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THE FUTURE OF WIND



NOIA president praises Golden State Winds lease ▼ Texas leads U.S. in production tax credit revenue with more than \$12 billion
 ▼ *Pattern Energy names Armistead as new CEO*



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de l'énergie renouvelable
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Wind
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U.S. offshore wind stays promising

With the start of 2023, it's interesting to look at all the wind projects that are in the works, both here in the U.S., as well as internationally. The promise of a robust offshore wind development in the U.S. is still very much the buzz as we move into the new year.

With offshore development still going strong on the East Coast, there has been some movement in bringing offshore wind to the West Coast as well.

For example, BOEM recently awarded a lease area of almost 81,000 acres to an offshore venture. That site is just one of five that was auctioned in what is considered the first floating offshore wind lease sale in the country and the first offshore wind lease of any kind on the West Coast.

Turning those goals into reality is going to take a lot of hard work and innovation. A lot of that type of work is reflected in this month's issue.

Making those turbines stand tall are simple bolts and the torquing that keeps them in place.

An article from ITH Bolting Technology looks at a maintenance-free bolting concept for bolts up to M100 (4").

And Sam Ortolani with Norbar Torque Tools shares his insights on the need for state-of-the-art equipment for achieving the most accurate torque requirements.

On the subject of wind measurement, our cover story is from Vaisala. In the article, Elvira Aliverdieva looks at how the use of Lidar is carving a strong foot forward in being the go-to choice when it comes to wind-resource assessment.

I hope you enjoy those articles and much more as we enter the new year and continue to share the good news and fascinating stories of the wind industry. The good news just keeps getting better for this renewable energy source.

Happy New Year, and, as always, thanks for reading!



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Report: Industry sees massive investments

From ACP

The last quarter of 2022 saw more than \$40 billion of new grid-scale clean-energy investments announced, a new report shows — the same amount as the total investment estimated for all clean-energy projects installed in 2021. The Clean Energy Investing in America report, released in December by the American Clean Power Association (ACP), is an analysis of the new U.S. clean energy landscape.

Alongside significant private investment, 20 new grid-scale clean-energy manufacturing facilities have been announced in the U.S., bringing with them an expected 7,000 new American jobs.

“As a new era dawns in clean energy, America is laying the foundation to become a manufacturing powerhouse,” said ACP Interim CEO and Chief Advocacy Officer JC Sandberg. “This growing sector will create thousands of good paying jobs in communities across the U.S. and will help reduce dependence on foreign energy sources to meet our domestic needs.”

The new report also revealed expected consumer savings of more than \$2.5 billion announced by utility companies that provide electricity to more than 15 million Americans. Companies explicitly tied these savings to federal incentives that make new project investment less expensive, meaning utilities can rely less on customer rate increases in order to fund projects.

“It is crystal clear that federal support for clean energy is already having a positive impact on the American economy and on the American people,” Sandberg said.

Highlights from the report include:

- 20 new clean energy manufacturing facilities have been publicly announced.
- More than \$40 billion in capital investment announced.
- \$2.5 billion in consumer savings announced.
- More than 13 GW of new clean energy capacity announced.

ACP’s Clean Energy Investing in America report is the first in what will be a series of regular reports.



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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DIRECTION

THE FUTURE OF WIND



Floating wind technology will be vital for the U.S. to meeting renewable energy goals, said NOIA president Erik Milito. (Courtesy: Ocean Winds)

NOIA president praises Golden State Wind lease off California coast

National Ocean Industries Association President Erik Milito praised the wind lease sale off the coast of California to the offshore wind venture Golden State Wind.

“The California lease sale gives the U.S. a chance to lead the emerging floating wind sector. Floating wind technology in its early stages but it is an advanced technology that will lead to strong growth in the deployment of offshore wind,” Milito said. “The timely scaling and deployment of floating wind technology will be vital in meeting U.S. and global renewable energy goals. The U.S. stands well-positioned to develop our deepwater wind resources and become a global hub of floating wind innovation. Offshore wind is a national endeavor with substantial benefits to our energy, jobs, and investment outlook.”

“We are only at step one of U.S. floating wind leadership,” he said. “The success of American offshore wind depends on further collaboration among stakeholders. Specifically, continued engagement between BOEM, NOAA, the military, and other oceanic users will help ensure that sufficient flexibility is provided, investment is promoted, and project impediments are avoided.”

MORE INFO www.noia.org

Texas leads U.S. in PTC revenue with more than \$12B

The latest analysis from IntelStor indicates that since the PTC program was instituted, wind-energy asset owners in the U.S. have generated more than \$47.5 billion in revenue from the PTC alone.

Texas has generated more than \$12 billion in PTC revenue by itself. Oklahoma generates \$58,125 worth of PTC revenue per MW per year, with Kansas



EDF North America's fleet of Vestas turbines is the most productive at generating PTC revenue with \$65,664 per MW per year. (Courtesy: EDF Renewables)

second at \$57,893 per MW per year and Nebraska third with \$57,266 per MW per year.

The Production Tax Credit (PTC) in the U.S. has been a powerful tool for asset owners to ensure the favorable financial health of their projects. More than 75 percent of the 138 GW of operational capacity in the United States has taken advantage of the PTC. Historically, it has provided between a \$10 to \$26 per MW/hr incentive on top of the power purchase contract price or merchant market rate.

NextEra Energy Resources has been the largest beneficiary of PTC revenue based on net production data through December 2021, but this perspective is skewed given the size of the fleet in the U.S. The normalized PTC revenue per installed MW per year indicates that many of the top asset owners in the U.S. are hovering around the capacity weighted market average of \$47,416.

IntelStor also benchmarked the capital efficiency of an asset owner's project CapEx expenditure relative to the amount of PTC revenue they earn. Some asset owners are only able to recoup single digit to low double-digit returns, but some savvy asset owners

have managed to see a return on their project CapEx of upwards of 40 to 50 percent just through PTC revenue alone. While this is project-site dependent, it underscores why site selection, the right equipment supply, and a proactive maintenance approach can have a profound influence on financial outcomes.

Out of the top 10 wind-energy asset owners in the U.S., EDF North America's fleet of Vestas turbines is the most productive at generating PTC revenue with \$65,664 per MW per year. Next on the list is Berkshire Hathaway Energy's Siemens Gamesa fleet at \$61,100 per MW per year and EDP Renewables' fleet of Siemens Gamesa turbines at \$54,427 per MW per year.

MORE INFO www.intelstor.com

Pattern Energy names Armistead as new CEO

Pattern Energy has named Hunter Armistead as its new CEO.

Armistead, Pattern Energy's current chief development officer, succeeded Michael Garland in the role.

Garland retired after his successful tenure as CEO of Pattern and its predecessors since 2009.

"This is an extraordinary time for the renewable energy sector and the entire Pattern team is exceptionally well positioned to deliver on the opportunities ahead," Garland said. "Given his long history as a leader of this company, the strength of his commercial instincts, and his passion for Pattern's vision, I believe Hunter is uniquely capable of leading this company in a way that provides consistency, continuity and leadership across the business both internally and externally."



Hunter Armistead is Pattern Energy's new CEO. (Courtesy: Pattern Energy)

"It has been a tremendous journey since we founded Pattern in 2009, and it is my honor and privilege to take on the CEO role," Armistead said. "Pattern began with a modest pipeline, a few dedicated professionals, and a vision to accelerate the world's energy transition. To see Pattern and our industry evolve into what we have become has been a beautiful ride and is one that has only just begun. I am 100 percent committed to driving the next chapter in our growth in a manner that is consistent with our mission, our culture and our values."

"I have seen first-hand Mike Garland's exceptional leadership of the company since 2009," said Lord John Browne, chairman of the board. "During his long service, he has led Pattern through many successful phases of development. We are most grateful for all he has done. We conducted a thorough search for his successor and concluded that Hunter Armistead was the ideal candidate. He cares deeply for the company's culture and people and brings great experience and understanding of the company's business to the role."

MORE INFO www.patternenergy.com



The lease area is in the Morro Bay area off the central coast of California. (Courtesy: Ocean Winds)

Golden State Wind gets California coast area lease

Ocean Winds and Canada Pension Plan Investment Board recently announced their offshore wind joint venture Golden State Wind has been awarded an 80,418-acre lease area by the U.S. Bureau of Ocean Energy Management (BOEM) in the Morro Bay area off the central coast of California.

The lease area is one of five sites off the coast of California that was the subject of an auction held by BOEM. This auction is notable as it is the first floating offshore wind lease sale in the country, and the first offshore wind lease sale of any kind on the West Coast.

Ocean Winds has more than 10 years of experience in floating offshore wind. Ocean Winds has a substantial portfolio of floating projects in Europe and South Korea.

Golden State Wind's winning bid for the lease area OCS-P 0564 was \$150.3 million, with OW and CPP Investments each maintaining a 50 percent investment in the project. When fully built and operational, the lease area could accommodate about 2 GW of offshore wind energy, generating enough energy to power the equivalent of 900,000 homes.

This will bring the U.S. and California closer to meeting their clean-energy goals of 15 GW of floating offshore wind generation by 2035 in the U.S. and 5 GW by 2030 in California, build-

ing a new domestic industry, creating jobs for Californians, and boosting the local economy.

As part of Golden State Wind's bid, OW and CPP Investments commit to investing \$30 million in workforce development and supply chain initiatives and to work closely with key local stakeholders to maximize the benefits to California.

"OW is a pioneer of floating offshore wind technology—with nearly 3.7 GW of floating wind projects in development or operations in Portugal, France, South Korea, and the U.K.—and we are ready to bring our expertise to the U.S. as well," said Michael Brown, Ocean Winds North America CEO. "OW currently has about 4 GW of projects already under active development in the Northeastern U.S., and this is the perfect opportunity to further expand our portfolio and contribute to the federal government's ambitious floating offshore wind targets."

"We are proud that our partnership with Ocean Winds has earned this opportunity to help accelerate the transition to lower-carbon sources of energy for Californians and, more broadly, to serve as an example for other jurisdictions," said Bruce Hogg, CPP Investments managing director. "This investment aligns well with our efforts to reduce carbon emissions across our portfolio while continuing to deliver strong, long-term risk-adjusted returns for the Fund's contributors and beneficiaries." 🌿

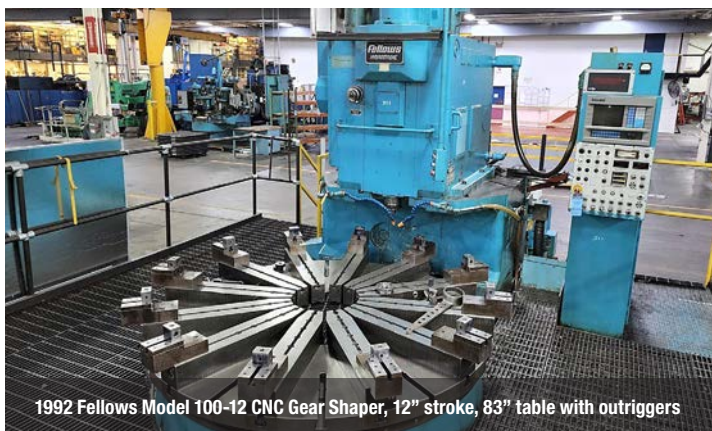
MORE INFO www.oceanwinds.com/north-america



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1992 Fellows Model 100-12 CNC Gear Shaper, 12" stroke, 83" table with outriggers



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**Gould & Eberhardt Model 96G
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**Fellows Model 10-4 CNC 3 axis
Gear Shaper w/ Fanuc Controls**



**1999 Gleason Pfauder Model P400G CNC
Gear Grinder 400mm diameter capacity**



**Fellows 20-8 CNC Gear Shaper, 8" stroke,
6 axis CNC controls Fanuc**



**Fellows Model 48-12 Shaper, 54" swing,
12" stroke capacity, 24" Riser Block**



IN FOCUS

WIND MEASUREMENT ▸ BOLTING & TORQUE

LIDAR: THE PATH FORWARD FOR WIND RESOURCE ASSESSMENT

Lidar is becoming standard for WRA as industry seeks increased data accuracy, reliability, and safety measures beyond traditional met masts. (Courtesy: Vaisala)

WindCube®



As the wind industry continues progressing into an increasingly tech-driven space, decision makers can expect met towers to be replaced mostly by Lidars for wind measurements.

By ELVIRA ALIVERDIEVA

The development of a successful wind-farm project depends on the developers' knowledge of how much energy can be produced in the potential development area. Location-specific information regarding the wind speed, meteorological patterns, terrain, and other factors advise the siting and design of a new wind-power project. But as turbines grow taller, it is important to accurately collect valuable wind data at the heights necessary to minimize uncertainty and ensure bankability.

In the past, meteorological masts served as the primary measurement technology for wind applications, but these instruments are struggling to keep pace with wind-energy innovation. Enter Lidar as a viable tool for accurately measuring the wind for even the tallest turbines, onshore and offshore and across a variety of climates and terrain types.

GATHERING THE RIGHT DATA WITH THE RIGHT TOOLS

Wind resource assessment (WRA) is a crucial stage in wind-energy development. The make-or-break point for any onshore or offshore wind farm project, WRA is imperative to collecting accurate data before construction can begin and is essential for securing financial investment.

While it is obvious that wind farms work most efficiently in locations with the most substantial wind-power generation potential, knowing where and how to optimize a site is paramount to production. Predicting how much power will be produced by atmospheric conditions at a given site, however, is only possible with the correct measurements. Since each wind farm is unique and presents distinct challenges, accurately quantifying the wind resources at a given site is critical to determining its financial and practical viability.

A met mast has been traditionally installed when measuring the behavior of the wind at a particular site because it creates a trackable data set, which can help investors feel more at ease when deciding if a project is worth funding. Even though met masts are typically reliable, their height makes them dangerous to work on.

Complicating the issue further, these free-standing towers equipped with meteorological instruments are prone to



Lidars have almost completely replaced the met mast offshore. (Courtesy: Vaisala)

mechanical error because of extreme weather conditions and vandalism. Finding and waiting on replacement parts can be difficult enough for wind-energy decision-makers, but global supply chain issues brought on by the pandemic have exacerbated these problems, causing repair times to skyrocket.

There are also limitations to a met mast's ability to effectively gather data at the hub heights of modern turbines. Shorter met masts rely on vertical extrapolation techniques that typically introduce error and uncertainty.

Additionally, installing a met tower is expensive and requires significant time and a lengthy permitting process. For offshore wind development, using met masts is impractical due to the construction requirement of a multimillion-dollar foundation out in the ocean. However, innovations have allowed companies to collect data about wind sites safely, quickly, and at unprecedented heights using Lidars, like Vaisala's WindCube.

It is no wonder that Lidars have almost completely replaced the met mast offshore. In fact, IEA Task 52, also called the "wind Lidar" task, expects Lidar technology to fully supplant traditional met masts, with Lidar already accounting for at least 10 percent of onshore WRA campaigns and permanent wind monitoring.

THE NEXT STEP FORWARD IN WRA DATA COLLECTION

In an industry where massive wind farms spring up regularly, light detection and ranging (aka Lidar) sensors can give developers an edge over their competition.

Lidar measures wind speed and wind direction by illuminating pulsed laser light and measuring the time for the reflected light to return. This advancing technology is changing how we map and measure the world and is increasingly used for hazard assessment, river surveys, atmospheric studies, wind profiling, and many other applications.

As the capacity and development of wind energy continue to increase, Lidar is quickly gaining in popularity among wind-energy industry stakeholders as a more cost-effective and accurate means for measuring wind output at every stage of a wind-farm project, whether it's a WRA campaign, power performance testing, turbine prototype testing, or permanent wind monitoring.

With wind data collected by Lidar at multiple user-defined heights, wind developers can more accurately assess wind resources at a given site and decrease uncertainties in the annual energy production (AEP) calculations. Not only does Lidar technology allow developers to more accurately assess the success of their projects at an early stage, but it



The advantage of using Lidar over more traditional technology is that it provides detailed measurements of the wind field at multiple heights above the ground. (Courtesy: Vaisala)

also streamlines regulatory approval, as regulators can access more accurate information about the project.

Recent research and real-world deployments reveal a WRA based on a standalone Lidar has almost the same uncertainty as one based on a hub height wind measurement with a met mast. Several Lidar types can be used for wind measurements. In offshore, vertical profiling and scanning Lidars can either be mounted on existing offshore platforms or placed onshore at the coastline. Lidar can also be integrated into a floating Lidar system (FLS), increasingly leveraged for offshore wind-measurement campaigns.

In onshore, several vertical profilers can be used in a measurement campaign: one as a fixed point of measurement while the others are moved around the site to decrease horizontal measurement uncertainty. By providing both the spatial resolution to analyze bigger areas and direct wind assessment to

▼ **Enter Lidar as a viable tool for accurately measuring the wind for even the tallest turbines, onshore and offshore and across a variety of climates and terrain types.** ▼

reduce vertical uncertainty, scanning and vertical profiling Lidar equipment decreases uncertainty and improves project bankability.

The advantage of using Lidar over more traditional technology is that it provides detailed measurements of the wind field at multiple heights above the ground, which can help determine wind speed and direction over large areas and deliver crucial environmental data quickly and safely.

In addition to the more accurate measurements at various heights, Lidar also delivers advantages such as speed and ease of deployment, flexibility, mobility, and reusability. At the same time, WindCube Lidars have been continuously validated and verified by independent third-party consultants to ensure data accuracy and project bankability.



In addition to the more accurate measurements at various heights, Lidar also delivers advantages such as speed and ease of deployment, flexibility, mobility, and reusability. (Courtesy: Vaisala)

These advantages over met masts help ensure the technology can be used across many types of terrain and in all climates. To better account for sitewide spatial variation and reduce wind-flow modeling uncertainty in complex terrain, modeling technologies exist to account for nonhomogeneous wind flow, correcting Lidar data so it is accurate, reliable, and bankable.

These advantages are increasing confidence and acceptability, motivating the trend away from met masts and toward Lidar as a standalone measurement system for WRA and the ensuing stages of a wind-energy project. Lidar is becoming standard for WRA, and the technology is only improving as the wind-energy industry seeks increased data accuracy, reliability, and safety measures beyond traditional met masts.

WITH LIDAR, THE FUTURE IS NOW

As wind-energy generation costs continue to fall, its potential for contributing to a country's electricity production is only becoming more relevant. This renewable resource is often challenging to assess because wind varies in time and space, resulting in complex measurements required for efficient operations. New technological strides are making this process easier and more fine-tuned, increasing investor confidence in the wind-energy industry.

As wind-energy developments continue, the demand for Lidar in WRA will also increase. At the same time, signifi-

cant technological advancements are improving efficiencies and making Lidar a more viable option for projects of all scales. If you're in the wind-energy industry, you'll want to use Lidar, period. No other technology comes close to delivering the same kind of actionable wind energy information across each development project stage as lidar.

Today, the wind-energy industry has the necessary guidelines and standards that create global confidence, knowledge sharing, and standardization of Lidar as an essential and expected part of most standard wind-energy processes. As Lidar technology advances and the wind-energy industry continues progressing into an increasingly tech-driven space, decision makers can expect that, within the next two decades, met towers will be replaced by Lidars to a large extent — if not exchanged entirely — for wind measurements in the wind industry.

When your entire project depends on the initial wind resource assessment, gaining the complete picture of the wind's behavior at a given location is only possible with modern Lidar solutions. ✌

ABOUT THE AUTHOR

Elvira Aliverdieva is a product and marketing specialist at Vaisala, a global leader in weather, environmental and industrial measurements specializing in the evolution of the company's onshore and offshore wind-product strategy with a primary focus on the booming offshore market.

BRIGHT IDEA

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BRINGING TORQUE CALIBRATION TO THE FIELD



Many players in the market, including the wind-energy industry, have found that current certificates of calibration are a must-have, whether they rent torque tools or use their own. (Courtesy: Shutterstock)

As market needs continue to change and get stricter, it is essential that state-of-the-art equipment is available to achieve the most accurate torque requirements.

By SAM ORTOLANI

Go back far enough and very few people even considered torque specifications for bolted joints. It simply came down to just tighten it as much as you can, add an extension or get a hammer, and tighten it some more.

Slowly, around the time manufacturers were producing high-performance aircraft engines for WWII, the world got on board with precise bolting. Even then, adopting torque specs was a slow and tedious process, and it would be decades before the industrial sectors realized the importance of having torque equipment serviced and calibrated. Now, auditors come looking for valid and current certificates of calibration for all bolting equipment being used on projects large and small.

CHANGING REQUIREMENTS

Because of this, the torque world has been changing as requirements become more stringent. Many players in the market, including the wind-energy industry, have found that current certificates of calibration are a must-have, whether they rent torque tools or use their own. Having high-quality calibration equipment available is fast becoming the new normal for many companies. For companies who operate multiple sites, each site having identical equipment makes for streamlined support and consistent operation.

Over time, calibration hardware, such as that offered by Norbar Torque Tools, has evolved to highly accurate digital hardware and the ability to transfer and store torque measurement and calibration data and equipment history for detailed tracking of every serialized piece of bolting equipment in use. Liability has forced the bolting world to know, and sometimes prove, the condition, history, and accuracy of each piece of equipment being used in order to bolt critical and non-critical joints.

SPECIALIZED EQUIPMENT

Today, the market is in need of modular-built calibration carts and systems used in both fixed and mobile applications.

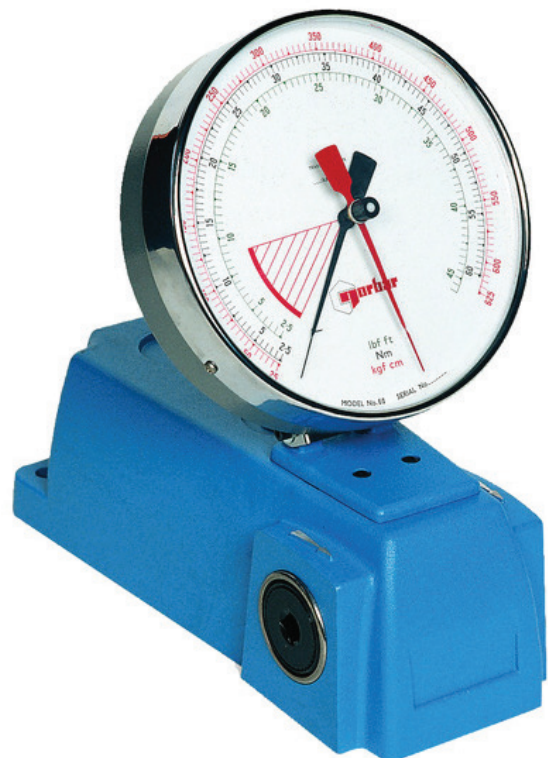
This modular design allows for easy and cost-efficient expansion of calibration capabilities as needs change and grow over time. Calibration carts are used to calibrate everything from hydraulic wrenches to powered torque multipliers to clicker-style torque wrenches. This type of hardware can be found in calibration labs and mobile calibration vans all over the industry — in other words, all the most common equipment used in the bolting world today. The modular design makes for easy expansion as a user's needs expand and evolve. Norbar can provide a neat and compact package to save space and full factory support to training techni-

cians. Annual calibrations to keep equipment up to date and traceable to all international standards are included.

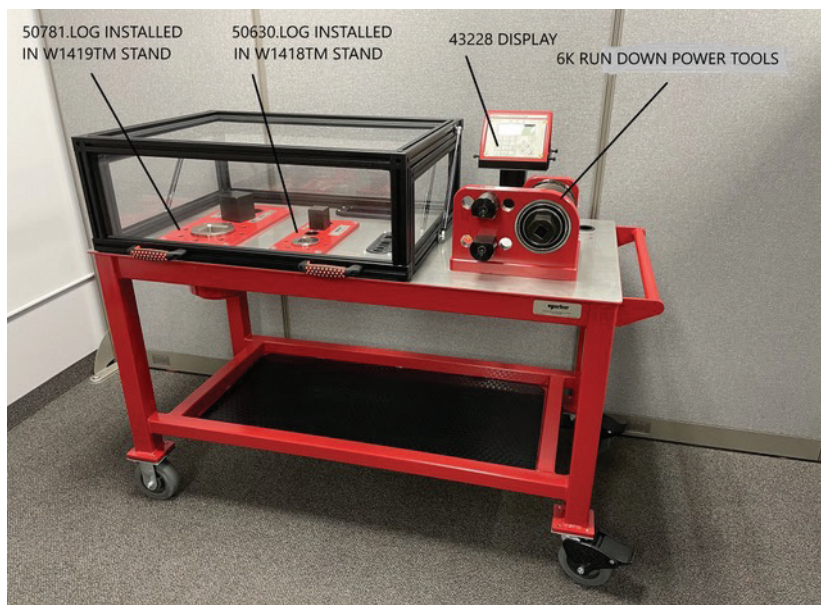
A typical calibration cart starts with a welded tubular steel frame with a stainless-steel tabletop. The length is determined by the equipment to be mounted to the cart. Three basic lengths cover the majority of options. All calibration cart projects and their various options can start with a basic discussion where a box is drawn around a customer's exact needs, both for current and future use.

Examples include an optional protective plexiglass cover mounted over two transducers for hydraulic wrenches. Transducers are installed in bearing-supported fixtures for improved accuracy and repeatability. These two transducers can cover a range of 100 lb-ft to more than 36,000 lb-ft. This is the most common hydraulic wrench set-up. Adjacent to the plexiglass cover is a 6,000 lb-ft run-down fixture for battery-, pneumatic-, and electric-powered torque multipliers, covering a range of 120 lb-ft to 6,000 lb-ft. Higher capacity run-down fixtures are available.

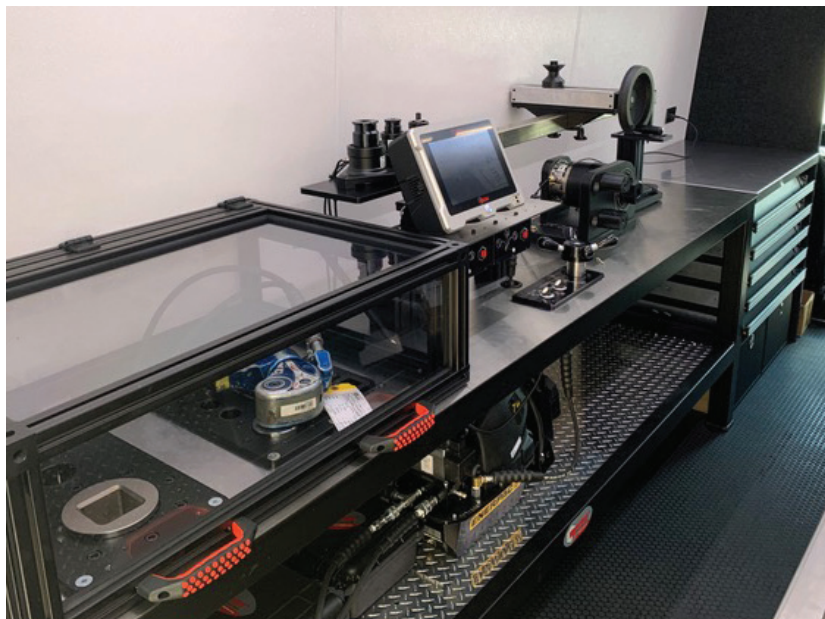
By adding length to the cart, a torque wrench loader can be mounted that is capable of calibrating torque wrenches up to 1,100 lb-ft. The torque-wrench loader also can be



An analog STM from the 1960s. (Courtesy: Norbar Torque Tools)



An example of a calibration cart. (Courtesy: Norbar Torque Tools)



A full-length cart installed in a van. (Courtesy: Norbar Torque Tools)

mounted to a stand-alone table to keep the cart short and more portable. A good torque wrench loader is designed to take the human factor out of torque-wrench calibration by mechanically applying load to the wrench so every click of the wrench is done exactly the same.

NEEDED TRAINING

With specialized torque equipment, training is paramount. Technicians will need to be trained either on-site or in a fa-



A microprocessor-based T-Box. (Courtesy: Norbar Torque Tools)

cility such as ones offered at Norbar. In a Norbar facility, disruptions are minimized while training is conducted in-house. This completed training ends with certificates of completion issued.

The training programs offered by Norbar are designed to work to ISO17025 standards, ISO6789 standards, and more.

Torque tools have come a long way since the days of old, so there must be a continual commitment to the development of new products and new technologies to prepare the world for the next generation. For those with a foot already in the calibration pool, they know the necessity of staying ahead of the curve.

For those getting ready to take that next step, working with a company that can help meet those needs and keep an eye toward the future is just one more valuable tool to keep handy.

Norbar Torque Tools has offered a comprehensive line of torque tools for more than 75 years, with factory offices around the world from Asia to the U.S. For more than 50 of those years, Norbar has provided torque calibration equipment going back to when it was only available in analog. With this experience, Norbar has not only


served industries with state-of-the-art torque equipment, it has had a front-row seat in the evolution of the precision bolting world. ✎

ABOUT THE AUTHOR

Sam Ortolani is national sales manager at Norbar Torque Tools, Inc. Ortolani has been with Norbar Torque Tools, Inc. for 16 years. Prior to Norbar, he spent 12 years in the fastener industry, working primarily in the custom-engineered fastening market.



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MAINTENANCE-FREE-BOLTING CONCEPT FOR BOLTS UP TO M100 (4")

Maintenance-Free-Bolting concept by ITH Bolting Technology and IHF Fastener Systems: IHF Bolts, IHF Round Nuts, and digital monitoring and application management for ITH Bolt Tensioning Cylinders. (Courtesy: ITH)

ITH Bolting Technology combines digital bolting tool procedures, advanced fastener design, and installation know-how to reduce maintenance costs significantly – proven for onshore and offshore wind-turbine installation projects.

By DIPL.-ING. FRANK HOHMANN

With its brand, IHF Fastener Systems, ITH Bolting Technology has developed innovative fastener systems up to M100 (4"), which are specifically designed to match the technical demands of onshore and offshore wind-turbine joints. ITH is a leading global system supplier in bolting technology providing bolting tools, engineering, fasteners, and service.

The "Maintenance-Free-Bolting" concept includes the technical coordination of ITH bolting tool systems with digital management software, specifically designed IHF fasteners, and advanced installation process know-how. The technical combination leads to repeatable, fast, and precise bolting procedures, which helps to reduce costly maintenance intervals on onshore and, especially, offshore wind turbines significantly.

BOLTING TOOL METHOD AND DIGITAL MANAGEMENT SOFTWARE

ITH bolt tensioning cylinders work according to the hydraulic frictionless and torsion-free tightening method. The method guarantees reproducible assembly preload FM within a close tolerance of ± 2.0 percent. For this method, ITH has developed a digital application management system, which offers customizable functions such as data-logging and step-by-step user guidance.

Depending on the demand of the customer, the bolting procedure and functions can be modified. All captured data such as applied pressure, applied preloads, angles of rotation of the nut run-down, bolt-ID, and more application data can be sent to a customer cloud.

MULTI-CERTIFIED IHF FASTENER DESIGN AND BENEFITS

Bolted joints on steel constructions can be classified according to the HV-standard as per DIN EN 14399 and DAST 021. Wind-turbine tower segments are mainly subjected to this standard, which determines that bolts are torqued, and fastener sets consist of a bolt, a nut, and two washers. Torquing is subjected to friction effects, which can affect the implementation of the applied assembly preload FM negatively.

Innovative IHF Fasteners – the IHF Stretch Bolts (head bolt in general up to M64, 2 1/2"), IHF Stud Bolts and IHF Round Nuts (up to M100, 4") – are based on optimized design to meet the technical demands of wind-turbine joints in terms of material, coatings, pre-load distribution, notch categories, and dimensions.

Compared to conventional HV-standard joints, IHF Fasteners offer several advantages:

- Integrated washers: In contrast to an HV-set, the more

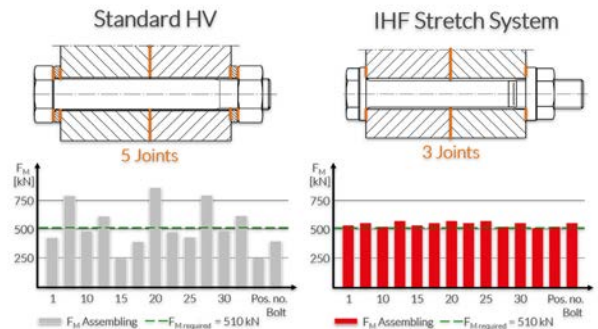


Figure 1: Conventional HV-standard configuration) compared to IHF fastener configuration and applied preloads for bolt size M36 (1 3/8"). (Courtesy: ITH)

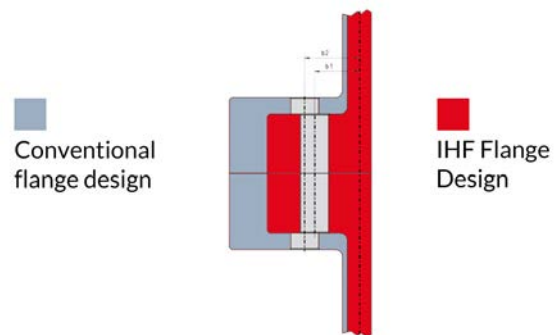


Figure 2: Optimized flange design options when using IHF Fasteners. (Courtesy: ITH)

recent bolt and nut set consists only of two components, the IHF Stretch Bolt/ IHF Stud Bolt and IHF Round Nut, which simplifies and accelerates the installation process, especially offshore.

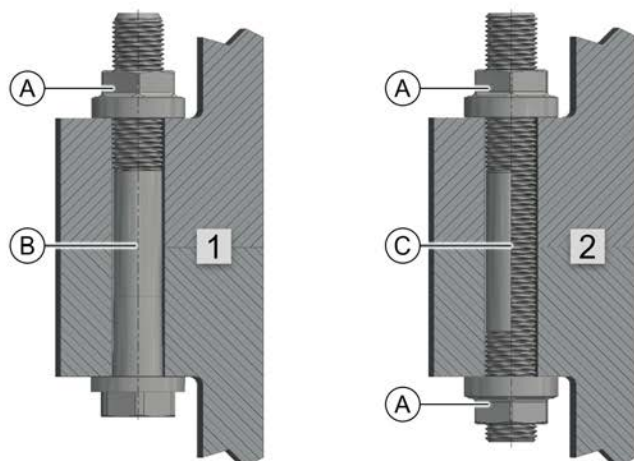
Design and optimized load distribution enable higher utilization of the material.

This enables a) to use less IHF Fasteners compared to standard fasteners or b) reduce the dimensions of the flange.

Due to their proven design, IHF Fasteners have received the European Technical Approval (ETA) by the DIBt (German Institute of Construction) to be applied as a substitute for conventional HV-standard fastener configurations.

INSTALLATION KNOW-HOW AND RESULTS

The "Maintenance-Free-Bolting" concept also includes several components that lead to a faster installation process.

**Configuration 1 - IHF bolt assembly:**

A. IHF Round Nut (acc. IHF-09.00100)

B. IHF Stretch Bolt (acc. IHF-09.00100)

Configuration 2 - IHF stud bolt assembly:

A. IHF Round Nut (acc. IHF-09.00100)

C. IHF Stud Bolt (acc. IHF-09.00100)

A. IHF Round Nut (acc. IHF-09.00100)

Figure 3: ITH configuration possibilities: IHF Round Nuts can be used with IHF Stretch Bolts in general up to M64, 2 1/2", or IHF Studs Bolts up to M100, 4" — no washers required. (Courtesy: ITH)

ITH hydraulic bolt tensioning cylinders can be equipped with handling systems and automatization components, which enable a semi-automatic nut run-down and an automatic nut alignment. Both automatization components are managed by the ITH software. Via an industrial touch-panel PC, users get a visual step-by-step process guidance. Bolt-tightening procedures are often subjected to the risk of possible incorrect operation, which is avoided by the user guide.

This process design not only accelerates installation procedures but also guarantees precise results. Special offshore packaging and the fact that no washers are required also simplifies and accelerates the installation.

WIND TURBINE APPLICATION AND SOLUTIONS

The proven "Maintenance-Free-Bolting" concept is in use on:

- ▀ Turbine tower bolts.
- ▀ Transition-piece to tower bolts.
- ▀ Monopile-to-transition piece.

Next to the Maintenance-Free-Bolting concept, ITH Bolting Technology also provides bolting tools, fasteners, and service for main wind-turbine nacelle bolting applications. Comprehensive support in terms of installation supervision, tool maintenance, tool calibration, and further is guaranteed by the global ITH network. ✎

ABOUT THE AUTHOR

Dipl.-Ing. Frank Hohmann is CEO of ITH GmbH & Co. KG (ITH Bolting Technology). ITH Bolting Technology is the worldwide



Figure 4: ITH bolt assemblies with IHF Stud Bolt and IHF Round Nut. (Courtesy: ITH)

leading system supplier for tension and torque tools to tighten and loosen industrial bolt connections bigger than M16 (5/8"). As a whole system supplier, ITH combines high-quality tool solutions, comprehensive engineering knowledge, innovative fasteners, and qualified services for the best technical and economic solution for business partners. As a private-owned engineering company with a long-term business strategy, the global ITH-network includes 12 ITH-subsidaries and more than 40 global representations. This guarantees fast and qualified tool services as well as customer proximity. With more than 200 international patents, ITH is among the most important drivers of innovation in industrial bolting technology.

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A large-scale photograph of a training facility. In the center, a massive white wind turbine nacelle is being worked on. Several technicians, wearing hard hats and safety harnesses, are positioned around the nacelle. One technician is on the ground, while others are on platforms or ladders. The background shows industrial equipment and a large open space.

PROFILE

WIND ACADEMY BY SIEMENS GAMESA

BUILDING A FOUNDATION OF SAFETY AND TECHNICAL SKILLS

Technicians practice working as a team in the Siemens Gamesa 2.3-MW nacelle. (Courtesy: Wind Academy by Siemens Gamesa)

Wind Academy by Siemens Gamesa provides internationally recognized training for wind-energy technicians with the advantage of having them ready to work within the framework of a three-week program.

By **KENNETH CARTER** ▀ Wind Systems editor

As the wind-energy industry continues to grow, the need for qualified technicians will be of paramount importance.

Where most technician training programs are 12 weeks or more, Siemens Gamesa has been able to cut that training time by a fourth at its Wind Academy training facility in Orlando, Florida.

“The facility is what Siemens Gamesa uses to train all of its technicians, from new hires with limited to no experience in the industry, all the way up to our highly advanced technical skills,” said Kyle DeWitt, director of training for North America. “We run the gamut of training competency here in the center.”

TRAINING FOR ALL

For the past two years, the Wind Academy by Siemens Gamesa has extended that training to whoever wants to become a wind technician, according to DeWitt. Before Wind Academy, a future technician would spend months in a program and still need further training before they would see the inside of a turbine, either with Siemens Gamesa or some other OEM.

“The idea behind Wind Academy was to offer a program to individuals, with limited to no experience in the industry, an opportunity for them to — in an accelerated fashion — break into the industry,” he said. “With Wind Academy, you come out of this program, and you are essentially, with maybe a small exception for some nuanced classes from individual OEMs or customers, ready to get to work.”

The three-week program offered by Wind Academy teaches the core of what a technician needs, according to DeWitt.

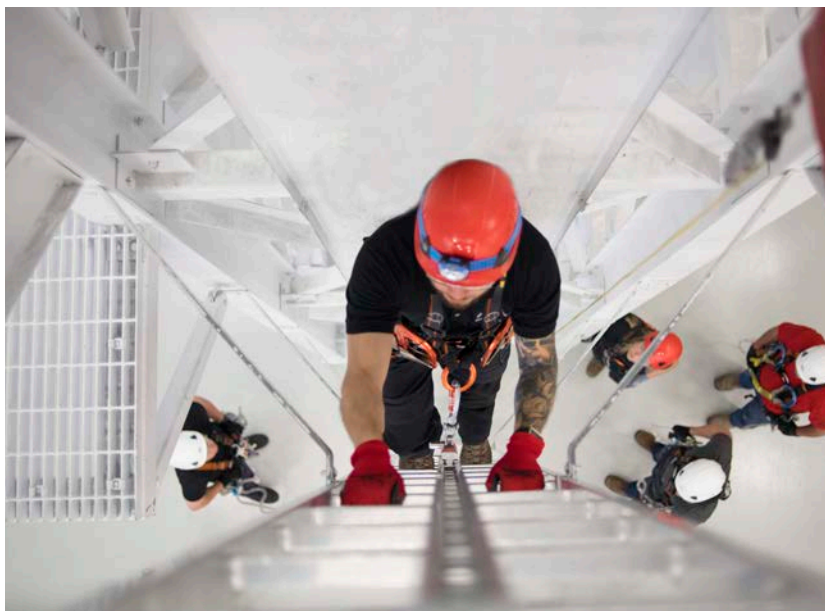
“We don’t add anything extra, but we haven’t cut anything out that’s necessary,” he said. “The backbone to our program is GWO — all of the Global Wind Organization training certificates. And, what you won’t see at other training programs is the duration, and that’s another huge value proposition.

We can bring a technician in, and within three weeks, you graduate. And, you graduate ready to go to a wind farm.”

INTENSE TRAINING

Needless to say, compacting all that needed training into a three-week window makes for a busy itinerary, according to DeWitt.

“The days are full, but the feedback we get from our technicians is that the program is intense, but it’s not so intense that you’re not able to retain what you’re learning,” he said. “You don’t come out of here with a certification that you don’t absolutely need.”



Practical exercises with personal fall protection equipment are important elements of the training program. (Courtesy: Wind Academy by Siemens Gamesa)

Newly minted technicians will leave the program with the basics, although they may need some additional training once they are hired, according to DeWitt.

“Each OEM or each customer might have some nuanced training that they require,” he said. “You can graduate from Wind Academy and then, to get into a Siemens Gamesa wind farm, you may need a couple of extra little things, but they’re very small and minor. But you’re getting the core that will be applicable to any of the OEMs, generally speaking, and most of our customers.”

CEMENTING A GLOBAL LEADER ROLE

The addition of the Wind Academy continues Siemens Gamesa’s vision to be a global leader in renewable energy, according to DeWitt.



The Wind Academy facility located in Orlando, Florida. (Courtesy: Wind Academy by Siemens Gamesa)



A technician demonstrates proper use of life-saving rescue equipment in a real-life setting. (Courtesy: Wind Academy by Siemens Gamesa)

“Wind Academy’s philosophy is the same, but focused on technician training,” he said. “We’re trying to be a leader and to lead the industry and the training industry within wind to do what we’re doing. (Before Wind Academy), people who want to be technicians take classes and courses that aren’t critical to getting themselves to work.”

And even though a technician might choose to not work for Siemens Gamesa, that technician is still instilled with the Siemens Gamesa mindset, according to DeWitt.

“That mindset is a safety-first, zero-harm culture, as well as a focus on quality, that we as an OEM want to see in all technicians,” he said.

The Wind Academy’s program is focused mostly on all the GWO basic safety and technical modules, and as part of that partnership with GWO, the course content is constantly being updated and improved, according to DeWitt.

“Together with GWO, Siemens Gamesa — not necessarily Wind Academy — but Siemens Gamesa with Wind Academy reviews what’s being taught, changes in the industry, changes in the regulations that the industry operates under, and we are constantly updating course materials as needed to meet those needs,” he said.

UNIVERSAL REQUIREMENTS

And that brings up a challenge that is constantly being debated within the industry: Just what is really required? DeWitt pointed out there is no set of official rules on what classes or certificates are needed in order to work at a certain location.

“What we’re trying to do, again with the overall company’s vision of being a leader and with Wind Academy following suit, we’re trying to define those,” he said. “We, as an OEM, are saying, ‘If you take this list, you are essentially qualified to be on a wind farm.’ To summarize, the challenge of the industry is that there are 1,000 different ways to put a basic qualification package together. We’re trying to define that as an OEM, teach that as Wind Academy, and then urge the industry to follow suit.”

The goal of a universal set of rules may be a challenging one, but DeWitt said he feels the industry is moving in that direction.

“Siemens Gamesa is very much aligned with GWO, and we do see the rest of the industry moving in that direction — not that we’re not all there yet,” he said. “Again, there are a lot of different opinions on what’s necessary and what’s not. Here at Wind Academy and Siemens Gamesa, we’ve really found that right balance between how much coursework you need to take vs. what’s unnecessary. So, I do see the industry moving that way, but it’s obviously a big process.”

OFFSHORE GROWTH

And as offshore wind grows in North America, it will become even more necessary for the proper training to be offered as more technicians are required. The good news is the certifications for offshore are very similar to onshore, according to DeWitt.

“The only difference is some of the safety training that’s required for offshore, because you’re working on the ocean,” he said. “There are ocean survival-type classes that we are in development on making offerings for. Again, there is no blanket industry standard, but essentially for us, for offshore, Wind Academy would get you almost all the way there. And then, there would have to be some extra survival-type training.”

In the short two years Wind Academy has been available, DeWitt said that about 40 students have gone through the training, and he added that he and the Wind Academy make a point to keep in touch with the students who graduate.

“We genuinely want to know where they get to work,” he said. “That’s the best, when you get the phone call and they say, ‘Thanks, I got my job. I love it.’ And then, when you hear from them a year later, ‘Hey, I’m successful. I’ve moved up into a maintenance-tech level.’ Just watching these students do what they wanted to do, and then knowing that Wind Academy was the on-ramp for them into the industry, is exciting.”

COMPREHENSIVE FACILITY

The facility in Orlando, about a mile from the Orlando International Airport, offers some impressive amenities, according to DeWitt. It’s a 40,000 square-foot facility with a section of eight classrooms that can hold 24 people each with one classroom with a capacity of 120. The training bay houses two full-size nacelles — a Siemens direct drive and a Siemens geared — used for technical and safety training.

“We also have three 30-foot-tall climbing towers that we do all of our safety and practical exercises on,” he said. “And then, finally, in the facility, we have two hydraulic and electromechanical labs — which is essentially a wind turbine broken down into pieces that technicians can come practice how to troubleshoot faults, familiarize themselves with the equipment, and learn all the technical details of the job.”

And although there are other facilities dedicated to training wind technicians, DeWitt boasted that Wind Academy is unique.

“The feedback we constantly get is, ‘This place is amazing,’” he said. “It’s really a world-class facility.”

BEING PREPARED

The “world-class facility” is prepared to be at the ready as the industry continues to grow, according to DeWitt.

“All indication is that the industry is going to continue to



Two Siemens Gamesa nacelles provide hands-on training opportunities. (Courtesy: Wind Academy by Siemens Gamesa)

expand; the rate of that expansion is maybe up for debate, but I don’t think there’s any question that it’s going to grow,” he said. “And everyone who works in the industry must attend training, whether before you interview to get into the industry, or you get hired and then have to take the training. So, this facility, in general, and Wind Academy as a part of that, are going to be crucial in getting that workforce ramped up. We’re going to have to get creative with capacity, such as how many technicians can we move through here without sacrificing any of the quality of the training.”

Currently, DeWitt said Wind Academy is still building a student base with class sizes consisting of no more than six students.

“Sometimes we have all six seats taken, sometimes we don’t,” he said. “We are actively recruiting and trying to get students enrolled.”

And although there is a cost involved with enrolling at Wind Academy, the main advantage over other training programs boils down to time, according to DeWitt.

“A competitor is going to have you sit in a course or a track for 12 or more weeks, where we’re going to have you out of here in three weeks with all of your internationally recognized certifications, ready to go to a wind farm,” he said. “That difference in time, where you could be on a wind farm working and getting your OJT and earning your paycheck, is where we really try and drive our value proposition.”

MORE INFO

www.windacademyusa.com

Adam Parr

Director of Communications & Public Affairs ▸ Gerdau



“The renewable energy sector is an important growth market for the steel industry.”

▀ What role does Gerdau serve in pushing recycling trends?

Gerdau's business is built around recycling and sustainability. Each year, we transform millions of tons of scrap into a variety of new steel products, promoting sustainable development around the world. All of Gerdau's North American steel mills use scrap-based electric arc furnace (EAF) technology, reducing the demand for natural resources and minimizing the release of greenhouse gases, in addition to reducing the amount of material discarded in landfills.

▀ Why is it important for manufacturers to take a green initiative in 2023?

In addition to being the right thing to do for the communities where we work and live, numerous stakeholders — including employees, customers, investors, and governments — are calling on manufacturers to improve their environmental performance. While our current greenhouse gas emissions are a fraction of the global average for the steel industry, Gerdau has established public goals to reduce our emissions in the near term, with an ambition to make our operations carbon neutral by 2050.

▀ How does that translate into the renewables sector, particularly wind energy?

The renewable energy sector is an important growth market for the steel industry. Steel production is also an energy-intensive process. The presence of more renewable energy sources on the grid makes steel products even cleaner. Today, the U.S. steel industry is the least carbon-intensive of all major steel-producing countries, and its footprint will continue to improve as more renewable energy sources come online.

▀ What types of materials are typically recycled within the wind industry and how are they used?

Gerdau's Metals Recycling business operates 21 scrap yards, purchasing, processing, and selling all grades of scrap metal, which is used both by our mills and by other businesses. We recycle discarded cars and appliances, aluminum, copper,



stainless steel, brass, batteries, and many other metal-containing goods.

▀ Are recycled materials being used for repowering older wind turbines? In what way?

Approximately 70 percent of the steel made in the United States is made by EAF steel producers, using recycled ferrous scrap as the primary input. Utilizing this clean, infinitely recyclable material will promote sustainability and reuse.

▀ What advantages can wind energy take from how other industries deal with recycling their materials?

As a developed economy, the U.S. enjoys established recycling networks and an extensive supply of scrap metal. This allows wind-energy developers to purchase from some of the cleanest steel producers in the world, improving their own footprint while building new renewable energy capacity.

▀ With green initiatives always an obvious objective for wind energy, how do you see the wind industry implementing recycling protocols to further that goal?

Across steel-consuming industries, we increasingly see customers making environmental performance a key component of procurement decisions. This incentivizes and rewards producers who are doing the right thing and supports further reductions in carbon emissions. ✍

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Havfram, an offshore wind services company in Norway, recently announced it has secured an additional \$250 million in equity funding. (Courtesy: Havfram)

► CONSTRUCTION

Norway's Havfram secures \$250M equity funding

Havfram, an offshore wind services company based in Norway, has secured an additional \$250 million in equity funding through a partnership between its primary sponsor, Sandbrook Capital, and Canada's PSP Investments.

The equity funding, in addition to credit financing from commercial banks and export credit agencies, will be used to build a fleet of offshore wind vessels. These vessels, capable of installing turbines reaching more than 300 meters in tip height and foundations of up to 3,000 tons at water depths of up to 70 meters, are

among the most critically scarce components of the global renewable energy supply chain.

Havfram's first vessel is under construction, following execution of a shipbuilding contract with CIMC-Raffles. The NG20000X vessel is equipped with a 3,250-ton crane and the latest battery hybrid drive train technology designed to reduce carbon emissions per MW installed by more than 70 percent compared to previous vessel models. The agreement with CIMC-Raffles contemplates the construction of up to four of the vessels.

"I am proud to announce this important milestone for Havfram Wind AS," said Even Larsen, Havfram's offshore wind construction CEO. "With this world-class equipment and one of the most experienced teams in the industry, we are certain that we will be able to provide a first-class service to

project owners, turbine suppliers, and construction partners globally. I'm also excited that our vessels will have some of the lowest emission profiles in the industry, as we have designed them to use latest electric battery and energy recovery systems, as well as numerous other sustainability innovations."

"Our planet can't afford delays in the fight against climate change," said Havfram CEO Ingrid Due-Gundersen. "The doubling of our equity funding only a month after Sandbrook's initial investment in Havfram is a testament to the fact that rapid progress can in fact be made when we bring together the right engineering and operational capabilities and specialized investors of scale. We're extremely grateful to Sandbrook and PSP Investments, not just for their trust and financial support, but also for the way they are



Cleveland-Cliffs and EDP Renewables' Headwaters III Wind Farm partnership will afford Cleveland-Cliffs the opportunity to advance its sustainability goals, and enabling EDPR NA to expand its Indiana portfolio. (Courtesy: EDP Renewables)

already leveraging their experience and extensive networks to help Havfram become a leading partner to the global offshore wind industry.”

“PSP Investments believes the build-out of the offshore wind supply chain to be part of the solution in addressing climate change and the global shift to net zero,” said Patrick Charbonneau, PSP senior managing director and global head of infrastructure investments. “The state-of-the-art vessels built by Havfram will enable the construction of the largest offshore wind turbines to date.”

MORE INFO havfram.com

► CONSTRUCTION

EDP Renewables signs Indiana wind-farm deal

EDP Renewables SA, through its fully owned subsidiary EDP Renewables North America LLC, (EDPR NA), and flat-rolled steel company Cleve-

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land-Cliffs Inc., has executed a 15-year power purchase agreement for 180 MW of the 200-MW Headwaters III Wind Farm in Randolph County. Headwaters III, about 70 miles east of Indianapolis along the Ohio border, is anticipated to be operational in 2025 and will, each year, power the equivalent of more than 54,000 average Indiana homes.

EDPR NA has developed and will construct, own, and operate Headwaters III Wind Farm, which is an extension of the operational 200-MW Headwaters I Wind Farm and the 198-MW Headwaters II Wind Farm in Randolph County. The project will create hundreds of jobs during peak construction and will employ local team members to operate and perform routine maintenance on the wind farm. Additional economic benefits in the form of landowner payments, local government payments, and an increase of money spent at businesses in the vicinity of the project will be disbursed as a result of the wind farm's entrance into Winchester and projected 30-year lifespan. Headwaters III will save about 355 million gallons of water a year, the amount of water that would be needed by conventional generation sources to produce the same amount of capacity as the wind farm. The project will produce clean energy while minimizing impacts on wildlife, habitat, and other environmental resources.

Cleveland-Cliffs and EDP Renewables' Headwaters III Wind Farm partnership will afford Cleveland-Cliffs the opportunity to advance its environmental and social sustainability goals, and enable EDPR NA to expand its portfolio in Indiana, where it maintains its position as the top producer of wind energy in the state.

"A key priority of Cleveland-Cliffs' greenhouse gas reduction strategy revolves around the efficient use of energy and clean energy. We are committed to the greening of the grid through renewable energy projects such as the Headwaters III Wind Farm," said Lourenco Goncalves, chairman, president, and CEO of Cleveland-Cliffs Inc. "This project is another step toward



An example of a PEMA wind tower production line. (Courtesy: Pemamek)

achieving Cleveland-Cliffs' emission reduction goal of 25 percent by 2030 and will advance our portfolio of renewable energy initiatives that are additive to the power grid."

"We are excited to begin our partnership with Cleveland-Cliffs to supply clean energy to support the production of American-made steel for a major American manufacturer," said Sandhya Ganapathy, EDP Renewables North America CEO. "We look forward to the eventual operations of this third phase of the Headwaters Wind Farm, also made possible by our supportive partners in the Randolph County community."

MORE INFO www.edpr.com/north-america

► CONSTRUCTION

Pemamek to supply wind equipment to Saudi Arabia factory

The Finnish welding and production automation company Pemamek Ltd. has signed a contract with Al Yamamah Steel Industries to supply PEMA onshore wind tower manufacturing lines. The order is a part of the construction project of the Al-Yamamah

Wind Energy Systems Factory, Saudi Arabia's first wind-tower manufacturing facility.

The new facility, contributing to local wind-power projects, is being carried out as part of Saudi Arabia's clean-energy transformation and Saudi Vision 2030.

The scope of delivery includes a significant amount of advanced PEMA welding automation equipment designed specifically for high-capacity and safe onshore wind tower manufacturing.

"We are very proud to be elected for this meaningful wind-power project," said Jukka Rantala, Vice President, Key Accounts at Pemamek. "Pemamek has a proven track record in developing highly advanced wind tower manufacturing solutions and now we are excited to create a substantial positive impact on Al Yamamah's production. It is also a big honor for us to help the ambitious Saudi Vision 2030 program with our state-of-art solutions."

Pemamek's delivery to Al Yamamah includes comprehensive project management, acceptance tests, production ramp-up, and training. The agreement includes a service contract with a spare part package, software support, and maintenance support.

MORE INFO pemamek.com

INNOVATION

Videoscope makes wind-turbine gearbox inspections faster

The IPLEX G Lite-W videoscope combines portability with imaging features packed into a small, ergonomic form. It enables users to visually inspect inside a wind-turbine gearbox without disassembling it to spot issues before they turn into lengthy shutdowns.

Wind-turbine gearboxes contain lubricating oil, which can adhere to the videoscope's lens and cause blurry images. The IPLEX G Lite-W videoscope's sealed tip keeps oil out while channels on the oil-clearing tip adaptor use capillary action to draw oil away from the lens, helping keep images clear.

To reduce the chance of damage during an inspection, the IPLEX G Li-



The IPLEX videoscope enables users to visually inspect a gearbox without disassembly. (Courtesy: Evident Scientific)

te-W videoscope is designed to meet IP65 standards and built to pass U.S. Department of Defense testing (MIL-STD). The insertion tube's durable articulation mechanism helps protect

the scope from damage when used in tight spaces.

The videoscope's optics balance the need to see areas of the wind-turbine gearbox up close, such as bearings

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TAILWINDS

THE BUSINESS OF WIND



Vaisala's WindCube has enhanced features. (Courtesy: Vaisala)

and gear teeth, spot defects in large spaces, and be small enough to fit into the spaces between turbine bearings to look for damage. An optional LED guide tube offers illumination to spot defects in large, dark spaces while the semiflexible guide tube makes it easy to position the videoscope to capture images. Users need one hand to control and maneuver the 4 mm scope to difficult-to-reach areas.

Weighing 1.16 kilograms (2.56 pounds), the compact IPLEX G Lite-W videoscope is easy to carry safely to the top of a wind-tower nacelle. Its ergonomic design enables users to control it while wearing gloves in tight confines. When the inspection is complete, the scope's smooth, oil-resistant coating makes cleaning fast and simple.

MORE INFO www.EvidentScientific.com

INNOVATION

Vaisala announces WindCube Lidar enhancements

Vaisala, a global leader in weather, environmental, and industrial measurements, including wind Lidar instruments for wind energy, recently announced enhancements to WindCube Lidar, including new design features, measurement capabilities,

and service and support for optimal Wind Resource Assessment in extreme weather conditions across a diverse array of climates.

With wind farms evolving to include larger turbines, increased heights, and deployment in a wider range of environments and conditions, the latest WindCube enhancements deliver:

■ A robust metallic wiper that resists corrosion in harsh conditions, while Vaisala's PTH WXT535 weather sensor delivers measurements of environmental parameters, including wind, rain, temperature, and barometric readings.

■ A new winter kit that safeguards the lidar from snow and ice.

■ An increased temperature range (50°C) that allows for deployments in the hottest areas around the globe.

■ Compatibility with the latest generation of EFOY fuel cell design for off-grid applications.

■ A partnership with SmartGrid that enables customers to collect reliable data at remote locations.

Measurement capabilities to ensure data accuracy for increasingly tall turbine hub heights; users now have the ability to compare Lidar data with measurements from an IEC-compliant met mast up to 200 meters.

The new WindCube service agreement streamlines operations, provides online educational resources to stay current on system operations and

management, minimizes disruption, and enables operation and minimal downtime in more global locations.

MORE INFO www.vaisala.com/en

INNOVATION

DNV, Reodor create service for wind-farm decommissioning

DNV, the independent expert in risk management and assurance, is moving ahead in collaboration with Reodor Studios to create a digital service that will make it easy to plan for sustainable decommissioning and recycling when a wind farm has reached the end of its life cycle.

In the 1970s, the wind-power industry boomed, and thousands of wind farms were built around the world. Now, 50 years later, the world faces a historic challenge: What do you do with a 300-ton wind turbine when it has reached the end of its life? ReWind, a brand-new digital service, aims to address this key issue for the wind industry.

Today, most decommissioned wind turbines are buried underground, for lack of a better solution. In 2020, Bloomberg highlighted the situation in Casper, Wyoming, where 870 wind-turbine blades are buried under a landfill. WindEurope estimates that 25,000 metric tons of wind-turbine blades will have to be recycled by 2025, and 52,000 metric tons by 2030.

DNV's specialist team analyzes and develops reports for wind-farm owners and operators, showing, among other things, which materials the wind turbines contain, how they can be disposed of in the best possible way, what can be recycled, and how. Now, in collaboration with Reodor Studios, a Norwegian corporate venture and innovation studio, DNV will shape this into a digital service.

"This service will enable wind-farm owners to quickly assess turbine recyclability percentage and options, end-of-life planning, and sustainable decommissioning," said Matthew Geraghty, founder and ReWind venture lead at DNV.

The use of wind energy will grow, and with that, the need to replace older turbines and equipment to keep pace with developments. Indeed, DNV's 2022 Energy Transition Outlook report forecasts that by 2050, wind will provide almost 50 percent of on-grid electricity in Europe, and 40 percent in North America and Latin America. New turbine types and bigger turbines, blades, and towers will raise capacity factors for onshore wind from 26 percent now to 34 percent, and from 38 percent to 43 percent for offshore wind by 2050.

"This is the first time in history that we have faced such a challenge," said Lucy Craig, director of Growth, Innovation & Digitalization, Energy Systems at DNV. "A wind turbine has a life cycle of around 20 to 30 years, and now, many wind turbines are approaching the end of their life cycle. Today, the process of recycling and decommissioning these

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is extremely complicated and manual, and large quantities of wind turbines end up in landfills, for lack of better solutions. Introducing this digital service helps the owner plan for decommissioning, map costs, and assess recycling options.”

To create a digital service that meets all its customers’ needs, DNV has initiated a collaboration with Reodor Studios. By combining Reodor’s

expertise in building digital products and services with DNV’s world-leading domain knowledge, the ReWind team can work faster, increase the chances of scaling successfully, and build a well-tested service that can make the process of decommissioning wind turbines smoother for wind-farm owners and operators.

“Capital Dynamics Clean Energy is committed to responsible investment

and ESG implementation throughout the investment lifecycle,” said current customer of the service Gintare Briola, Head of Portfolio Management, CEI at Capital Dynamics. “ReWind’s recyclability study for our wind farms helped us gain a better understanding on the recyclability of the equipment, the existing and developing recycling methods, including for composite blade waste, and forecasted decommissioning costs. ReWind also provided recommendations for various stages of the project life cycle that we at Capital Dynamics hope to implement to minimize environmental impact and reduce lifetime emissions.”

“DNV, which already has a large customer base of wind-power operators and owners and sits on world-leading knowledge of wind power, has foreseen the need for this service, both through dialogue with the customers, but also through hard data,” said Kate Butchart, strategic adviser at Reodor Studios. “Add to that Reodor’s creativity and experience in building products and services, and I believe it’s a perfect match to create a solution that can potentially solve a huge industry – and global – need.”

The digitization project is now ongoing, with the team working on validating market needs, developing a service concept, business model, and a scalable growth strategy based on customer insights.

MORE INFO www.dnv.com

MAINTENANCE

Windcat installs Digital DPR on entire boat fleet

Windcat Workboats, a European provider of specialist crew transfer vessels to the offshore wind power industry, has installed Reygar’s Digital Daily Reporting System, Digital DPR, across its entire fleet of more than 50 workboats.

The Digital DPR (DDPR) app runs from a touchscreen tablet onboard

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Windcat Workboats' vessels operate in the European offshore wind sector, and also in the oil and gas industry and outside Europe. (Courtesy: Windcat Workboats)

and is easy to use for busy workboat skippers. It reduces the administrative burden of daily progress reporting as well as improving report accuracy and timeliness.

"DDPR saves a lot of time on what is otherwise a long and detailed task," said Aaron Trebilcock, Windcat Workboats master. "The daily progress report is automatically generated and sent out at the end of the shift in a format that is simple to digest."

Reygar's time-saving reporting technology has gone through comprehensive trials on several Windcat Workboats CTVs over the past 18 months. Feedback from skippers and management was positive and fleet wide rollout was completed in mid-October.

"We are committed to meeting the reporting needs of our customers



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SEA-KIT International has secured its first export deal with an order from ThayerMahan. (Courtesy: SEA-KIT)

with a digitalized vessel fleet,” said Phillip Goffin, Windcat IT manager. “We also want to look after our crews and back-office teams by reducing the reporting burden and streamlining where possible.”

DDPR either works alongside Reygar’s award-winning BareFLEET vessel monitoring system, where installed, or runs as a standalone solution. The app can be customized to gather DPR data including crew details, fuel and consumables use, various task types, transits, passenger transfers to turbines and working hours data. Data input live from the vessel can be seen instantly in the cloud by shore staff, with users also able to access cloud based KPI data.

“By providing our customers with a standalone version of this reporting solution, we can make the benefits of digitized reporting available to all fleet operators, whether they use our BareFLEET monitoring system or not,” said Chris Huxley-Reynard,

Reygar CEO. “We enjoyed working closely with the team at Windcat to ensure that our DDPR app incorporated the needs of different stakeholders both within and outside their organization.”

MAINTENANCE

SEA-KIT secures first USV export deal

SEA-KIT International recently announced its first Uncrewed Surface Vessel (USV) export sale to ThayerMahan, a leader in autonomous maritime solutions based in Connecticut.

“We are always striving to improve the efficiency of maritime domain awareness and to keep people safe,” said Mike Connor, ThayerMahan president and CEO. “SEA-KIT’s flexible payload design enables us to host multiple, sophisticated maritime sensing systems onboard, which in turn will support ThayerMahan to continue leading the field of remote and autonomous mobile acoustic sensing and sense making.”

“We envisage that the introduction of this hi-tech USV to our portfolio will enhance the protection of ports and vessels at sea as well as have a positive impact on illicit trafficking across international borders,” Connor said.

ThayerMahan is a provider of remote and autonomous maritime sensing systems for government, industry, and academia. The company plans

MORE INFO www.windcatworkboats.com

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Vestas has signed a new agreement with blade supplier TPI Composites. (Courtesy: Vestas)

to use the SEA-KIT USV to support introduction of the technology into government service, as well as for its own commercial activities in U.S. and international waters.

“This U.S. export deal marks a significant milestone in the company’s journey so far,” said SEA-KIT CEO Ben Simpson. “The U.K. is forging a leadership stance in Maritime Autonomous Systems innovation, and we are proud to be part of that. We look forward to a fruitful, ongoing partnership with ThayerMahan and to supporting their current and future maritime domain awareness goals.”

ThayerMahan is set to take delivery of the latest 12-meter SEA-KIT X-Class design in spring 2023, with plans for it to enter operation over the summer.

MORE INFO www.sea-kit.com

MANUFACTURING

Vestas expands blade partnership with TPI Composites

Vestas recently signed a multi-year agreement with long-time partner TPI Composites Inc. (TPI), a supplier of

wind-turbine blades and services, to strengthen its scalable global supply chain network for current and future wind turbine blades.

“The continued and expanded partnership highlights how we are increasingly collaborating with partners, and how we continue to evolve and re-shape the industry together,” said Tommy Rahbek Nielsen, executive vice president and chief operating officer of Vestas.

“We have been working together with TPI since 2014 and during that time, they have become one of our most trusted and strategic blade partners. With this agreement, we are happy to continue this journey, leveraging their global footprint and providing their scalable, high-quality, and sustainable supply together.”

TPI and Vestas work together on global manufacturing and supply chain operations, based on Vestas’ specifications and requirements, and TPI is supplying a range of blade variants to Vestas’ 2- and 4-MW platforms as well as the EnVentus platform.

TPI will continue supply of blades from its existing global production footprint, while optimizing the production setup in current facilities, and evaluate new locations for possible future growth in strategic markets. Ves-

tas and TPI are equally investigating further collaboration possibilities for the V163-4.5 MW and V236-15.0 MW turbines and assessing the optimal manufacturing and production location setup for these new blades.

The new agreement is a continuation of the existing Vestas and TPI partnership agreement, and further builds on the expanding capabilities of TPI and core strengths of both companies.

Sharing manufacturing operations across the renewables industry is more relevant than ever to ensure sites are not sitting idle and creates a flexible, scalable, and efficient supply chain that enables industrial scale to meet global net-zero ambitions.

“We are proud of our long and successful partnership with Vestas and are pleased that Vestas has chosen to further expand its relationship with TPI,” said Bill Siwek, CEO, TPI Composites Inc.

“We look forward to continuing our collaboration with the supply of current and future blade models, blade design, and other services globally.”


MORE INFO www.vestas.com

MANUFACTURING

Vestas secures 203-MW order for U.S. project

Vestas has received a 203-MW order to power an undisclosed wind project in the U.S. The order consists of 45 V150-4.5 MW wind turbines.

The order includes supply, delivery, and commissioning of the turbines, as well as a multi-year Active Output Management 5000 (AOM 5000) service agreement, designed to ensure optimized performance of the asset.

Turbine delivery begins in the third quarter of 2023 with commissioning scheduled in the fourth quarter of 2023. 

MORE INFO www.vestas.com

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The screenshot shows a web browser displaying the storefront for Tork Worx on the Wind Systems Community website. The page layout includes a header with the Wind Systems logo and a navigation bar. The main content area features the company's name, a brief description of their services, and contact information. A video player is also visible on the left side of the page.

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The background features a dark blue field with a grid of white lines. Overlaid on this are various technical diagrams, including triangles, circles, and arcs, some with numerical values like 45.5902, 10.4137, 83.5254, 19.6278, 50.6471, 40.7083, 8.4806, 12.6824, 51.85, 63.602, 2621, 76.4167, 12.6824, 7.9315, 8.4806, 71.8101, 9.2863, 51.85, 64.8085, 12.6824, 92.6703, 64.8085, 1.21, 83.5254, 12.6824, 76.4167, 51.85, 8.4806, 10.4137, 83.5254, 19.6278, 50.6471, 40.7083, 8.4806, 12.6824, 51.85, 63.602, 2621, 76.4167, 12.6824, 7.9315, 8.4806, 71.8101, 9.2863, 51.85, 64.8085, 12.6824, 92.6703, 64.8085, 1.21. The text is positioned in the upper left and center.

CROSSWINDS

THE FUTURE OF WIND

PROGRESS AND OUTLOOK IN WIND-ENERGY RESEARCH

Several studies have demonstrated data-driven approaches are beneficial in wind-energy analysis in various areas.

By GALIH BANGGA

Wind-energy research plays a vital role in the possibility of the success story of wind energy as one of the most promising sustainable energy sources. This continuous process has been achieved from the era of small wind turbines to the current multi-MW standard and beyond.

1 INTRODUCTION

Wind energy has become an essential part of human life worldwide and has undergone massive development in different areas in recent decades. This is driven by the constant depletion of fossil fuels, fear of the energy crisis, price volatility, and people's awareness of cleaner and greener sources of energy. Wind energy is one of the most promising and mature sources of sustainable energy in terms of technology and market readiness. In fact, the growth of wind energy is considered as the fastest among other renewable energy sources. The success story of wind energy is tightly coupled with the long history in its research and development in many aspects. This includes the continuous effort spent on improving the reliability of wind turbine designs and site assessments.

The rapid growth of wind energy raises new challenges, which need to be addressed accordingly. One of the major concerns in wind-energy development is the space availability and the increased demand for wind power. The fear of an energy crisis makes it worse because a significant proportion of the current energy supply is still reliant on fossil fuels.

In contrast, renewable energy sources, such as wind energy, still cannot replace the fossil fuel dependency completely. The design of wind turbines, for instance, has established a clear direction to increase the power of each turbine up to 10 to 15 MW, and may be much higher in the future. This surely poses a completely different challenge compared to the wind-turbine technology in the past, e.g., a large wind turbine has much, much longer, more slender, and flexible blades. On the other hand, centralized power stations adopting these gigantic machines may not be suitable for remote areas with limited grid connectivity. This is where a decentralized energy concept using small wind turbines has found its place and is considered a viable solution.

The discussions below provide an overview of the trend of wind-energy developments that challenge the current research orientation. This article is aimed at discussing the direction of the current wind-energy research and its importance to meet future expectations. This article compiles and provides the key findings of several recent studies, and it is focused on the technical aspects of wind-energy modeling. Most studies were collected from articles published in *Energies* within the last two to three years and several selected studies from various publications. Two main topics will be discussed in this article: (1) in the area of wind-tur-

bine design and computations and (2) in the usage of data-driven approaches.

2 CHALLENGES IN WIND-TURBINE DESIGN AND PREDICTION TOOLS

Wind-turbine design is one of the most important aspects in ensuring the generated power and the lifetime of the turbine meet the expected demand. As a part of this process, the resulting loads must be measured or estimated correctly. It is agreed that the reliability of wind-turbine load assessments depends strongly upon the accuracy of wind-turbine prediction tools themselves. In practice, load-case analyses are performed to evaluate wind-turbine loads and performance under various conditions, including turbulent wind, controller fault, extreme conditions, etc.

Progress has been made in ensuring the accuracy of common prediction tools with various fidelity levels for wind-turbine analysis. Michna et al. [1] provided a comprehensive assessment of different computational fluid dynamics (CFD) codes in predicting the transition process of a wind-turbine airfoil. The studies were compared with experimental data and an integral boundary layer code. It was confirmed the calculated aerodynamic force coefficients from different CFD codes are consistent despite the different mesh distributions used. Tagliaferro et al. [2] performed a study that was aimed at establishing and validating an initial setup for a tension-leg platform for floating offshore wind turbines (FOWTs) with a meshless code. The study concluded that meshless CFD models can provide reasonable accuracy in simulating turbine operating conditions. It was suggested to further explore the characteristics for different scenarios such as for semi-submersible platforms. Li and Yang [3] compared the degree of flow dynamics in wind-turbine wake obtained from actuator disk and actuator surface computations. The studies revealed the agreement of both methods depends on the inflow conditions. Because numerical studies were usually conducted independently from one author to the other authors with various codes, it is often difficult to derive the exact conclusion when the same turbine model is evaluated at a later time. Collective comparative studies such as those reported by the International Energy Agency (IEA) can be useful in assessing the coherence of codes with different fidelity levels to model turbine physics [4,5].

Further investigations were performed for offshore wind turbines' specific cases. Cottura et al. [6] modeled an offshore floating wind turbine and examined the behavior resulting from a wide spectrum of sea and wind states typical of the Mediterranean Sea. The turbine levelized cost of energy (LCOE) was further evaluated. The studies indicated there is a tight relationship between the environmental conditions and the cost of energy. Liu and Yu [7] also performed

a study that attempted to model the complex dynamics of SPAR-type FOWTs under wave group scenarios. It was concluded the natural frequency responses increase with corresponding frequency wave loads, suggesting that the amplified motions may endanger the system in operation.

The usage of numerical tools is also proven to be helpful for improving the geometry of a wind turbine. Khlaifat et al. [8] demonstrated the design of a wind turbine could be optimized based on the local wind conditions, highlighting the design of wind turbine might be adjusted depending on the site location for obtaining the best performance. Further optimization was also carried out by adding passive flow controls, such as Gurney flaps, e.g., by Chakroun and Bangga [9], Gupta et al. [10], and Wiśniewski et al. [11].

Numerical tools also may be used to improve the turbine performance by airfoil reshaping, e.g., by Bangga et al. [12] and Kim et al. [13]. Lee and Shin [14] adopted the blade-element momentum (BEM) theory as a tool to compute the wind-turbine loads for wind-turbine design optimization process. BEM has been proven to be suitable even for a very large wind turbine having a 10-MW rated power [15,16]. Rogowski et al. [17] also confirmed numerical approaches can be used to assist the selection of the most optimal airfoil shape for a particular wind-turbine type.

To fully understand the characteristics of wind-turbine loads, a comprehensive inclusion of aeroelastic effects in CFD will be necessary. Lipian et al. [18] provided an example of fluid-structure interaction (FSI) studies for a small wind turbine. Although it was already expected, the aeroelastic effects will have little influence on small rotors, the studies revealed FSI is still beneficial for the strength analysis. Tian et al. [19] conducted an FSI study for a 1.5-MW wind turbine rotor having a diameter of about 84 meters during strong winds. The main aim of the study was to explore the stress distribution, as well as the damage to the turbine blades. By combining the results of the numerical simulation with the experimental data, the study provided the location of typical failure areas. Using an FSI approach, Santo et al. [20] managed to evaluate the characteristics of a large turbine having a diameter of 100 meters under the influence of wind gusts. The study showed an initial decrease in the rotor blade loads and displacement is a consequence of the negative velocity augmentation at the gust border. The structural inertia causes a tip movement delay when the gust positive core acts on the blade. Although a high peak is reached by the axial force on the blade, the occurrence of flow separation over the span prevents the blade from reaching extreme deflections. Several other studies also highlighted three-dimensional separated flow for a rotating blade could be influenced by various physical effects such as the Coriolis and centrifugal forces, as well as unsteady effects [21–24].

3 USING DATA IN WIND-TURBINE ASSESSMENT

Data-driven approaches have gained their momentum in recent years in various aspects including wind-energy sector. This area also received a huge interest in the wind-energy

research community as documented in numerous studies [25–31]. These studies covered a wide area of interests, such as wind-turbine modeling, time-series forecasting, and health monitoring.

Very recently, Geibel and Bangga [25] compared various data-driven algorithms to reconstruct the wind-turbine wake flow field and time-series under realistic inflow conditions. The time-series prediction was based on the bi-directional long short-term memory (Bi-LSTM) approach and was verified using data from high-fidelity CFD simulations.

The obtained results showed data-driven approaches for wind-turbine wake prediction could offer an alternative to conventional prediction approaches. Delgado and Fahim [27] also suggested the LSTM-based method is suitable for short-term time-series prediction by using a database from a supervisory control and data acquisition (SCADA) system.

Donadio et al. [26] further attempted to combine a numerical weather prediction with a machine learning approach for wind-assessment purposes. This study also highlighted that machine learning is helpful and suitable for such prediction tasks. Data-driven approaches have also been used to model the turbine performance and health condition. Lin and Liu [30] applied a deep-learning approach to study the major driven force on the mooring line tension for floating offshore wind turbines. The study considered a number of conditions from cut-in to cut-out wind speeds. It was concluded the mooring loading is mainly determined by the surge motion. In contrast, this study demonstrated the blade and the tower elasticity have fewer consequences.

Rushdi et al. [31] attempted to employ experimental data to train machine learning regression models of an airborne wind-energy system. In agreement with the above observations, this study also suggested the great promise of machine learning in wind-turbine prediction tasks. Santolamazza et al. [28] proposed a methodology based on machine-learning techniques with the data obtained from a SCADA system. The main objective was to characterize the behavior of some of the main components of wind turbines (such as gearbox and generator) and to predict operating anomalies. The adopted method was tested on wind turbines in Italy to evaluate its suitability, and it was demonstrated to successfully provide an aid for the maintenance of a wind farm. In a similar field, Kang et al. [29] adopted a support vector machine (SVM) to achieve an optimized economy and availability by an opportunistic maintenance policy. The study indicated the data-driven condition-based maintenance policy is helpful in reducing the maintenance expenditure of offshore wind turbines.

Mentioned studies demonstrated data-driven approaches are beneficial in wind-energy analysis in various areas. It is agreed the main challenges for most models are the source of the data and the real practical implementations. ↵

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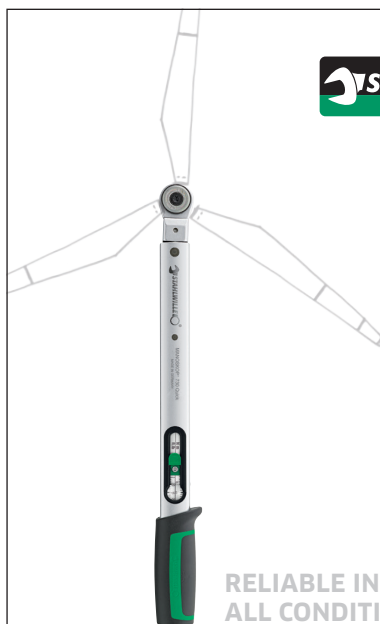
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DATA AVAILABILITY STATEMENT

Data can be made available by contacting the corresponding author.

CONFLICTS OF INTEREST

The author declares no conflicts of interest.

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Dr. Galih Bangga has collected years of experience in the field of wind-turbine aerodynamics as a senior engineer at DNV in the U.K. and as a scientist at the University of Stuttgart in Germany. Copyright: © 2022 by the author. Licensee MDPI, Basel, Switzerland. This article (<https://www.mdpi.com/1996-1073/15/18/6527/pdf>) is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>). It has been edited to conform to the style of Wind Systems magazine.

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