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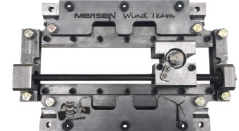
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AI APPLICATIONS IN WIND SYSTEMS

Artificial intelligence can help the wind-energy sector address challenges and offer immediate improvements.

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► THE FUTURE OF WIND



Global Wind Service marks 15-year anniversary ► ArcVera Renewables launches recruitment drive ► EverWind Fuels' Nova Scotia project moves forward



ARE WE FACING A RENEWABLE ENERGY BOOM?

With decreasing costs, government incentives, and environmental concerns driving the use of renewable energy, there are still potential challenges to be faced in order to meet global net-zero goals.

TAILWINDS

THE BUSINESS OF WIND

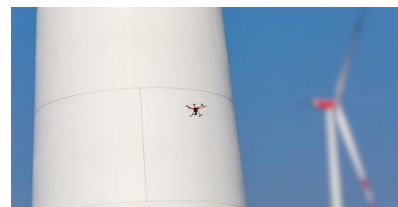


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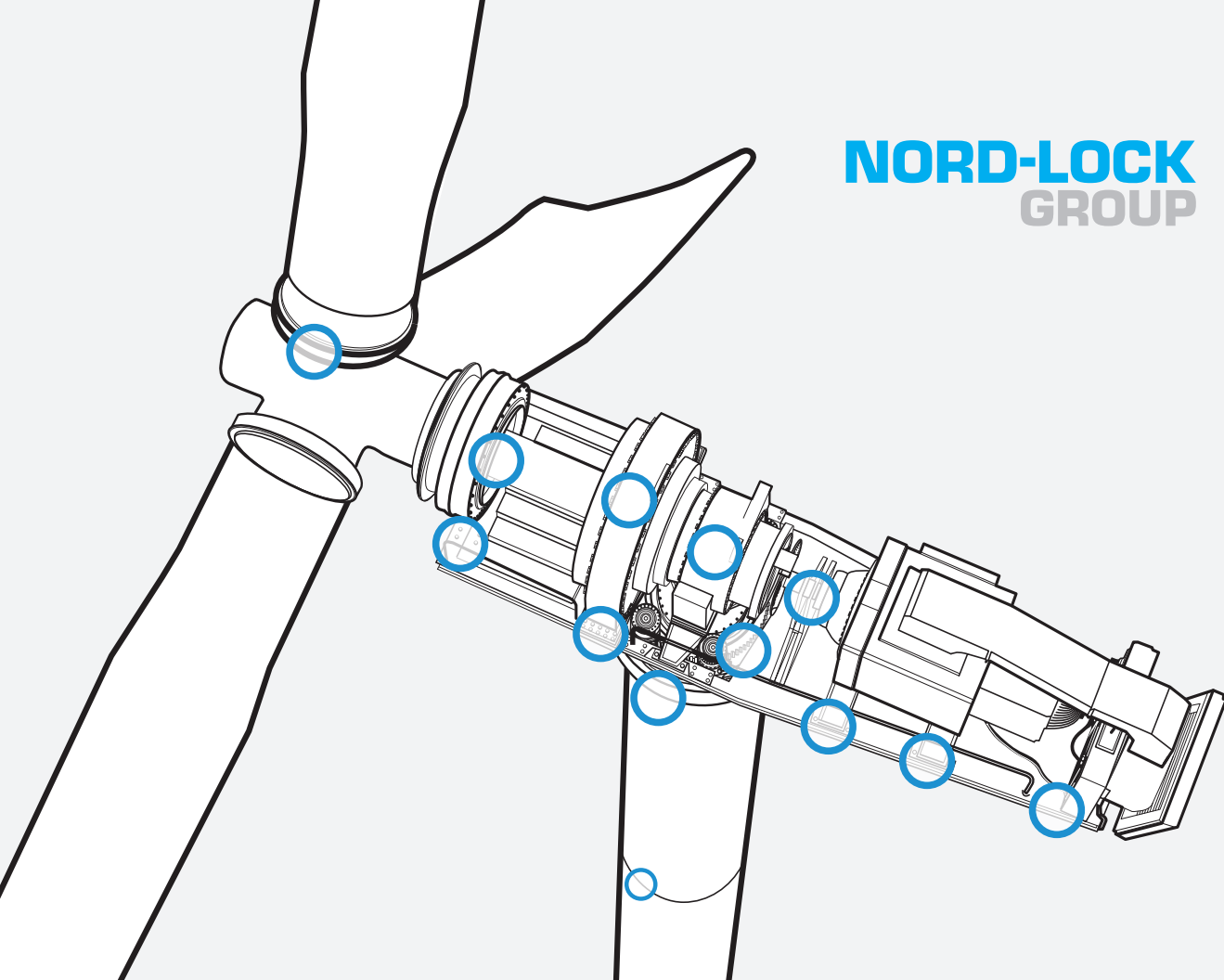


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FROM THE EDITOR

Wind Systems – it's easy being green

By the time you read this, we'll be at least six weeks into 2022, and as far as the future of renewable energy is concerned, I feel like it's the beginning of a brighter — and greener — future. And by green, I mean both ecologically and economically.

This year marks the third year of *Wind Systems*' efforts to reduce its carbon footprint by offering digital-only issues six months of the year.

Starting in 2021, *Wind Systems* began publishing six issues in a digital-only platform with the six remaining issues of the year being a print-digital issue combination. To add to our commitment to lower our carbon footprint, the six print issues are published on 10 percent recycled paper.

This, by no means, marked a change in the quality and quantity of the latest and best information about the wind-energy industry we continue to bring to you every month.

Just take a look at what this issue has to offer, and you'll see that our task to bring you interesting and informative wind-industry news has always — and is very much still — our primary mission.

With a focus on operations and turbine maintenance, our February issue has a lot to take in.

Beginning with our cover story, Dr. René Morkos, CEO of ALICE Technologies, shares his insights on how artificial intelligence can help the wind-energy sector address challenges and offer immediate improvements on a variety of issues.

An article from Airswift's Jordan Mason looks at refreshing offshore wind's hiring strategy in order to avoid potential project delays.

Fire risk always hangs like a specter over a successful wind operation. That's why it is paramount that potential hazards are addressed before they happen.

Firetrace's Ross Paznokas addresses the industry's attitude toward managing problems such as fire damage. Even though such incidents are rare, it's still an issue that needs to be taken more seriously as wind-sector development increases.

You'll find all that and more in this month's issue. It may be digital, but it's still 100 percent *Wind Systems*.

Stay safe and healthy out there, and, as always, thanks for reading!



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Report: Corporations buy record amount of clean energy in 2022

From ACP

The American Clean Power Association (ACP) recently released a report that shows corporations purchased more clean energy in 2022 than any previous year. The Clean Energy Powers American Business report provides a detailed picture of how commercial and industrial (C&I) companies are driving demand for American clean energy and accelerating the clean-energy transition through purchases of clean power directly from wind, solar, and energy storage plants.

Even as power purchase agreement (PPA) prices increased, corporations purchased nearly 20 GW of clean energy in 2022, more than 4 GW higher than any previous year. By the end of the year, more than 300 corporations had contracted more than 77 GW of clean energy. Once operational, that is enough capacity to power the equivalent of over 1,000 data centers, or 18 million American homes.

“Economic and environmental benefits, as well as growing pressure on corporations to meet sustainability targets, have led to a 100-times increase in corporate clean power procurement over the past decade,” said JC Sandberg, Interim CEO and Chief Advocacy Officer. “During that same period, solar and wind costs have decreased 71 percent and 47 percent respectively, making both more attractive to corporate energy buyers.”

The tech industry leads the list, and the clean-power horse race between Amazon, Meta, and Google continues to play out. Between 2020 and 2022, Amazon announced 11 GW of new PPAs. Meta, the second-largest clean power purchaser, has, on average, announced more than 940 MW of new clean-power procurement each year since 2013. Google, one of the earliest adopters of clean power, had a slow year of procurement in 2021 but rebounded in 2022 with more than 940 MW.

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cleanpower.org/clean-energy-powers-american-business



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DIRECTION

THE FUTURE OF WIND

Global Wind Service
employs more
than 1,700 people
from 39 different
nationalities.
(Courtesy: Global
Wind Service)

Global Wind Service marks 15-year anniversary with impressive credentials

Global Wind Service (GWS) is celebrating its 15-year anniversary in wind. Since securing its first contract in Esbjerg, Denmark, GWS has worked on close to 2,000 projects in 40 countries around the world.

The company employs more than 1,700 people from 39 different nationalities, working across 13 local business units and on site.

“Global Wind Service has come a long way over the past 15 years,” said Michael Høj Olsen, CEO of GWS. “From being a smaller entrepreneurial provider of manpower, co-founded by Lars Bo Petersen and Michael Nielsen who is still active and shareholders in GWS, to now being one of the preferred project partners globally, for complete wind turbine services, we have managed to grow together with our clients and adapt to industry needs. We can all be very proud of what we have achieved — it is something that would not have been possible without all our dedicated and skilled colleagues.”

As projects have become more complex and challenging, GWS has invested in training, processes, and in systems to meet higher standards for safety, quality, and technical expertise. In 2021, Global Wind Service Academy was established in Szczecin in Poland to further develop and strengthen competences and to make sure GWS can educate technicians with the right mindset and skills.

“It’s only by working together, that we can reach the ambitious targets set out by the different governments for a greener planet,” Olsen said.

Key accomplishments over the past 15 years include taking a leading position within offshore installation and service; the installation of the first offshore wind turbines in the U.S. at Block Island in 2016; installation of the first offshore wind farm in France, Parc Éolien en mer de Saint-Nazaire, in 2022; and playing a role in the growing offshore market in Taiwan with local establishment and colleagues.



ArcVera is looking to fill multiple roles in all business areas to support its new targets. (Courtesy: ArcVera Renewables)

Other accomplishments include the establishment of a team of more than 250 specialized blade technicians and back-office staff, as well as the entering of markets such as Turkey, Lithuania, Serbia, etc. to support partners and clients in the installation of onshore wind farms.

MORE INFO www.globalwindservice.com

ArcVera Renewables launches recruitment drive

ArcVera Renewables, a global provider of consulting and technical services for wind, solar, and energy storage projects, has revised its growth objectives upwards as market demand expands in key renewables project services segments. The company is looking to fill multiple roles in all business areas to support its new targets.

Over the past three years, ArcVera Renewables has experienced strong development with an average 20 percent year-on-year growth. With the Inflation Reduction Act policy driver set to create positive market conditions for renewable energy deployment in the United States, the company forecasts another 30 percent demand increase for its services in 2023 and beyond. In its new strategy update, ArcVera expects to continue reaping the benefits of its diversification into solar and storage in support of hybrid and green hydrogen projects, with solar energy services becoming a key engine of its growth alongside onshore and offshore wind.

“This steady performance is largely supported by our company’s long-term commitment to continuous innovation, and an intrinsic desire to help renewable energy projects succeed across the globe,” said ArcVera Renewables’ CEO Gregory Poulos. “It has been strengthened by timely investments in key overseas markets, notably South Africa, Brazil, and India. We are now actively seeking new administrative and technical talents to join our teams of atmospheric scientists, engineers, data analysts, and commercial specialists to deliver technical excellence for our clients’ projects around the world and contribute to maintaining our leadership position at the forefront of renewable energy technical innovation.”

For the last four decades, ArcVera has built its success by leveraging expertise at the intersection of science, technology, and engineering to meet some of their clients’ most complex project technical challenges. Its teams mobilize their advanced technical expertise and decades of global experience to provide trustworthy, insightful, risk-mitigating, and accuracy-driven renewable energy project services.

“2022 has been a great year for ArcVera and its clients,” Poulos said. “We were particularly excited to see the billion-dollar acquisitions of Scout Clean Energy and TriGlobal Energy, two loyal clients, whose projects we have proudly supported from company inception. These success stories underpin what ArcVera really stands for, which is to provide our clients with a

significant technical edge to increase their projects' value. We will keep doing what we do best and seize the new opportunities presented by the IRA to accelerate our growth next year."

MORE INFO www.ArcVera.com

EverWind Fuels' Nova Scotia project moves forward

EverWind Fuels Company, a developer of green hydrogen and ammonia production in Atlantic Canada, was successful in its response to the Province of Nova Scotia's request for applications (RFA) to commence the process to lease Crown Land to provide power to its multi-phase green hydrogen hub development project at Point Tupper.

EverWind and the Province of Nova Scotia have entered into a memorandum of understanding in respect of the process for EverWind to exclusively apply for and obtain a lease of the Crown Land subject to the MOU. Such Crown Land is projected to support the development of approximately 2 GW of onshore wind-generation capacity. The intended onshore wind farm will enable EverWind to reach 1 million tons of annual green ammonia production capacity by 2026.

"The MOU for the lease of Crown Land for onshore wind-farm development is a crucial step forward for EverWind to develop gigawatt-scale green hydrogen and ammonia production," said EverWind CEO Trent Vichie.

The Crown Land subject to the MOU is predominately located within the municipality of the District of Guysborough. EverWind is in the process of revising its proposed wind-farm development plan and will publicly share those proposed plans in upcoming months. The permitting and development of the wind farm will follow Nova Scotia Environmental Assessment regulations, including comprehensive effects studies and analysis, as well as public, stakeholder and rightsholder engagement, followed



EverWind Fuels is working toward a green hydrogen facility at Point Tupper, Nova Scotia. (Courtesy: EverWind Fuels)

by submission of an environmental assessment.

"EverWind is committed to openness and transparency," Vichie said. "We look forward to working closely with the municipality of the District of Guysborough to develop a sustainable project that supports their strategic development goals while respecting the interests of residents of the region."

EverWind is proud to share this RFA success with the corporate entities of the First Nations of Paqtnkek (Bayside Corporate), Membertou, and Potlotek.

"For generations, Mi'kmaw were prevented from participating in and benefitting from the economic development of our natural resources; this project provides an opportunity to make the dreams of our grandparents a reality," said Rose Paul, CEO of Bayside Development in Paqtnkek. "Economic reconciliation through meaningful partnerships in the development of our natural resources will advance our work toward becoming a sovereign nation and ensure prosperity for future generations. We are exercising our treaty rights to this land with a goal of creating energy sovereignty for our First Nation."

"Since time immemorial, the Mi'kmaw have been stewards of this land," said Chief Terry Paul, Member-

tou CEO. "EverWind recognized from the beginning that this project should be informed by two-eyed seeing practices. We are working in partnership with them to develop a project that aligns with Mi'kmaw values of respecting and protecting the environment while balancing the needs of people and nature."

EverWind's project is expected to create thousands of jobs and attract meaningful ancillary industry and technological IP to the region. The significant economic upside is compounded by a meaningful opportunity for Canada to continue supporting its European allies in the green-energy transition and ambitious decarbonization goals.

MORE INFO www.everwindfuels.com

Offshore wind sees strong fourth quarter

The American offshore wind industry closed 2022 strong despite impending challenges and economic uncertainty, according to the U.S. Offshore Wind Quarterly Market Report released by the Business Network for Offshore Wind, a non-profit working to accelerate offshore wind development and build a dedicated manufacturing supply chain in the United States.

The last three months of 2022 are notable for the first federal offshore wind auction along the U.S. West Coast and key port investments, yet the combination of supply chain bottlenecks and rising commodity prices could hamper progress in 2023.

Key takeaways from this quarter's report on U.S. offshore wind activity include:

► The California lease auction marked the U.S.' entry in the floating offshore wind market and an important opportunity to pioneer cutting-edge technology here at home.

► Domestic supply chain development was buttressed by key growth in the offshore wind steel sector and major investments at U.S. ports in four

key states — California, Connecticut, Massachusetts and New York.

▀ The same inflationary conditions disrupting the European offshore wind industry finally reached U.S. shores, resulting in project delays.

▀ With a capable workforce, critical infrastructure components, and the potential to generate nearly 9 GW of offshore wind that could power nearly 3 million homes, the Gulf region is primed for an offshore wind boom.

“The U.S. offshore wind industry remains on solid footing, even with the speed bumps and setbacks we saw emerging at the end of 2022,” said Liz Burdock, president and CEO of the Business Network for Offshore Wind. “We cannot rest on the long-term promise of this industry, however, and we must work to overcome our known challenges — from port infrastructure to transmission and supply chain shortages — that rising global inflation and surging demand have



The American offshore wind industry closed 2022 strong despite impending challenges and economic uncertainty. (Courtesy: Business Network for Offshore Wind)

only been amplified. With two U.S. commercial-scale offshore wind projects poised to begin operation and a slew of others slated for approval, this new year is a critical moment to double down on coordinated action and

focus our efforts on building a strong domestic supply chain that will continue moving the industry forward.”

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O&M: OPERATIONS ▼ TURBINE MAINTENANCE

AI APPLICATIONS IN WIND-ENERGY SYSTEMS

AI-driven tools for construction optimization can reallocate valuable resources to circumvent spiraling delays. (Courtesy: ALICE Technologies)





Artificial intelligence can help the wind-energy sector address challenges and offer immediate improvements on several fronts.

By DR. RENÉ MORKOS

Artificial intelligence (AI) has been receiving a lot of attention in recent years, and for good reason; this technology has the potential to revolutionize nearly every industry. The renewable-energy sector is no exception. In 2021, the World Economic Forum published a paper discussing how AI could be harnessed to accelerate the transition to renewable energy, covering aspects as diverse as governance, design, and risk management.

Less than two years later, AI use cases are already being employed effectively in many aspects of wind energy production — with promising results.

Wind energy is one of the most efficient and sustainable forms of renewable energy — and currently the fastest-growing source of electricity in the world. However, this swift expansion leaves the wind sector facing significant challenges in terms of efficiency, scaling, and costs.

Artificial intelligence can help the wind-energy sector address these challenges, offering immediate improvements on several fronts. And as the industry matures and advances, exploration of new applications for AI-driven technologies are likely to offer additional pathways for wind-power innovation.

In this article, we'll explore some of the most exciting ways AI-driven tools are being used within the wind-energy sector, why this technology is likely to become even more integral to the industry in the coming years, and how AI technology can keep projects on time and on budget.

WEATHER FORECASTING AND WIND ANALYSIS

Artificial intelligence enables constant, consistent, and near-instantaneous analysis of vast amounts of environmental data — empowering accurate prediction and real-time adjustment to current weather and wind conditions. This leads to improved planning and operational efficiency, eliminates unnecessary shutdowns due to weather or environmental hazards, and reduces equipment malfunction and damage caused by atmospheric conditions.

MAINTENANCE OPTIMIZATION

Some wind-energy providers are already using AI to predict maintenance needs and optimize turbine performance. By monitoring wind conditions and cross-referencing environmental data with records of past maintenance, AI can identify patterns that may indicate a need for future maintenance



AI holds great promise for reducing the cost of constructing wind-energy systems and wind farms, helping get projects back on track and keeping them there. (Courtesy: ALICE Technologies)

or repair. This information can then be used to create an optimized schedule, identifying exactly when (and how often) maintenance should be performed.

TURBINE MONITORING AND INSPECTION

Inspection of wind turbines is a critical task to ensure their safe and efficient operation. AI-driven tools can be used to monitor the performance of turbines in real-time, as well as to automate turbine inspection. When combined with powerful computer vision or cutting-edge robotics, these tools often reveal defects that are easily overlooked by human inspectors, identifying potential problems while providing powerful insights that boost operational efficiency.

AI-driven tools not only enhance the safety of turbine operations, but their use also mitigates exposure to risks caused by failed equipment — avoiding costly downtime, while ensuring that turbines are operating at peak efficiency.

WIND SYSTEMS PRODUCTION OPTIMIZATION

Because generation of electricity from wind power is intermittent, increased integration of wind systems into existing power grids poses challenges to flexibility, safety, and stability of current power systems. Large-scale expansion of wind-power generation hinges on optimized control and operation of wind turbines and power systems — which, in turn, hinges on crucially accurate analysis and forecasting of weather, wind speed, and their subsequent effects on wind power generation.

As use of renewable power continues to evolve and expand (both in literal terms, and as a share of the global power supply), more accurate predictions for solar and wind power generation become ever more critical for forecasting power demand, improving production uptime, and boosting energy system and storage capacities.

WIND-POWER USE FORECASTING AND SCHEDULING

AI definitely has a role to play in effective energy dispatch and usage scheduling. Demand forecasting is a complex endeavor; when poorly executed, it can trigger power blackouts, brownout scheduling, and/or result in renewable curtailment.

AI is good at detecting complex usage patterns and flagging potential concerns. Through analysis of historic consumption and usage data, today's machine learning tools can also predict consumer demand at both the individual and aggregate level.

According to recent studies, artificial intelligence accurately predicts wind-power generation, energy production, and power and usage demand, enabling smart grids to store and transmit power more safely, efficiently, and sustainably. Improved accuracy of forecasting models supported by artificial intelligence and machine learning tools empowers operators to methodically balance supply and demand on the electricity grid — significantly reducing the cost of renewable energy provision.

REMOTE AND OFFSHORE OPERATIONS

Offshore wind farms are an important source of renewable energy, and their efficient operation is critical for reaching global climate goals. AI can play a key role in remote monitoring of both onshore and offshore wind farms, ensuring that hard-to-access locations are running smoothly.

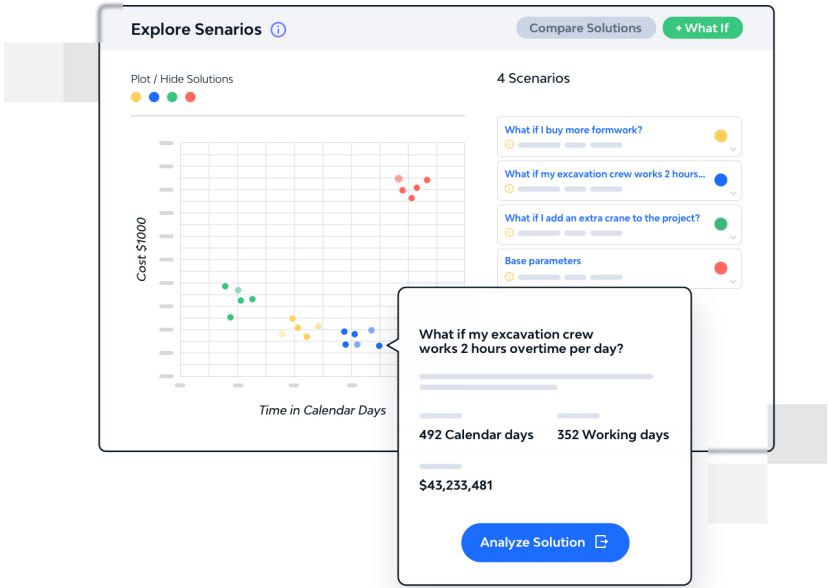
When leveraged for the purposes described above, AI reduces the need for onsite monitoring or staffing for remote locations – significantly reducing the cost of operation for offshore wind farms. Improved logistic and production efficiency further maximizes site output, increases profit margins for offshore wind production, and improves site monitoring logistics and operational feasibility – qualities critical to continued growth and sustainability of global wind energy adoption.

One of the less-considered ways in which AI can benefit the wind-energy sector is in the process of scaling physical growth.

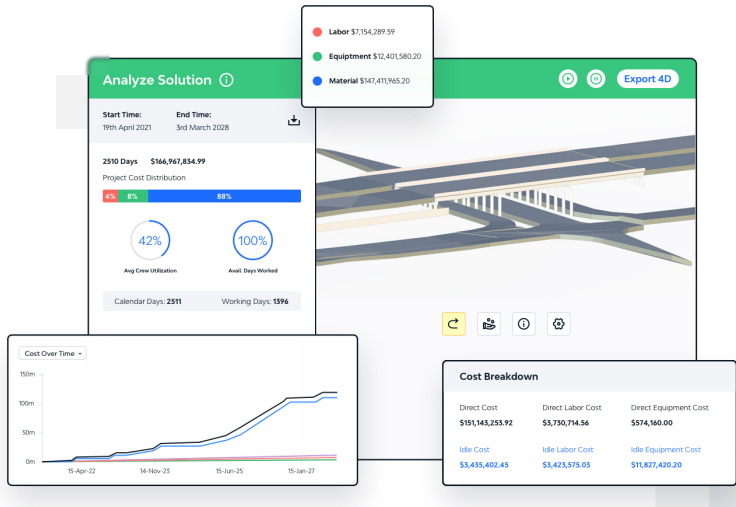
The cost of constructing wind-energy systems and wind farms has been a major historic barrier to the widespread adoption of renewable energy. Location and geographic challenges abound – with onshore and offshore sites presenting their own sets of logistical hurdles and variations. The approach to installation of building-integrated wind turbines deviates drastically from best practices for installation of free-standing turbines – and each project also arrives with a host of construction and engineering complexities unique to its specific structure and site location.

Add to all of this the need for intense spatial and physics calculations, environmental and aesthetic analysis, use and installation of specialized equipment, and the unique governmental and regulatory considerations that accompany the construction of large-scale utility infrastructures – and the complexities involved in construction of wind-energy systems begin to add up to their accompanying cost.

The powerful processing capabilities of artificial intelligence make it possible to address these complexities quickly and efficiently – while minimizing project expenses, across several cost silos.



By using AI tools like ALICE Technologies for project recovery and construction optimization, wind-energy providers can eliminate delays, minimize build cost, and improve project time-to-



In the wind-energy sector specifically, AI presents more efficient methods for optimization of design, construction, and installation of wind-turbine systems. (Courtesy: ALICE Technologies)

SITE SELECTION AND ENVIRONMENTAL ANALYSIS

Turbine placement and siting of wind-harvesting farms have a major impact on the generation and storage capacity of these renewable power systems. Because of its innate ability to assess and analyze massive amounts of relevant geographical and environmental data, many companies are already leveraging AI to identify sites with the most

favorable wind resources and conditions — as well as to secure land and spaces with the best access to existing grid infrastructure, for future development.

GENERATIVE DESIGN AND PRECONSTRUCTION PLANNING

AI-driven iterative and 4D design can help providers innovate, generating detailed construction plans, schedules, and “digital twin” site models and equipment designs — all tailored to site-specific conditions and restrictions — before ever breaking ground.

Virtual models of proposed wind farms can be used to identify potential issues and optimize turbine layout and efficiencies in the pre-construction phase. This saves time and money, eliminating potential delays and costly adjustments to the project plan and scope of work. AI-driven planning also reduces the need for on-site customization and adjustment, post-construction — at a drastic reduction in cost.

WIND SYSTEMS CONSTRUCTION OPTIMIZATION

Recent advances in artificial intelligence have introduced solutions that can reduce the cost of major infrastructure construction significantly; for many large-scale and complex projects, by as much as 30 percent.

In the wind-energy sector specifically, AI presents more efficient methods for optimization of design, construction, and installation of wind-turbine systems. For example, GE recently announced their use of AI-based tools to analyze installation logistics resulted in a 10 percent reduction of expenses for wind turbine installation — a global cost savings totaling a potential \$25 billion over the next 10 years.

PROJECT BUILD AND INSTALLATION RECOVERY

When construction of wind-energy infrastructure or turbine installation goes sideways, resulting delays can cost millions of dollars per day. AI-driven tools for construction optimization can reallocate valuable resources to circumvent spiraling delays — suggesting options for task, equipment, or labor resequencing that keep a major project moving forward. With so much at stake, and so many moving parts, maintaining progression is critical — making on-the-go scheduling adjustments and speedy project recovery backed by AI an invaluable asset.

By using AI tools like ALICE Technologies for project recovery and construction optimization, wind-energy providers can eliminate delays, minimize build cost, and improve project time-to-completion when the unforeseen occurs. They’ll also boost overall performance throughout the entire project lifecycle — maximizing wind-energy output, while minimizing operational expense and risk.

To succeed at the global goal of achieving net-zero by 2050, the renewable energy sector needs to eliminate emissions completely. Bloomberg NEF’s New Energy Outlook 2020 emphasized that by 2050, solar and wind could provide 56 percent of global power — with wind clocking a massive 4.6 TW. PNAS determined wind could feasibly provide 5.75



TW — a whopping half of the world’s all-purpose power — in a 2030 clean-energy scenario. These scenarios are possible under regulatory policies and guidance currently in play — with no further policy support. This is a solid testament to the fact that the economics of renewable energy storage and systems have evolved to be significant drivers of global power sustainability and decarbonization efforts — even without robust carbon pricing or unified net-zero targets.

Overall, AI holds great promise for reducing the cost of constructing wind-energy systems and wind farms, helping get projects back on track and keeping them there, and supporting the industry as it expands its global reach in sustainable energy production. As these technologies continue to develop, additional innovation can be expected — introducing further improvements beneficial to the wind-energy sector, and its continued evolution toward a sustainable future. ↘

ABOUT THE AUTHOR

Dr. René Morkos is an adjunct professor at Stanford University and CEO of ALICE Technologies. Inventor of the world’s first Generative Construction Simulator and Optimizer, Morkos obtained his Ph.D. in artificial intelligence for construction as a Charles H. Leavell Fellow at Stanford University, where he teaches in the Civil and Environmental Engineering department. He is a second-generation civil engineer, with more than 23 years of experience in construction. He has worked as a project manager on reconstruction efforts in Afghanistan, automation of a \$350 million gas refinery expansion in Abu Dhabi, construction of an underwater pipeline, implementation of ERP systems, and various virtual design and construction projects. Morkos founded ALICE technologies in 2015; its mission is to improve standards of living by reducing the cost of construction and infrastructure development by at least 25 percent worldwide.

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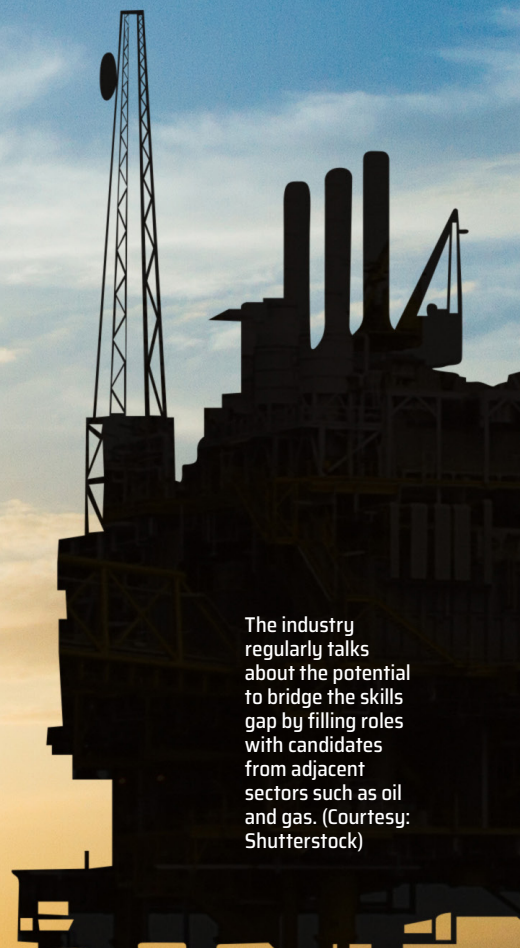
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HOW TO REFRESH OFFSHORE WIND'S HIRING STRATEGY TO AVOID PROJECT DELAYS



The industry regularly talks about the potential to bridge the skills gap by filling roles with candidates from adjacent sectors such as oil and gas. (Courtesy: Shutterstock)

Across the renewables industry, creating an ample pipeline of talent remains a work in progress, with the pressure set to increase as markets grow in line with global ambitions.

By JORDAN MASON

Historically, offshore wind developers have relied nearly entirely on exporting expertise from Europe to fill open vacancies in developing markets. But exponential growth expected from emerging markets such as North America, Taiwan, and Japan will put a squeeze on talent.

Last year, the Global Wind Energy Council estimated 3.3 million direct offshore wind energy supply chain jobs could be created by 2025 based on its annual growth estimates. Indeed, the U.K.'s wind industry has grown a staggering 16 percent year on year, and is set to employ more than 97,000 people by 2030. Similarly, North America's recent target to install 30 GW by 2030 is expected to create nearly 80,000 jobs.

Although competitive salaries, attractive benefits packages, and well-defined career prospects will attract candidates to the sector, this can only go so far. Rather, a refreshed talent strategy is required to ensure projects are not unduly delayed by a shortage of skills. What that strategy looks like will ultimately vary by geography; however, there are several universal considerations to be made.

THE GEOGRAPHICS OF RECRUITMENT NEED A SHAKE-UP

If the global pandemic taught us anything, it is that many jobs do not need to be executed in a specific location all the time, and we need to upskill local candidates to serve in emerging markets.

Most workers have an interest in relocating, often allured by the idea of an accelerated career path. However, for many, the practicalities of family life and the usual visa implications create a challenge in turning this aspiration into actuality. If we remove the obstacles of location and time zones, many more candidates for niche roles suddenly become available. Rather than requiring complete relocation, candidates could be given the option of the same role with occasional international travel.

A further consideration is keeping recruitment trends in mind. Year after year, Airswift's Global Energy Talent Index (GETI) finds that Europe is the preferred destination for relocation within the renewables sector. Instead of basing a role on location, companies may find it easier to advertise the role as being based in Europe and provide assistance to relocate global candidates.

Although European fabrication will continue to be a major export, emerging markets, particularly those in Asia, are increasingly establishing their own supply chains and recruitment needs. The global pandemic gave us a glimpse

of what life will be like if we do not source more of the workforce locally to meet those needs — in short, this picture is full of project delays. Successful recruitment of client representatives and quality control roles from competent local content will be vital for ensuring high-quality fabrication from hotspots such as China, Taiwan, and Korea.

Similarly, as offshore wind's footprint expands globally, it is essential that companies upskill local workforces to ensure global standards for safety and quality are adhered to without the need to import this expertise from elsewhere. Creating a heightened safety culture is a substantial undertaking that will need careful and consistent implementation over a long period of time.

THE TECHNOLOGY SECTOR IS A PEER

There is an increasing overlap in skills between the renewables and technology sectors. Expertise in SCADA systems, cyber security, and IT are all highly sought after by offshore wind. As such, the technology sector is a peer and a rival for talent from which the renewables sector often faces stiff competition.

While remuneration and benefits packages are becoming more comparable, one major selling point of the renewables sector is typical contract lengths. Most offshore wind projects take several years to design, build, and commission, which presents the opportunity for contractors to work on one project and with one team for an extended period. This not only offers job security, but also a depth of experience that is not so readily achieved if working on several shorter projects.

BEING OPEN TO DIFFERENT EDUCATION AND EXPERIENCE

It remains quite common to see highly competent candidates sifted out of the interview pile because they do not meet specific education or experience requirements considered essential to the role. And the same happens in reverse, too — well-qualified candidates are put off applying because they don't have a master's degree in renewable energy or sustainable engineering, for example, despite having worked in the sector for the best part of a decade.

The industry regularly talks about the potential to bridge the skills gap by filling roles with candidates from adjacent sectors such as technology, oil and gas, and power, but we won't be able to make this happen at scale if we don't become more open minded about the backgrounds of candidates that we interview. Every job description should be thorough to ensure everything that is labeled essential



There is an increasing overlap in skills between the renewables and technology sectors. (Courtesy: Shutterstock)

is indeed essential and could not possibly be achieved any other way.

OFFER CERTIFICATION AND TRAINING TO SUITABLE CANDIDATES

Many candidates from adjacent sectors have a wealth of complementary skills that would make them an ideal fit for offshore wind but naturally do not have the right Global Wind Organization (GWO) certificates to do so. The package cost for all five mandatory safety courses is more than a thousand pounds, which is prohibitive to some would-be applicants.

Industry initiatives that ease the burden of certification on the worker are welcomed. For example, GWO's Safety Training Access program allows qualifying workers with existing certification to follow a fast-track route rather than undertake the full mandatory training. However, offering certification as part of all appropriate recruitment drives, and particularly for positions that are renumarated via payroll, would significantly boost the number of potential candidates applying.

Structural engineering roles are another good example. The principles for designing an oil and gas jacket foundation are not all that dissimilar to those for an offshore substation or wind-turbine generator (WTG) for an offshore wind project. Recruits may need support with learning new software or adhering to specific industry or geographic standards, but at the core, structural engineering is still structural engineering.

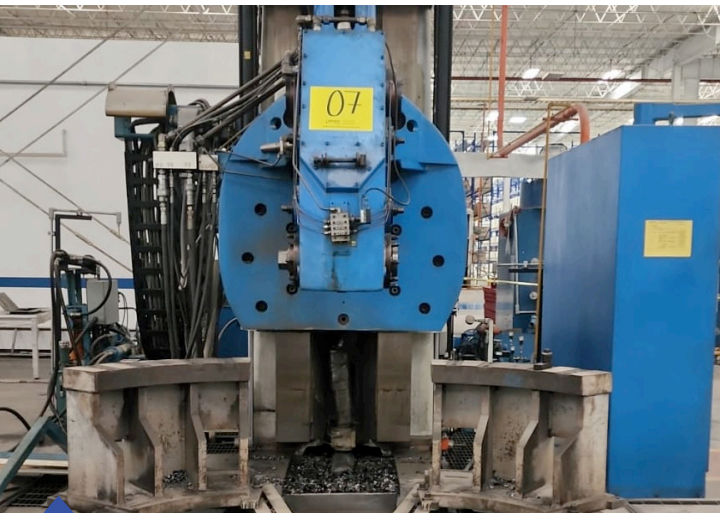


As offshore wind's footprint expands globally, it is essential that companies upskill local workforces to ensure global standards for safety and quality are adhered to. (Courtesy: Shutterstock)

Across the renewables industry, creating an ample pipeline of talent remains a work in progress, with the pressure set to increase as markets grow in line with global ambitions. Hiring managers will need to push on every open door to attract candidates into the sector and evolve their hiring strategies to support efforts to do so. ↗

ABOUT THE AUTHOR

Jordan Mason is the contract recruitment manager for Airswift.



Gould & Eberhardt 160G CNC Gashing Machine



Gleason Pfafter P1200G CNC Gear Grinder



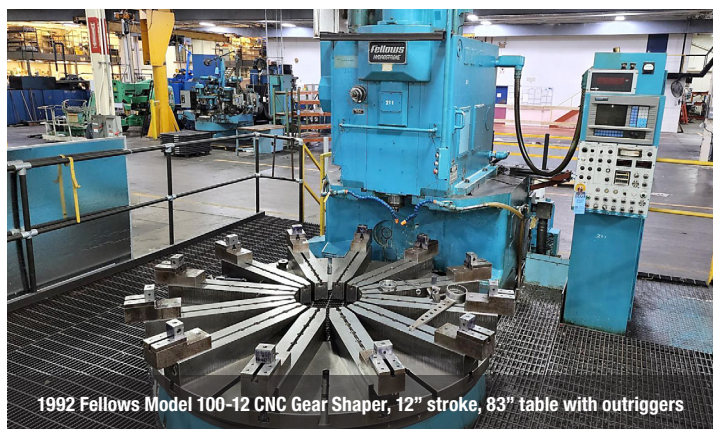
Fellows Model 10-4 CNC 3 axis Gear Shaper w/ Fanuc Controls



1999 Gleason Pfafter Model P400G CNC Gear Grinder 400mm diameter capacity



2010 Gould & Eberhardt Model 120-GH 3 Axis CNC Gashing Machine, 150" Diameter



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



Klingelberg PFSU 1200 Gear Tester with new software/charting



Gould & Eberhardt Model 96G CNC Gear Gashing machine



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

TURBINE MAINTENANCE

WIND-TURBINE FIRE RISK: THE TIME TO ACT IS NOW



Figures on the likelihood of a wind-turbine fire range between 1 in 2,000 to 1 in 7,000 turbines. (Courtesy: Firetrace)

Industry attitude toward managing avoidable problems such as fire damage lacks rigor, but the time to change this attitude is now, on the eve of historic development in the wind sector.

By ROSS PAZNOKAS

Wind turbine fires are relatively rare. But when turbines do catch fire, the ensuing spectacle of rotating flames and falling debris is impossible to ignore.

Less transparent, though, is industry-wide data on details such as how many turbines burn down and the full cost of damages when they do. Most often, these facts are known only to insurers and project owner-operators.

The recent fire to a Vestas V90 2MW turbine at Galgenberg wind farm in southwestern Germany -- for which, in the absence of lightning, investigators have so far struggled to identify the cause -- brings the wind sector's lax attitude to controllable risks under the microscope once again.

As this and other recent incidents have shown, once a turbine catches fire, there is little authorities can do but try to secure the area from flaming debris and monitor the flames as they burn themselves out.

Again, this is not an isolated occurrence. Mere days later, a Senvion turbine caught fire at Cullerin Range wind farm in New South Wales with investigations yet to understand the cause. And in late October 2022, a Vestas V110-2.0 turbine caught fire at Diamond Trail wind farm in Iowa County. In this instance, the flames spread to the field below, and several other turbines had to be taken offline for additional inspections to assess the fire risks, which lead to further disruption and lost revenue.

The question that will increasingly be asked of the wind industry, as it continues to grow, is what measures are being taken to avoid preventable losses like these?

While it is true that learning the specific cause of a turbine fire can prove difficult, expensive, and time consuming, understanding how these assets can be protected from this risk, and acting upon this knowledge, is not.

WHO IS TAKING RESPONSIBILITY?

The key obstacle to mitigating avoidable risks is the assumption that responsibility falls elsewhere in the supply chain.

The time and financial constraints pressing developers are such that to install fire suppression technology at the manufacturing stage is not a priority, even though it is available. Additionally, project owner-operators tend to assume fire risk has been "designed out." Experience shows this is not the case; it has merely been passed on to the owner-operators who need to retrofit the appropriate technology to protect their assets.

With owner-operators deferring responsibility of fire-risk management to developers, and vice versa, it is too often the case that risks are not managed at all. The result is an implicit attitude that the insurer will shoulder the costs if a fire indeed occurs. While more insurance capital is flowing into the market, the market is also hardening in

response to increased losses. Thus, owner-operators who are seen to be passing the tab onto insurers are at the mercy of underwriters increasing premiums accordingly.

Not only that, but the more the insured lean on insurance to pick up their risks, the greater the possibility that insurers will move to increase deductibles and remove coverage for lost revenue during periods of downtime in order to re-balance underestimated renewable energy risk portfolios. Since the average downtime after a wind-turbine fire is approximately 12-18 months, this could reach up to \$1 million per affected turbine.

Legislation also has a role to play in ensuring wind energy assets are adequately protected from fire. At present, there is very little standard legislation that mandates fire-safety precautions specifically for the wind sector.

In places such as Ontario, Canada, where some policies exist to enforce the use of vetted risk protection technologies, this is very much the exception rather than the rule. It is far more often the case that fire-safety features, though recommended, are left to the discretion of the owner-operator. Given that this comes at a cost, albeit less than the rounding error in renewable project budgets, the odds are increasingly stacked against the necessary management of fire risk.

All things considered, the lack of collective responsibility taken by key stakeholders in the wind sector to implement the requisite safety features is concerning, particularly ahead of an expected period of expansive growth.

HOW CAN OWNER-OPERATORS TAKE RESPONSIBILITY?

Project owner-operators can play a pivotal role in changing the way in which the industry approaches fire risk management both in existing assets and in future assets.

In the case of the Vestas V90 turbine, the wind-farm operator, Windpark Saar, speculates that an issue with the braking system may have caused the fire. This, and other failures, are unexpected in a model that is only 7 years old. This incident serves as an example of how unpredictable problems can lead to catastrophic fire damage and demonstrates how this risk can only be effectively managed by the installation of a clean-agent fire-suppression technology.

Regardless of age, wind turbines are high-voltage machines that produce a lot of heat and are subjected to harsh weather conditions. Degradation and maintenance needs are to be expected. High-voltage cabinets, transformer rooms, brake and slip rings are all routinely checked for signs of wear, but not all of these parts are protected from fire risk even though they can be easily equipped with the technology.



As it stands, fire-suppression systems are nearly always retrofitted after a fire incident, rather than proactively ahead of an event. (Courtesy: Firetrace)

Currently, the industry focus is on building bigger wind turbines with more capacity – the most recent being a colossal 18 MW wind turbine released in China. However, even as the designs of new turbines increasingly upgrade the power production of the asset, there is no reason for owner-operators to believe their models will be equipped to mitigate risks such as fire. In fact, the only way they can be assured of this with new assets is by requesting that designers incorporate the relevant safety features and factor that into their expenditure.

Precise figures on the likelihood of wind-turbine fire range between 1 in 2,000 to 1 in 7,000 turbines depending on who you ask, but the salient point is this threat exists and affects turbines every year.

As it stands, fire-suppression systems are nearly always retrofitted after a fire incident, rather than proactively ahead of an event. Considering the cost of the lost asset, loss of revenue due to downtime, and the insurance increase per turbine after a fire event, this is equivalent to shutting the stable door after the horse has bolted. And this is before considering the impact of reputational damage and disruption to day-to-day business operations.

And so, the proactive installation of fire-suppression technology, either at the manufacturing stage or as fleet retrofit projects, represents a proactive and cost-effective

way for owner-operators to manage their risks and protect themselves against significant potential losses.

WHICH OTHER INDUSTRY STAKEHOLDERS CAN HELP DRIVE CHANGE?

The loss of an asset to fire has direct implications for insurers. It isn't just the potential \$9 million claim for cleaning up and replacing a damaged turbine, but the business interruption and lost revenue on top of that, which could amount to as much as \$2,000 a day.

According to data from GCube, a leading underwriter for renewable projects, insurers have seen a 38 percent increase in business interruption claims since 2016. As the price of premiums rise in response to this, there is a concern that this does more to consolidate, rather than deter, the attitude that the bill for fire damage can just be passed onto the insurer.

A possible middle-ground here would be for insurers to incentivize the retrofitting, or “opt-in” at the manufacturing stage, of fire-suppression systems with decreased premiums or lower deductibles for the project owner-operator to reduce the volume of annual claims related to fire.

With proven and bankable clean-agent fire detection and suppression solutions available in the market, it makes sense for insurers to encourage the insured to take up the

option to protect themselves against the worst-case scenario. This is already the case in more mature industries open to fire risk, such as manufacturing and machining, where insurers are offering discounts when sufficient risk-protection technology is proven to be in place.

HOW GOVERNMENTS CAN TAKE RESPONSIBILITY

Government policy can play a powerful role in a unified industry approach to managing fire risk, too.

In a moment where wind projects are being deployed at a historic rate around the world to meet net-zero targets, governing bodies can ill-afford the reputational damage that comes with wind-turbine fires.

In spite of this, across much of North America, there is no mandate for even so much as a fire-risk assessment for wind-farm owner-operators, let alone fire-suppression systems. And though countries in Europe, such as Germany, have brought in such mandates in recent years, the stipulations of that legislation still leave room for owner-operators to interpret the risks and make their own decisions — as opposed to having legislation that directly dictates the behaviors and actions needed to protect the lives and livelihoods of the technicians and the community.

The wind sector in the U.S. has yet to introduce strict regulation, and it currently abides by the National Fire Protection Association 850 code that applies to all forms of power generation. This offers a set of recommendations but no requirements. As the sector primarily operates on a utility scale, it will only be a matter of time before strong, uniform guidelines surrounding fire risk are required.

What are the consequences of failing to change the industry's current attitude to fire risk?

According to the research of the International Association for Fire Safety Science (IAFSS), there is stubborn reticence to report wind-turbine fires. Going back to the years between 2006-2010, both The Telegraph and Renewable UK estimated a total of 1,500 wind-turbine fires. This, in contrast to the Caithness Windfarm Information Forum (CWIF) statistic of 142 reported cases in the same period, indicates that roughly 90 percent of cases go unreported.

Not only is this approach unsustainable as more wind projects are commissioned, but it also prevents the industry from understanding the true level of risk fire represents and, as a result of this lack of knowledge, from building the necessary best practice in response.

To ensure we make the most of this period of growth, the wind industry must now demonstrate its sustained



Government policy can play a powerful role in a unified industry approach to managing fire risk. (Courtesy: Firetrace)

commitment to safety. Failure to proactively protect against controllable risks like fire could set us back with the following issues:

- ▀ Unsafe work environments for on-site personnel.
- ▀ Unnecessary loss of assets to fire – the cost of which is often underestimated.
- ▀ Additional strain on already stretched supply chain.
- ▀ Increased insurance claims, leading to increased premiums, decreased coverages, and/or insurers leaving the renewables market.
- ▀ Increased risk of wildfires in surrounding areas.
- ▀ Reputational loss and public criticism of the industry.

What is essential now is that the sector works collectively to own these risks, rather than assuming someone else will take responsibility. Ultimately, project owner-operators need to take the lead and invest in clean-agent fire detection and suppression systems, but, equally, it is incumbent on the other stakeholders to encourage this best practice with incentives and policies.

If all parties work together, the risk of wind-turbine fires and their numerous safety, financial, environment, and reputational consequences will be drastically reduced — if not eliminated. ✎

ABOUT THE AUTHOR

Ross Paznokas is the Global Business Development Manager-Clean Energy for Firetrace International, a global organization supporting renewable energy with suppression systems custom built for each client's unique application. More info: www.firetrace.com.



PROFILE

ARCVERA RENEWABLES

FOUR DECADES OF EXCELLENCE IN RENEWABLE ENERGY PROJECTS

ArcVera Renewables executed the technical analysis for the Leeward Renewable Energy 60.9-MW Crescent Ridge Wind project in Tiskilwa, Illinois, a full-scale wind farm repowering that required the removal of the entire existing wind turbine, including the supporting tower structure. (Courtesy: ArcVera Renewables)

ArcVera Renewables contributes to the world's renewable energy future by guiding its clients to successful project development and operational outcomes while accelerating the deployment of wind, solar, and storage facilities globally.

By KENNETH CARTER ▀ Wind Systems editor

Keeping a wind farm up and running is a monumental task made up of a myriad of smaller — but by no means less important — tasks. The same is true for solar, battery, green hydrogen or hybrid renewable facilities.

ArcVera Renewables keeps a handle on many of those tasks with experience and expertise that runs deep.

“If you think of anything technical, we probably do it,” said John Bosche, president and principal mechanical engineer at ArcVera.

Developers, owner-operators, and sometimes turbine vendors make up the bulk of ArcVera's client base. The company's expertise is applied to all manner of renewable energy projects globally, and covers from inception — prospecting — through development, financing, and operations.

RESOURCE ASSESSMENT

For wind energy, ArcVera is mostly known for its meteorological and energy resource assessment speed, fidelity, and accuracy, according to Bosche.

“That's kind of our bread and butter,” he said. “But we're also involved on the engineering side of things. We do a lot of independent engineering associated with project finance, including technology risk analysis. We do due diligence related to mergers and acquisitions or just the sale of a project. Part of that is we do a lot of wind-turbine technical due diligence design review.”

Other tasks that ArcVera performs involve failure analysis as part of a warranty or insurance claim, according to Bosche.

“Sometimes we even engage as an expert witness in an arbitration, when those come up,” he said.

POWER PERFORMANCE TESTING

Another major aspect of ArcVera's expertise is power performance testing, according to Bosche, which the company has been doing since 2001.

“We have a deep bench and a lot of knowledge when it comes to power performance testing,” he said.

Most of ArcVera's power performance testing still involves legacy techniques with met masts, though the company is seeing an increase in testing with Lidar as well; Lidar was recently approved as a viable option for wind measurement.

“Lidar can save a good bit of money, and it can make things easier for sure,” he said. “For sure, it's an emerging trend. And, even newer, is doing tests with the nacelle Lidar. I was on the standards committee that wrote the standard for how to take wind measurements using the nacelle Lidar.”

An interesting aspect of wind energy is that the technical methods used can often come full circle with innovative advancements, according to Bosche.

“Everything old becomes new again,” he said. “Another topic I worked on with the standard committee 10 or 15 years ago was doing a test using the nacelle anemometer. That kind of fell out a favor for a lot of years, but now we're seeing renewed interest in doing nacelle anemometer testing.”

Even with its involvement on the technical side of things on a wind farm, ArcVera also has experience in repowering wind farms, as well as decommissioning them, according to Bosche.

“We have a financial analyst, so we do financial analysis that often goes together with the due diligence or project optimization work we do, such as with hybrid renewables projects; however, we're not attorneys; we're not accountants; we're not involved in that part of the commercial side of the industry,” he said.

DEEP ROOTS

ArcVera has been a company since 2017, but its roots go back to near the very infancy of commercialized wind energy in 1979, which means the expertise that makes up ArcVera spans decades, according to Bosche.

“The vast majority of people on our staff have at least 10 years of experience, and many of us have 30 or more years of experience,” he said. “But generally, with a few exceptions, the vast majority of our staff have more than 10 years of experience, and they are senior, recognizable people in the industry. This experience leads to insights that many cannot otherwise benefit from.”

ArcVera then takes that expertise and meshes it with its clients' needs, according to Bosche.

“We are responsive to deadlines — we always meet deadlines that we commit to,” he said. “And we are flexible. If a client wants something that's not quite part of the standard analysis, the answer is always yes. We'll do what they need. We are very attentive to client needs, and that goes along with that very senior scientific knowledge.”

Bosche also points out that even though ArcVera's beginnings are in the U.S., the company very much has an international presence.

“Our roots are in the U.S. and it's definitely still where most of our work is, but we have offices now formally formed in Brazil, South Africa, and India,” he said. “And from there, we do work elsewhere in South America from the Brazil office, elsewhere in Africa from the South Africa office, and elsewhere in Asia Pacific from the India office.”



The 54-MW Ventus Wind project — El Salvador's first constructed wind project. Located in Metapan, El Salvador, the project was developed by Tracia Networks and commissioned in July 2021. ArcVera has extensive experience in Latin America and supported the Ventus project with its technical services expertise from prospecting through development and financing. ArcVera Renewables engages its technical know-how internationally, with established offices in São Paulo, Brazil; Bangalore, India; and Cape Town, South Africa. (Courtesy: ArcVera Renewables)

The Brazil office has been around for over a decade, and it is a significant portion of our overall business at the company. The South Africa and India offices are newer and they're growing quickly. We are dedicated to the global success of the renewables business."

EVOLVING WITH THE INDUSTRY

ArcVera and the companies that make up its history have definitely come a long way from the beginnings of the industry, according to Bosche.

"At the very beginning, people literally were measuring the wind using kites," he said. "And analysis was done with pencil and paper or spreadsheets at best. We've had to adapt and evolve, and we've actually tried to be thought leaders and lead the way as methods advanced to better ways of measuring the wind, better ways of analyzing it with better computer models."

For wind flow modeling, for example, ArcVera doesn't use linear models or CFD models that don't properly account for atmospheric stability, according to Bosche.

"You can kind of trick them into accounting for atmospheric stability, but we use a full physics atmospheric model called WRF, and it is far and away the most accurate way of modeling wind flow across the wind site."

And although other companies use WRF or run meso-scale models that account for atmospheric stability, ArcVera runs it at a much higher resolution, according to Bosche.

► We are flexible. If a client wants something that's not quite part of the standard analysis, the answer is always yes. We'll do what they need. We are very attentive to client needs, and that goes along with that very senior scientific knowledge. ►

"We run it at a 200-meter resolution or better, which is kind of comparable to the scale of an actual wind turbine," he said. "With that resolution, you can really see the variation of wind across the site at the relevant scale of the optimization of wind turbine placement."

The result of that increased resolution means specific modeling points are included and captured in the model, where in, for example, a more common resolution of 1 to 1.5 kilometers may miss certain topographical features that could essentially interfere with a wind farm's energy production, according to Bosche.

"We feel like we really are industry-leading when it comes

to wind flow modeling and other types of analysis,” he said.

ArcVera has also been researching wake modeling, with Bosche saying the company has done some cutting-edge research to show that wakes persist much longer and much farther than legacy wake models have suggested in the past, especially with offshore wind.

And the same can be said with ArcVera’s goal to stay current along the engineering side of the wind industry, according to Bosche.

“As I mentioned, I’m on the IEC committee that writes the standards for how to do power curve testing, and I’m regularly meeting with the world’s best experts on power curve testing and staying current with cutting-edge technology, whether it’s nacelle Lidar, ground-mounted Lidar, etc.,” he said. “We are staying current with technology and even leading the industry to develop that new technology.”

CUSTOMER NEEDS

Staying on top of that technology also goes hand-in-hand with staying flexible with customers’ needs, no matter if those needs involve a common task or something unique to the client, according to Bosche.

“Sometimes there are recurring tasks; if somebody wants a bankable wind resource assessment, and it’s in flat terrain in Kansas, it’s kind of turn the crank but we can usually find something unique to address — we’ve done that a hundred times before, and we can do it again,” he said. “But often, the requests are much more complicated than that — maybe they don’t have very much wind data collected on site yet, the terrain and meteorology are complex, or maybe it’s a site with some unusual ice conditions or something like that. We always strive to do what the client needs and not just try to fit their project into a box of a standard product that we have available. We start with the custom needs of the client. If there’s something off the shelf or standard that can work for them, great. But we don’t ever make that assumption at the beginning of our project.”

OFFSHORE DEVELOPMENT

And as more offshore wind projects grow off the U.S coast, Bosche said ArcVera is making waves in that development as well.

“We have a dedicated business development person for offshore,” he said. “We have engineers with offshore experience; we have meteorologists with offshore experience. We’ve tailored all of our meteorological modeling to be relevant for offshore. I mentioned the nacelle Lidar power curve



ArcVera’s CEO and Principal Atmospheric Scientist, Gregory Poulos, at a wind-farm construction in progress. The ArcVera technical leadership team prefers to engage directly in work in progress, traveling to project sites as the technical scope of work requires. (Courtesy: ArcVera Renewables)

testing that we’ve been involved with. That’s the appropriate way to do a power curve test offshore, so we’re fully set up and ready to go for doing power curve testing offshore. We have the pieces in place. We have actually worked on quite a few offshore projects already, and it’s growing quickly.”

And with those developments, Bosche said he predicts a very bright future for ArcVera in not just wind, but all across the renewables sector, solar, storage, and green hydrogen.

“At least for the next 10, 20 years, we anticipate being very busy,” he said. “Our goal is to — and it’s written into our culture statement — use our brains to help our clients accelerate the deployment of renewable energy globally. That’s our intention always.”

From a consulting firm perspective, Bosche said he has seen competitors get acquired by multinational consulting firms, while ArcVera has continued to stay modest in size, which has been essential to ArcVera’s success.

“We continued to stay nimble while they were growing and being acquired and consolidating, and that was part of why V-Bar and Chinook Wind merged back in 2017, so that we could grow in the face of a consolidating industry,” he said. “It allows us to do more R&D. That R&D is absolutely critical to innovation and making our customers more successful. We spend a significant fraction of our annual revenue on R&D to stay at the forefront of the industry, and we’ve been able to do that because of scale. And we think it makes an interesting place for us in the industry as a really 100 percent, renewables-focused, independent consulting firm, but with the scale to have an international presence and to do good R&D.”

MORE INFO arcvera.com

Brent Kisling

Executive Director ▀ Oklahoma Department of Commerce



“(In 12 years,) we went from basically zero kilowatts of production to now, depending on how you count it, second or third in the nation in installed wind-energy capacity.”

While most equate Oklahoma with oil and gas, the state is actually a leader within the renewable energy sector in the U.S., with nearly 40 percent of the state’s total electricity generated from renewable resources. Oklahoma also produces 68 percent more energy than it consumes. *Wind Systems* recently talked with Brent Kisling, executive director of the Oklahoma Department of Commerce, about Oklahoma’s renewable energy sector and how its growth has allowed the state to become a national leader in energy production and emissions reduction.

▀ How has Oklahoma’s approach to developing renewable energy differed from other states?

The biggest difference for us is the fact that we have historically been a hydrocarbon mining state. The fact that we have embraced all types of energy the way that we did is a little unique. The other thing that’s a little unique is, Oklahoma does best on recruiting businesses and industries to the state whenever we have a specific focus, and I’ll give you a couple examples: We did this with the aerospace industry probably 10 to 15 years ago, and we created some new incentives. We hired a bunch of staff to focus on it, and now aerospace is our second largest employer — behind energy — in our state.

But we did the same thing with wind energy about 12 years ago — around 2010 or 2011. We created a bunch of amazing incentives, hired a bunch of staff that went to every trade show, and met with every CEO.

We went from basically zero kilowatts of production to now, depending on how you count it, second or third in the nation in installed wind-energy capacity. We do well whenever we focus on it, and we were definitely focused on wind energy.

▀ Nearly 40 percent of Oklahoma electricity comes from renewables. What steps did the state take in order to become a leader in the renewables sector?

It started with the incentives where we identified the production of electricity from wind generation to manufacturing in our state. We were able to do some specific exemptions on property taxes within the state. That helped us be very competitive early on, but the cool part of the story, and again, maybe something that’s unique about Oklahoma, is that we did create all of those 10 or 12 years ago, but none of those incentives exists anymore in Oklahoma. We used to have a whole hallway of staff focused on renewables. We don’t have to have them anymore because now we have an established, mature industry that is just building on itself. We put the infrastructure in first, and now the industry’s following.

▀ How do you think other states can emulate Oklahoma’s examples?

Oklahoma wants to electrify the nation. We produce 68 percent more electricity than we use here, so we already export a lot of that electricity. And with the way it looks like automobile propulsion is heading, the fact that everything in your house nowadays seems to be running off of electricity, I think the two most important things to produce in the country over the next several decades are going to be electricity and food. And we do both of those very, very well.

I want to make sure we continue to be competitive, but also, I know this is about wind energy and about renewables, but we want to maintain our leadership in the mining of hydrocarbons as well. We’re top five in natural gas and top five in crude oil production. We want to maintain that as well. We truly are an all-of-the-above state.

▀ Was it difficult to convince Oklahomans of the advantages of the renewable energy?

I would say early on it was difficult, but that changed fairly rapidly as well. The message that works for Oklahomans on renewables is not necessarily the discussion about climate change or even emission reductions, even though we're one of the leaders in the nation on that. What folks in Oklahoma really understand is that early on, most of these wind farms were built with power purchase agreements. And so you had some of these major corporations that were coming in and doing 15- and 20-year power purchase agreements to take the flexibility of electric pricing out of their proforma. And when you can get a fixed-rate contract or close to a fixed-rate contract for 20 years on your electricity, then you're going to want to move your data center to Oklahoma. You're going to want to move your heavy manufacturing facility to Oklahoma. That was where the convincing really happened.

▀ What effects has your energy growth had on the local environment and the economy?

It's huge for rural Oklahoma and, specifically, for education. In our state, which is true in a lot of states, but for sure in Oklahoma, we fund education through local property taxes. We supplement that in some cases around the state with state-allocated dollars, but for the most part, most of our funding comes from ad valorem taxes. Wind energy, that's their thing, and if you're a school district and you can get a wind farm located in your school district, then you're probably going to get a new gymnasium. You're probably going to get some additional classrooms with better audio/visual capabilities. You're going to have higher paid teachers in that district. So on the taxes side, it was huge for local economies.

But the other part is the landowner payments. Every time one of those turbines is spinning, it's driving more revenue down into that dirt that's going to that local landowner. And the beauty of wind energy is that you can continue to farm that field; you can continue to raise cattle. You continue to have a net income off of that quarter section of land, and you can supplement it with those landowner payments. Those dollars end up going to the local convenience store. They go to the local retail shops. So, for the areas of Oklahoma where wind energy landed, it was revolutionary for them.

▀ Since you don't have the incentives in place anymore, how do you continue to advance that part of renewables in the state?

By being supportive of transmission coming to the state. We are very supportive, and that goes through our Oklahoma corporation commission. They have been very open to allowing for additional transmission to come here, so that we can generate those electrons and then move them to other population centers throughout this part of the United States.

I think one of the biggest things that's going on right now that will benefit Oklahoma's economy are some of these interchange agreements that are happening between the southwest power pool, for sure to the east and the west.

We haven't seen a lot of that with ERCOT to Texas, but we have to the east and the west, and that way we can pump an electron into the grid in Oklahoma and get it to St. Louis, get it to the Tennessee Valley Authority, and maybe you can get that out to the Atlantic and the East Coast. If we can get more of that to the west, as well, and get over the mountains, that really opens up a lot of opportunity for us in the state. I know we have agreements with Alabama Power, so there are some specific states we do, but most of those early power purchase agreements were with Anheuser-Busch and Ford Motor Company and, of course, Facebook and Google and some of those.

▀ Have the net zero goals set by the Biden administration accelerated Oklahoma's push for renewables, or is the state already ahead of the game in comparison?

We feel like we're already ahead of the game, and the fact that Oklahoma never did it with a mandate. We did it with a carrot rather than a whip, and that was very successful for us.

▀ Anything else you'd like to mention that we didn't talk about?

I think two points could be made that relate specifically to wind energy in Oklahoma. You asked about what was unique about our state, and we did a great job of attracting wind-energy generation of electricity. We haven't had a lot of the supply chain that has come in yet. We have the infrastructure in place, the offload facilities. We have an inland port here. We have all of the infrastructure in place to support that supply chain, but we haven't seen a lot of that come to the state yet. That's maybe an important point that we try to make all the time. It's one of our big pushes. The other part of wind energy that relates to the rest of our economy is that there are a lot of companies now that are wanting to reduce their carbon footprint. They want to be able to be secure that they're going to be using renewables for their operations, and unlike other states with that much production, like we do here, we can make that kind of a promise.

And that's why you see some of these battery manufacturers and automobile manufacturers moving here to the state. You see green hydrogen production. We had a huge announcement a couple weeks ago in the southern part of our state, an Australian company named Woodside that's looking to produce green hydrogen, which is going to be renewables, electrolyzing water in order to pull hydrogen.

We're getting a lot of attention for those, and who would've known 10 years ago, when we put together this focus on wind, that that would be one of the unintended consequences, but it certainly has been. And that's why Oklahoma's the 11th fastest growing state in the nation right now. That's why we have a top-10 unemployment rate. We have a lot of those jobs pouring in here, and it's because we focused on the right things 10 years ago. ✨

MORE INFO ▀ www.okcommerce.gov



Codling Wind Park will require almost 30 percent fewer wind turbines than in the original proposal. (Courtesy: Codling Wind Park)

► CONSTRUCTION

Ireland wind project will require 30% fewer turbines

Ireland's largest Phase One offshore wind project, Codling Wind Park, which will be located off the County Wicklow coast, will require almost 30 percent fewer wind turbines than originally proposed. The development will still generate enough renewable electricity to meet more than 20 percent of Ireland's 2030 offshore wind targets.

While the initial estimate for the

number of turbines required had been put at a maximum of 140, the project team said that advances in wind-turbine technology, combined with a more detailed understanding of the wind-farm site, means a maximum of 100 turbines will now be required.

It has also been confirmed by Eir-Grid that Poolbeg in Ringsend will be the location of the project's electricity grid connection with 1,450 MW — enough electricity to power up to 1.2 million Irish homes — confirmed as the maximum amount of electricity it will generate.

Codling Wind Park is a 50/50 joint venture between Fred. Olsen Seawind

and EDF Renewables and will be about 13 to 22 kilometers off the Co. Wicklow coast between Greystones and Wicklow Town.

Feedback gathered from the public as part of a January and February consultation process will feed into the ongoing development of the project, and updated proposals will be presented at a third phase of public consultation later this year.

"We have made significant progress since our first phase of public consultation in March 2021 and we are looking forward to updating people, in Wicklow and Poolbeg in particular, and receiving their thoughts and feedback



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When operational the Siemens Gamesa wind turbines will provide enough green electricity to power around 100,000 homes. (Courtesy: Siemens Gamesa)

on a range of topics, including the design of the project, the Environmental Impact Assessment we are working on, the best way we can deliver benefits to local communities through the Community Benefit Fund over the next 20 years and how best we can continue to engage with the fishing and sailing communities,” said co-project director Scott Sutherland.

When developed, Codling Wind Park will be Ireland’s largest offshore wind farm. The project is expected to create more than 1,000 jobs in the construction phase and 75 new, long-term jobs associated with its proposed operations-and-maintenance base at Wicklow Port.

Subject to all necessary permits and consents being received, Codling Wind Park could begin construction in 2026 and is expected to take two to three years to complete.

MORE INFO codlingwindpark.ie

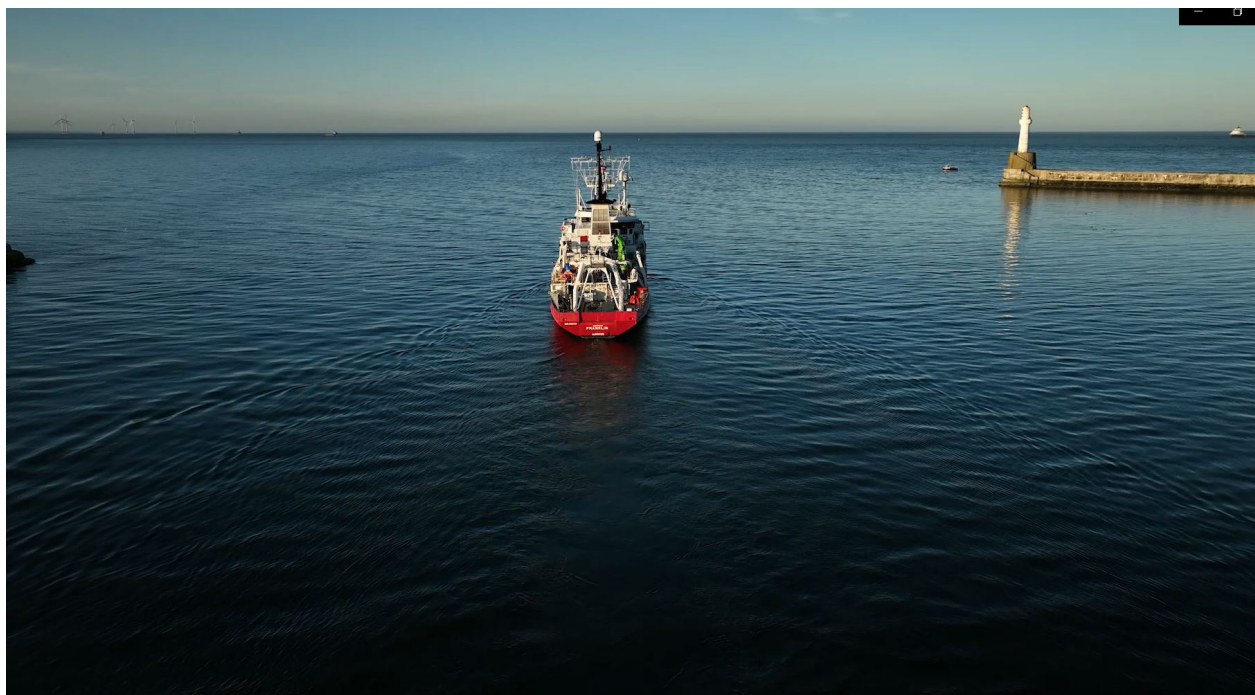
CONSTRUCTION

Siemens Gamesa selected by OX2 for project in Finland

Siemens Gamesa’s SG 6.6-170 wind turbine has been chosen for the OX2’s next project in Finland.

The Niinimäki project will be in the Pieksämäki municipality in the Southern Savonia region of the country and will use 22 SG 6.6-170 turbines, among the most powerful in the on-shore wind landscape. With a hub height of 165 meters, these turbines will capitalize on strong wind speeds found in the region. When operational, these wind turbines will provide enough green electricity to power about 100,000 homes.

The deal follows a 70-MW deal for the Riberget project in Sweden signed with OX2, as the two companies col-



The Salamander project is designed to provide the Scottish supply chain with an early capacity development opportunity. (Courtesy: ERM)

laborate to push wind energy forward in the country.

Once installation is complete, expected in late 2024, Siemens Gamesa will also assume maintenance services for the project over a 35-year period.

“Our collaboration with OX2 continues to grow in the Nordics with another significant deal in Finland,” said Clark MacFarlane, CEO for Siemens Gamesa’s onshore operation in Northern Europe and the Middle East. “The country is truly stepping on the accelerator in its drive to promote wind energy, and we are pleased to provide leading technology to help meet its ambitions.”

According to WindEurope, wind energy accounts for 10 percent of the country’s electricity, and its objective is for that to increase to at least 27 percent by 2025 through both onshore and offshore wind. Finland aims to be carbon neutral by 2035.

This latest deal in the country builds on several others that Siemens Gamesa has collaborated on with partner OX2 since 2016 which total over 700 MW.

The Siemens Gamesa 5.X platform has now sold more than 4.5 GW of sales since its launch, with more than 2 GW coming in this region.

MORE INFO www.siemensgamesa.com

CONSTRUCTION

ERM’s MarineSpace to lead Salamander impact assessment

Salamander, a joint venture between Simply Blue Group, Ørsted, and Subsea7, has selected MarineSpace, an ERM Group company, to lead the environmental impact assessment (EIA) for the floating offshore wind project off northeast Scotland.

As part of the work, engineering consultant NIRAS has been contracted by Salamander to lead the Habitats Regulations Appraisal (HRA), and Brown & May Marine Ltd will provide commercial fisheries support.

The Salamander offshore wind project, 35 kilometers off Peterhead,

will be a contributor in delivering the U.K. government’s target of 5 GW of operational floating offshore wind by 2030.

The project is designed to provide the Scottish supply chain with an early capacity development opportunity, enabling it to play a much greater role in subsequent large-scale floating offshore wind buildout.

“This is another milestone in the development of the project,” said Huw Bell, Salamander project director. “We are working with very experienced companies that are supporting us with our ambitions in creating a project that play a significant role in how the industry delivers floating wind going forward.”

Salamander will deploy floating offshore wind technologies to support the cost reduction and learning journey needed for the commercial deployment of floating offshore wind.

Salamander recently awarded the pre-FEED foundation design to Ocergy for its OCG-Wind foundation technology. Salamander is intended to be progressed through the innovation track of Crown Estate Scotland’s Inno-



Ocean Wind's Scottish wind farm is expected to meet the power requirements of about 650,000 households. (Courtesy: Palfinger)

vation and Targeted Oil and Gas (INTOG) leasing round. The INTOG round will grant seabed leases through an auction process, which will be split into two pots — one for smaller scale innovation projects of less than 100 MW and one for larger projects linked to oil and gas infrastructure.

MORE INFO www.erm.com

CONSTRUCTION

Palfinger to provide new cranes to Scotland wind farm

In 2023 Palfinger will deliver 60 of its new PF120-4 fixed boom cranes to the Moray West Offshore Wind Farm in Scotland and one PTM12000 jetty crane to its Operations & Maintenance (O&M) base.

Thanks to its long coastline and ideal wind conditions, Scotland is a hotspot for the offshore wind industry. The Moray West offshore wind farm is in the outer Moray Firth off Inverness.

In addition to the 60 fixed boom cranes, Palfinger will supply a PTM12000 jetty crane for Buckie Harbour. The commercial port has been selected as the long-term Operations & Maintenance (O&M) base and will be used to support the construction phase of the Moray West offshore wind farm and beyond.

The large-scale project is being developed by Ocean Winds, a 50-50 joint venture formed by EDP Renewables and ENGIE. It will consist of 60 wind turbines, each with a generating capacity of 14.7 MW.

Once operational, the Scottish wind farm is expected to meet the power requirements of about 650,000

households in Scotland for the next 25 years and thereby contribute to the county's targets of achieving net zero emissions by 2045.

"We are proud that the launch of our renewed range of fixed boom cranes allows us to offer our customers and partners even better performance in their daily business and that the re-designed solution is well received by them," said Gunther Fleck, Vice President Sales & Service Region Marine at Palfinger.

"What is more, the delivery marks the start of a promising partnership between Palfinger Marine and Ocean Winds."

Palfinger's range of fixed boom cranes comes prepared for load handling operations with a safe working load of 1,000 kilograms at 3- to 7-meter outreach in single line operation and up to 3,000 kilograms at 2.9- to 6.9-meter outreach in double line operation.

MORE INFO www.palfinger.com

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Sven Utermöhlen, CEO of RWE Offshore Wind (left) and Marc Becker, CEO of Siemens Gamesa's offshore business (right), at the Danish National Test Center for Large Wind Turbines in Østerild, Denmark. (Courtesy: RWE)

CONSTRUCTION

RWE signs Siemens Gamesa for Denmark plant

RWE is progressing with the deployment of Denmark's largest offshore wind power plant by signing a Preferred Supplier Agreement with Siemens Gamesa; 72 units of Siemens Gamesa's flagship SG 14-236 DD offshore wind turbines are planned to be installed at RWE's 1,000-MW Thor project. In addition, a service contract for the wind turbines is included. All deliveries are subject to RWE's final investment decision.

"With Thor, we will massively contribute towards Denmark's ambitious climate targets," said Sven Utermöhlen, CEO of RWE Offshore Wind. "In order to deploy this offshore project, we will rely on our track record of more than 20 years in offshore wind and on experienced suppliers, like Siemens Gamesa, which are committed to working hand in hand with Danish supply chain companies and the local

workforce. As RWE, we want to be one of the key drivers of offshore wind energy in Denmark."

"We're thrilled to collaborate once more with RWE, and feel particularly encouraged by the signing of the Preferred Supplier Agreement for the Thor project," said Marc Becker, CEO of Siemens Gamesa's offshore business. "Our partnership already encompasses 12 offshore wind projects in both operation and development, totaling over 5.1 GW of capacity in several countries."

RWE will build the Thor wind-power plant in the Danish North Sea, about 22 kilometers from Thorsminde on the west coast of Jutland. Installation of the turbines at sea is expected to begin in 2026. The installation works are planned to be carried out from the Port of Esbjerg, Denmark. Both RWE and Siemens Gamesa intend to use the skilled local workforce during the construction and commissioning of the project, both in the harbor as well as offshore.

The SG 14-236 DD is Siemens Gamesa's flagship offshore wind turbine. It features a capacity of almost 15 MW and a 236-meter diameter rotor with

an astounding swept area of 43,500 square meters.

For the operation and maintenance of Thor, RWE will set up a service base at the port of Thorsminde. RWE intends to contribute to the local economy and community by creating up to 60 permanent jobs. This includes technicians, engineers, nautical personnel as well as crew for the service vessels.

With a planned capacity of 1,000 MW, Thor will increase Denmark's share of electricity produced from renewable energy sources and help to reduce the country's carbon emissions, in line with the European Green Deal. Once fully operational, which is planned to be no later than the end of 2027, RWE's Thor offshore wind power plant would be capable of producing enough green electricity to supply the equivalent of more than one million Danish households.

MORE INFO thor.rwe.com

INNOVATION

Vestas Denmark prototype turbine produces first kWh

Vestas has finalized installation of the V236-15.0 MW prototype turbine at the Østerild National test center for large wind turbines in Western Jutland, Denmark. The prototype has successfully produced its first kWh of power and will now undergo an extensive test and verification program to ensure reliability before full type certification and serial production begins.

"This is a great step forward in our ambition to accelerate the green energy transition and it is a major milestone for Vestas and our partners," said Anders Nielsen, Vestas Chief Technology Officer. "Colleagues across Vestas have worked very hard and collaborated closely to ensure the rapid progress in developing and assembling the V236-15.0 MW prototype, and this achievement is a testament to the dedicated

Vestas has announced preferred supplier agreements for the V236-15.0 MW turbine for a total of more than 8 GW in five different markets. (Courtesy: Vestas)

work of the many Vestas employees involved. With this wind turbine we set new standards for technological innovation, industrialization and scale across renewable energy to create a sustainable offshore wind industry.”

The prototype development and assembly work has taken place across Vestas’ R&D and production sites in Denmark. The blade molds have been developed at Vestas’ blade factory in Lem and the 115.5-meter prototype blades have been manufactured at Vestas’ offshore blade factory in Nakskov. The prototype nacelle has been developed and assembled at the offshore nacelle factory in Lindø port of Odense. The test program for the generator, converter, and grid system integration has already started at LORC test facility in Denmark.



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With a swept area exceeding 43,000 square meters, the V236-15.0 MW moves the boundaries of wind-energy production to about 80 GWh/year, enough to power about 20,000 European households and displace more than 38,000 tons of CO₂ every year.

The V236-15.0 MW is designed to perform while reducing the number of turbines at park level, strengthening the project business case. The globally applicable offshore turbine offers 65 percent higher annual energy production than the V174-9.5 MW, and for a 900 MW wind park it increases production by five percent with 34 fewer turbines. It offers partial-load production, resulting in a more stable energy production, and a capacity factor over 60 percent depending on site-specific conditions.

Launched in February 2021, Vestas has until now announced preferred supplier agreements for the V236-15.0 MW turbine for a total of more than 8 GW in five different markets.

MORE INFO www.vestas.com

INNOVATION

Russelectric highlights EMO switches

Russelectric, a Siemens business, a manufacturer of power control systems and automatic transfer switches, is highlighting the external manual operator (E.M.O.), a standard feature of the Russelectric® RTS-03 Series and RTS-30 Series of open-transition automatic transfer switches, a line of 480 VAC 30-cycle and 3-cycle UL tested switches available in the market today. The unique External Manual Operator feature enables easy, safe, and quick manual transfer with the door fully closed, reducing downtime and the risk of arc flash injuries.

With the external manual operator, the manual transfer process is faster for both the preferred and the alternative power sources, and no special



In a pilot project, TÜV NORD is using drone support for the end-of-warranty inspection. (Courtesy: TÜV NORD)



The EMO design enables manual transfer with the door fully closed. (Courtesy: Russelectric)

procedures are required to ensure the system is de-energized during the transfer operation.

The External Manual Operator uses

the same Russelectric transfer mechanism as the automatic electrical operator. During an open-transition transfer, the contact mechanism is locked in position until an over-center position is reached. Preloaded springs then instantaneously open the closed contacts (quick-break) and instantaneously close the open contacts (quick-make) with only a momentary break in between.

This quick-break design along with rapid arc quenching features provide for rapid arc interruption, under maximum voltage and amperage, reducing contact erosion and overheating to extend useful life. Russelectric transfer switches have the highest 480 VAC 3-cycle closing and withstand ratings of any switches available today.

MORE INFO www.russelectric.com

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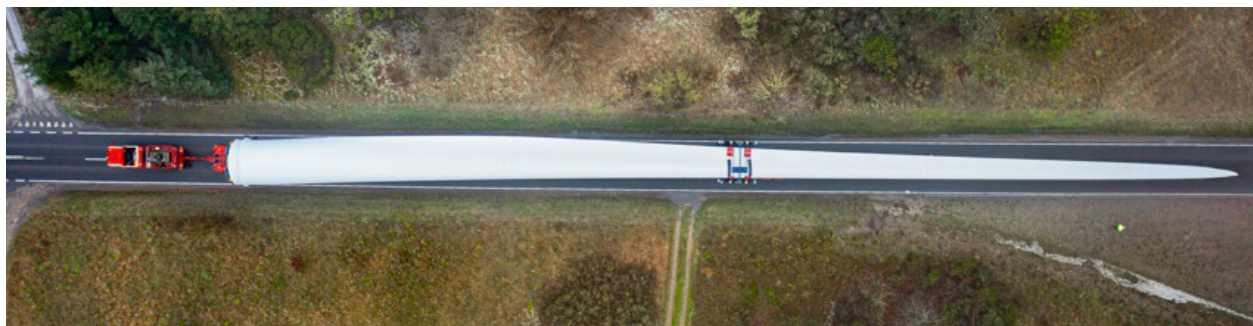
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When it is installed, the Vestas/ENGIE project will be the largest wind project in Latin America. (Courtesy: Vestas)

MAINTENANCE

TÜV NORD pilot project uses drones for turbine inspection

In a pilot project for a European wind turbine manufacturer, TÜV NORD is using drone support for end-of-warranty inspection. The entire concrete tower is photographed by drone; experienced TÜV NORD experts later evaluate the images. In the medium term, an automated image recognition system is also to be used, which will pre-sort images with conspicuous features on the basis of extensive training data so that the experts can view and evaluate the images in an even more targeted manner.

“Initially, small cracks and spalling can later lead to critical damage in the concrete structure,” said wind-energy expert Michael Lange, who is responsible for remote inspection projects for renewable energies at TÜV NORD. “That is why it is important to assess any anomalies on the tower before the end of the warranty period so that they can be repaired.”

Using drones for this inspection simplifies image capture and also means greater occupational safety, as no additional skilled personnel with rope access technology have to be deployed, according to Lange.

“We are also working on a system that will allow the drone to fly autonomously up the tower, so that jobs can be completed in less time,” he said.

“We use digital technologies such

as drones or new software solutions to make services more efficient or safer,” said Alexander Ohff, TÜV NORD’s executive vice president of the renewables segment. “Pilot projects evaluate the benefits in practice.”

Using the drone-based inspection, 34 of the manufacturer’s wind turbines have already been assessed this year. The results have been validated. Now, the procedure is being extended to additional sites. Talks are under way with other manufacturers and wind farm operators.

MORE INFO www.tuev-nord-group.com

MANUFACTURING

Vestas gets repowering order for U.S. wind project

Vestas has received a 73-MW order to repower an undisclosed wind project in the U.S. The order consists of 33 V110-2.0 MW wind turbines in 2.2 MW operating mode, which will replace the site’s current technology.

The order includes supply, delivery, and commissioning of the turbines, as well as a 10-year Active Output Management 5000 (AOM 5000) service agreement.

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

MORE INFO www.vestas.com

MANUFACTURING

Vestas, ENGIE expand partnership on Brazil wind farm

Vestas and ENGIE Brasil Energia SA are expanding a partnership, with the 288-MW order of 64 units of V150-4.5 MW wind turbines for the Serra de Assuruá wind farm in Gentio do Ouro in the state of Bahia, Brazil.

Both companies signed an agreement to implement the largest wind project in Latin America that, once fully installed, will have a total nominal capacity of 846 MW.

Vestas will also deliver a 25-year Active Output Management 5000 (AOM 5000) service agreement. This agreement will optimize energy production while also providing long-term business case certainty.

“It is a pleasure to work in partnership with ENGIE Brasil Energia and reinforce the joint commitment to facilitate and accelerate the energy transition in Brazil,” said Eduardo Ricotta, President of Vestas Latin America. “At Vestas we will continue working to contribute to the development of the Brazilian energy matrix based on wind energy and closely with our partners to continue developing large-scale projects such as the Serra de Assuruá.”

The delivery and commercial operation of Serra do Assuruá is estimated to start gradually from the second half of 2024.

MORE INFO www.vestas.com

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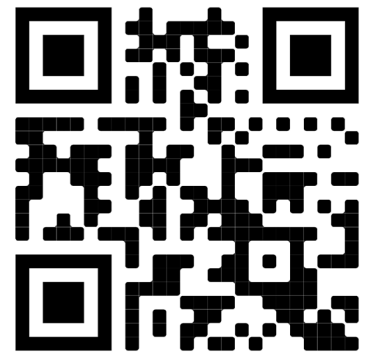


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THE FUTURE OF WIND

ARE WE FACING A RENEWABLE ENERGY BOOM?

According to the International Energy Agency (IEA), renewable energy made up 26 percent of the global power generation mix in 2020. (Courtesy: Shutterstock)



With decreasing costs, government incentives, and environmental concerns driving the use of renewable energy, there are still potential challenges to be faced in order to meet global net-zero goals.

By KATIE COLLINS

Renewable energy has been gaining momentum in recent years as a viable alternative to traditional fossil fuels. From solar and wind power to hydro and geothermal energy, more and more countries are turning to renewable sources to meet their energy needs. The use of renewable energy has been growing at a rapid pace, and many experts believe we are experiencing a renewable energy boom.

The current state of renewable energy can be seen in the increasing percentage of renewable energy in the global-energy mix.

What does this mean? It means we are indeed facing a renewable energy boom, and the increasing demand for renewable energy, cost decreases, government incentives, and environmental concerns are the main drivers of this boom. What is the impact of this boom on the economy, and what does it mean for the future?

THE GROWTH OF RENEWABLE ENERGY

The growth of renewable energy can be seen in the increasing amount of renewable energy being produced and used around the world. According to the International Energy Agency (IEA), renewable energy made up 26 percent of the global power generation mix in 2020. This means 26 percent of the energy used to power homes, businesses, and factories came from renewable sources such as solar and wind power. This is an increase from 24 percent in 2019. The IEA also predicts the use of renewable energy will continue to grow, reaching 30 percent by 2025 and 35 percent by 2030.

There are several factors driving this growth in renewable energy. One of the main factors is renewable energy is becoming less expensive to produce. This is especially true for solar and wind energy. As technology improves and economies of scale are achieved, it becomes cheaper to produce and install solar panels and wind turbines.

Another factor driving the growth of renewable energy is government incentives. Many governments around the world are offering financial incentives to encourage the use of renewable energy. This can include tax breaks, subsidies, and other financial incentives.

Finally, environmental concerns are also playing a role in the growth of renewable energy. Climate change and air pollution are serious concerns, and many people and organizations are choosing to use renewable energy as a way to reduce their carbon footprint and help the environment.

THE IMPACT OF RENEWABLE ENERGY ON THE ECONOMY

The growth of renewable energy is having a positive impact

on the economy. One of the main benefits is job creation. The installation and maintenance of renewable energy systems, such as solar panels and wind turbines, creates jobs in engineering, construction, and manufacturing. Furthermore, the development of renewable energy sources can also lead to regional economic development, as it can attract investment and create jobs in areas where renewable energy is being produced.

In addition to job creation, renewable energy can also lead to economic growth. As more renewable energy is produced, it can help reduce the cost of energy, which can in turn lead to increased economic activity. This can be especially beneficial for businesses and industries that are energy-intensive.

Another factor driving the growth of renewable energy is government incentives. Many governments are offering financial incentives to encourage the use of renewable energy. This can include tax breaks, subsidies, and other financial incentives. For example, in Missouri, there are several solar incentives available for residents and businesses to install these systems, such as a state tax credit, grants, and net metering policies. Also, in Germany, the government provides feed-in tariffs for wind energy, which guarantee a fixed price for electricity generated by wind power; this has been a key factor in the country's success in developing wind energy.

While there are many economic benefits to renewable energy, there are also potential challenges. One of the main challenges is the need for investment in infrastructure. To meet the growing demand for renewable energy, significant investments in new renewable energy systems and infrastructure will be required. This can be a significant cost, especially for countries and regions just starting to develop their renewable-energy systems.

Another potential challenge is the impact on traditional energy industries. As renewable energy grows, it can lead to a decline in demand for fossil fuels and nuclear energy. This can have a negative impact on industries heavily dependent on these energy sources.

The impact of renewable energy on the economy is mostly positive, but it is important to keep in mind the need for investment in new infrastructure and the potential impact on traditional energy industries. Also, government incentives play a major role in promoting the use of renewable energy and it varies from country-to-country and state-to-state.

THE FUTURE OF RENEWABLE ENERGY

The future of renewable energy is bright, with many advances in technology and research taking place. One of the



The growth of renewable energy is having a positive impact on the economy. One of the main benefits is job creation. (Courtesy: Shutterstock)

most promising areas of research is in the field of energy storage. As renewable energy sources such as solar and wind are intermittent, energy storage systems are needed to ensure a stable and reliable energy supply. Advancements in battery technology, such as the development of lithium-ion batteries, have made energy storage more efficient and cost-effective. Another area of research that holds promise is the development of new renewable energy sources. For example, researchers are working on developing new ways to harness the power of the ocean, such as wave and tidal energy. Additionally, advances in bioenergy, using biomass, are being made to produce electricity, heat, and biofuels.

Overall, the future of renewable energy is promising, with many new technologies and research developments taking place that will help to make renewable energy even more efficient, cost-effective, and reliable.

The use of renewable energy is expected to keep increasing. Furthermore, many countries are committing to achieve net-zero emissions by the middle of this century, which means a significant increase in renewable energy is required to reach this goal. This will also lead to a greater demand for energy storage systems, which will be crucial to make renewable energy reliable and more accessible.

CONCLUSION

We have seen that the use of renewable energy is increasing

globally, driven by a combination of decreasing costs, government incentives, and increasing concern for the environment. The impact of renewable energy on the economy has been mostly positive, with job creation and economic growth being some of the main benefits. However, there are also potential challenges such as the need for investment in new infrastructure and the potential impact on traditional energy industries.

The future of renewable energy is bright, with many new technologies and research developments taking place that will help to make renewable energy even more efficient, cost-effective, and reliable. Governments play a crucial role in promoting the use of renewable energy, and different incentives and regulations are in place in various countries and states.

The renewable energy boom is a positive development that has the potential to bring many benefits to the economy and environment. It is important to continue to support the growth of renewable energy and invest in new technologies to ensure a sustainable and reliable energy future. ✍️

ABOUT THE AUTHOR

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