and revitalize American communities if policy leaders place economic progress over partisan division. “Today’s report shows that the manufacturing activities across the clean-energy sector drive a ripple effect of economic growth that extends far beyond factory walls, reaching every corner of the country. Reshoring this critical supply chain requires a shared commitment by both industry and policymakers to prioritize domestic economic growth and global competitiveness.”

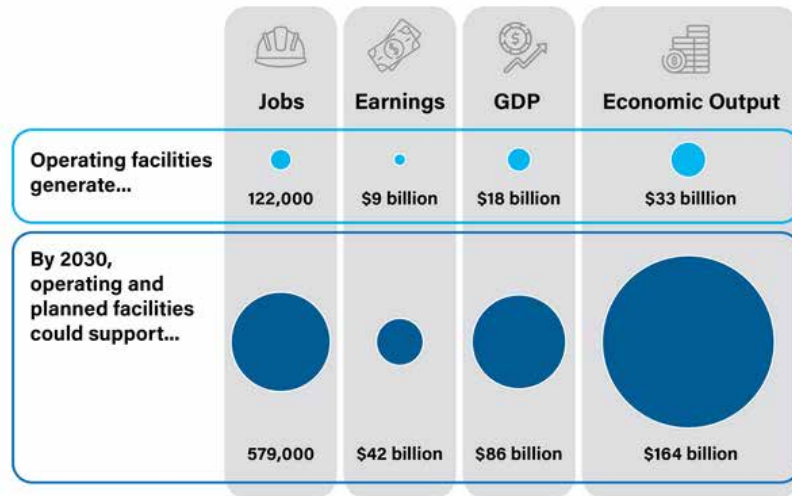
The report illustrates how the industry has laid the groundwork for a secure domestic supply chain, revitalizing manufacturing communities and driving American competition on the global stage.

More than 800 manufacturing plants contribute to the U.S. clean energy supply chain, with at least one in every state; 200 existing manufacturing facilities are actively building primary clean power components across 38 states to supply the booming demand for new energy in America.

New data highlights how clean-power manufacturing is creating generational opportunities at the local level, providing opportunities across skillsets, industries, and generating wages well above the national average.



By deploying the Dina Polaris vessel, equipped with geotechnical drilling, sampling, and testing equipment along with an offshore laboratory, Geoquip provided seabed data. (Courtesy: Geoquip Marine)



An American Clean Power report shows a sustainable ripple effect in clean energy manufacturing. (Courtesy: American Clean Power)

Clean-energy manufacturing is booming in regions across the country, such as the Southeast, Midwest, and in states like Texas. The clean-energy manufacturing workforce made on average \$42,000 more than the average worker in the U.S. economy in 2024.

These manufacturing jobs also generate additional employment across the economy: Upstream supply chain

jobs paid an average of \$75,000, while downstream jobs supported by household spending — such as those in retail, food service, and hospitality — averaged about \$52,000.

The report said that America’s power needs are growing fast — projected to rise 35 to 50 percent by 2040 — as data centers expand, domestic manufacturing rebounds, and transporta-

tion and buildings electrify.

MORE INFO cleanpower.org/resources/america-builds-power

Geoquip completes survey for Germany offshore wind projects

Geoquip Marine, a provider of geotechnical services to the global offshore energy sector, recently completed a preliminary geotechnical site investigation for two 4-GW offshore wind projects. The investigation will support the developer in advancing the next phase of design for both project sites, located in the German sector of the North Sea.

Under the contract, Geoquip drilled 28 boreholes across the project sites to analyze the subsea terrain for turbine foundations. It underwent thorough soil sampling and seismic site monitoring to inform the engineering parameters for both projects in depths of 40 meters. By deploying the Dina Polaris vessel, equipped with geotechnical drilling, sampling and testing equipment along with an offshore laboratory, Geoquip provided seabed data,

identifying challenging site conditions safely and efficiently.

Germany has set ambitious offshore wind capacity targets of at least 30 GW to be installed by 2030, and these projects will be vital in supporting the country in reaching its goal. The potential renewable power from both projects aims to integrate low-carbon, hydrogen, and biofuel production, supporting wider industry decarbonization in Germany. Due to its stringent processes around safety, transparency in reporting, and rapid response, the developer presented Geoquip with its safety award for its work on the project.

“Receiving this safety award is a testament to our commitment to delivering reliable data with safety at the heart of everything we do,” said Fatih Topal, Geoquip Marine project manager. “It reflects the precision and transparency we bring to every stage of our work, especially as we identify and mitigate complex site and seabed conditions to support the safe development of critical wind projects. Safety and reliability aren’t just priorities for us, they’re the foundation of our approach, and we remain focused on setting the standard across the industry.”

MORE INFO www.geoquip-marine.com/

NRG appoints new global sales vice president

NRG Systems, a leader in wind and solar resource measurement and intelligence, has appointed John Carroll as vice president of Global Sales. In this role, Carroll will lead NRG’s global sales strategy with a focus on expanding international market share, driving revenue growth, and delivering strong financial performance. He will also oversee customer engagement, strengthen relationships with NRG’s authorized dealers and technical partners, and advance the company’s presence across its portfolio. With more than three decades of experience in the energy industry, Carroll brings a proven track record of commercial

success, team leadership, and strategic growth. His background spans the renewable energy, grid automation, power systems, and decarbonization sectors. Most recently, he served as vice president for the Commercial



John Carroll is NRG Systems’ new Vice President of Global Sales. (Courtesy: NRG Systems)

and Industrial (C&I) business in North and Latin America at SolarEdge.

“We are thrilled to welcome John to our team,” said Evan Vogel, president of NRG Systems. “His leadership experience, market

insight, and strong industry relationships will be instrumental as we continue to scale globally and expand our impact across the wind and solar sectors. John’s deep understanding of customer needs and his talent for building lasting partnerships align

perfectly with NRG’s customer-first approach and will further strengthen our position as a trusted leader and innovator in renewable energy worldwide.”

Carroll is also a retired U.S. Navy Reserve captain with four command tours over his 25-year military career. He holds a BSEE in Electrical Engineering from N.Y. Maritime College, an MBA from Adelphi University, and strategy and policy certifications from the National Defense University and Air Command & Staff College.

“I am honored to join NRG Systems, a company with a clear vision for the future of renewable energy,” Carroll said. “NRG is a long-standing industry leader known for delivering trusted, customer-focused resource measurement solutions. I look forward to building on that legacy and working with our talented global team to deliver meaningful value to our customers and partners around the world.”

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WIND BLADE SAFETY: THE TRUE COST OF QUALITY



As blades now exceed 100 meters in length and towers climb even higher, advanced inspection technologies become increasingly critical. (Courtesy: CICNDT)



No single inspection or one-time procedure guarantees blade safety; what protects workers, communities, and assets is the accumulated effect of thousands of quality decisions made throughout the blade's life.

By **BRETT DAVIS** and **JEREMY HEINKS**

In the wind-energy industry, conversations about safety often center on tower heights, blade lengths, or extreme weather events. But for those in the field — technicians, inspectors, engineers, and operators — safety starts long before a blade ever turns. It begins with decisions made during design, the precision on the manufacturing floor, the hands that install, the eyes that maintain, and the teams who inspect.

At the core of every safe wind turbine is one simple truth: quality is safety.

THE BLADES

The towering blades that cut through the sky are marvels of composite engineering. But they are also among the most vulnerable components in the entire wind-energy system. Spanning up to 80 meters and weighing several tons, a single blade carries enormous loads with every rotation — millions of cycles, year after year. While these blades are designed for decades of service, their true safety margin depends not only on the blueprint, but on the discipline applied at every stage of their lifecycle.

When most people outside the industry hear about blade failures, they picture dramatic scenes: blades shearing off towers, collapsing structures, or scattered fragments across a field. These catastrophic failures, however, rarely happen without warning. More often, they are the result of small, often invisible defects that quietly build over time until the system can no longer tolerate them.

Some of these flaws begin during design — miscalculations in load paths, insufficient bondline durability, or underestimated lightning strike effects at structural interfaces. Others arise in manufacturing: bondline voids, poorly cured laminates, or contamination introduced during layup. Still more appear during handling, transport, or installation, where minor damage can worsen after thousands of operational cycles.

Nowhere is this risk more serious than at the blade root, where composite materials, steel inserts, and fasteners meet under extreme stress. This is the point where every opera-



Maintenance teams face a constantly evolving list of risks: leading edge erosion from rain and sand, lightning strike damage, temperature-induced fatigue cracking, and progressive weakening of adhesive bondlines. (Courtesy: CICNDT)

tional load transfers into the turbine's rotating hub. If the root fails, there is no backup. The blade separates. The hub destabilizes. And in extreme cases, the tower can collapse. Cosmetic damage elsewhere may reduce performance, but root failures carry serious safety threats.

BEFORE INSTALLATION

The journey toward failure often begins before the blade is ever installed. Transportation damage remains one of the most overlooked contributors to blade integrity problems. As blades grow larger, more flexible, and structurally complex, the risks during transport increase dramatically.

Field teams have documented numerous cases where impacts to the root bushings occurred during loading or unloading. Something as simple as a forklift arm lightly striking a threaded stud can introduce tiny cracks in the metal insert. These flaws may not prevent immediate installation, but once the turbine begins operation, fatigue cycles take over, and the cracks grow. If left undetected, they progress into bondline separations or full bushing fractures, both of

which carry serious safety consequences.

Vibration during long-haul trucking, improper stacking for overseas shipments, and inconsistent cradle support all add to the potential for subsurface delamination, which may remain hidden for years without targeted inspection.

If transportation introduces early risk, installation becomes the final hands-on moment before blades enter decades of service. Mistakes during this stage often involve much more than simple misalignment. Bolt tensioning methods, torque settings, preload sequences, and balance tolerances all carry long-term safety implications. While some debate remains between torque and direct tensioning approaches — often dividing new-school and old-school practices — any deviation from proper specifications introduces long-term safety risks.

One of the most dangerous risks is under-torqued bolts at the root connection. Even minor deviations from specification can allow microscopic movement between mating surfaces, generating heat, initiating cracks, and eventually causing stud failures. In severe cases, entire root sections

have detached while spinning, sending blades hundreds of meters away and bringing down towers.

Every installation technician working at height is not simply assembling hardware. They are signing off on the structural safety of that turbine for the next 20 or 30 years. The responsibility they carry affects not just the operators but the landowners and nearby communities as well.

Even with strong design, manufacturing, and installation practices, no system is flawless. Inspection often serves as the final line of defense. As blades now exceed 100 meters in length and towers climb even higher, advanced inspection technologies become increasingly critical.

Ultrasonic phased array systems have become essential tools. They allow technicians to map subsurface bondlines at the root, routinely detecting partial disbonds, delamination growth, and early signs of stud interface cracking. If not addressed, any of these conditions could eventually lead to blade separation.

TAKING INSPECTION TO THE NEXT LEVEL

Modern inspection goes beyond scheduled maintenance. Post-transport receiving inspections, periodic torque checks, and advanced NDE scans all help identify developing issues before they escalate. The best inspection programs do not simply search for defects; they monitor defect growth and track changes over time, providing operators with actionable information to plan repairs or replacements safely.

Even after blades are installed and inspected, the safety work continues. Maintenance teams face a constantly evolving list of risks: leading edge erosion from rain and sand, lightning strike damage, temperature-induced fatigue cracking, and progressive weakening of adhesive bondlines.

The environment is relentless. UV radiation, moisture cycling, ice loads, and thermal gradients all work against structural integrity. Fatigue cracking often begins deep within the laminate, invisible to surface inspection until significant damage has already occurred.

Without consistent, technically sound inspections, these aging effects slowly erode the safety margin. As fleets age, blades approaching the end of their fatigue life will require more frequent and specialized evaluations.

Many safety programs focus on responding after something goes wrong. In wind energy, real safety depends on discipline applied years, sometimes decades, before a failure occurs. It requires full commitment from everyone involved: engineers, factory workers, transport crews, installers, inspectors, and operators. It demands clear communication, well-defined procedures, and ongoing investment in both people and technology.

No single inspection or one-time procedure guarantees blade safety. What protects workers, communities, and assets is the accumulated effect of thousands of quality decisions made throughout the blade's life.

In that sense, quality is not simply an engineering metric. It is a safety behavior.



One of the most dangerous risks to a wind turbine is under-torqued bolts at the root connection. (Courtesy: CICNDT)

RISING STAKES

As wind energy continues to grow across the globe, safety cannot remain a background conversation. Blades are getting longer. Loads are increasing. And the stakes — both financial and personal — are rising. The industry's real commitment to safety will not be measured by marketing slogans, but by its willingness to invest in quality at every step: design, manufacturing, transportation, installation, inspection, and maintenance. Because when a 70-meter blade releases from its hub, there are no second chances. ↘

ABOUT THE AUTHOR

Brett Davis is director of Strategic Solutions for CICNDT and Omni-NDE. With nearly 20 years in NDT, he develops inspection procedures, programs, and technology strategies that help improve safety, quality, and efficiency in industries including wind energy, aerospace, defense, and manufacturing. Jeremy Heinks is CEO of CICNDT and owner of the AIMM Center in Ogden, Utah, which provides advanced composite inspections and NDT training programs. With more than 25 years of experience, he supports wind energy, aerospace, space, and manufacturing sectors with a focus on composite quality, program development, and technician training.

IN FOCUS

WIRES & CABLES

CYCLIC RATING OF WIND- FARM CABLE CONNECTIONS



Examining an approach for calculating enhanced ratings for cable circuits connecting wind farms to the grid.

By RICHARD CHIPPENDALE, JAMES PILGRIM, ALI KAZEROONI, and DAVID RUTHVEN

Cable circuits connecting wind farms to the grid are subject to highly variable loading. The sizing of such cables according to conventional continuous rating methods, e.g. IEC 60287, can lead to some conservatism. Traditional daily loss load factors are also unsuitable for use with these circuits, as unlike demand driven circuits there is no discernible daily load cycle. This study uses electrical and thermal data from operational wind farm circuits to propose an alternative cyclic rating method for sizing such circuits.

1 INTRODUCTION

The transition toward a low carbon economy [1] has led to a large number of wind farms being connected to the U.K. electricity grid, with further installations planned. The cable circuits that connect the wind farm to the grid can be a significant proportion of the overall project cost, particularly for more remote sites where the nearest suitable substation may be more than 20 kilometers away. The current rating of the cable circuits is usually determined based on conventional continuous rating methodologies, such as IEC 60287 [2]. This approach neglects the fact that power from renewable sources is inherently variable and hence there can be many periods when assets are not fully utilized and true operating cable temperatures are much lower than the design maximum.

Given the widespread availability of distributed temperature sensing (DTS), it is possible to make real-time measurements of cable temperature. The temperature measured is not that of the conductor, but when coupled with thermal models, it is possible to use DTS systems to calculate dynamic current ratings (DCRs). SP Energy Networks, the company responsible for the operation of the electricity distribution networks in Southern Scotland and Merseyside & North Wales, has previously trailed the implementation of a DCR system to monitor the temperature of four 33 kV export cable circuits associated with four onshore wind farms in Scotland [3].

While DCR enables an operator to verify the thermal capacity of their cable circuits in real time, it cannot be used as a design tool; the cable circuit must still be designed using offline calculations with a suitable set of assumptions. This article presents a cyclic rating method that can be used for such calculations. Prior to presenting the new method, temperature measurements from an example installation are shown to demonstrate the potential benefits of using non-steady state methods.

2 TEMPERATURE MONITORING METHOD

The installation used as a case study for this article consists of four 33 kV wind-farm cable circuits connecting to East Kilbride South 275/33 kV substation in Scotland. In the

following sections, the layout of the cable circuits and examples of measured temperatures are presented.

2.1 Cable circuits monitored

Figure 1 shows the layout of the cable circuits that connect windfarms A-E to the East Kilbride South substation. Circuits A-C consist of $3 \times 1c$ 630 mm² Cu XLPE insulated cables, while circuit D consists of $3 \times 1c$ 240 mm² Al XLPE insulated cables. Each circuit is installed in separate ducts arranged in a trefoil formation, with the sheaths solidly bonded. The ducts have an outer diameter of 160 mm and inner diameter of 150 mm. Circuits A-D share a common trench for the first 0.7 km from the substation. Circuits A-C continue to share a trench for the next 10 km until these circuits separate. The trench containing circuit A-C is crossed by two 275 kV circuits that connect wind farm E to the grid. Further circuit routing details may be found in [3].

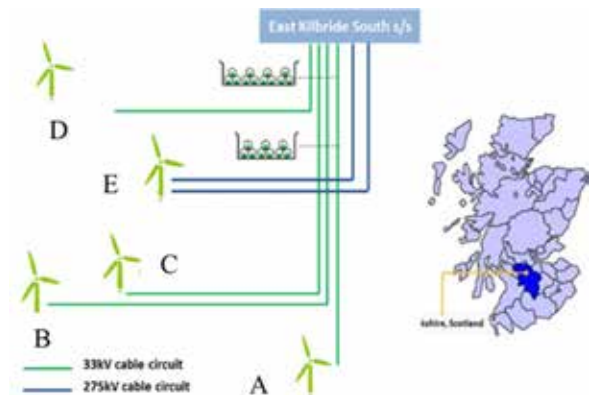


Figure 1: Schematic diagram of installation.

2.2 DTS system architecture

The DTS fiber used to measure the cable circuit temperatures was installed in a separate micro-duct (internal diameter of 10 mm) in the center of each trefoil bundle as shown in Figure 2. The gap in the trefoil formation was chosen as the optimum location for the micro-ducts and thus the optical fibers. The fibers were jointed every 0.5 km, within 10 m of the 33 kV joint bays.

The DTS system is capable of measuring the temperature along the full length of each of the cable circuits at a resolution of 1 meter, with a temporal resolution of 30 minutes.



Figure 2: Optical fibre location [3].

The measurements are then fed into the DCR system, as shown in Figure 3, such that the conductor temperature may be estimated and the dynamic rating data may be made available to the network operator.

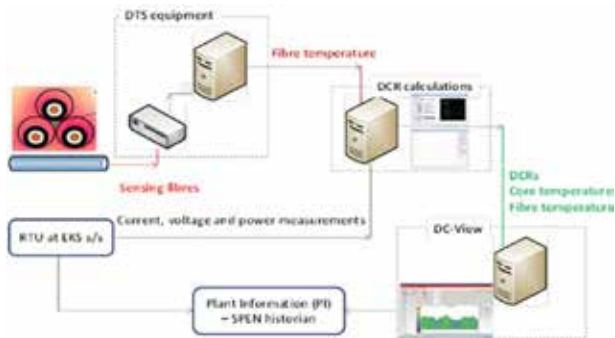


Figure 3: DTS system architecture.

2.3 Location of hotspots

One particular benefit of using DTS systems is the ability to track the locations of hot spots along the circuit length. Figure 4 shows the spatial locations of the hottest points on Circuit B over an 8-months period. Red points represent the hottest point on the whole circuit, with blue representing the second hottest locations. It can be seen that in the latter part of the duration assessed, the hot spot locations have changed. This is due to circuit B being commissioned before the remaining circuits are operational, which has a mutual thermal impact on circuit B.

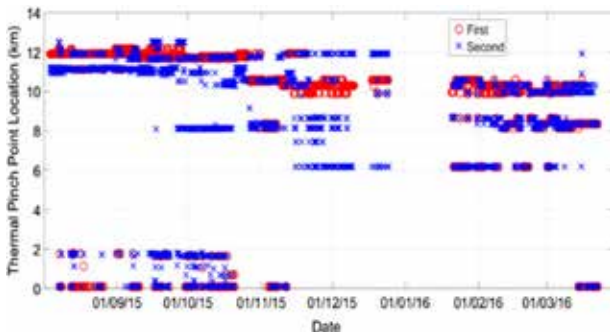


Figure 4: Hot spot temperature distribution on circuit B.

By reviewing the hot spot locations at the time of the highest loads, it was possible to identify the sections of the route that would need to be considered in the most detail when calculating the cyclic ratings. The hot spots were typically associated with localized increase in burial depth, either due to crossings with other circuits or underneath natural obstacles such as rivers. While a deeper section will often have a lower continuous rating, the thermal time constant is typically longer. This means that these sections stand to benefit most when a cyclic rating is considered.

Figure 5 shows an example of the fiber temperature distribution at five hot spots on circuit B. The most common temperature is approximately 17°C, which would represent a small rise above the standard soil temperature of 15°C, but peak temperatures of up to 39°C were measured within the fiber duct under the most onerous circuit loads.

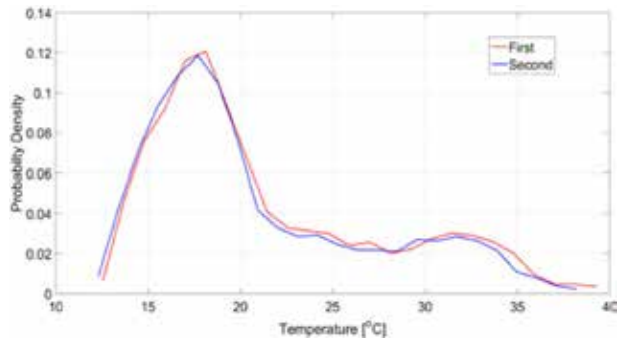


Figure 5: Hot spot temperature distribution on circuit B.

3 CYCLIC RATING REQUIREMENTS

Conventional cyclic ratings, such as those given in U.K. Energy Networks Association (ENA) Engineering Recommendation (ER) P17 [4], are typically based upon a 24-hour domestic/residential load cycle. This is because they have typically been used to obtain ratings for cases where the circuit loading is demand driven, rather than generation driven.

3.1 Requirements

The basic requirements for the cyclic rating method for wind farm application were as follows:

- Simple square wave shape (for easy computation using analytical tools).
 - Can be calculated either at the design stage, or as an up-rating of an existing installation.
 - It should be feasible to calculate the rating without the use of finite element tools, or other advanced software.
- Given these requirements, the preferred strategy is to
- i: Design a calculation which can be solved using either wind resource data to estimate a cable current, or using real circuit load data.
 - ii: Make use of existing IEC calculations for cyclic rating factors where possible.

3.2 IEC 60853 method

Two internationally standard methods for calculating cyclic ratings have been made available by IEC. IEC 60853-1 [5] contains a method that is valid for cables with rated voltages at 30 kV and below, while IEC 60853-2 [6] is valid for cables with rated voltage above 30 kV. The primary difference between the two calculations concerns the thermal model used for the cable itself. Cables at 30 kV and below have a shorter thermal time constant, as the thermal capacitance of the cable is smaller than would be the case for a higher voltage

system. Hence IEC 60853-1 calculates the cyclic rating on the assumption that the cable thermal capacitance can be neglected, meaning that only the thermal capacitance of the surrounding ground is considered. This can also be appropriate for a buried 33 kV cable circuit.

The cyclic rating according to IEC 60853-1 is calculated by multiplying the continuous rating, I_{con} , by the cyclic rating factor M . The first step is to obtain the loss load factor, μ , given by Equation 1.

$$\mu = \frac{1}{n} \sum_{i=0}^n Y_i \quad \text{Equation 1}$$

Y_i is obtained by squaring the load cycle $I(t)$, then normalizing against the maximum load squared, before decomposing into a series of hourly rectangular pulses Y_0, Y_1 and so on. Here i represents the number of hours prior to the expected peak temperature and n is the total number of hours considered.

Having obtained μ , Equation 2 is then used to obtain the value of the cyclic rating factor M .

$$M = \left[\sum_{i=0}^m Y_i \left[\frac{\theta_r(i+1)}{\theta_r(\infty)} - \frac{\theta_r(i)}{\theta_r(\infty)} \right] + \mu \left(1 - \frac{\theta_r(m)}{\theta_r(\infty)} \right) \right]^{-1/\alpha} \quad \text{Equation 2}$$

Here $\theta_r(i)$ is the temperature rise at time i hours due to the application of a step function of load equal to the continuous rated load. The first half of (2) accounts for the transient response for the past ' m ' hours and the remaining terms consider the historical response through the average loss factor. The ratio of temperature at time ' i ' to steady state can be expressed by Equation 3:

$$\frac{\theta_r(i)}{\theta_r(\infty)} = 1 - k_1 + k_1 \gamma(i) \quad \text{Equation 4}$$

Here $\lambda(i)$ represents the transient temperature rise at the duct surface and is given by Equation 4:

$$\gamma(i) = \frac{-Ei(-D_c^2/16t\delta) - (N-1)Ei(-D_f^2/16t\delta)}{2\ln|4LF/D_c|} \quad \text{Equation 4}$$

where D_c , L , t , δ and N are the external diameter of the duct [m], burial depth [m], the point in time [s], thermal diffusivity [m^2/s] of the soil and the number of active circuits, respectively. Whilst the left-hand side of the numerator in Equation 4 represents the thermal response of the cable under consideration, the right-hand term represents the impact of additional circuits. The distance from the cable in question to the additional circuits is given by D_f , defined in Equation 5 as

$$D_f = \frac{4L}{F^{(N-1)^{-1}}} \quad \text{Equation 5}$$

The coefficient F used to express the steady-state mutual heating caused by the other cables in the group is Equation 6

$$F = \prod_{k=1}^{N-1} \frac{d'_{pk}}{d_{ok}} \quad \text{Equation 6}$$

Guidance on the means by which d'_{pk} and d_{ok} can be calculated for groups of circuits is given in [5]. It should be noted that some additional terms can become necessary as more circuits are added, or as the transient becomes longer.

The final outstanding term in Equation 3 is k_1 , which represents the ratio of the duct external surface temperature rise above ambient to the conductor temperature rise above ambient under steady-state conditions and is calculated by Equation 7

$$k_1 = \frac{W(T_4 + \Delta T_4)}{\theta(\infty)} \quad \text{Equation 7}$$

4 DEFINING A LOAD CYCLE

This section presents the methods used to perform the cyclic rating calculations. The method has been adapted from that published in [7] to suit a 33 kV cable circuit.

4.1 Distribution of load

It is well known that the outputs of wind farms will vary with time as the prevailing weather changes. When the power curve of a wind turbine is taken into account, these two factors together will have a significant impact upon the time series loading of the cable circuit. Figure 6 shows the cumulative distribution of the normalized load on each of the cable circuits. It should be noted that circuits A and D have been in service for less than 1 year at the time of the data analysis being undertaken, therefore the shape of the distribution is slightly different to that of the remaining circuits.

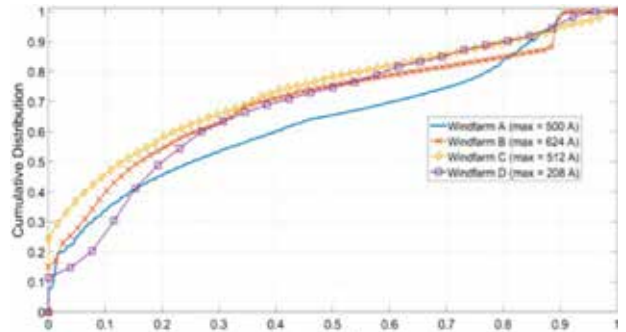


Figure 6: Distribution of load on circuits A-E.

The following features can be seen from Figure 6:

- For 50% of the time, the loading on all of the circuits is <30% of the maximum value (resulting in <10% of rated heat generation in the cables).

- Excluding wind-farm A (for which the least data was available), loading in excess of 80% of the rated value occurs for <20% of the time.

This demonstrates why a continuous rating method could prove to be very conservative. However, Figure 4 does not provide information about how the high and low loadings are distributed in time. This can be achieved through a persistence analysis.

4.2 Persistence analysis

The purpose of the persistence analysis is to allow the variables Δt_{rate} and Δt_{low} shown in Figure 7 to be obtained. The procedure to perform the analysis can be summarized as follows:

- i: Obtain a long time series of wind speed data (or load current data).
- ii: Remove the effects of very short events, pass the times series data through a moving average filter with window length of 6 hours.
- iii: Define a critical value of wind speed (or load current) above which the loading on the cable is considered significant. This obtains the value I_{low} , which will be assigned as the minimum load on the circuit.
- iv: Pass the filtered time series through a binary filter, such that any value $I(t) \leq I_{low}$ is considered low loading, all others are considered as high loading.
- v: Calculate the duration of each spell of high and low loadings.

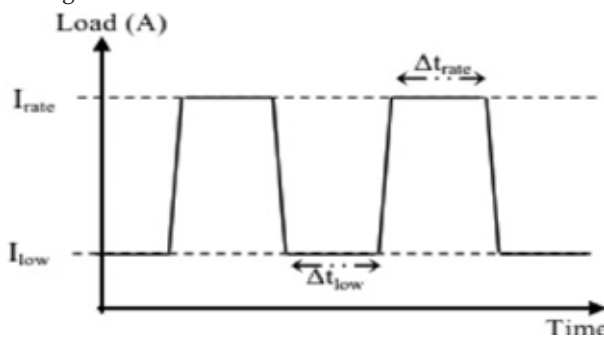


Figure 7: Shape of recurrent load cycle [7].

The result of this analysis will be a distribution of low and high load durations, which can then be assessed to determine suitable values for Δt_{rate} and Δt_{low} .

The results of this analysis for the outputs of the five wind farms are presented in Table 1. It should be noted that the maximum values found for hours below the loading threshold may include planned downtime. The following section discusses the strategy for defining load cycles from this data.

WF	Hours above I_{low}		Hours below I_{low}	
	Mean	Max	Mean	Max
A	31	146	54	878
B	22	155	62	1584
C	20	105	69	1103
D	20	107	53	361
E	10	75	67	1145

Table 1: Persistence above and below 50% loading.

4.3 Correlation analysis

Given that four of the cable circuits for the different wind

farms share the same trench, it is important to consider the cross correlation of the loading on these circuits. Table 2 presents the maximum cross correlation of loading on the circuits, based on the original time series dataset. As the lowest correlation is 83%, it would be valid to assume that peaks in output would be coincident on all four circuits, i.e. the thermal worst case.

	A	B	C	D
A		0.83	0.90	0.89
B	0.83		0.93	0.91
C	0.90	0.93		0.92
D	0.89	0.91	0.92	

Table 2: Maximum normalized cross correlation of load on circuits A-D.

The cross correlation between the temperature data recorded by the DTS and the circuit loading has also been investigated. The key findings were

- i: The normalized cross correlation between load and temperature was high for all circuits, typically in excess of 94%.
- ii: For the majority of the hot spots tested, the lag between the high load and resulting thermal response was in the region of 2.5 to 3 hours. This matches well with the expected thermal time constant of the 33 kV cable system. Given that the thermal response of the soil is very slow, the temperature does continue to rise after this time but at a much-reduced rate.

The time lag between the load and the thermal response is clearly much shorter than the mean persistence values shown in Table 1. Therefore, the use of IEC 60853-1, i.e. neglecting the cable thermal capacitance in calculating the cyclic rating factor, is a reasonable assumption.

4.4 Cycles defined

Taking the results of the persistence analysis and the cross-correlation analysis together, it is reasonable that circuits A-D can all be represented by the same load cycle. This is because the persistence values are comparable and there is strong correlation between the peaks in load. Taking averages and discounting some potentially atypical data, the values proposed for the variables in Figure 7 are

- $I_{low} = 0.5I_{cont}$.
- $\Delta t_{rate} = 21$ h and $\Delta t_{low} = 65$ h.

Applying this cyclic load within the modified IEC 60853-1 calculation, a potential 17% increase in wind-farm generation uniformly across all wind farms is possible with an assumed 78°C thermal limit. When a more complex model is used to calculate the thermal response, taking full account of the thermal capacitance of the cable, the cyclic rating factor obtained is very comparable. These results are for a generic circuit installation and care should be taken to consider potential thermal pinch points, as this would restrict any permissible generation increase.

5 LESSONS LEARNED

Based on experience of applying this method to several case



studies, the following points should be considered prior to using the method:

i.: To obtain a representative cyclic load curve, the minimum acceptable length of the circuit loading time series input is one year, although more data would be preferable.

ii: The value of I_{low} selected must be sufficiently low that if such a load was applied constantly the increase in soil temperature around the cable would be minimal.

iii: When conducting the persistence analysis, it can be beneficial to solve additionally for a threshold of 80% of rated load to identify the durations of the worst-case peak loads.

iv: Analysis of DTS data shows that circuit hot spots can move between seasons, which may mean that multiple sections need to be rated with the lowest common rating being chosen for the circuit.

v: Sections of cable installed “in air” may have a higher continuous rating, but their short time constant may mean that they reach steady-state conditions within the duration of a single peak. Coordination of ratings between sections is essential.

6 CONCLUSIONS

This article has presented an approach for calculating enhanced ratings for cable circuits connecting wind farms to the grid. The numerical analysis required to design the cyclic load profiles can be completed using a wide range of software.

By adapting the existing IEC 60853 calculation, it is possible to assess the cyclic ratings without the need to solve long duration transient models. Care must be taken in selecting appropriate values of Δt_{rate} and Δt_{low} if the available time series of data is short, as it is possible that the data will not fully reflect extreme values.

For the case studies considered to date, rating enhancements of about 25-35% above the IEC 60287 rating have been found to be possible, particularly for deeply buried cables. It is recommended that a DTS system should be installed if a wind-farm circuit is designed on this basis, unless additional

analysis can be completed to demonstrate that the load cycle chosen is sufficiently conservative.

7 ACKNOWLEDGMENTS

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PROFILE

WEIDMULLER

DELIVERING INNOVATIVE TECHNOLOGY FOR WIND

Weidmuller USA's BLADEcontrol monitoring system with web-based visualization provides powerful insights on the condition of wind turbine blades. The WebVis feature highlights single turbine and fleet-wide diagnostics to help identify anomalous behavior, minimize unplanned downtime and maximize productivity. (Courtesy: Weidmuller USA)

BLADEcontrol



For 175 years in Europe and 50 years in the U.S., Weidmuller has offered resilient electrical components for wind-turbine systems as well as a condition monitoring system that can increase turbine availability, reduce unplanned downtimes, and ensure optimal efficiency.

By **KENNETH CARTER** ▸ Wind Systems editor

From a distance, a wind turbine looks like one enormous machine, but in reality, that machine is made up of thousands of different parts that must constantly perform in harmony to create electricity.

Many different companies may be responsible for maintaining those pieces, but companies like Weidmuller transform traditional maintenance through insightful operational data, while leaning into 175 years of experience to add even more services to its wind-energy portfolio.

“We are in several areas of the wind industry,” said Pete Tecos, director of new energy solutions at Weidmuller. “First and foremost is, we’re trying to develop safe, secure, resilient solutions for the electrical cabinets and the interconnectivity of the systems within the wind turbines. This goes across our core portfolio of terminal blocks, power supplies, electronic load monitoring, surge protection, heavy duty connectors, all the way to programmable automation controllers, and industrial I/O.”

In addition to the core connectivity and electrical cabinets, Weidmuller has developed customized LED tower lighting systems, according to Tecos. These are highly engineered systems specific to turbine models that can be installed easily, and the lighting is tailored for each particular tower.

“However, where we bring unique value to the wind industry, is with our emphasis on condition monitoring systems, and that’s in a couple of different areas,” he said.

BLADECONTROL CONDITION MONITORING

One of those areas is for the root connections of the wind-turbine blade, according to Tecos, BOLControl is a system that monitors the bolts that connect the blade to the hub. But Weidmuller’s premier condition monitoring product is BLADEcontrol, the company’s condition monitoring system for blade health.

“It is capable of detecting cracks, debonding, delamination, and other damages at very early stages when blades can be repaired cost-effectively utilizing condition-based maintenance, rather than time-based maintenance,” he said. “Data-driven decision making is really critical for the industry as it exists today. In addition to damage detection and blade degradation, BLADEcontrol is also excellent at detecting ice buildup on blades, which is essential for those wind-farm installations in cold regions. Buildup of ice can be detrimental to a blade and even the entire wind turbine. Our system can detect the buildup of ice, and if it gets to a critical mass, BLADEcontrol can send an alarm to the turbine controller to shut down so that the ice can be abated, and then issue a restart request once it’s diminished to a point that’s deemed safe.”

GUIDING PRINCIPLES

With 175 years of history under its belt, Weidmuller is a company that has centered itself around innovation and connectivity in the industrial environment, according to Tecos, but under the guiding principles of sustainability and responsibility.

“Some of the key elements of that philosophy involve customer-centric innovation,” he said. “Weidmuller positions itself as a partner in industrial connectivity and supporting our customers through digital transformation with intelligent products, solutions, and services. Like many of our customers, we emphasize continuous innovation in order to meet the evolving technological challenges of the future. That’s first. The second is some of our key corporate values, which would include service, competence, and reliability since 1850. Very few companies can make that statement.”

That means high-quality products with a strong price-to-performance ratio, where creativity and innovation is present in all of Weidmuller’s business units, which includes the company’s organizations and its qualified and committed employees who complement its products and solutions with outstanding logistics capabilities, according to Tecos.

“Our third key element is sustainability and responsibility,” he said. “I’d say Weidmuller is deeply committed to ethical and sustainable business practices, and we align with a variety of international standards, like the German Supply Chain Act, the UN Global Compact, and other Declaration of Human Rights standards that foster responsible corporate citizenship. We’ve implemented a code of conduct and principles for human rights and decent work environments, which applies globally across all business units, and subsidiaries and partners of Weidmuller.”

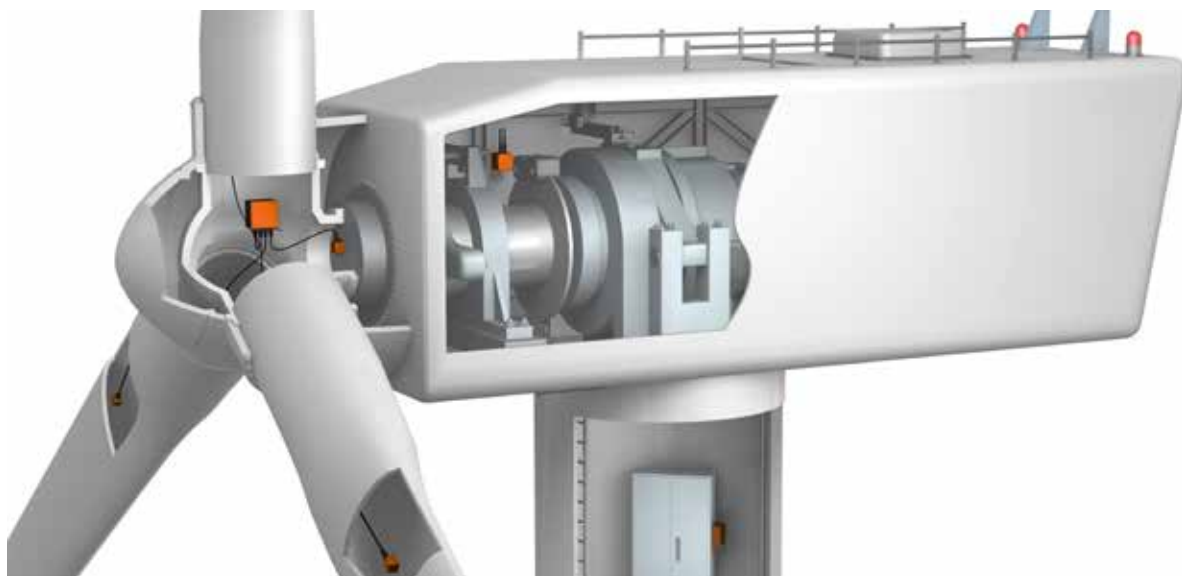
The company’s last key element would involve global and local engagement, according to Tecos.

“We are a family-owned company with global scale,” he said. “While we have a presence in over 80 countries, we value both global reach as well as local responsibility, and we balance them accordingly, striving to create a meaningful connection, whether it is power, signal, data, or the human relationship. That’s really what we’re driving toward.”

EXPANDING IN THE WIND SECTOR

Although Weidmuller has made a name for itself by manufacturing terminal blocks, power supplies, controllers, I/O and more, it’s with its condition monitoring products where Tecos said the company is really making a name for itself within wind energy.

“I think one of the excellent examples of how Weidmuller



BLADEcontrol with web-based visualization measures vibration response inside the blade to detect performance and structural-related issues. (Courtesy: Weidmuller USA)

has tracked the evolving wind industry is rooted in our focus on blade condition monitoring,” he said. “If you look at what’s happened in the wind industry over the past two decades, in an effort to bring down the levelized cost of electricity to make wind energy the viable competitive energy source that it is today, the industry has had to increase the power output of the turbines.”

One of the ways to do that is to make turbines — and their blades — larger, according to Tecos.

“We see blade lengths have more than doubled in that 20-year timeframe,” he said. “We see rotors reaching farther and farther up into the sky, where they could be subjected to stronger jet streams and sometimes more turbulent air. This makes the blades one of the more costly and higher risk components of the wind turbine. Yet the manufacturing process of blades has remained virtually unchanged in that timeframe. It’s primarily a manual process, which makes it inherently susceptible to error and defects.”

Because of the turbines’ exponential growth, condition monitoring — once thought of as an accessory — has become a necessity, according to Tecos.

“Data-driven operations and maintenance directly mitigate the risk of unplanned downtime, or even catastrophic failures,” he said. “It’s a tool that’s going to be required by both OEMs and operators to make sure that fleets can operate at their optimal capacities and performance.”

WORKING WITH CUSTOMERS

Finding the proper product for a customer can be a process, but it’s a necessary one to ensure the best fit, according to Tecos.

“The first steps often include setting up a workshop with the customer, so we can ascertain the following things: No.

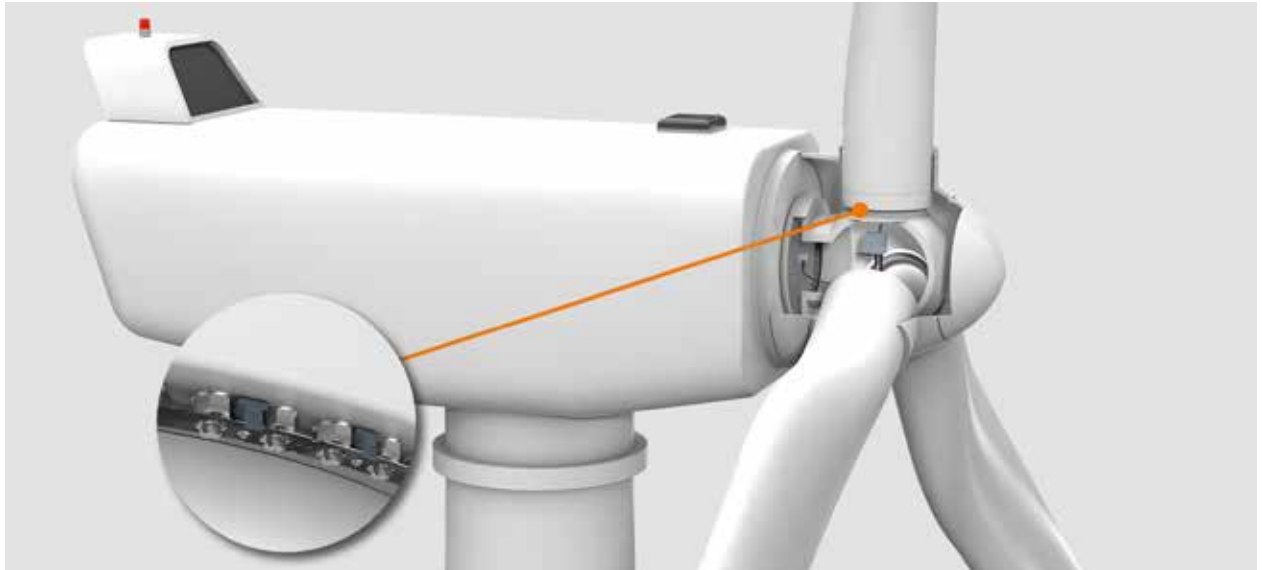
1, do we thoroughly understand the problem our customer is trying to solve? Are we also taking into account or into consideration the needs of the end customer? We like to take it full scale — from not only our customer, but the end customer,” he said. “We can then assess: Do we have a solution or solutions? There could be multiple ways we could approach it, but which solution is most viable both technically and commercially? Can it be deployed within the necessary timing requirements? Is it scalable or even translatable? By scalable, obviously, is it applicable not just to a single turbine, but across a fleet or across a platform of turbines? Translatable means: Could we take this solution and apply it in a different industry or to a different type of asset, but using the basic same philosophies of the solution that we applied to a wind turbine? Then finally, does it drive unique value to our customer and the industries that we mutually serve? That’s really the salient point.”

175 YEARS OF BUSINESS

Weidmuller has its roots in textiles, beginning in Germany in the 1850s. In 1948, the company took what it had learned in stamping and metal fabrication and used that knowledge to pivot into the electrical connectivity industry, where Weidmuller created, developed, and invented the first insulated terminal block, according to Tecos.

“The terminal block has basically been synonymous with Weidmuller since that time,” he said. “It’s the core product for which we are known, although in the ensuing 80 years or so since its development, we have created a portfolio that spans more than 54,000 SKUs, from terminal blocks to full industrial automation solutions.”

Since 1850, Weidmuller has existed as a privately held, family-owned company, a monumental achievement that



BOLTcontrol from Weidmuller USA is an innovative monitoring system that detects broken bolts or studs in the blade root that connects to the hub and alerts operators immediately. (Courtesy: Weidmuller USA)

few — if any — companies can duplicate, according to Tecos.

“We can cite so many examples of companies and empires being built that are subsequently sold off by future generations — that is not the case here,” he said. “Since 1850, the family is committed to this company, committed to the employees, and most importantly, committed to the customers and the industries that we are privileged to serve. I think that’s one of the proudest achievements of the company.”

50 YEARS IN THE U.S.

As part of that 175-year history, Weidmuller is also celebrating 50 years in the U.S. with its Richmond, Virginia, location, according to Tecos. On June 11, Weidmuller’s supervisory and executive boards came to Richmond to celebrate this milestone along with state and local economic officials, customers, distributors, and more. The celebration also served to commemorate the grand opening of the company’s engineering and production facility, which broke ground in May of 2023.

A half century serving North American companies, as well as Weidmuller’s near two century existence, makes it essential that the company keeps an eye on an ever-changing future for the wind sector.

To that end, Tecos said he expects to see a convergence of IT and OT so the wind turbine can be viewed holistically. This will enable operators and OEMs to streamline operations and minimize inefficiencies, while maximizing productivity and profitability.

“The goal is to acquire, aggregate, and analyze data regardless of asset brand, age, or control type so that AI and machine learning tools can transform that operational data and leverage it to elevate performance and improve designs,” he said. “Also, I just can’t imagine there’s not going to be a



An aerial view of the headquarters of Weidmuller USA in Richmond, Virginia, showing the new 24,000-square-foot Engineering and Production Facility outlined in Weidmuller’s signature orange. (Courtesy: Weidmuller USA)

transformation regarding the adoption of automation for the production of blades and other major elements of the wind turbine that are currently tied to manual processes.”

And with Weidmuller’s recent expansion at its Richmond facility, the company is ready to face much of what’s next on the wind-energy horizon, according to Tecos.

“We have just expanded our operations by 24,000 square feet; this is dedicated to engineering as well as manufacturing, and a good portion of that manufacturing capacity is going to be allocated to clean-energy initiatives, certainly combiner boxes for PV, but we’re also looking at the possibility of making BLADEcontrol stateside as well,” he said. “That’s pretty exciting. And we’re looking forward to implementing that.” ✌

MORE INFO www.weidmuller.com



David DiNunzio

Key Account Manager, Wind ▶ Castrol

“Lubrication technology can not only improve the reliability of the assets but also get them to perform their best.”

▶ **Castrol committed to undertaking one of the most robust long-term lubricant tests carried out by a lubricants company. What was the main goal for this two-year field trial?**

We’ve always thought that there were efficiencies to be gained from lubrication technology. We’ve seen this in other industries. Until now, the data we collect has been translated into benefits for the equipment in terms of wear reduction, equipment reliability, and making them work longer. From an energy-generation standpoint, we had test results in the lab, and we wanted to see if we could replicate that in the field, because you can do all the testing you want in the laboratory, but you want to see what the real “seat-of-the-pants” feel is. We had a unique opportunity with a large Midwest wind farm, and we took it.

▶ **What were some of the general results from the field study?**

The big learning is the efficiency gained by using the latest Castrol high-performance drivetrain lubricants, which amounted to 0.72 percent more power compared to the competitive products. On the surface, that may not seem like a lot, but it’s very significant in terms of energy generation. Based on the type of turbines that we used in the field study at that site, it amounts to approximately \$1,250 of additional revenue per year per turbine.

The turbines we used were on the smaller side compared to what’s being produced today. So, if you use larger turbines, and if you have a site with a higher capacity factor — meaning, the wind blows higher and blows more in that area — your gains could be greater. We look at these test results as a conservative estimate. When you factor in that most of the cost has already been rolled into the turbine itself, that additional revenue just goes straight to the bottom-line in terms of profit for the energy producer.

▶ **Why do the results matter, and what impact does lubrication have on the performance of a turbine’s drivetrain in general?**

Energy producers are always looking for ways to be able to

generate more power: How can we extract more from the wind? How can we take that and get more power to the grid? But then, they’ve got to balance that with investment cost. Our test results prove that we can leverage the lubrication technology to give them some of that benefit with little-to-no investment required. The turbines require lubricants anyway, so it’s not something that has to be bolted onto the turbine or added on as an extra cost; it’s something that’s part of the routine maintenance. The results matter as they show how using advanced lubricant technology can drive profits for wind operators.

▶ **How did the journey to the field trial begin?**

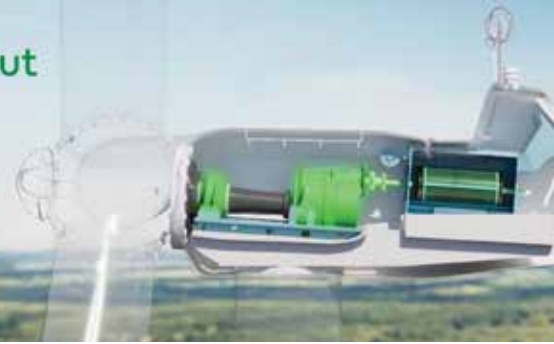
We’ve done a lot of independent lab studies, as you can imagine. During our benchmarking process, we looked at different additive systems and compared them to competitive products that were out in the market. We started to see differences in terms of coefficient of friction. Along with coefficient of friction, we also looked at wear numbers, how much metal was removed, and vibration during test processes. When these certain lab tests indicate better performance, our minds instinctively go toward improving bearing life or gear life and equipment life. But when we wanted to look at how does that impact production, we needed to take that information a step further. We did a study with a European university and another large energy producer to do a full-scale demonstration of what’s called a highly accelerated life test, or a HALT test.

That kind of test is solid because it allows you to control the variables and “keep the noise” to a minimum. It’s really a strong data point to have in the process.

It works by using a full-scale rig — in this case it was 850 kW — a gearbox, electric motor, and generator arrangement where you control the power in and you can measure the power out. It’s a great way to see what gets lost during the translation. In that test, we were able to log a 0.8 percent benefit just from changing the gear oils that were in the gearbox. That made us question, what else can we do with that? It’s what really made us interested to take that into the field and see what happens.

Power meets Profits: How Castrol Lubricants Enhance Wind Turbine Output

A milestone trial result independently consulted and validated



Castrol's lubricant field study took two years to complete. (Courtesy: Castrol)

► What methodology was used to ensure the validity of the trial?

This is where we brought in industry experts, including an engineering firm, Wood PLC — to help us design this test. What was recommended was the side-by-side test method. It's a well understood process for being able to compare variables with turbines out in the field. It now sits within the IEC standard and is commonly used to compare control systems and blade adjustments, among other things. It essentially uses two turbines in very close proximity to each other to try to minimize the variables. That way, you can start to make the adjustments and see the resulting differences.

► Why was it important for third parties to independently validate the results?

We needed those industry experts to help guide us through this entire process. We (Castrol) can bring the lubricant technology expertise and speak to what we've seen in the lab and consider how we want to try and isolate certain results that have changed. They have the experience of consulting on all the other things needed for the field test. ONYX Insight was another consultant that did a lot of data gathering.

We gathered data for two solid years, but the entire process — from implementation and post-processing took the better part of four years. A big piece of that time was spent trying to minimize variables and filter all the data to find where the lubricants can impact production. We set up a test with eight different turbines — four of them running Castrol lubricants and four of them running competitive products.

We ran them for a year, and then we swapped the lubricants over. That way, we didn't just happen to get lucky picking the good turbines for the Castrol products and the not-so-good turbines for the competitive products. By tracking for a whole year, we also took some of that seasonal effect out. Considering seasonal impact really helps to ensure that you're comparing "apples to apples" as best you can.

ONYX compiled all that data, and then created a large technical report. Next, we brought in DNV — a well-respected name in the wind industry and across many industries — to audit and approve the process and the methodology. To qualify our results, it was important to get the correct trial setup as well as the correct analysis and audit process afterwards.

► Were there any findings that surprised you and your team?

I think comparing the field data to the results that we got from that highly accelerated life test was most surprising. We got 0.8 percent in that result, and we got 0.72 percent in the field study. There's going to be some noise in both of those results, but the numbers were close. I think it was cool to see that similarly to the bench tests, we could understand where losses occurred. We noticed that with the competitive gear oils, the gearbox oil temperature started to climb. As the energy goes through the system, not all of it makes its way to the generator; some of it gets lost to friction. The friction heats up the gear oil instead of going out to produce power.

► Based on the results of the field trial, what message would you like to convey to OEMs and wind-farm operators looking for ways to increase productivity?

It's great to be able to see how lubrication technology can not only improve the reliability of the assets but also get turbines to perform their best. Lubricants are part of the process and part of the requirement for the machines. Choosing the ones that can have the most impact and help improve the goal of energy production — with a low-cost or a no-cost — seems like a no-brainer. We now have the field results to back up how choosing the right product can help your equipment last longer and produce more power... and more profits. ✌

MORE INFO

www.castrol.com/wind-us



Combilift's new Combi Load Xtender offers a versatile option for businesses in tight logistics zones. (Courtesy: Combilift)

► CONSTRUCTION

Combilift debuts load extender

Combilift debuted the Combi Load Xtender at Ligna 2025. The pantograph-style load extender is designed to transform how businesses manage truck and container loading, especially in space-restricted environments.

Designed specifically for environments where access is limited or dual-side loading is not feasible, the Combi Load Xtender offers a versatile option for businesses operating in tight logistics zones, congested yards, or facilities with restricted trailer access. It is valuable for operations involving rail wagons or loading bays that offer only single-side access.

The Combi Load Xtender's ultra-low mechanism height ensures seamless operation beneath standard trailer beds, avoiding any structural interference while maintaining full functionality. Its open-frame pantograph design provides operators with visibility during loading and unloading, allowing for more accurate and safer handling of goods.

Safety is a core focus of the Xtender's design. By allowing operators to securely position loads against the far, closed side of a trailer, it reduces the risk of products toppling and enhances personnel safety by minimizing exposure to active traffic zones.

Its robust construction is built to withstand demanding industrial environments, and Combilift has filed patents for the design in both Europe and the United States.

The introduction of the Combi

Load Xtender marks an advancement in logistics technology. It offers a practical, efficient, and safe solution to a long-standing challenge — enabling full-scale, one-side loading in a wide range of real-world scenarios.

Also at Ligna 2025, Combilift debuted the Combi-FSE 8000, an 8-ton electric sideloader combining performance with zero emissions.

MORE INFO www.combilift.com

► CONSTRUCTION

Aikido signs agreement for floating wind platform

Aikido Technologies, a floating offshore wind technology provider, re-

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Aikido is working with Norway’s METCentre on a floating wind platform. (Courtesy: Aikido Technologies)

cently signed an agreement with Marin Energy Test Centre (METCentre) in Haugesund, Norway, to deploy a 15-MW demo project, called AO60. Once installed in 2027, the platform will be one of the largest floating wind platforms constructed and deployed to date.

The METCentre has a long history of supporting floating wind projects, including the world’s first floating wind turbine, deployed by Equinor (then Statoil) in 2009. The AO60 project will showcase how the Aikido Platform technology can lower costs while engaging with local Norwegian supply chain partners to assist in the assembly and deployment of the platform. Due to its compact flat-pack configuration, Aikido’s technology can leverage existing maritime infrastructure, ports, and vessels already in use in Norway.

“We are proud to announce our partnership with the METCentre,” said Sam Kanner, Aikido CEO. “As evidenced by the recent Utsira Nord actions, Norway is a key floating wind market. This project will show how Aikido can leverage existing infrastructure and vessels to reduce risks and accelerate the deployment of floating wind in Norway and around the world.”

“This project offers valuable industry experience and supports the development of a full-scale, innovative, and cost-effective solution,” said Cecilia Girard-Vika, METCentre director. “We are very excited to welcome Aikido to our site in Norway and connect them with Norway’s strong floating offshore wind supply chain.”

The Aikido Platform consists of 13 modular steel components, including columns and trusses, that can be fabricated at existing offshore wind or steel fabrication sites.

For the AO60 project, the components will be transported to a final assembly site near the test center, where the platform can be completed in a matter of days, not months, like traditional construction techniques. The Aikido Platform uses pin joints to complete the assembly of the platform without any major welding or painting work. The pin joints act as hinges and allow the platform to be folded during assembly, taking up just one-third of the space of traditional designs. Once deployed in the water, the platform is able to unfold during a simple ballasting procedure.

MORE INFO www.aikidotechnologies.com



With a new operational hub in Dallas, Texas, Aeronex is expanding its reach in the U.S. and internationally. (Courtesy: Aeronex)

INNOVATION

Peak Demand changes name to AccuGrid

Peak Demand Inc., a U.S. manufacturer serving the electric utility industry, recently announced it has officially changed its name to AccuGrid Technologies Inc. The rebranding reflects the company's sharpened focus on instrument transformers and its commitment to setting new standards for accuracy, reliability, and performance on the grid.

"For the past nine years, Peak Demand has been defined by entrepreneurial growth and product innovation," said Jon Rennie, president and CEO of AccuGrid Technologies. "Now, as AccuGrid, we're zeroing in on our core strength — delivering the highest performing instrument transformers

in North America with the shortest lead times in the industry."

As part of the rebrand, AccuGrid Technologies is launching AccuGrid Easy — a program offering that includes:

- ▶ The industry's only 10-year warranty on instrument transformers.
- ▶ 24-hour lead times from the industry's largest stocked inventory.
- ▶ Best-in-class temperature performance, accuracy, and rating factors.
- ▶ The broadest transformer portfolio for legacy replacements.
- ▶ Solid dielectric construction for long service life.

All manufacturing will continue at the company's Wilson, North Carolina, facility. The company's leadership, team, and customer service remain unchanged.

"AccuGrid Technologies represents our commitment to precision, performance, and speed for a stronger, smarter grid," Rennie said. "We're excited

about what's ahead and proud to continue serving utility customers across North America."

MORE INFO www.accugridtech.com

INNOVATION

Aeronex secures \$62M financing round

Aeronex, a leading provider of robotic inspection, maintenance, and AI-driven solutions for wind turbines, recently announced it has secured \$62 million in capital in a significantly oversubscribed financing to accelerate its global expansion and technology development.

The funding round was co-led by Activate Capital and S2G Investments, with additional participation from



Venture For ClimateTech has selected the next 20 early-stage startups to join its accelerator program. (Courtesy: Venture for ClimateTech)

Carbon Equity and Overlap Holdings, alongside existing investors Lightrock, Blume Equity, Metaplanet, Change Ventures, and Extantia. This latest funding follows Aeronex' securing of a 4 million euro grant from the EU Innovation Fund in 2024 and a \$30 million funding round in 2023.

“Our mission is to automate wind-turbine inspection and maintenance globally,” said Dainis Kruze, co-founder and CEO of Aeronex. “The world cannot meet its renewable energy goals without innovation — and there simply aren't enough qualified technicians to keep up with the growth of this industry. With this new investment, we're expanding faster than ever to meet the urgent demand for intelligent, robot-enabled and AI-powered solutions.”

With a new operational hub in Dallas, Texas, Aeronex is expanding its reach in the U.S. and internationally, working with industry leaders such as GE Vernova, NextEra, Vestas, Enel, and Siemens Gamesa, and delivering the full spectrum of robotic inspection, maintenance, and data-driven diagnostics.

With this \$62 million investment, Aeronex will expand its operational capacity worldwide and accelerate research and development in AI-driven automation, robotics, and cus-

tommer-facing software solutions. The company plans to scale up its robot manufacturing capabilities and invest in advanced predictive maintenance

tools, leveraging data from thousands of robotic inspections. These initiatives will enable Aeronex to further accelerate preventive maintenance in the wind industry.

“Our investment in Aeronex represents the continuation of a long-held thesis at Activate that successfully transitioning our energy systems to renewable power will require fundamentally new technologies and business models to manage the distributed infrastructure,” said Paul Neal Jordan of Activate Capital. “In a world where energy costs are rising — and energy resilience and security more critical than ever — Aeronex brings a unique set of robotic and AI capabilities to bear for wind, one of the fastest growing and cheapest forms of new energy generation globally.”

Aeronex' technology is delivering measurable progress in clean energy by optimizing turbine performance, extending asset lifespans, and mini-



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InterBolt has incorporated a new feature into its intelligent bolting system. (Courtesy: Interbolt)

mizing downtime for wind-farm operators globally. Since 2020, Aerones has enabled nearly 400,000 MWh of additional clean electricity and helped avoid 165,000 tons of CO₂ emissions, with the potential to prevent more than 170 million tons in the next five years, while servicing more than 10,000 turbines annually in more than 30 countries.

MORE INFO www.aerones.com

INNOVATION

Venture accelerator selects 20 climate tech startups

Venture For ClimateTech has selected the next 20 early-stage startups to join its accelerator program dedicated to the commercialization of impactful climate technologies to power the future of clean tech. Participating teams receive up to \$50,000 each in non-dilutive funding as well as one-on-one

mentoring and curriculum catered to prepare teams for first customer contracts, pilot runs, investors, and business growth. The program is administered by NextCorps and supported by the New York State Energy Research and Development Authority.

The 20 companies were selected from a pool of 311 applicants across 66 countries. Applicants undergo a rigorous technical evaluation and vetting process, culminating in a pitch to a screening committee. The top 40 companies were chosen from the applicant pool to participate in the Venture For ClimateTech Bootcamp, a week of educational programming and exercises to experience what the program is like, while being evaluated on performance, materials, and engagement.

The new cohort of Venture For ClimateTech joins a league of 58 alumni companies working to address and mitigate the effects of climate change. Since 2021, team sizes have increased by 80 percent on average, creating 123 new jobs. Cumulatively, the past four cohorts have secured more than \$107 million in follow-on funding, averag-

ing roughly \$1.8 million per company.

“These teams represent the top 5 percent of climate innovation startups around the globe, based on their technical expertise, innovation, and team composition — that made the selection process incredibly difficult,” said Jack Baron, managing director of Venture For ClimateTech. “Cohort 5 spans the entire energy spectrum — solar, wind, hydrogen, biomaterials, and storage. From energy leadership to greenhouse gas reduction, these companies exemplify global excellence in innovation and job creation. Once again, New York State is leading the way, thanks to support from NYSERDA.”

“The companies selected to participate in Venture For ClimateTech’s next cohort are on the cusp of scaling innovative technologies that reduce emissions and advance innovative clean energy solutions,” said Stephen Bravo, NYSERDA director of commercialization. “NYSERDA is proud to support the development and commercialization of products that can contribute to a more sustainable future in New York State.”

The three-phase accelerator program kicked off in mid-May with support and mentorship on customer discovery, investor pitching, business validation, building a team, and pathways to scale.

The selected companies range from California's 17, Inc. that builds modular green ammonia units, to solar panel architecture manufacturer SunSpan.

MORE INFO forclimatetech.org/venture-for-climatetech

▀ **MAINTENANCE**

InterBolt features load monitoring to address fatigue failures

InterBolt™ has incorporated a new feature into its intelligent bolting system. The U.K.-based manufacturer is first to market with a solution that offers



Left to right: Aurora Energy Services CEO Doug Duguid, Deputy Foreign Minister Kate Forbes and Drew Stevenson, lead IRATA instructor. (Courtesy: Aurora Energy)

dynamic load monitoring to quantify cyclic loading of bolted connections.

This feature enables engineers to measure bolt load up to up to 250Hz while the asset is operational. The In-

terBolt sensors autonomously measure the bolt load at high frequency, then transmit wirelessly to the InterBolt Cloud where it is stored, analyzed, and visualized. This means engineers can

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remotely monitor cyclic loading of bolted connections from anywhere with an internet connection.

InterBolt typically provides bolt load measurements every hour or day. With its dynamic load monitoring feature, it is now possible to capture critical bolt load data in much shorter intervals, as low as 4 milliseconds. Through a sophisticated burst sampling regime, InterBolt can still achieve its impressive 12- to 15-year battery life with dynamic load monitoring enabled.

“Our dynamic load monitoring feature is a real game changer; 80 percent of bolting failures are due to fatigue, but engineers currently have no way of measuring cyclic loading and identifying when fatigue failures are likely to occur,” said InterBolt CTO Jack Hughleigh. “Now, with InterBolt, cyclic loading can be quantified for the first time. This will significantly accelerate design validation and be an important tool for bolt failure investigations.”

The InterBolt system provides real-time bolt load measurements via a miniature bolt load sensor embedded directly into the bolt or threaded stud itself. The technology provides onsite bolt load measurements to ensure bolts are tightened accurately as well as remote bolt load monitoring to eliminate the need for manual periodic inspection. The system features long-range wireless communications (up to 1 kilometer), LED indicators, and a 12- to 15-year battery life. The technology is already widely used across the European and North American wind, rail, and mining industries.

MORE INFO www.interbolt.co.uk

► MAINTENANCE

B&K Vibro names Castro as new CEO

Brüel & Kjær Vibro (B&K Vibro), a worldwide supplier of condition monitoring and protection solutions for industrial machinery, has named Victor Castro as



Victor Castro is the new CEO of B&K Vibro. (Courtesy: B&K Vibro)

its new CEO.

Castro, who will be based at B&K Vibro's headquarters in Darmstadt, Germany, will lead the global organization in growth and operational management.

“B&K Vibro

has a proud legacy as pioneers in condition monitoring and machine protection, delivering innovative solutions that optimize asset uptime and performance while safeguarding people, infrastructure, and machinery. With a robust foundation built on integrity, teamwork, and ambition, we are committed to giving every machine a voice, providing actionable insights that boost productivity and support a sustainable society,” Castro said.

Castro joined B&K Vibro in 2023 as CFO, and his promotion to CEO reflects his ongoing achievements in that role. Prior to B&K Vibro, he served more than 20 years as a managing director, CFO, and CEO, acquiring a proven track record in leading organizations through sustainable growth, strategic realignment, and digital transformation. Castro has an extensive background in financial services, IT, R&D, and digital platforms, having worked with software solution and digital health providers. As an experienced change manager, Castro has successfully spearheaded company reorganizations, expanded product portfolios, and optimized processes to drive profitability and innovation.

“B&K Vibro will invest in future product development driven by customer feedback and market intelligence,” Castro said. “We aim to develop a service-oriented ecosystem for machine protection and condition monitoring, leveraging state-of-the-art technology. Additionally, we are committed to strengthening our collaboration with the NSK Group in product lifecycle management, capitalizing on our shared strengths to deliver compre-

hensive turnkey solutions that meet the evolving needs of our customers.”

MORE INFO www.bkvibro.com

► MAINTENANCE

Aurora Energy opens Scotland training center

Kate Forbes, Scotland's Deputy First Minister, recently opened Aurora Energy Services' Renewable Energy Training Centre in Inverness.

The 1.2 million pound training center has already demonstrated its importance to Scotland's net-zero ambitions, delivering training to more than 1,000 individuals in its first year of operation and positioning itself to train more than 2,000 workers annually who will be central to the country's renewable energy future.

The 11,000-square-foot center eliminates the need for prospective wind-sector workers from the Scottish Highlands, Western Isles, and Orkney to travel to Aberdeen, the Central Belt, or North England for essential safety and technical training qualifications.

“Our transition to a net zero and climate resilient Scotland will put money in people's pockets, improve health and wellbeing, lead to better public services and protect our planet for future generations,” said Kate Forbes, deputy first minister and cabinet secretary for Economy. “Workers are at the heart of Scotland's just transition, and it's vital we plan for a multi-skilled workforce and enable offshore workers to carry their experience and expertise into different roles as the energy sector evolves.”

The center's facilities include classroom and audio-visual assets, overhead craneage, working-at-height frame and rope access frames, a mock turbine nacelle and a sea survival tank, and has achieved accreditation from the world's leading training bodies: the Global Wind Organization, Industrial Rope Access Trade Association, and the Engineering Construction Industry



Russelectric's new accessory brings together data from multiple automatic transfer switches. (Courtesy: Russelectric)

Training Board — making it the Highland's only triple-badged training facility of its kind.

“Establishing the training center has provided a bridge between Scotland's proud oil and gas energy heritage and our renewable energy future,” said Doug Duguid, Aurora Energy CEO. “If Scotland is serious about meeting net-zero levels by 2045, we have to put in place the workforce to construct, maintain and service the vast wind-re-

lated infrastructure, and Aurora's Inverness facility is playing a vital part in that process.”

MORE INFO www.auroraenergy.com

MANUFACTURING

Russelectric introduces ATS remote accessory

Russelectric, a manufacturer of power control systems and automatic transfer switches, recently introduced its new ATS remote annunciator (RTS-RA), an accessory that brings together data from multiple automatic transfer switches into a single display. The remote annunciator is designed to be configured by the customer. It allows monitoring of the position and status of up to eight Russelectric ATS types RTSCD and RPTCS, as well as viewing

power data for each ATS and accessing current alarms and logged historical alarms. Users can initiate load tests and set timers remotely using the RS-422/485 Protocol to ATS. In addition, there is the ability to configure email alerts for alarms. An Ethernet connection is available for exchanging data via the OPC UA protocol to another SCADA or building management system.

ATSs manufactured by Russelectric are modern, high-speed switching devices designed to transfer electrical loads from a preferred power source to an alternate power source when voltage and/or frequency vary beyond preset limits. They also retransfer loads when the preferred source is restored.

Russelectric provides high-integrity power control solutions for mission critical applications in the healthcare, information technology, telecommunication, water treatment, and renewable energy markets. ↵

MORE INFO www.russelectric.com

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‘INNOVATION
IN AMERICA IS
UNSTOPPABLE’

During his CLEANPOWER Opening General Session address, ACP President Jason Grumet said investment in renewables is soaring, with 400,000 workers employed by the industry, 120,000 working in the manufacturing sector, and more than a million other jobs supported by the energy supply chain. (Courtesy: Wind Systems)

Despite challenges, the U.S. has the opportunity to become energy independent by employing an ‘all-of-the-above’ energy strategy, provided this inclusive model doesn’t get bogged down by politics.

By **KENNETH CARTER** ▶ Wind Systems editor

The current shadow of uncertainty the Trump administration has cast over the state of renewables in the U.S. was a noted concern at CLEANPOWER 2025, but the experts and insiders refused to let it darken the real results that renewables have created, as well as the potential future they continue to inspire.

CLEANPOWER 2025 brought nearly 9,000 attendees and 500 exhibitors to Phoenix, Arizona, May 19-22, to see the latest renewable-energy innovations and hear experts from all sides of the sector emphasize the gains of the last year, as well as discuss an optimistic — yet cautious — look at what’s next on the horizon.

“In energy policy, pragmatism always eventually wins,” said Jason Grumet, president of the American Clean Power Association. “There’s a reason why we built more wind power in the Trump administration than the Biden administration, and we produced more oil and gas in the Biden administration than the Trump administration. But erratic policy has a real cost. It has a cost to consumers, to companies, and obviously to the communities that are thriving with new energy jobs and investment.”

INVESTMENT IS SOARING

To that end, Grumet, during his CLEANPOWER Opening General Session address, was quick to point out that investment in renewables is soaring, with 400,000 workers employed by the industry, 120,000 working in the manufacturing sector, and more than a million other jobs supported by the energy supply chain.

“These are good jobs; these are family-sustaining jobs,” he said. “The report that we released (in May) indicates that the average salary in clean-energy manufacturing is \$118,000 a year, and we have 200 facilities operating as we speak; 90 of them have just come out in the last two and a half years, and 45 more are under construction. Last year alone, all of you, all of us, this industry, invested over \$80 billion in American energy infrastructure and manufacturing, so we are bringing it to the American economy.”

But investment isn’t the only bright spot as renewables move forward, according to Grumet.

“Innovation in America is unstoppable,” he said. “We have made remarkable progress in the last 20 years in fossil-energy and renewable-energy production. All technology has weaknesses, but they’re different weaknesses, and what we understand now is we can combine the collective strength of all the different ways that we produce power in this country. We can, in fact, achieve the goal by mid-century of an energy economy that is reliable, affordable, secure, and clean.”

ARIZONA’S ENERGY GRID

Part of that diverse energy thinking was what brought

CLEANPOWER to Phoenix, Arizona, according to Arizona Gov. Katie Hobbs.

“Arizona prides itself on our reliable, diverse energy grid, where homes have large-scale solar plants and wind farms across the state,” she said. “We have the Palo Verde Nuclear Generating Station, which is the largest nuclear power plant in the country. We also boast a large energy-storage capacity. We’ve seen significant growth in battery storage. Multiple new battery storage projects came online last year. We are a major energy hub in the West, providing energy to neighboring states and Canada.”

Because of Arizona’s position as a reliable, powerful energy producer, the state has become a center of American manufacturing resurgence, according to Hobbs.

“About 30 miles north of (Phoenix), TSMC Arizona is producing the most advanced semiconductor chips made in America,” she said. “Their investment has grown from \$65 billion to now \$165 billion with their recent \$100 billion announcement. This demonstrates our capacity to produce the energy to meet high demand. Other major manufacturers, like Honeywell, Boeing, LifeCycle, and Lucid, continue to thrive here. From electric vehicles to batteries to military technology and public safety tools, companies of all shapes and sizes are taking advantage of our reliable and resilient grid.”

In order to continue to take advantage of these energy opportunities, Hobbs said she recently signed legislation that would advance clean power while removing some of the backstops that could attempt to stop it.

“I signed securitization legislation making it easier for utilities to transition to a cleaner grid,” she said. “It allows them to manage debt during transition without passing these costs onto consumers. It will save Arizona families money on their energy bills and create more jobs in our clean-energy economy.”

U.S. GRID CHALLENGE

Even with Arizona’s positive approach to the energy grid, the country as a whole will need to step up — sooner rather than later.

“I don’t want to hyperbolize too much, but America’s grid is facing a ... monumental challenge,” said John Hensley, senior vice president, markets and policy analysis at American Clean Power. “Today, the U.S. consumes around 4,300 TW/h of electricity annually, but in just a decade, that number is going to skyrocket to 5,139 TW/h. That’s another 900 TW/h of new electricity. That’s like adding two more Texas to our grid, and it doesn’t stop there.”

In the next decade, 500 TW/h will be lost due to older power plants retiring, while the total net electricity demand will be 1,300 TW/h by 2035, according to Hensley.



Arizona Gov. Katie Hobbs said the state has become a center of American manufacturing resurgence because of Arizona's position as a reliable, powerful energy producer. (Courtesy: Wind Systems)

“Just for some perspective, that’s like building a third of our electric grid all over again, meaning that will require a space program like Apollo,” he said. “We are going to need to build 850 GW of new power capacity in this country. What does that look like? It’s more than 175 GW of wind power, more than 475 GW of solar, a 100-plus GW of natural gas, and another 120 GW of battery storage — not to mention the nuclear, geothermal, and other advanced energy technologies that are going to have to be part of the equation.”

But growing the energy grid is not without its challenges, according to Laura Beane, president of Vestas North America and ACP board chair.

UNEXPECTED CHALLENGES

Even though Beane said she was aware of the political environment she was inheriting as ACP board chair, she admitted that she has still been surprised by what the energy sector has been facing since the current administration has taken the governmental reins.

“I was engaged with our customers, working to plan and execute wind-turbine orders for their developing projects,” she said. “The chair-elect is essentially chair-in-waiting, and when I accepted, I was cognizant that the timing was such that I would be stepping into the actual chair role for 2025. I, of course, recognized the reality of the ever-changing political dynamic in this country, but I must admit that I did not quite envision that we would find ourselves here. When you scroll through another social media post or see another headline where wind or solar or storage is being disparaged or attacked, I think it’s natural to feel like the story of clean energy is being shaped by far-away actors or forces that seem against us, and it can feel isolating.”

However, Beane said there is reason to be encouraged. “The clean-energy industry doesn’t have a single narrator,” she said. “It’s built on thousands of stories, like yours. Your voices and your stories are the prevailing force that’s moving this industry forward.”

REAL-WORLD EXAMPLES

As examples of this, Beane pointed out that the Fowler Ridge Wind Farm built in Benton County, Indiana, brought in tax revenue that allowed that area to hire paramedics and other trained medical personnel who could quickly be accessed by residents to provide life-stabilizing support while being transported to a hospital where none existed previously.

In Southwest Florida, after the region was struck by Hurricane Ian in 2022, streets were flooded, grocery stores were shuttered, and hospitals ran on backup generators. But, in Babcock Ranch, power stayed on, thanks to the FPL Babcock Ranch Solar Energy Center and FPL Babcock Preserve Solar Energy Center.

“For the people in Babcock Ranch during Hurricane Ian, it delivered security, stability, and safety during a disaster,” Beane said.

And battery storage stepped up during a blistering Texas heat wave in 2023, when the state endured one of the longest and hottest summers on record.

“Power demands surged as millions of Texans cranked up their air conditioning — not just for comfort, but for safety,” Beane said. “Because of a surge in storage capacity, the grid did not buckle. Quietly, without fanfare, energy storage stepped in, keeping homes powered.”

None of these stories, according to Beane, would exist without the industries represented at CLEANPOWER.

“You are the clean-energy industry, not somebody watching or criticizing from the sidelines, but somebody doing the hard work when nobody is watching or listening,” she said. “Yes, the headlines can be painful, and the politics are messy. But when people question clean energy’s reliability, you have proof. When they question its value, you have lived experience saying otherwise.”

ENERGY DIVERSITY

In order to meet America’s energy requirements, not just its goals, diversity will be key, according to Grumet.

“Winston Churchill said that security lies in variety and variety alone, and the data says that’s true today in the regions of this country that have the most diverse energy supply, where reliability is by far the strongest, and the cost of business and consumers are the lowest — and the energy sector gets this,” he said. “It’s why we are all aligned in support of a true ‘all-of-the-above’ energy strategy. I point out a lot that we’re in this together. Two-thirds of all of the renewable power deployed in the United States of America is being built by companies that also have fossil assets. And we take very seriously the shared commitment across the electric sector to have affordable, reliable, clean power.”

To that end, ACP is working with its partners in oil and

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gas and nuclear to ensure the country has a permanent system that is not just efficient, but trustworthy, according to Grumet. That means a stable technology-neutral tax policy that will continue to support investment.

“But above everything, we are focused on skyrocketing demand,” he said. “The challenge of adding two Texas to our electricity grid in the next 10 years, it focuses the mind, but it also raises the stakes for public policy. For the last two decades, we’ve basically had flat growth, and that has allowed us to accommodate bad policy. It’s allowed us to keep the lights on despite the fact that our government shifts back and forth, picks the technologies it likes, and discourages the technology that it doesn’t. That’s against the parts of the American economy. But we can’t do that anymore. Over the next decade, we have to maximize renewable energy deployment. We have to add new gas to the grid. We have to commercialize advanced nuclear. We’ve got to try to realize the potential with geothermal, and we’re going to have to extend the operating life of existing facilities.”

U.S. VS. CHINA

The next three years are going to determine whether it’s the U.S. or China who wins the race for digital dominance, according to Grumet.

“We are the guys who are shovel ready,” he said. “The power that can come on the grid in the United States of America in the next three years is almost entirely renewable resources, and this is the worst possible moment to take power away from the people. Despite these fundamentals, economics, and engineering, every change in politics ushers a new game of energy green light/red light. There’s a part of the cancel culture we don’t talk about. It is a cancel culture that makes any long-term investment in America a risk and undermines global confidence in the idea that the United States is the place to do business.”

But there is a positive side, according to Hensley: This is the moment clean power was built for.

“Last year, 93 percent of all new generation added to the grid was clean,” he said. “That’s \$70 billion of investment in our economy supporting 1.4 million American jobs, 80 percent of which are in Republican districts. We’ve also just built 45 new manufacturing facilities with another 180 facilities on the way. That’s in a domestic supply chain that’s in motion today, driving us toward half-a-million clean-energy manufacturing jobs by 2030.”

And between now and 2030, the U.S. is looking at the largest build-out of energy infrastructure in American history, according to Hensley.

“Demand is growing; power plants are retiring, and we have the technologies that can rise to meet the moment,” he said. “Solar, we think, is going to lead, and (battery) storage, once a niche market, is scaling very quickly.”

The wind market has hit some permitting challenges and regulatory issues, but Hensley predicts the wind sector to rebound. “We expect that technology to hit double digits by the end of the decade, and offshore wind is defending itself

from all sides at the moment,” he said. “We’ll see nearly 10 GW installed by decade’s end, but none of this is guaranteed. Federal tax uncertainty, tariffs, regulatory challenges, permitting delays, and a tremendous lack of investment in our transmission infrastructure could, of course, slow our progress. We have to solve these issues not later, but today.”

GOOD NEWS

But there are signs of good news among the discouragement, according to Grumet.

“We’re greatly encouraged by the news (recently) that the Trump administration and New York Governor (Kathy) Hochul have come together on a plan that will bring 1,500 men and women back to the job site on the entire Empire Wind project,” he said. “This is a one and done. What’s most encouraging about that discussion is it seems like it is opening up the idea of critical infrastructure of all kinds in New York and around the country. And that is the only way we win, so I think we’re all going to be looking at that announcement and making sure that it actually applies broadly across all energy technology.”

Despite the constant push and pull on Capitol Hill, Grumet said the energy sector can set an innovative course as long as it stays diligent.

“While we’re making progress, it’s tough out there,” he said. “There are strong signals of pragmatism among the core group of senators who appreciate that we are going to have to make changes in energy policy — that the clean-energy credits and a lot of the energy credits in this energy package are going to be phasing down, but they’re committed to doing it in a way that protects jobs, protects the economy, and protects the country. We are working closely with those members, talking about specific fixes in legislation that will save the taxpayers money, but will do so in a way that does not undermine the progress that we are making as a nation on clean energy.”

ECONOMIC PING PONG

The momentum is there, according to Grumet, and he is quick to point out that challenges can and will be overcome.

“But our country deserves better than a Congress that plays ping pong with our economy and our security,” he said. “We’ve got some work to do together ... Democracy and advocacy are a team sport, and so I need you all to be loud. I need you to tell anyone who will listen — and a lot of people who won’t — about the role that our industry is having on your communities, on your families, on your businesses. And while politicians are going to continue to try to divide us, I’m asking and urging you to avoid being pulled into the old arguments of division that pit one type of energy against the other. Because we all know the truth: America has to embrace all forms of domestic energy. We can’t leave it in the ground. We can’t leave it in the reactor. We can’t leave it in the river. We can’t leave it in the sun. We can’t leave it in the wind. We need it all. And clean power is going to lead the way.”



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