



Windergy 2025: Opportunities & Emerging Trends

A Strategic Outlook for 2026



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Shaping the Wind Story
After COP30

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Wind Ongoing



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(Wind and Solar-Multiband Capacity Under Services)



1000+

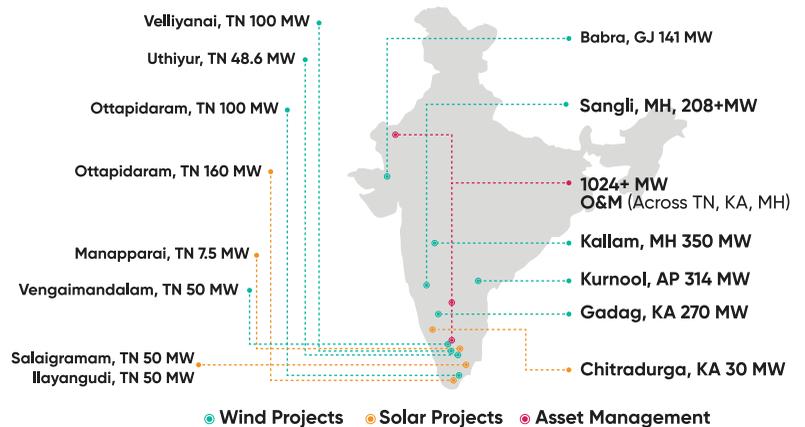
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This Issue of Indian Wind Power has been designed by



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Indian Wind Turbine Manufacturers Association

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From the CEO's Desk

Dear Readers,

Windergy 2025 was a powerful testament to what the Indian wind sector can achieve when industry, government, and global partners move in step. Graced by the presence of the Hon'ble Union Minister for New & Renewable Energy for the inauguration, the event underscored wind energy's central role in India's growth story and long-term energy security.

This edition welcomed over 16,000+ visitors, 350 exhibitors, and delegations from 20+ countries, transforming Windergy into a truly global platform for collaboration. A series of targeted bilateral meetings and MoUs deepened partnerships across technology, finance, manufacturing and supply chains, reinforcing India's position as both a high-potential market and a credible export hub for wind technologies.

Across the inaugural session and high-impact discussions, a clear message emerged: India's wind sector is entering a new phase defined by integrated planning, bankable policies, domestic manufacturing strength and timely project execution. States such as Tamil Nadu, Karnataka, Gujarat, Maharashtra, Rajasthan and Kerala showcased concrete steps on repowering, storage-linked projects, land and evacuation reforms, and green energy corridors—demonstrating how state-level leadership will anchor the 100+ GW wind ambition for 2030.

Central Government policymakers also echoed this vision. The Ministry of New and Renewable Energy (MNRE) reemphasized that wind will remain essential for upcoming Round-the-Clock (RTC) and Firm and Dispatchable Renewable Energy (FDRE) tenders. With viability-gap funding for offshore wind, stronger domestic manufacturing through ALMM-Wind and ALMM-WTC and localisation efforts, and dedicated task forces to resolve transmission bottlenecks, the government has shown strong intent to translate

policy into ground reality. SECI's roadmap wind-only parks and the country's first Contracts-for-Difference (CfD) tender signals a future where wind energy is not just installed, but firmly integrated into India's dispatchable power ecosystem.

Manufacturing and supply chain competitiveness remained at the heart of the dialogue. OEMs and component manufacturers reinforced that India is already a global supplier for key wind components, and with multi-year volume visibility, streamlined approvals and logistics, and dedicated wind manufacturing clusters, the country can rapidly scale into a world-leading export hub for next-generation turbines.

IWTMA is deeply grateful for the continued guidance and support of the Ministry of New & Renewable Energy, Ministry of Power, Niti Aayog and our partnering State Governments, whose policies and proactive engagement are enabling the sector's next wave of growth. Sincere thanks are also due to the IWTMA wind industry leaders, members, knowledge partners and international collaborators who made Windergy 2025 a landmark edition and continue to champion India's clean energy transition.

The task ahead is clear: convert shared conviction into accelerated execution. India can set new benchmarks for affordable, reliable and sustainable power. The winds of change are here—and together, we will ensure that India not only rides them, but leads the world with them.

With warm regards,

Aditya Pyasi
CEO, IWTMA
(Indian Wind Turbine Manufacturers Association)



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— 1958 - 2022 —



The seventh edition of Windergy India 2025, India's only trade fair and conference for wind energy, concluded successfully at the Chennai Trade Centre (October 29-31, 2025). Windergy India 2025 brought together 350 exhibitors from 20+ countries and attracted 16,000+ visitors. Country pavilions representing Denmark, Germany, and Spain showcased international cooperation in advancing wind power technologies. The 2025 edition was a vibrant hub of collaboration, innovation, and dialogue, amplifying India's renewable energy ambitions.

Windergy India 2025: Inaugural Session



Windergy India 2025 Conference began on 30 October 2025 with the formal inauguration of the trade fair setting a powerful tone for collaboration and rapid expansion of India's wind sector.

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We extend our heartfelt gratitude to:



Shri Pralhad Joshi, Hon'ble Minister for New & Renewable Energy and Consumer Affairs, Food & Public Distribution, for delivering an inspiring keynote and reaffirming India's push towards 100 GW of wind by 2030, and 30 GW of offshore wind.



Mr. Johann Saathoff, Parliamentary State Secretary, Germany, for his distinguished presence and valuable contributions. His insights and commitment to strengthening Indo-German cooperation in the renewable energy sector added immense value to the event.



Shri S. S. Sivasankar, Minister for Transport & Electricity, Tamil Nadu, for his strong commitment to state-level wind expansion, repowering, and offshore development.



Shri Santosh Kumar Sarangi, Secretary, MNRE, for his inaugural address highlighting India's rapid RE growth and the crucial role of wind within RTC & FDRE tenders.



Shri Girish Tanti, Chairman, IWTMA, for setting the context and calling for coordinated action on transmission, repowering, and domestic manufacturing.

All EC Members of IWTMA, whose presence and leadership strengthened the industry's collective voice.



Dr. Saravanan Manickam, Vice Chairman, IWTMA, for delivering the vote of thanks and acknowledging the contributions of all dignitaries.

50 HINE

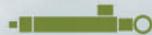
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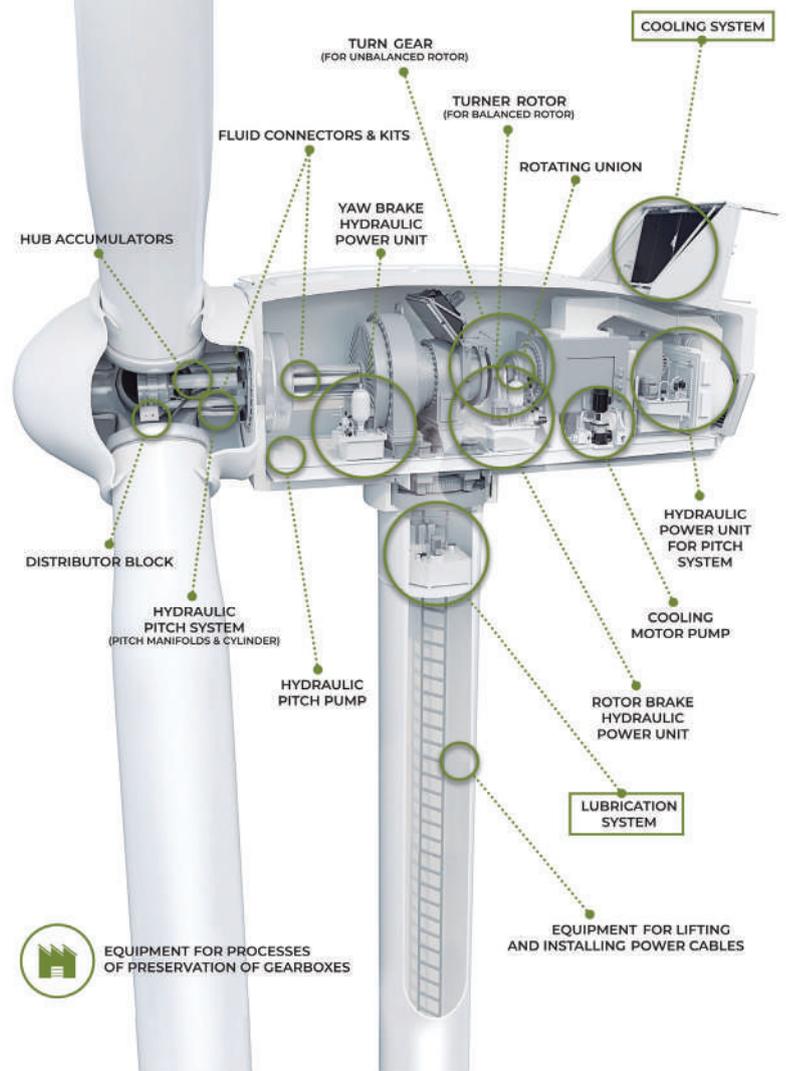
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IWTMA Signs Landmark MoUs



IWTMA signs Memorandum of Understanding with German Wind Energy Association (BWE) and The Council on Energy, Environment and Water (CEEW) aimed at accelerating India's path from 53 GW to 100 GW of wind energy by 2030.

These major collaborations aligns industry, policy, and research objectives to drive India's wind sector into its next phase of growth.

State's Presence

Tamil Nadu, Karnataka, Kerala, Rajasthan, Gujarat, and Maharashtra showcased strong commitments at Windergy

India 2025, focusing on repowering, hybrid tenders, and evacuation upgrades. Tamil Nadu emphasized offshore potential and grid readiness, while Karnataka highlighted major policy reforms and storage-based hybrids. Kerala stressed demand growth and terrain-based constraints requiring new green corridors. Western states Rajasthan, Gujarat, and Maharashtra reinforced large-scale pipelines, RE zones, and steady policy momentum to accelerate India's wind build-out.

Windergy India 2025 - Key Policy Announcements from MNRE



At the Windergy India 2025 in Chennai, Union Minister for New & Renewable Energy, Shri Pralhad Joshi, announced major developments that signal India's strongest wind expansion phase to date.

The Minister confirmed that 6 GW of new wind capacity is expected to be added by the end of FY 2025–26 the highest-ever annual addition, significantly higher than last year's 4 GW. "This financial year alone, India has already added over 3 GW of new wind installations," he said.

Reaffirming India's progress toward the 500 GW RE goal by 2030, the Minister emphasized that wind will contribute 100 GW or more. India currently has 54 GW installed wind capacity and another 30 GW under implementation, keeping the nation firmly on track.

He highlighted that Tamil Nadu, Karnataka, and Andhra Pradesh together account for nearly half of India's total wind capacity, underscoring the critical role of southern states.

The Minister also announced several manufacturing and policy advancements:

- Local content in India's wind industry has reached 70%, with a target of 85% under the Atmanirbhar Wind Mission by 2030.
- GST on wind equipment has been reduced from 12% to 5%, lowering turbine costs by ₹25 lakh per MW.
- The new ALMM–Wind framework will strengthen quality and support India's ambition to meet 10% of global wind demand by 2030 and 20% by 2040.
- Shri Joshi also referenced NIWE's latest assessment showing 1,164 GW of onshore wind potential at 150 m hub height. To unlock new areas, the government has launched VGF for Offshore Wind, targeting the first 1 GW (500 MW each in Gujarat and Tamil Nadu).

MNRE Secretary Shri Santosh Kumar Sarangi added that the Tamil Nadu offshore wind tender is expected by February, marking a major milestone in India's offshore journey.

Windergy India 2025: Conference Sessions

Panel Discussion 1: State Leadership: Powering Wind



- State policy support and investor confidence
- Coordination between state governments, MNRE, SECI and regulators

States emphasised that evacuation and transmission readiness are the single biggest determinants of whether wind capacity can grow at the scale required. Tamil Nadu, Karnataka, Kerala and others stressed right-of-way issues, long substation timelines and the need for coordinated central-state transmission planning.

The panel convened senior officials across India’s most wind-rich states together with central agencies to examine how states will translate national wind ambitions into actual capacity. The moderator—Shri Dinesh Jagdale—set the tone by highlighting India’s milestone of crossing 500 GW installed power capacity and reporting that nearly half of national demand on the referenced day was met by renewable sources. The discussion aimed to surface practical solutions around:

- Transmission readiness
- Land and right-of-way (ROW) challenges
- Repowering and new capacity development

MNRE reassured the sector that demand for wind will be strong, driven by RTC and FDRE tenders where wind’s complementary generation profile is essential. The ministry emphasised domestic manufacturing (ALMM, DCR, and component-level localisation) but said support mechanisms are still under consultation.

Panel Discussion 2: Wind Manufacturing – Way forward to Atmanirbharta (A Govt. - Industry Dialogue)



Dr. P.K. Dash, Scientist E, MNRE, framed Atmanirbharta as India should be strong enough to withstand external shocks and vibrant enough to leverage and build the potential of people of India. Definition has to come from the industry on what would they consider to be essential elements of the wind industry to be self reliant

OEM leaders (Suzlon, Senvion, Envision, Adani) stressed that sustained volume visibility is the key to capacity and cost: industry can add capacity, but real execution on the ground must rise to justify investments; a stable multi-year build path will pull down costs and enable exports.

The session “Wind Manufacturing: Way Forward to Atmanirbharta” examined how India can scale domestic wind manufacturing for India and for the world. The moderator (Siddharth Jain) presented recent market data to ground the discussion: India’s wind market is accelerating (from ~4 GW to ~6 GW this year) with a possible pathway of 6–10 GW depending on execution. While the 100 GW target anchors domestic demand, the panel also flagged 40-50 GW export potential across components due to global growth and supply needs.

Panel Discussion 3: Global best practices for wind installations and O&M



The panel opened with a clear message: operations and maintenance are vital to India's long-term system reliability and cost optimisation as the country's wind fleet scales rapidly. The moderator, Ms. Svetlana (Wood Mackenzie), explained the session would focus on two major themes:

1. Latest updates in predictive maintenance and lifetime extension
2. Data access, analytics, insurance, and cybersecurity

India's O&M landscape is evolving: two-thirds to three-fourths of the fleet is currently serviced by OEMs, but developers are expected to gradually shift toward in-house O&M while independent service providers expand. The session revolved around predictive maintenance, lifetime extension, data usage and insurance/cybersecurity, noting India's fleet will reach 50 GW by 2025 with another 75 GW by 2034, and turbine sizes shifting from 3–5 MW toward 5–7 MW, increasing downtime costs and O&M importance.

Panel Discussion 4: Opportunities & Challenges for Cost Reduction of Raw Material Suppliers to Wind Components



The session examined how raw material costs affect the competitiveness of India's wind manufacturing supply chain and what steps can be taken to reduce these costs. MNRE highlighted a recurring policy dilemma: interventions that help one part of the value chain can pressure another. The ministry therefore evaluates proposals through broad stakeholder consultation and supports localization where capacity and capability already exist.

To ensure cost competitiveness and mitigate raw material expenses, a two-pronged policy is recommended: this includes considering Production Linked Incentives (PLI) for raw materials available within India and rationalizing import duties for those materials that are not domestically present. Furthermore, while the aspiration is for India to become a global component manufacturing hub, this goal is currently challenged by limitations in capacity and technical capability. Crucially, significant First Pass Quality (FPQ) issues are evident, with rejection or rework rates reported to be as high as 30 to 40%. To successfully overcome these barriers, specific, targeted support must be provided, particularly when local industry commits to substantial manufacturing capital expenditure (Capex).

Panel Discussion 5: Opportunities and Challenges in growing the C&I market for wind and hybrid projects

C&I consumers are the major drivers of India's clean energy transition. The C&I segment accounts for roughly half of national electricity consumption and is shifting to renewables for cost and sustainability. Solar is the cheapest option in many cases. However, wind and wind solar hybrids together with storage are essential to deliver round





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the clock supply and to raise utilization factors beyond what standalone solar can provide.

Execution is the main bottleneck. Land acquisition, right of way (RoW) and sharply rising corridor costs, plus contractor and material constraints, were

highlighted. Location choice and grid interface are becoming more nuanced as the grid's ability to absorb variability shrinks. Developers said hybrid value is not fully reflected in customer tariffs. Panelists also flagged unequal treatment on connectivity and DSM between DISCOM and C&I projects.

Regulators emphasized tightening DSM over time and investing in better forecasting and scheduling. The Ministry said banking cannot be a long-term crutch and deviation allowances should reduce toward zero over the next few years.

Panel Discussion 6: Repowering Wind projects in India



Repowering is positioned as the fastest route to unlock more wind generation at existing sites since land and grid interfaces already exist. MNRE sees repowering as a win-win and will help remove procedural bottlenecks, including pragmatic approaches to technical studies where legacy turbines are simply replaced, and align transmission upgrades through Green Energy Corridor work.

Developers flagged two execution pain points tail-end voltage upgrades from 11 kV

and 33 kV to suit MW-class machines and tight micro-siting on fragmented parcels; reduced spacing helps but sites need custom modeling. Legal and commercial clarity is required on land aggregation, land swapping, right of way, land ceiling, group captive ownership continuity, PPA continuity and treatment of additional generation; single-window processes and MNRE FAQs were proposed.

CEA outlined evacuation options use existing margins from earlier N-1 design, augment ICT where feasible and co-locate storage to meet stricter DSM and grid code needs; CEA is modeling mixed old-new fleets at interconnection to guide compliance. Advisors urged a repowering aggregator model and state-led clustering so repowering is done at site scale rather than turbine scale, achieving materially higher capacity and energy yields while addressing legacy fragmentation.

Panel Discussion 7: Domestic Supply-Chain & Export Competitiveness



The moderator (Dr. Saravanan Manickam, Vice Chairman, IWTMA & Country Head & MD-India, Nordex Group) positioned the session at the intersection of domestic supply chain depth and export competitiveness. The panel mixed OEMs, global component suppliers, logistics leaders, and a policy think tank—reflecting that India's path to becoming an export hub depends as much on manufacturing and certification as on ports, roads, and rules.

Speakers agreed India has a deep wind manufacturing heritage and a broad supplier base across blades, towers, gearboxes, converters, controls, cooling, and monitoring systems. OEMs reported active capacity expansions and rising localization. A supplier noted a new 5-GW electronics/converter factory in Bengaluru operating at roughly half capacity and already supporting global demand, with intent to support "India-for-India" as local volumes rise.

The panel supported manufacturing clusters for components and blades to tap local labor pools and shorten internal logistics—citing the existing Chennai-Trichy belt as an example. Still, given the transport limits on blades, OEMs expect multiple blade facilities across regions to control final-mile risk and cost.

Panelists saw Europe—especially Germany and Spain—and the Middle East as immediately accessible for Indian exports, subject to each market’s grid and certification nuances. Component exports are more straightforward (given global supplier ties), while full-turbine exports remain a priority for Indian OEMs,

with the caveat that heavy items (notably towers) will localize in the destination to manage cost and local-content rules.

Panel 8: Advancing Offshore Wind Development in India



The session opened with a candid diagnosis. India’s first two offshore attempts a 500 MW VGF project in Gujarat and a 4 GW seabed lease in Tamil Nadu were terminated in August for lack of bids. The panel stressed that this is not unique to India. Since 2022 many markets have seen failed auctions or cancellations as costs rose, and financing tightened. Denmark and the United Kingdom faced weak rounds. The moderator underlined that India must adjust conditions before a second attempt because it is harder to recover after repeated failures.

Developers need de risked projects and a visible multiyear pipeline. Denmark’s experience shows deep market dialogue and more flexibility help. Germany’s lesson was to allocate more risk to the state at the start and keep rules stable. Mature markets took years to reach auction readiness. For OEMs, Offshore is a different industry from onshore. Most cost sits in balance of plant and public infrastructure. Industry confidence depends on an ecosystem plan, not single projects.

MNRE sees the first challenge as developer scarcity and higher perceived risk. It is reworking the approach, engaging with industry and studying global fixes. Studies suggest pairing auctions with a demand plan and considering support tools such as VGF and CFDs. Early projects can be smaller to get learning by doing.

Panel 9: Winds of influence: Women Leaders Redefining India’s Wind Sector



The panel opened with positioning of inclusion as a core lever for India’s wind ambition under Atmanirbhar Bharat. The moderator noted that women make up a small share of the wind workforce worldwide and an even smaller share in India, especially in manufacturing, field work and site operations. The purpose of the discussion was to move beyond technology and policy to the people who implement both. The panel brought together leaders from manufacturing, policy, sustainability, technology, commercial and strategy to identify barriers and agree on practical ways

to widen participation and strengthen competitiveness.

Speakers stressed that the first barrier is often internal. Ambika urged women to challenge self-selection out of core operations and to rotate across functions to build confidence and credibility. A panellist described early-stage credibility gaps and showed how persistence, varied assignments, and visible delivery-built acceptance in site heavy industries. Another panellist argued that contracts and tenders can drive change by linking a portion of payments to safety and inclusion outcomes and by tracking not only hiring but retention and progression over the full project life.

The unifying message was clear. If India wants a larger, faster and more reliable wind build out, inclusion must live in policy, procurement and daily practice on factory floors and windy ridges, not only in mission statements.

Next-Gen Epoxies – Paving the Way for Safer Wind Manufacturing



The wind energy sector is undergoing pivotal regulatory changes that enhance workplace safety and fortify long-term turbine performance. With the European Union's reclassification of certain epoxy diluents as carcinogenic, mutagenic, and reprotoxic (CMR) substances, manufacturers are actively transitioning to alternatives not classified as CMR. By eliminating these hazardous chemicals from epoxy systems used in turbine blade manufacturing, the industry is significantly reducing health risks for workers, creating safer production environments, and ensuring compliance with evolving safety standards. The challenge for manufacturers is to find alternatives that not only create a safer

environment for workers, but also provide the wind blade performance, reliability and durability required in a highly competitive and demanding industry.

In 2024, the European Union chemical agency conducted an investigation into 59 epoxy diluent chemicals, resulting in the application of CMR (carcinogenic, mutagenic, and reprotoxic) classifications to these substances. This reclassification affected most two-component epoxy systems currently available, prompting mandatory supply chain communication of updated classifications. Harmonized classification is anticipated to become legally binding for certain substances by 2026.

Implications for Blade Manufacturers

These regulatory changes are significant for wind turbine blade manufacturers. Epoxy systems are integral to blade production, and new classifications directly impact the materials available for use, product qualification processes, and worker safety protocols. Manufacturers must ensure that their products comply with updated chemical safety standards, which is essential for maintaining market access and meeting evolving safety requirements. The need to transition to alternatives also introduces operational and technical challenges, particularly in maintaining the structural integrity and

performance standards expected in the industry.

Development of Alternative Technologies

In response to the regulatory developments, Gurit has been engaged in the removal of CMR-classified chemicals from its product portfolio. Following the announcement of newly classified diluents, Gurit's technical team has focused on developing alternative formulations for the affected products used in the wind sector. Reformulation efforts have progressed across Gurit's full epoxy range, resulting in alternatives for most impacted products. Notably, Gurit reports that these new solutions have not increased costs or compromised product performance, allowing customers to continue operations with minimal disruption to product qualification status. Although the regulatory changes currently pertain to the EU, Gurit has implemented these new formulations globally, providing wider access to materials.

Availability of Safer Products

The following Gurit products designed for the wind sector and are immediately available:

- Ampreg 3X laminating range: Utilized by blade manufacturers for hand impregnation of fibers at ambient temperatures (15–25 °C), this range offers multiple hardener speeds and incorporates light reflective technology. Ampreg 32 serves as a lower hazard alternative to Ampreg 30, while Ampreg 33 is an alternative to Ampreg 31, featuring drainage resistance. The range is available as a cartridge dispense system, employing a patent-pending application method developed for wind blade repair.
- Spabond 730 adhesive: This rapid-curing structural adhesive is suitable for bonding various dissimilar materials. It gels after 10 minutes, solidifies in 2 hours, and achieves a substantial degree of cure after 6 hours at ambient temperature. It is available in 400 ml cartridges and has received OEM qualification.



- Epoxy in-mold gelcoats: Gurit's latest generation of gelcoats are not classified as CMR and serve as a durable barrier between mold and blade, supporting surface finish and reducing post-mold preparation time.

Ongoing Chemical Safety Initiatives

The European Commission's Chemical Strategy for Sustainability has broadened the criteria for the classification of Substances of Very High Concern (SVHCs) and CMRs, leading to new reclassifications

each year. For manufacturers, this means a constantly evolving list of chemicals to avoid and an increased need for vigilance in supply chain management. Gurit maintains a strategy of monitoring regulatory developments, reducing the use of higher hazard chemicals in formulations and production, and proactively developing alternative technologies. These efforts are aimed at supporting blade manufacturers in complying with chemical safety standards while maintaining product quality and performance. Additional information regarding chemical safety initiatives is available in Gurit's Sustainability Report.

“Chemical safety is absolutely fundamental to who we are at Gurit. Protecting our colleagues, our customers, and the end users of our products is a responsibility we take seriously, and we're committed to staying ahead of regulatory change. By continually reformulating and improving our chemistry, we ensure the wind industry can rely on materials that are not only high-performing but also free from chemicals of concern.”

Amy Moram, Chemical Compliance Manager and Sustainable Products Lead

Company Background

Gurit supplies composite materials and engineered solutions for wind blade manufacturing and service. Its offerings include epoxy lamination systems, adhesives, gelcoats, core materials and kits, glass pultruded profiles, and tooling technologies. Through collaboration with OEMs and blade service teams, Gurit supports process optimization, material qualification, and the development of high-efficiency wind turbine blades.

AUTHOR



Amy Moram is Gurit's Chemical Compliance Manager and Sustainable Product Lead, recognized for her expertise in ensuring the safe, responsible use of chemicals across a complex product portfolio. With over two decades in composites, she has led major regulatory and sustainability initiatives that strengthen both environmental performance and operational safety.

Transmission Technologies for Offshore Wind Integration: HVDC, DLR, Advanced Conductors, and Energy Storage

Authors: Dr. Raj Shah, Leo Jiang, Mathew Stephen Roshan, William Chen

Abstract:

The expansion of offshore wind farms has increased the demand for transmission technologies that can reliably deliver large-scale renewable power to the grid. This paper reviews recent advances in high-voltage direct current systems, dynamic line rating, advanced conductors, and energy storage systems. Multi-terminal high-voltage direct current systems networks provide controllable, long-distance transmission with reduced curtailment, while dynamic line rating improves utilization of existing infrastructure through real-time capacity adjustments. Advanced conductors such as aluminum conductor composite core increase ampacity, reduce line losses, enhance wildfire resilience, and energy storage systems technologies stabilize the grid by providing frequency regulation, black start capability, and cost reductions. Together, these innovations strengthen wind energy transmission and enable a more resilient and sustainable power system.

Introduction:

As the world shifts towards renewable energy driven by climate change and sustainability targets by governments and regulatory bodies, it has increased the demand for efficient transmission of wind energy. Therefore, over the past three years, there have been significant advancements in wind transmission

technologies, such as high-voltage direct current (HVDC) transmission systems, Dynamic Line Rating (DLR), advanced conductors like Aluminum Conductor Composite Core (ACCC), and Energy Storage Systems (ESS). These technologies have substantially improved the efficiency and reliability of wind energy transmission, especially in Offshore Wind Farms (OWFs). This paper will review these recent innovations, emphasizing their technological benefits and current real-world applications.

Multi Terminal HVDC Systems

In recent years, developers have built larger OWFs farther offshore

to increase renewable electricity generation, using stronger and more consistent wind conditions and the flexibility of open ocean space. At these distances, traditional High Voltage Alternating Current (HVAC) transmission is inefficient because long AC cables suffer from skin effects, stability limits, reactive current loss, and the need for frequency synchronization with the grid [1]. High Voltage Direct Current (HVDC) transmission systems overcome these issues by using an offshore rectifier to convert the wind farm's AC input to DC, transmitting it through the HVDC line, and converting it back to AC using an inverter [2].

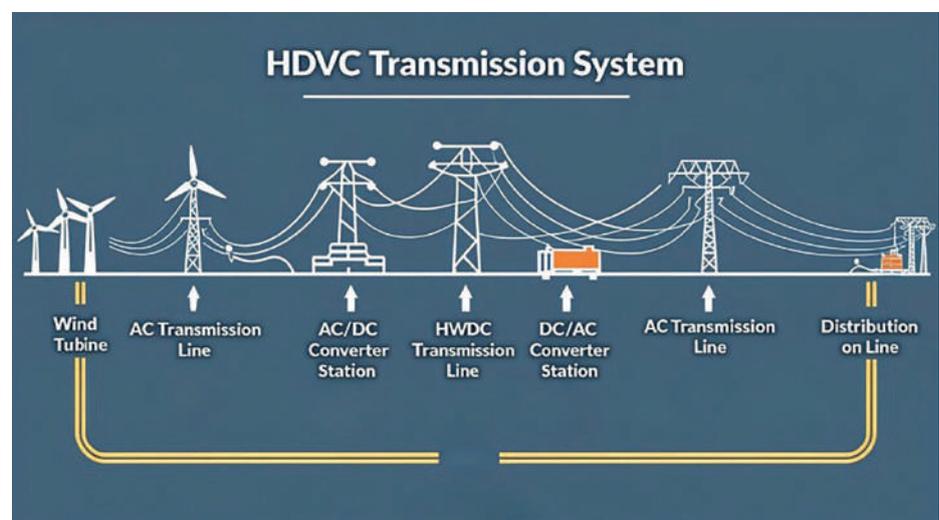


Figure 1: HVDC Transmission System. AC/DC Converter Station (Rectifier), DC/AC Converter Station (Inverter)



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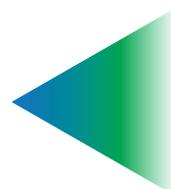
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The comparisons between HVDC and HVAC transmission systems are shown in the table below, using metrics that are limitations in HVAC transmission systems:

Metric	HVAC Transmission System	HVDC Transmission System
Skin effects	AC current flow limits capacity	Negligible
Stability	Less controllable due to loops and oscillations	Controllable since operator sets variables
Reactive Current Loss	High due to reactive charging currents in long AC cables and require reactive support	Very low since there is no reactive charging, only active power carried (DC).
Frequency Synchronization	Must remain synchronous, AC links require same frequency on both ends	Can connect asynchronous systems since DC decouples frequency between two AC networks
Cost	Lower terminal cost, but high cable cost over long distances. Efficiency lost with distance	Higher terminal converter cost, much lower cable cost over distance

Table 1: Comparing HVDC and HVAC Systems [3],[4].

HVDC transmission systems eliminate skin effect and reactive current losses while providing controllable power flow and asynchronous grid interconnection, making them well suited for long-distance, large scale offshore wind integration. In line commutated converter (LCC) HVDC,

thyristor valves are arranged in six- or twelve-pulse bridges, with commutation driven by the AC system voltage and key components including high harmonic transformers, DC-side smoothing reactors (typically 0.1–0.5 H), reactive power compensators rated at about

60% of converter capacity, and high pass filters to manage voltage stress, maintain steady current, and suppress switching and harmonic currents for acceptable power quality [4].

LCC HVDC Transmission System Process

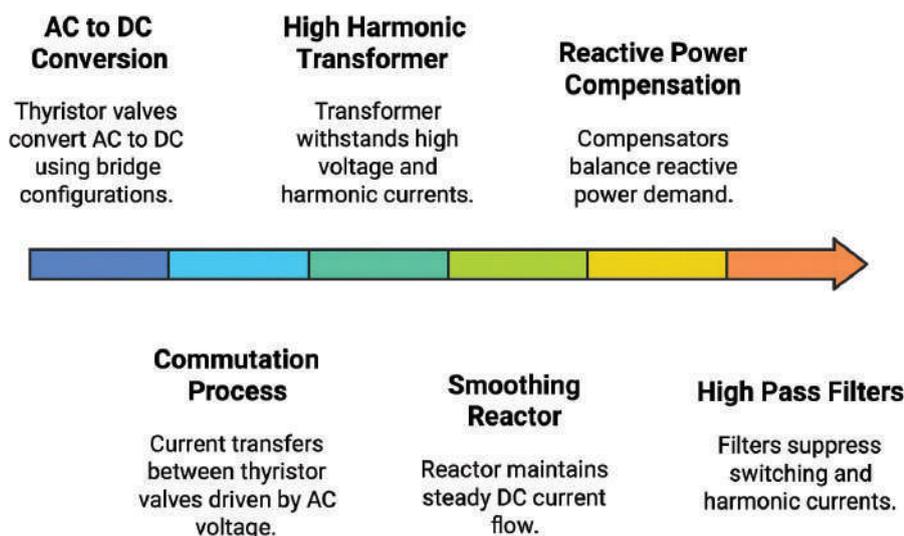


Figure 2: LCC HVDC Transmission System Process [4].

Because LCC converters draw reactive power and rely on a strong AC grid for commutation, they need external reactive compensation and, despite high power and voltage ratings, offer limited flexibility at low load and cannot black start weak grids. In contrast, VSC HVDC systems use self-commutating, voltage-controlled IGBT valves with PWM and compact harmonic filters, overcoming many LCC constraints [5]. This paper therefore focuses on multi-terminal HVDC (MTDC) systems, where three or more converters share a common DC network so any terminal can inject or extract power, interconnecting multiple OWFs and onshore grids across borders beyond simple point-to-point links [6],[7]; a later table compares MTDC and point-to-point HVDC performance under extreme conditions such as heatwaves and wildfires.

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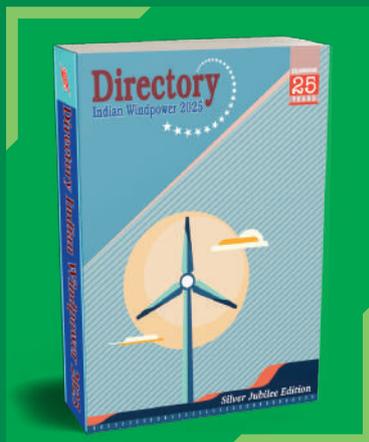
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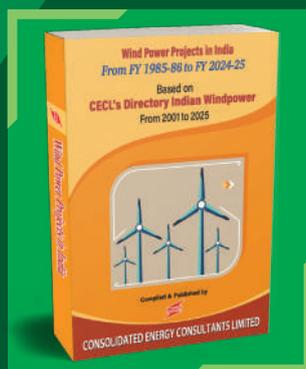
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	P2P HVDC	MTDC
Configuration Redundancy	Single path, if either end fails, link is lost. Unserved load reduction 6.7 % only	Meshed paths, power can be rerouted around outages. Built in redundancy translates to less unserved load, up to 8.6 % reduction
Operational Flexibility	No rerouting options if the only path is down. Reduced total generation cost by only 5.9 %	Meshed topology allows operators to shift power to multiple sources, enabling dynamic rerouting. Reduced total generation cost by 6.4 %
Reduced Curtailment (loss of excess energy)	Can only evacuate surplus wind energy from the single wind farm connected to the converter. If the converter hits the maximum capacity, extra generation faces AC network limits and must be curtailed. Reduce curtailment by 41.8%.	By being able to collect output from multiple wind farms, MTDC can carry away surplus generation of wind energy to terminals that are least congested. Reduce curtailment by 50.3%.

Table 3: Comparing P2P vs MTDC transmission system [8].

There have been recent adoptions of MTDC systems including the Shetland HVDC project and the in-development phase of the North Sea Wind Power Hub, shown in figure 3.



Figure 3: North Sea Wind Power Hub projected location and architecture [28].

The Shetland HVDC project links the 443 MW Viking Wind Farm to the GB grid via a 260 km subsea cable in a three terminal configuration that splits power flows between Shetland, Spittal, and Blackhillock, enabling up to 1.8 TWh per year of generation, enough for nearly 500,000 homes, and supporting 35 permanent jobs and about £70 million in local economic benefits [9],[10]. The North Sea Wind Power Hub, an international MTDC concept connecting OWFs in Denmark, the Netherlands, Germany, and Norway, is projected to cut transmission asset lifecycle costs by around 30% for a 180 GW offshore rollout compared with radial connections, increase social welfare

by €1.0 to 1.7 billion per year, and reduce CO₂ emissions from Europe’s power sector by about 4% by 2040 [11]. Together, these projects show that MTDC based wind transmission is both technically feasible and economically advantageous for large scale renewable integration [9],[10],[11].

Dynamic Line Rating:

Conventional Static Line Rating (SLR) are determined using conservative, “worst case” weather assumptions (e.g. 40 C ambient, zero wind, high solar loading) [12]. Under SLR, the ampacity (maximum allowable current) is chosen so that, even in the hottest, no wind,

high sun conditions, the conductor won’t overheat or sag beyond safe levels. But often actual weather is milder, resulting in SLR underutilizing transmission assets. Therefore, DLR is introduced as it continuously adjusts a conductor’s allowable current in real time by measuring tension, which reflects the combined effects of conductor heating, sag, wind cooling, ambient temperature, and solar radiation. Tension based DLR systems can send live ampacity updates, enabling operators to use temporary increases in capacity when weather conditions permit. The table below will compare SLR and DLR systems incorporated in wind energy transmission.

Feature	SLR	DLR
Weather basis	Assumed worst case (fixed)	Measured in real time (tension sensors), allowing proactive load adjustments to prevent overheating and excessive sag
Congestion Relief	No dynamic congestion mitigation, underutilization of existing transmission lines	Enables active congestion relief by leveraging temporary capacity gains to redirect load
Integration in Wind Energy	Limits wind generation	Supports higher wind integration (e.g. increase of 2 feet per second in wind speed can increase ampacity of transmission line by 15%)
Transmission Efficiency	Fixed rating, suboptimal asset use	Optimizes utilization of transmission network, and boosts power capacity of existing grids by 10-30% for most of the time.

Table 4: Comparing SLR and DLR [12],[13]

Dynamic line rating (DLR) continuously adapts conductor ampacity to actual weather and operating conditions. By using real time tension measurements, it reduces wind generation curtailment, smooths power flow, and can avoid costly new cables or towers for OWFs while enhancing grid stability [14]. The Electric Reliability Organization notes that reliable DLR operation depends on accurate sensor and weather data, cybersecure systems, and secure communication infrastructures so real time ratings can be integrated into control rooms and coordinated among transmission owners, operators, and reliability coordinators [14]. Recent projects highlight the benefits. In the AEL/LineVision 2023 demonstration on a 345 kV line, peak DLR reached 4931 A, a 141% increase over the 2043 A static rating, with average and median DLR of 3294 A and 3279 A, about 60 to 61% above static, whereas an Ambient Adjusted Rating averaged only 2687 A, 32% above static [15]. In the 2022 National Grid and LineVision collaboration on offshore export circuits to England and Wales, DLR averaged 29 to 33% above post fault static ratings, an extra 900 A, exceeded static ratings in 96% of hours, and daily forecasts delivered a 9% ampacity uplift that increased boundary capacity on the SSHARAN B7a interface by 19% and would have avoided approximately £14.25 million in 2022 payments



[16],[17]. Together, these results show that DLR can significantly increase ampacity, lower costs, and reduce wind curtailment risk, underscoring its growing role in wind energy transmission [17].

AVCR, ACSS, and ACCC conductors

Conventional Aluminium Conductor Steel Reinforced (ACSR) conductors consist of one or more layers of cold

drawn aluminum strands helically wound around a galvanized high steel core. The steel core gives the high tensile strength, while aluminum strands provide good conductivity. There have been two other

types of conductors called Aluminum Conductor Steel Supported (ACSS) and ACCC conductors that have better performance compared to ACSR. ACCC consists of annealed aluminum strands helically wound around a steel core and

ACCC consists of a lightweight, hybrid carbon fiber reinforced polymer core and uses annealed trapezoidal aluminum strands. The table below shows the results of the data when ACSR, ACSS, and ACCC conductors are tested:

Metric	ACSR	ACSS	ACCC
Max Operating Temperature	~75-100o C	~200-210o C	210o C
Degree of Sag at 180 C	~222 cm	~241 cm	~101 cm
Tension loss at 180C	~74%	~60%	~50%
10 Year Creep Strain	0.047%	0.051%	0.035%
30 Year Total Cost Efficiency	Lowest ampacity	Moderate ampacity	Highest ampacity
Ampacity Increase vs ACSR	—	~1.2x	~2x
Relative Initial Cost Upfront	1x	~1.1-1.5x	~5-7x

Table 5: Comparing metrics of ACSR, ACSS, and ACCC conductors [18].

ACCC conductors cost more than ACSR and ACSS but offer minimal sag, reduced tension loss, very low long term creep, and up to twice the ampacity, allowing wind farms to increase export capacity without new cables or towers [19]. In AEP’s 345 kV reconducting project, replacing two 120 mile ACSR lines with ACCC doubled capacity, cut power losses by 30%, and saved \$15 million, and similar deployments in Greece and California are expected to

deliver higher ampacity, lower losses, and improved wildfire resilience, making ACCC a cost effective option for wind energy transmission [19],[20].

Energy Storage

Energy Storage systems (ESS) store energy for later use, balancing supply and demand in power grids. The integration of energy storage systems is crucial for renewable energy sources

like wind power by storing excess energy when generation exceeds demand and releasing energy during shortages to stabilize the grid. Ullah et al. categories ESS technologies into different sections, including electrochemical (batteries), mechanical (hydro, compressed air, flywheels, supercapacitors), and chemical (hydrogen) storage [21]. The overview of main ESS types and how they operate are shown in the table below:

Storage Type	What it is	How it works
Battery ESS (BES)	Electrochemical cells (e.g. Li-ion, lead acid)	Charges the battery by converting excess wind generation reversibly
Supercapacitor ESS (SCES)	Double layer capacitors or pseudocapacitors (store energy using oxidation/reduction reactions)	Stores energy electrostatically between charged plates and discharges by releasing stored ions
Flywheel ESS (FES)	Rotating mass (rotor) coupled to motor or generator	Electrical energy spins rotor and generator extract the energy by slowing down rotor
Superconducting Magnetic ESS (SMES)	Superconducting coil maintained below critical temperature	Electrical current circulates indefinitely in the coil, storing energy in the magnetic field.
Hydrogen ESS (HES)	Electrolytic hydrogen production and storage	Surplus energy goes to an electrolyzer. H2 stored and later reconverted to electricity
Hybrid ESS (HESS)	Combinations of two or more ESS technologies	Each subsystem operates within its optimal range

Table 6: Different ESS types and their functions [21]

Energy storage systems (ESS) help wind farms by injecting or absorbing power to counteract frequency deviations, emulating synchronous generator inertia, and smoothing output through storage and release of energy, which reduces curtailment, improves grid stability, and lowers the levelized cost of energy [21],[22],[23],[24]. Grid forming battery systems also allow offshore wind farms to black start and operate in islanded mode during disturbances without external voltage support [25]. At the Hornsdale Wind Farm in South Australia, a 150 MW / 194 MWh lithium ion BESS can inject 100 MW within 150 ms, prevented under frequency load shedding by delivering 84 MW during an August 25, 2018 event, and helped cut average Regulation FCAS costs from \$470/MWh to \$40/MWh, yielding about \$116 million in savings [26],[27].

Conclusion:

The transition to renewable energy requires transmission systems that can reliably deliver large scale offshore wind power to the grid. Recent innovations like MTDC HVDC networks, DLR, advanced conductors like ACCC, and ESS address the technical and economic challenges of wind transmission. These technologies not only improve efficiency and reliability but also reduce curtailment, enhance grid stability, and lower overall system costs. As more real-world adoptions continue to emerge, these advancements show a clear path towards building more interconnected, resilient, and sustainable transmission infrastructures capable of supporting the global shift to clean energy.

AUTHOR



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KREDL's Role and Insights from Windergy India 2025

By Mr. K.P. Rudrappaiah, MD, KREDL

Windergy India 2025 was a significant platform for the Karnataka Renewable Energy Development Limited (KREDL) to engage with global and national leaders shaping the future of wind energy. As a Partner State, Karnataka's participation underscored its deep commitment to accelerating clean energy growth and strengthening India's wind ecosystem.

The event offered an invaluable opportunity for KREDL to showcase Karnataka's strong policy environment, natural wind potential, and investor-friendly initiatives. Our State continues to be one of the most attractive destinations for wind sector investments, supported by a robust regulatory framework, progressive governance, and a clear long-term vision for renewable energy expansion.

A key highlight of the event was Karnataka receiving the award for Highest Under-Construction Wind Capacity, a recognition that reflects our strategic approach, effective inter-agency coordination, and sustained effort in building a modern, scalable wind ecosystem. This achievement also reinforces Karnataka's leadership as a frontrunner in India's renewable energy transition.

Over the three days, KREDL had the opportunity to participate in high-level discussions, industry roundtables, and B2B interactions. These engagements allowed us to connect with OEMs, developers, technology innovators, and financiers, enabling deeper understanding of evolving technologies including larger turbine formats, repowering solutions, hybridisation models, and digital asset management tools. The live demos, technical sessions, and exhibitions further enriched our insights into global advancements and emerging market trends.

The visit of Union Minister Shri Prahlad Joshi to the KREDL pavilion was particularly encouraging. His appreciation for Karnataka's clean energy initiatives reaffirmed the strong alignment between State and Central efforts in meeting India's renewable energy goals. Equally meaningful was the continued guidance and support from Hon'ble Energy Minister Shri K.J. George, whose leadership has strengthened KREDL's resolve to scale up renewable capacity with speed and efficiency.



Windergy India 2025 was more than an exhibition, it was a catalyst for forging meaningful partnerships. The event reinforced the importance of innovation, policy stability, and collaborative action in shaping the next phase of India's wind energy story.

KREDL remains committed to deepening industry engagement, driving new project development, enabling repowering and hybridisation, and improving ease of doing business for investors. As we move forward, our focus will be on translating these learnings into on-ground progress and ensuring Karnataka continues to lead with ambition, capability, and a clear vision for a cleaner and greener future.

As the Partner State, Karnataka leaves Windergy 2025 with renewed momentum, deeper industry partnerships, and a strengthened resolve to scale up wind capacity across the State."



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- Dynamic pitching and advanced yaw alignment control strategy.

Mr. Amit Kansal

CEO & MD,
Senvion India



Need for Future-Ready Turbines Engineered in India

A special interaction with Mr. Amit Kansal –
CEO & MD, Senvion India

To begin with, please share your insights on the future of WTG platforms.

The wind sector in India is currently experiencing a significant transition. After years of rapid growth, the question is no longer just how much capacity we can add but what kind of turbines will power the next phase. IPPs are constantly looking for a better return on investment. They want more generation from their assets, predictable performance, and solutions that make their renewable projects bankable and future ready.

How do you see the current evolution of wind turbine platforms shaping the wind energy landscape?

As India transitions to more complex platforms, it is crucial that turbines are manufactured and engineered within the country.

The Ministry of New and Renewable Energy has accurately outlined a timeline for conducting research and development in India. India's emergence as a global growth engine necessitates the engineering of technology within its borders. Such an initiative will provide more jobs to the highly talented youths of the country.

What key innovations is Senvion integrating into its WTG platforms to enhance efficiency and reliability?

Senvion's 4XM platform is conceived, engineered, and manufactured in India; it combines high local content with design principles that meet international standards. It is rooted in Indian requirements yet ready for global grids.

The prototype, installed and spinning in the Tirunelveli district of Tamil Nadu, is the state's first installation of a 4 MW platform turbine with a rotor diameter

of 160 metres and a hub height of 140 metres, ranking the Senvion 4.2M160 among the largest turbines entering commercial rollout in India.

What makes this turbine special?

At its core, the Senvion 4.2M160 is a three-bladed, pitch-regulated, variable-speed machine in the 4 MW class. The large rotor provides a generous swept area, central to annual energy production. Hub-height options up to 140 metres give developers flexibility when optimising layouts for terrain and wind shears.

Engineering teams in India and Germany developed the 4XM platform over several years, with support from extensive research and development efforts. The design brief was clear: to maximise energy yield at low- and medium-wind sites, keep structural loads under control for long service lives, and make the turbine practical to operate and maintain for decades.

Can you please elaborate on the features of the new platform?

Controls and safety

The turbine uses adaptive strategies. Sensors feed data to the control system, which adjusts operation continuously as wind conditions change. Braking and shutdown routines are tuned to limit extreme loads. The modular control architecture supports diagnostics and future updates, with safety integrated from the start.

Electrical systems and grid behaviour.

The Senvion 4.2M160 uses a DFIG generator that enables independent control of active and reactive power. This supports a high power factor and meets the latest Indian grid code requirements. The design aligns with IEC standards and can adapt to other grids—important for a product that carries a ‘Made in India’ story but has a global horizon.

Cooling and temperature management

For Indian conditions, heat is a daily reality. The 4XM platform uses liquid cooling for major components and air cooling for auxiliaries, keeping temperatures safe even when ambient conditions soar.

Lightning protection

Many of India’s best wind corridors also sit in high lightning exposure zones. The 4XM platform, therefore, uses an IEC-compliant lightning protection system that is designed to capture, conduct, and safely dissipate strikes. The system is approved for LPL-1 according to IEC 61400-24, and it works with other protective devices in the electrical system to lower the chances of lightning damaging the blades, bearings, or converters.

Blades and aerodynamics

The blades feature an aerodynamic

design with advanced materials to ensure strength and efficiency. Integrated flow management elements help maintain performance across conditions. The blade design balances energy capture, load management, and noise reduction. It is engineered to enhance power output and reliability, while sensors provide real-time data to support long-term durability.

The 4XM blade programme includes blade testing, leading edge protection, and manufacturability considerations.

The 4XM blade programme has undergone thorough testing and validation beyond standard requirements to ensure durability and performance. Leading-edge protection and manufacturing processes focus on reliability, quality, and longevity, supported by advanced monitoring and sustainable materials.

Serviceability

The 4.2-M160 turbine is designed with ease of service in mind. Inside the tower and nacelle, walkways, ladders, and anchoring points follow EN and OSHA guidance. Modular nacelle covers, provisions for small service cranes, and craneless repair techniques reduce downtime. Senvion India has been in the business of operations and maintenance for more than ten years. They offer long-term service contracts and have their maintenance teams.

How is Senvion positioning itself with respect to the new ALMM requirements and localisation while maintaining its platform’s competitiveness in India?

The 4XM platform reflects India-led engineering backed by global R&D collaboration. It’s built for India’s wind conditions and ready for export to markets that value reliability and cost efficiency. This is not just a product; it’s a statement of India’s capability to innovate and lead in renewable energy

technology.

The Senvion 4.2M160 achieves more than 85% local content. Nacelles are assembled in Baramati, blades are manufactured in Tiruchirappalli (with a new facility coming up in Gujarat), and towers are sourced from manufacturers across India. Senvion’s current production capacity is 1 GW annually, with work ongoing at an advanced stage to upscale it to 2 GW.

India’s revised Approved List of Models and Manufacturers (ALMM) places a clear emphasis on local manufacturing, grid compliance, and cyber security. The 4XM platform is a proprietary, in-house design supported by local manufacturing and over 85% localisation. The Senvion 4.2M160 has been engineered to adhere to the spirit and requirements of the revised ALMM framework.

The platform already has 600 MW of firm orders. For customers, this combination of new technology, local manufacturing, and proven service capability makes the 4.2M160 a bankable choice. Thus, we believe we are competitive in India!

The turbine was launched at Windergy 2025. Was this a significant occasion for Senvion?

Absolutely. The turbine was launched at Windergy India 2025 in Chennai by the Hon’ble Union Minister for New and Renewable Energy, Shri Pralhad Venkatesh Joshi. We are extremely grateful to the Hon’ble Minister for his presence at this significant event. The excitement during the launch was palpable. Additionally, we provided an extensive virtual tour of our prototype installed in Tamil Nadu, which received highly positive feedback. The tour allowed participants to appreciate the scale of the nacelle and rotor as well as understand the machine’s operational behaviour.

LAULAGUN

bearings

Mr. Pello Irujo

CEO –
Laulagun Bearings,
Spain



Windergy India 2025 illustrated a sector poised for scale, growth, and deeper collaboration. As a global business leader, what signs of renewed confidence or momentum stood out to you that reinforce India's rise as a manufacturing powerhouse?

Windergy India 2025 was the most impressive edition we have attended in the last four years. The exhibition was larger, more international, and featured not only OEMs and utilities but also a strong presence of service providers such as maintenance and logistics companies. The conference sessions attracted influential industry leaders and offered valuable insights. For Laulagun, this was the event with the highest level of engagement, where conversations were translated into concrete requests for quotations and projects, signaling that the market is accelerating. India's commitment to decarbonization (500 GW non-fossil by 2030 and 100 GW wind by 2030), backed by ambitious targets for 2035, reinforces the country's position as a future manufacturing powerhouse.

Laulagun's global footprint spans mature and emerging wind markets. How is the India entity strengthening the company's long-term competitiveness on the international stage?

Laulagun chose India as a strategic location to become a truly global player because of its immense potential and skilled workforce. Since establishing our presence, we have confirmed that this was the right decision—not only have we attracted top talent, but we have also seen strong government support for companies investing locally. India's clear strategy to protect and grow its domestic industry, including measures such as ALMM compliance and mandatory certifications for critical components, ensures that Laulagun India is well-positioned to serve OEMs and contribute to the country's renewable energy ambitions.

As CEO, what leadership principles or values shape your vision for expanding Laulagun's footprint in India's rapidly evolving wind ecosystem?

Laulagun India is not just a subsidiary; it is an integral part of Laulagun. We apply the same leadership model, processes, and operational standards in India as we do in EU. This approach has accelerated the ramp-up of our Indian plant, which now employs 160 professionals who manage everything from bearing design to final production. We are "global", managing culture values professionalism above nationality, and our teams collaborate seamlessly across languages - Spanish, Basque, Hindi, Tamil, French and English—creating a truly global organization.

Tamil Nadu is becoming a preferred destination for wind component manufacturing. How do you see your India facility contributing to the state's ambition of becoming a global wind industry hub?

We chose Tamil Nadu because it is one of India's most important wind hubs, home to leading OEMs such as Siemens Gamesa, Nordex, and Vestas, as well as other major players. This strategic location allows us to stay close to our customers and industry partners. Laulagun India is fully dedicated to the wind sector and plays an active role in Tamil Nadu's green transition. It is clear the commitment of this state, as Tamil Nadu alone delivered nearly 1 GW of wind in 2024. All our employees are from the state, and we collaborate closely with local universities and training centers to nurture talent. Our commitment is clear: to strengthen India's position as a global wind industry hub supporting Make in India strategy.

Modern wind platforms demand stronger, more adaptable engineering partnerships. How is Laulagun collaborating with OEMs in India to co-develop solutions, accelerate innovation, and enhance turbine performance?

Our engineering department in India supports global design

efforts while also working on local product development and prototype industrialization for Indian OEMs and international customers with assembly plants in India. Our long-term strategy and knowledge since the end of the XX century allow us to empower our Indian team to innovate and develop next generation bearing solutions for future turbine platforms.

With turbine sizes and project complexities increasing worldwide, what foundational capabilities must India build today to emerge as a key contributor to next-generation global supply chains?

India must reduce its dependency on imports for critical components and subcomponents. In our case, this means developing competitive suppliers for large, forged rings—up to 3–4 meters in diameter—and ensuring the availability of high-quality alloy steel. This requires investment in forging and heat-treatment capacity for large components, as well as a robust domestic steel industry capable of producing the necessary formats. Building these capabilities will position India as a strong contributor to global wind supply chains.

How do you see emerging investment trends in India's wind sector influencing Laulagun's long-term growth strategy and expansion roadmap?

Over the past six to seven years, we have seen India invest heavily in infrastructure such as ports, roads, and industrial corridors, which directly benefits the wind sector. Foreign and domestic investments in renewable energy have grown significantly, creating a dynamic ecosystem around our plant. When we first established our facility, the area had only a few manufacturers; today, it is a thriving industrial zone. This trend gives us confidence to plan for capacity expansion and technology upgrades, ensuring Laulagun India remains a key pillar of our global strategy. India has become the world's third-largest economy, boasting a very attractive population pyramid (average age 28), over 5,000 universities, GDP growth of 6.5% (higher than any other nation), interest rates at 5% and falling, and inflation below 3% etc. All indicators are very promising. India is performing exceptionally well due to an extraordinary well define strategy.

In your view, how can strong public-private partnerships accelerate infrastructure development, logistics readiness, and investment inflows for India's wind industry?

The transformation we are witnessing in India's wind sector would not be possible without strong public-private collaboration. Private investment must be supported by public initiatives that create an enabling environment, modern ports, efficient road networks, and logistics and energetic infrastructures. Without this, industrial growth faces significant constraints. India is making commendable progress in this area, and continued partnership will be essential to scale manufacturing and attract global investment.

India's renewable energy policies are evolving at an unprecedented pace. How is Laulagun leveraging this policy momentum to optimize investment, scaling decisions, and technology deployment?

A stable and forward-looking policy framework as the revised ALMM-regulated procurement and components list is critical for investment confidence. India's clear long-term strategy and ambitious targets provide certainty that the market will remain strong. This assurance has allowed us to maximize our current capacity and plan for expansion. Without this policy clarity, we would not consider such strategic moves. The framework gives us confidence to invest in advanced technology and scale operations to meet future demand.

Every industry faces critical turning points. Which challenges in India's wind sector do you believe are becoming catalysts for innovation, operational efficiency, or new business opportunities?

One critical challenge is the limited availability of large size forged rings in India. These rings require special alloy steel and advanced heat-treatment capabilities, which are currently scarce locally. This dependency on imports increases costs and impacts competitiveness, especially on export markets where fully assembled bearings from abroad enjoy duty exemptions. Additionally, the recent increase in Basic Customs Duty from 10% to 15% on imported rings—representing 65–70% of bearing cost—further pressures margins. These constraints are driving innovation in supply chain localization, forging technology, and material science, creating opportunities for new partnerships and investments in India's industrial ecosystem.

Digitalization is reshaping manufacturing worldwide. What role do advanced technologies such as automation, predictive analytics, and smart quality systems play in overcoming operational hurdles and elevating India's manufacturing competitiveness?

Digitalization is a strategic enabler for competitiveness. At Laulagun, automation reduces variability and accelerates throughput in large bearing production. Predictive analytics helps us anticipate equipment failures and optimize maintenance schedules, minimizing downtime and cost. Smart quality systems ensure traceability and compliance with global standards, which is critical for OEM partnerships. For India, these technologies bridge the gap between cost efficiency and world-class quality, positioning the country as a reliable hub for next-generation wind components.

Looking ahead over the next five years, how do you envision Laulagun India contributing to the global company strategy, and what milestones are you most excited to achieve?

Laulagun India is central to our global growth roadmap. Over the next five years, we aim to double production capacity, integrate advanced machining capabilities, and expand our engineering team to lead product development for emerging turbine platforms. We are excited about milestones such as launching new bearing designs tailored for 15+ MW offshore turbines, achieving full ALMM compliance, and positioning India as a global export base for critical components. Our vision is clear: Laulagun India will not only serve the domestic market but become a strategic pillar for global supply chains.

Mr. Sunil Kumar Srivastava

General Manager,
TPI Composites India Pvt. Ltd,
Kanchipuram



Windergy India 2025 (Oct 29-31st) placed a strong emphasis on self-reliance (Atmanirbhar Bharat) and advanced manufacturing. From your leadership perspective, what encouraging signals did you see around India's readiness for next-generation turbine platforms?

This Windergy India was most successful event in recent years due to high number of companies participated & demonstrated their product and capabilities. It gave opportunity to not only existing player in the industry but many new entrants to this sector who are ready to explore Indian Wind Energy sector.

I had attended exhibitions and Conference/ panel discussions in Windergy India at Chennai. It was quite evident that Indian Wind Industry is growing faster than it was expected which is very good sign.

It was quite encouraging to see the latest technology integration in this sector and planning of higher capacities (4MW & 5MW) of Wind Turbines for the domestic market.

Personally, it was great opportunity to meet Wind Industry veterans, colleagues and some key figures and to know the future landscape of Indian wind Industry. I had pleasant surprises with meeting of many of ex colleagues and with some of them after many years.

TPI India has emerged as a key global facility. What strategic priorities have guided your transformation journey across operations, culture, and customer partnerships to consistently deliver world-class outcomes?

I am in this Industry since last 18 years and observed Blades

are most critical component of Wind Turbine. We were careful of this fact while setting up the plant and our focus was highest quality of the Blades. We remain committed to follow the intended design, consistency in manufacturing process and always explore new ideas and improvements. Our prime focus is defect-free blades only must go out of our plant. I am happy that we are successful in this mission and continue to follow same focus.

As India moves toward 100 GW of wind capacity by 2030 (with GWEC projections up to 107 GW), what capability enhancements or long-term investments are you steering to align with this national ambition?

Currently we are producing the blades for export markets. Blades Produced at our Chennai plant being shipped to US, Europe, Australia, South Africa and South American countries. Our prime focus is to remain competitive with highest standard of Safety, best quality, on time delivery and cost for global markets which will help for India to become export hub for the Wind Industry.

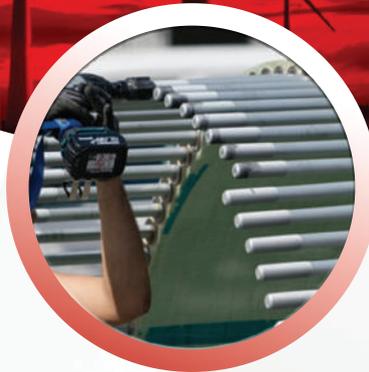
Our next focus is to support country for net Zero journey with supplying blades for the domestic market. We are working with OEMs to expand our manufacturing footprint for the Indian market.

OEMs are rapidly transitioning to larger rotors, hybrid configurations, and repowering programs. How is TPI India strengthening its manufacturing, tooling, and engineering capabilities to support this next cycle of turbine evolution?

As Industry is transitioning to larger rotors, the technology advancement is imminent. Even though labour is cheap in India, but technology advancement is required for better



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quality and consistency. We always try to improvise the processes, methods and tools for quality and productivity improvements. We have strong engineering team for designing the processes and tooling who closely work with production to understand the manufacturing challenges and improvements. Our Engg team give feedback to design to improve upcoming designs in terms of manufacturability and better productivity. We are at very advanced stage of AI integration into Blade manufacturing process which is unique and will be industry trend setter.

TPI India's recognitions including global safety accolades and workplace culture awards reflect deep organisational discipline. What practices or leadership mindsets have been central to building a high-trust, high-performance culture?

The Wind industry is quite new in comparison to automotive Industry and technology is still not so advanced. I came from automotive background and could find huge improvements opportunity with implementing systems and procedures. Our strong focus was highest safety standard, zero defect and on time deliveries. Our objectives are drilled down to everyone, and entire organization is aligned towards these goals and work together. We celebrate our success together and work together to improve in case of failure if any.

Talent readiness is becoming a competitive differentiator for the wind industry. How is TPI India developing the next generation of composite specialists and leaders through structured training, upskilling, and exposure to global best practices?

In this Industry Product and processes quality still largely depends on the human skills. Being relatively small industry there is always scarcity of good human resources whether in shopfloor or engineering skill. We focused to generate new resources and started hiring freshers at shopfloor operator and engineer level also. The main objectives were to bring more resources to Industry and get fresh brain. We also hired engineers from automotive industry to bring new perspective to blade manufacturing. In that way we have developed many resources both at production operator level and engineer level. We have best & unique training structure & programs for skilling and upgrading the skills.

Government partnerships and state-level incentives (e.g., Tamil Nadu) have supported your scale-up journey. Which policy mechanisms have been most impactful for TPI India?

During our plant set up whole world got into covid lock down. It was difficult time for us to set up new plant. We got very good support from Tamil Nadu govt and local administration to continue our operations and plant setting

up activities during entire lock down period. Govt is supporting us for road infrastructure development, access to nearby port etc. Also, TN Govt has offered Capital subsidy, electricity tax waiver and one time training subsidy. These are quite helpful & encouraging for Industries to set up manufacturing.

While India faces challenges around grid stability and supply chain variability, the country also offers strong structural advantages. From your vantage point, what unique strengths especially within Chennai's industrial ecosystem position India to become a global hub for blade manufacturing and services?

Chennai has following advantages:

- Wind Turbine installation was started in Tamil Nadu almost 30 years back. There are various western OEMs already operating at Chennai and around. It has various design offices and manufacturing plants.
- Now Chennai has developed as cosmopolitan city, and people are moving from different part of the country to the Chennai. There is availability of talent and skilled resource.
- Kamraj Port Limited is working aggressively to develop the port infrastructure to handle and ship the big blades.
- State and NH departments are working in collaboration to develop road infrastructure to support the heaving parts like Blade shipment and road transportation.

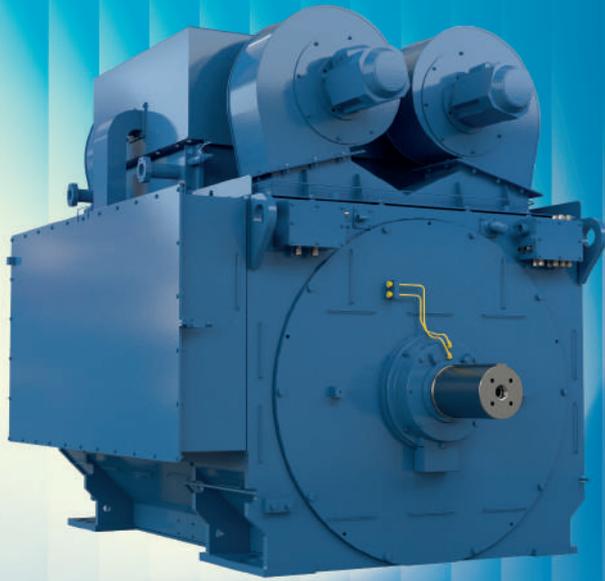
All these developments have made Chennai a global hub for manufacturing and services.

As India accelerates toward its renewable energy ambitions, what is your long-term vision for TPI India's role in strengthening the country's manufacturing leadership and contributing to the global transition to cleaner energy?

We are manufacturing the wind blades since last 6 years and able to maintain high level of safety and Quality standards. We never missed any delivery to our customers. Blade manufacturing companies are bench marking TPI India. Currently TPI Global is undergoing thru financial restructuring processes at US. Once this phase is over, I see bright future for TPI India in terms of filling our plant capacity. Since Indian Wind Industry is growing, I see opportunity to contribute and as well help India to become export hub with lots of push for localization & with support of Govt policies.



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REGULATORY UPDATES - Oct. 2025 onwards

Mr. Om Taneja, Independent RE Consultant



A. MNRE has issued an O.M. No. 233/1/2018-Wind dated 29.10.2025, regarding SOP for ALMM-Wind and ALMM-WTC in continuation of MNRE's O.M. of even no. dated 31.07.2025 regarding amendment to "Procedure for inclusion/Updating Wind Turbine Model in the RLMM (renamed as ALMM(Wind)). The Standard Operating Procedure (SOP) is issued for benefit of stakeholders and compliance.

Key Points of the SOP / Notification

1. Renaming & Framework

- o The earlier "Revised List of Models & Manufacturers (RLMM)" is now renamed as ALMM-Wind.
- o A separate list, ALMM-WTC, is introduced for wind turbine components.

2. Mandatory Sourcing of Key Components

- o Wind turbine OEMs (original equipment manufacturers) are required to source blades, towers, gearboxes, generators, and special bearings (main, pitch, yaw) only from manufacturers listed in ALMM-WTC.

- o The SOP requires that the Type Certificate of a wind turbine model explicitly mentions the manufacturing or assembly facilities for those components.

3. Inspection & Quality Assurance

- o A MNRE will constitute a technical team willto physically inspect the component manufacturing facilities.
- o Only components from those certified and inspected facilities (i.e., on ALMM-WTC) will be eligible to be used in ALMM-Wind-approved turbine models.

4. Cybersecurity & Data Localisation

- o All operational data from wind turbines must be stored in data centres / servers located within India.
- o Real-time transfer of operational data outside India is prohibited. Operational control of wind turbines must be from within India.
- o OEMs must establish an R&D centre in India within 1 year of the notification.



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5. Exemptions / Transitional Provisions

- o Projects whose bids closed before the date of the OM (31 July 2025) are exempt from the component-sourcing requirement, if they commission within 3 years.
- o Wind power projects (captive / open access / C&I / third-party sale) to be commissioned within 18 months from the OM date are also exempt.
- o New turbine manufacturers or new turbine models are exempt (i.e., they don't have to use ALMM-WTC listed components) for up to 800 MW of capacity over 2 years.

6. Transparency & Disclosure

- o The SOP increases supply-chain transparency: manufacturers must disclose their vendors / sources for the key components (blade, tower, etc.) when applying for ALMM-Wind.
- o Public listing under ALMM will include details of these component suppliers.

7. Credibility of Certifying Bodies

- o The SOP requires that both type certification bodies and ISO / quality certification bodies be accredited, ensuring their credibility.

8. Goal / Strategic Intent

- o The move is clearly aimed at boosting domestic manufacturing ("Make in India") by ensuring key components are produced locally. It also strengthens data security and cyber-resilience in the wind energy sector via localization of data and control.

On December 01, 2025 as per OM of MNRE, Clause 8.1 para titled 'Performance Efficiency and Safety Issues' of the above cited SOP is amended as below:

The committee will deliberate on the turbine's performance, ensuring the power curve has been tested and certified by an accredited laboratory in accordance with IEC 61400-12-1 and that all supporting performance data aligns with regulatory expectations including performance in representative geographical conditions. Manufacturers accordingly are encouraged to carry out the prototype testing in India. The requirement of prototype testing in India will be mandatory after two years from the date of issuance of this amendment subject to a review.

- B. MoP has issued the draft Electricity (Amendment) Bill, 2025, along with an explanatory note, and a comparative statement detailing the existing provisions of the Electricity Act, 2003, the corresponding proposed amendments and justifications thereof.

Major Reforms in the Draft Electricity (Amendment) Bill, (2025)

Mandatory Cost-Reflective Tariffs

- The draft Bill requires electricity regulators (state electricity regulatory commissions, SERCs) to set cost-reflective prices – i.e., the tariff must more closely match the actual cost of supply.
- If a utility (a discom or generator) fails to submit its tariff petition on time, the regulator can act suo motu (on its own) to revise tariffs.
- Revised tariffs determined via this process would be implemented from April 1 of the next financial year
- At the same time, the draft Bill retains the ability for state governments to provide advance subsidies to certain consumer groups (e.g., vulnerable consumers) so that tariffs remain affordable.

2. Elimination / Phasing Out of Cross-Subsidies

- The draft bill proposes to phase out cross-subsidies (where some groups pay more to subsidize others) for: manufacturing enterprises, the Indian Railways, and metro systems. The timeline: within five years of enactment.
- The logic: reducing industrial and transport tariffs will boost competitiveness (especially for MSMEs), lower logistics costs, and make tariffs more economically efficient.
- However, to protect poorer / vulnerable consumers, the subsidy mechanism is preserved but made more transparent and targeted.

3. Competition in Distribution (Multiple Discoms)

- The draft Bill allows multiple distribution licensees (discoms) to operate in the same geographic area (i.e., network sharing).
- It mandates non-discriminatory open access to existing distribution infrastructure, so different suppliers can use the same network.
- To ensure reliability, regulators can designate a "supplier of last resort": if a consumer's chosen supplier fails, this fallback supplier will serve them – but possibly at a premium over the cost of supply.
- The idea is to push distribution away from monopoly state-discoms to a more consumer-choice, competitive model

4. Institutional & Regulatory Strengthening

- Creation of a National Electricity Council, to coordinate electricity policy between the Centre and states. Chaired by the Union Power Minister, with state power ministers as members
- Regulators (CERC / SERC): stronger accountability. The Bill enables removal of commission members for “willful violation” or “gross negligence
- The draft Bill proposes strict timelines: commissions must dispose of adjudicatory cases within 120 days
- Increase in the size of the Appellate Tribunal for Electricity (APTEL): from 3 members to 7 members to handle backlog.

5. Recognition of Emerging Technologies

- Energy Storage Systems (ESS) are formally defined in the draft Bill (e.g., systems that store electricity and release it when needed).
- The definition of “power system” is expanded to include ESS.
- For captive generation (i.e., companies producing power for their own use), the draft Bill gives explicit regulatory authority to central and state governments to frame rules – bringing more clarity.

6. Market Development & Clean Energy Push

- The Central Electricity Regulatory Commission (CERC) is empowered to introduce market-based instruments: spot markets, derivatives, contracts for difference (CfDs), virtual PPAs, etc.
- It mandates state regulators to ensure a minimum share of electricity is procured from non-fossil (renewable) sources, per targets prescribed by the central government.
- There are penalties for non-compliance with Renewable Purchase Obligations (RPO), potentially exceeding the cost of RE certificates (RECs) to discourage non-serious compliance.

7. Right-of-Way & Electric Line Authority

- The draft Bill replaces earlier telegraph-focused legal provisions (e.g., from the Telegraph Act) and introduces an “Electric Line Authority” (ELA) to manage electric lines / right-of-way
- This is intended to streamline the process of laying, maintaining, and managing transmission/distribution lines.

8. Enforcement & Penalties

- For non-compliance with non-fossil obligations or unauthorized electricity use, the draft proposes monetary penalties. For example, a proposed penalty rate (for RPO shortfall) is in the range of ₹ 0.35 to ₹ 0.45/kWh.
- The assessment period for unauthorized use might be limited (e.g., to one year) and appeals’ deposit requirements are reduced.

9. Governance over Captive Generation

- The draft Bill gives powers to central and state governments to frame uniform rules for captive power generation – clarifying criteria, verification, and regulation.
- This could encourage more industries to set up captive generation (especially clean energy + storage) by reducing regulatory uncertainty.

Other Notifications:

22.10.2025_CERC proposes buy-out price of INR 245 per MWh for fulfilling RCO obligations

03.10.2025_MNRE Advisory to all Government agencies (Both Central Govt./State Govt.) in Renewable Energy sector regarding Strict compliance of rules and regulations in procurement of Goods and Services.

13.10.2025_MNRE releases importer manual for Renewable Energy Equipment Import Monitoring System (REEIMS)

10.10.2025_Government of India notifies first emission intensity targets for carbon intensive sectors

07.10.2025_CEA proposes upgrades to power sector infrastructure and cybersecurity standards

11.09.2025_APTEL upholds wind developers’ claim for compensation under deemed generation

India News

MNRE Pushes for 85% Localisation in Wind Projects

Union Minister Pralhad Joshi has urged the wind energy sector to raise domestic content from the current 64% to 85%, reinforcing the government’s focus on deeper manufacturing localisation. The Minister noted that higher domestic value addition would help position India as a global hub for wind turbine and component manufacturing.

Source: *Economic Times Energy* | Oct 2025



Tamil Nadu Opens Bids to Convert Old Windmills into Solar-Wind Hybrids

Tamil Nadu Green Energy Corporation Ltd. (TNGECL) has floated tenders to repower ageing wind farms by integrating solar capacity, creating hybrid projects totaling 34.75 MW (18.75 MW wind + 16 MW solar). The initiative, estimated at ₹200 crore, covers locations including Kayathar, Muppandal, Kethanur and Puliyankulam and supports the state’s hybridisation strategy.

Source: *The New Indian Express* | Nov 2025

India Strengthens Position as Wind Component Export Hub

India’s turbine, blade, tower, and nacelle manufacturing capacity now exceeds 20 GW annually, enabling the country to emerge as a major global export hub for wind components. The growth in domestic capability continues to boost India’s participation in global supply chains.

Source: *Economic Times Energy* | Oct 2025

India’s Wind Capacity Could Reach 452 GW by 2050

India’s wind energy capacity could scale to 452 GW by 2050, according to industry leaders at the Windergy India 2025 press conference. India has utilised only about 4.5% of its assessed potential of 1,165 GW, despite strong growth from 21 GW in 2014 to 53 GW today. The sector’s 122% expansion over the past decade strengthens India’s position as the world’s third-largest wind market.

Source: *BusinessWorld Energy* | Oct 2025

Inox Wind & KP Energy Partner to Develop 2.5 GW of Renewable Projects

Inox Wind and KP Energy have signed an MoU to jointly develop 2.5 GW of renewable energy capacity, spanning wind and hybrid wind-solar projects. Inox Wind and its subsidiaries will supply turbines and engineering support, while Inox Green will oversee long-term O&M. KP Energy will handle land acquisition, connectivity, statutory clearances and EPC execution. The partnership strengthens both companies’ presence in India’s rapidly expanding utility-scale renewables market.

Source: *Economic Times Energy* | Nov 2025

VOC Port Sets Record by Unloading 103 Windmill Blades in One Shipment

V.O. Chidambaranar Port Authority (Tuticorin) achieved a major milestone by unloading 103 windmill blades from a single vessel - MV GHT Marinas on 11 November 2025. This surpasses the previous record of 101 blades.

The port has handled 2,300 blades up to October in FY 2025–26 a 61% increase over the 1,425 blades handled during the same period last year.

The cargo arrived from Qinzhou Port (China) and was handled at Additional Berth-II using two harbour mobile cranes along with NTC Logistics India Pvt. Ltd. as the logistics and stevedoring partner.

Source: *VOC Port Authority Official Press Release* | Nov 2025

CERC Allows Tariff Relief for RE Projects Following GST Rate Cut

The Central Electricity Regulatory Commission (CERC) has ruled that power distribution companies may seek tariff adjustments for renewable energy projects affected by the GST reduction announced in September 2025. The GST rate cut from 12% to 5% will be treated as a “change in law” event for projects where bid submission took place before 22 September but procurement or commissioning occurred after this date.

CERC stated that RE developers and discoms must account for the impact of lower GST rates during tariff determination and pass on the benefit to consumers as part of anti-profiteering measures. The regulator noted that the reduced tax rate results in a tangible decrease in project cost, and generating companies must share all supporting documents with discoms for reconciliation.

Source: *Business Standard* | Nov 2025

Unlocking Uncontracted RE Projects

IWTMA Chairman, Shri Girish Tanti expects over 40 GW of uncontracted RE projects to shift to the FDRE model, integrating wind, solar and BESS for firm power. About 45.34 GW of awarded capacity is still awaiting PPAs and is under government reassessment.

Source: *Economic Times Energy* | Dec 2025

International News

New Jersey's 2.4 GW Offshore Wind Project Cancelled

Invenergy has cancelled the 2.4 GW "Leading Light Wind" offshore project off the coast of New Jersey due to cost inflation, supply-chain constraints, and regulatory challenges. The cancellation reflects the broader difficulties facing U.S. offshore wind developers.

Source: *Utility Dive* | Oct 2025

Ørsted Announces Workforce Reduction Amid Market Pressures

Ørsted has confirmed a major organisational restructuring, including a significant reduction in global headcount, as part of its response to rising project costs and market volatility. The company stated that the changes aim to stabilise finances and streamline operations across its offshore wind portfolio.

Source: *Ørsted Corporate Announcement* | Oct 2025

GWEC Urges Japan to Reform Offshore Wind Auctions

The Global Wind Energy Council (GWEC) has called on Japan to improve its offshore wind auction design, citing the need for clearer permitting, stronger transparency, and better public-private collaboration. The reforms are expected to be crucial for Japan to meet its renewable energy deployment targets.

Source: *Wind Insider Asia* | Nov 2025

Global Offshore Wind Capacity Projected to Triple by 2030

According to IRENA's latest offshore wind outlook, global capacity currently around 83 GW could nearly triple by 2030. Strong policy commitments, falling technology costs, and expanded manufacturing capacity across Europe and the Asia-Pacific region are driving this acceleration.

Source: *IRENA Offshore Wind Outlook* | Sep 2025

Global Offshore Wind Awards 2025 Highlight Innovation and Excellence

The Global Offshore Wind Awards 2025 have opened nominations, recognising outstanding achievements in technology, project execution, safety, and supply-chain advancement. The awards reflect the sector's ability to innovate despite market and supply-chain pressures.

Source: *RenewableUK* | Oct 2025

Gurit Inaugurates Advanced Composites R&D Center in Tianjin, China

On 17 November, Gurit officially inaugurated its Advanced Composites Research & Development Center in the Tianjin Economic-Technological Development Area (TEDA). The unveiling ceremony, held at Baoxin Tower, marks a significant milestone in Gurit's global strategy, strengthening its "R&D-

to-production" capabilities and reaffirming its long-term commitment to the Chinese market. The center will focus on research, development, analysis, and testing of PET materials and will be fully operational by the end of 2025.

Source: *Gurit Corporate Release* | Nov 2025



Shaping the Wind Story After COP 30: Why Strategic Communication Will Decide the Future of Hybrid Grids and Storage

By Mayuri Singh and Nishant Saxena

COP30 ended with a message that echoed across pavilions in Belém. Tripling renewables is no longer a distant aspiration. It has become the centrepiece of the global Action Agenda, backed by unprecedented commitments for grids and storage infrastructure. Countries and utilities collectively signalled that the energy transition will now be decided on the strength of the

wires beneath our feet and the batteries behind the meter.

In Brazil's humidity soaked air, one number travelled rapidly across negotiations. A one trillion dollar global pipeline for modernising and expanding grids is finally in motion. Companies under the Utilities for Net Zero Alliance locked in 148 billion dollars annually for clean

energy grids and storage. Governments announced regional financing packages. Energy storage pledges were renewed with political backing. These are not just financial signals. They are narrative signals. They tell the world that the bottleneck is shifting from ambition to implementation.

India now finds itself at a pivotal



moment. Our wind sector has technical maturity, investor appetite and clear complementarity with solar power, yet struggles with integration and alignment across regulation, procurement, and public imagination. And this is where strategic communication combined with regulatory clarity becomes a decisive tool. Wind, solar and storage can only move together when their story moves together.

Where Wind Fits Into the Energy Transition

During daylight hours, solar has dramatically reshaped India's supply curve. At night, thermal plants still shoulder nearly eighty percent of non-solar demand. Wind is the only renewable resource capable of altering this equation at scale because it peaks in the very hours when solar sleeps.

Wind and solar, when paired well, behave like two musicians carrying different parts of the same melody. Their diurnal and seasonal complementarity creates a smoother power curve. It reduces strain on dispatch planners. It helps utilities meet Renewable Purchase Obligations more reliably.

And it turns wind-solar hybrids into stronger performers with higher CUF, better utilisation of transmission corridors and more competitive tariffs.

Yet this complementarity remains an under-told story. Investors appreciate it. Engineers work with it every day. Policymakers acknowledge it in principle. But the wider public and even DISCOM boards often engage with wind as an isolated technology rather than as part of a hybrid or storage ecosystem that delivers round-the-clock clean power.

This gap in storytelling shapes a gap in regulation and procurement. And the reverse is also true.

The Regulatory Reality: Promising on Paper, Patchy in Practice

The regulatory architecture around India's wind expansion is evolving, but

unevenly. We now have:

- A rising RPO/RCO trajectory that mandates wind-specific procurement.
- Ten gigawatts of planned annual wind auctions from 2024 to 2028.
- New micrositing guidelines and repowering incentives.
- Hybrid and storage-linked tender designs.

On paper, this is a well-structured ecosystem. On the ground, three challenges dominate.

First, RPO/RCO compliance remains inconsistent across states, creating uncertainty for developers and turbine manufacturers.

Second, grid connectivity and land coordination continue to delay commissioning timelines, which undermines project bankability.

Third, storage and hybrid tenders still operate within procurement frameworks designed for single-technology projects. This limits the scope for optimising wind-solar complementarities and using BESS judiciously rather than ubiquitously.

These are not just administrative issues. They shape how the sector is perceived. Regulation tells a story long before communications teams do.

Storage: Crucial, But Not the Only Hero

At COP30, battery storage was framed as the backbone of future grids. Countries pledged to scale storage sixfold by 2030. Developers showcased hybrid solar-storage projects. Utilities stressed that flexibility will define the next decade of clean energy.

Yet in India, storage must not be seen as a silver bullet that can substitute for the natural synergy between wind and solar. Storage is expensive and still scaling. A communications narrative that overstates its role risks shifting focus away from a simpler, more cost-efficient solution. The grid gets more reliable

when wind and solar are planned and procured together. Storage then acts as a balancing force, not the foundation.

Telling this story clearly is essential for policymakers because it reassures them that the path to round-the-clock renewables is both technically feasible and economically rational. And it is equally essential for the public, who often hear about intermittency but not about complementarity.

Why Communications Must Move In Step With Grid Codes and Policy Design

Here is where the combined expertise of a communications strategist and a regulatory advisor becomes powerful. India's renewable narrative needs three specific reframings.

One, shift from megawatts to megawatts delivered when needed.

This aligns communication with the very heart of grid integration. Policymakers increasingly want dispatchable renewable power. A narrative focused on hybrid CUF, evening peaks, and avoided thermal ramping helps build confidence in wind-solar-storage ecosystems.

Two, spotlight regulatory certainty as a climate ambition enabler.

Auction stability, timely grid access, hybrid tender consistency and clear rules for BESS services must be communicated in tight language so investors see predictability.

Three, humanise the transition.

People trust energy stories when they understand what is at stake. Renewable energy creates manufacturing jobs, supports local economies, reduces air pollution and strengthens energy security. Wind cannot remain only an engineering discourse. It must become a livelihoods discourse.

Communications that stay in lockstep with evolving legal incentives and grid reforms ultimately help policymakers see renewables not as an intermittency challenge but as a reliability solution.

The Way Forward: India Needs Technical Proof, Regulatory Certainty and Narrative Confidence

COP30 has shown that grids and storage are now global priorities. India has the advantage of a naturally complementary resource profile, a strong manufacturing base and ambitious national targets. What we need next is synchronisation.

- Synchronisation between regulation and procurement.
- Synchronisation between wind and solar.
- Synchronisation between storage economics and grid codes.

And above all, synchronisation between policy ambition and public imagination.

When strategic communication explains grid integration in accessible language. When regulation reinforces clarity rather than complexity. When hybrid projects are framed as the foundation of India's round-the-clock clean energy future. Then the sector not only builds capacity but also builds confidence.

The energy transition is no longer a story of technologies competing for space. It is a story of systems learning to breathe together. And in that story, wind will matter more than ever.



AUTHORS



Mayuri Singh is a regulatory and legal specialist in India's energy and infrastructure sectors, bringing more than two decades of experience across policy design, compliance architecture, and sectoral governance.

As co-founder of Comm'fident, she builds regulatory storytelling frameworks that help clients navigate emerging grid codes, storage norms, and renewable energy regulations.

A POSH trainer, Mayuri, through her work blends courtroom precision with sectoral insight, ensuring that communication strategies remain legally grounded and aligned with India's evolving energy transition pathways.



Nishant Saxena is a strategic communications advisor, journalist, and co-founder of Comm'fident, a purpose-driven consultancy shaping climate and energy narratives in India.

He works at the intersection of policy, public storytelling, and sectoral strategy, helping organizations communicate complex climate and energy transitions with clarity and cultural resonance.

Through Climate Kahani, his Hindi climate newswire, he focuses on translating global energy developments into accessible, ground-level stories that inform public understanding and influence decision-makers.



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Overview

SANY Wind Energy India Pvt. Ltd. is a subsidiary company of SANY Renewable Energy Co. Ltd. The company focuses on manufacturing, supplying, and servicing advanced onshore wind turbines tailored to India's renewable-energy landscape. Leveraging global expertise and strong local operations, SANY is rapidly expanding its footprint in the Indian wind sector.

Headquarters & Presence

- Headquartered in Pune, Maharashtra
- Manufacturing/Assembly of Nacelle and Hub of 4 MW wind turbine and its testing
- Growing presence across key wind states through major IPP projects deployments

Products & Technology

- Specializes in MW-class onshore wind turbines
- Flagship model in India: SI 16840 – 4 MW turbine
- Vertically integrated manufacturing for key components including blades, generators, control systems, and drivetrains
- Solutions optimized for diverse Indian wind conditions, ensuring high performance and reliability
- Planning for large capacity wind turbines suitable for low-medium wind regime of India

Certifications

- ISO 9001:2015 certified for quality management systems
- 4 MW Turbine model approved under MNRE-ALMM, meeting Indian regulatory and grid code compliance standards



Major Achievements

- Secured significant wind turbine supply contracts in India (2024–25), including large orders
- Successfully supporting “Make in India” through increasing localization and domestic supply chain development

Strategic Focus

- Strengthening India's renewable energy ecosystem through technology, local manufacturing, localization of key components in India and local R&D
- Delivering cost-efficient, high-reliability wind turbine solutions supporting India's clean-energy targets
- Enhancing O&M capabilities and digital monitoring systems for improved asset performance

Parent Company

SANY Renewable Energy Co. Ltd., Beijing, China, the global parent organization, is a leader in wind turbine R&D, manufacturing, and wind-farm operation worldwide, with projects across Asia, Europe, Africa, and the Americas. Please visit <https://en.sanyre.com.cn/> for more details.

About Country Manager and Director:

Dr. Govind Bhagwatikar

has been leading this Indian subsidiary of Sany RE since its inception. With over 30 years of experience in grid-connected wind and solar power, he has held leadership roles at Welspun Renewables, Siemens Wind Power, Vestas, MEDA, and other major organizations. He holds a Ph.D. in Electrical Engineering, specializing in Wind Energy Integration with Power Grid.



Under his leadership, Sany Wind India has made significant progress in the country's wind energy sector, including successful market entry, the launch of its 4 MW turbine model, and the securing of major wind turbine orders—positioning Sany as one of the leading wind turbine suppliers in India.

WELCOME
IWTMA NEW MEMBER

KK Group – Powering Change in India



KK Group is a global leader in power, controls, cooling, and monitoring solutions for renewable energy and energy intensive industries. We are a diverse team of more than 3,700 people across 10+ countries around the world, including more than 450 colleagues in India.

With more than 45 years of experience in the wind industry and technologies installed in over 120,000 turbines globally, we deliver advanced systems that enable renewable energy to electrify industries, homes, and communities worldwide.

Backed by our long-term owner, A.P. Moller Holding, we are expanding into energy-intensive industries such as hydrogen, mining, rail, and defence, enhancing industrial efficiency, and support the transition to a cleaner future.

Why we are here

The world's energy demand is shifting rapidly to address the growing climate crisis, geopolitical challenges and concerns about energy security. Together with our partners, we strive to enable the transition to electrification through renewable energy adoption as well as increasing efficiency of energy intensive industries worldwide.

Our solutions help increase the reliability and reduce cost of renewable energy production and increase the efficiency of industries through advanced cooling solutions.

What we do

Our converters, controllers, backup, cooling and monitoring solutions are critical technologies that unlock the potential of renewable energy and increase the energy efficiency. Our expertise spans the full value chain - from development and manufacturing to service and digital solutions, supporting the entire lifecycle of our customers' assets. We excel in system integration and supply chain coordination, delivering modular, cost-efficient products that optimize performance.

KK Group in India

KK Group has operated in India since 2017, building strong, long-term partnerships with leading wind OEMs across the country. In 2025, the company expanded its presence by opening new offices and launching a major manufacturing facility in Bengaluru, further diversifying its production capabilities and contributing to India's energy transition.

This new Bengaluru factory stands as KK Group's largest manufacturing site outside of Europe. Currently, over 300 team members are dedicated to producing high-quality converters and controls for the wind sector, while an additional 150 professionals work in the newly established global shared service center, leveraging India's rich talent pool. Once fully operational, the manufacturing facility is expected to bring on board more than 150 additional members and nearly double its overall output.



Trusted Protective Coatings

For the wind energy industry

Hempel, a world-leading supplier of trusted coating solutions, operates globally with a strong set of values and a clear focus on sustainability. Serving customers across the infrastructure and energy industries, decorative and marine, the company maintains factories, R&D centres and stock points in every region.

Its paints and coatings are present in nearly every country, protecting and enhancing buildings, infrastructure and critical assets.

These solutions help customers reduce maintenance costs, improve aesthetics and boost energy efficiency, making Hempel an integral partner in a wide range of sectors.

Central to the company's mission is its commitment to shaping a brighter future through sustainable coating technologies. Hempel maintains that long-term business success is only possible by placing sustainability at the core of its operations - a strategy it says strengthens competitiveness, increases resilience and reduces risk.

Proven performance in the wind energy industry

A supplier to the wind energy industry since the very beginning, we have delivered coating systems to many of the world's best-known wind farms.

Over the years, we have built up vast experience and knowledge of the industry, and our proven track record makes us the trusted coatings partner for wind turbine manufacturers around the world.

From wind turbines and power stations to some of the world's most famous bridges and buildings, our coatings can be found around the world, protecting valuable structures and equipment from corrosion.

As well as a complete range of high-performance coatings and trusted technologies, we provide customers with expert technical service and support to ensure our coatings add real value to their business.



Global presence

With 80 offices, 27 ISO-certified production units and 10 Research & Development centres across the globe, we are uniquely placed to serve the global demands of the

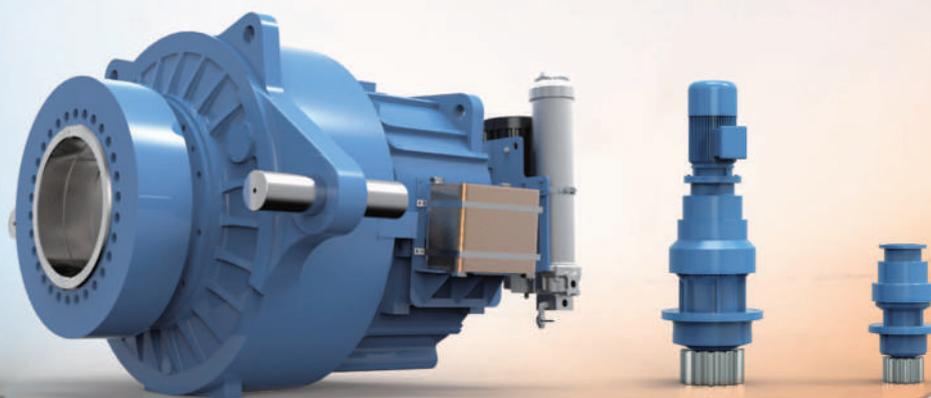
wind energy industry. We can deliver high volumes anywhere on the globe and tailor our global solutions to meet your local needs.



Founded in Copenhagen in 1915, Hempel is majority-owned by the Hempel Foundation. The foundation provides a solid economic base for the group while supporting cultural, social, humanitarian and scientific initiatives around the world."

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Printed by R.R. Bharath and published by Indian Wind Turbine Manufacturers Association and printed at Ace Data Prinexcel Private Limited, 3/304 F, (SF No. 676/4B), Kulathur Road, Off NH 47 Bye Pass Road, Neelambur, Coimbatore 641062 and published at Indian Wind Turbine Manufacturers Association, Awfis, 7th Floor, RR Tower IV, Thiru Vi Ka Industrial Estate, Guindy, Chennai 600032.

Editor: Parkavi

COOPER NEW ENERGY CO., LTD.



COMPANY PROFILE

Cooper New Energy Co., Ltd. was established in 2011 and is a diversified industrial group company. Its main business covers multiple sectors such as intelligent equipment, high-access lifting equipment, concrete tower equipment, safety protection equipment, wind turbine supporting equipment, and structural component integration equipment. It is a Chinese National Specialized and Innovative "little giant" enterprise, a National High-tech enterprise, and has obtained more than 170 patents.

Cooper has established long-term strategic partnerships with well-known domestic and foreign new energy enterprises such as China Huaneng Group, State Power Investment Corporation, China CSSC, China Three Gorges Corporation, Goldwind Technology, Windey Wind Power, Mingyang Intelligent, Enercon, Siemens Gamesa, etc., through a full range of low-carbon technology solutions and comprehensive benchmark demonstration projects. Cooper takes "green, cooperative, and sustainable" as its core values and is committed to "promoting energy transformation and creating a beauty era of new energy".

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01 LIFTING EQUIPMENT-SERVICELIFT



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- Two-hand control function:** Two-hand switch triggers restrictions, completely eliminating the possibility of one-hand operation.
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SLING POCKET TYPE
SINGLE BLADE SPREADER

C-CLAMP TYPE
SINGLE BLADE SPREADER

CONVENTIONAL SPREADER FOR LARGE-MW WIND TURBINES



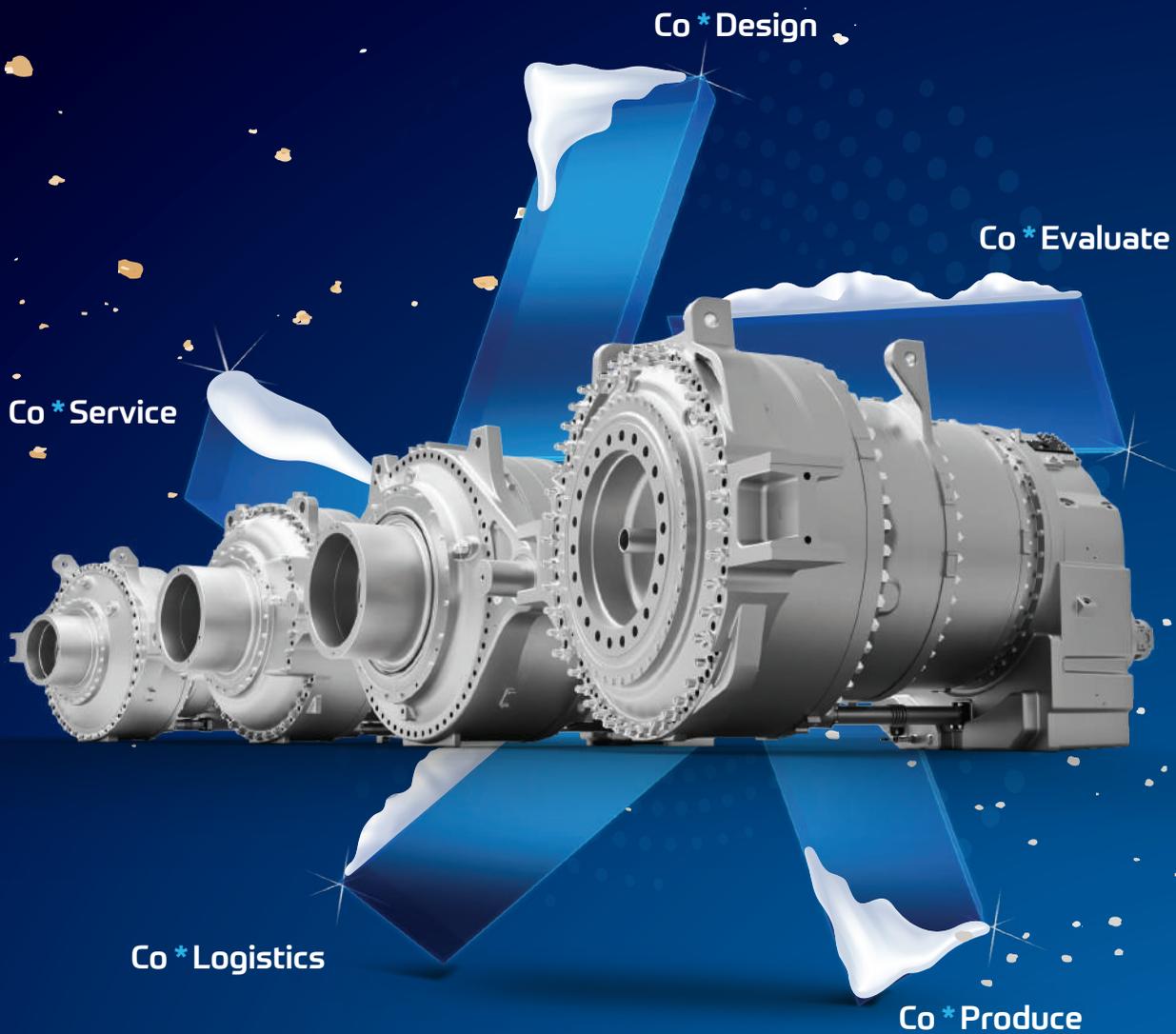
NACELLE SPREADER

TOWER SHELL SPREADER

BLADE SPREADER

ROTOR SPREADER

Wishing you a powerful 2026!



System Co*operation in Wind Power

As we wrap up another inspiring year at ZF Wind Power, a global leader in wind gearbox technology we want to thank all our partners, customers, and colleagues around the world. Together, we've taken powerful steps towards a sustainable future — through innovation, collaboration, and our unique approach to System Co*operation, which connects the entire wind value chain. With 2026 on the horizon, we're excited to continue this journey with you — driving the energy transition forward and shaping a cleaner, more sustainable future together.



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