Built to adapt: reshaping offshore wind with flexible, scalable generator technology

Words: Jason Moody, Chairman of GreenSpur

Offshore wind has become a cornerstone of global net zero ambitions. With over 250 GW of capacity targeted for deployment by 2030 and individual turbines now reaching 20 MW or more, the industry is advancing at scale and unprecedented pace. Yet the fundamental drivetrain technologies powering these machines have remained largely unchanged for nearly two decades. As turbines grow larger and supply chain complexity increases, the need for more flexible, scalable and regionally adaptable generator technology has never been clearer.

GreenSpur is responding to this challenge. Rather than refining the status quo, it has developed a fundamentally new approach to generator design. At the heart of the technology is a magnet-agnostic axial flux architecture, scalable across a wide range of applications and engineered to suit varying supply chains, material constraints and OEM strategies.

For manufacturers and developers seeking new pathways to efficiency, system integration and resilience, this solution offers something rare: flexibility without compromise.

Reframing the generator challenge

Most utility-scale turbines today rely on radial flux permanent magnet generators, a design choice driven by the efficiency and torque density of neodymium-based magnets. While effective, these machines tend to be large, heavy and tightly bound to global rare earth supply chains. Price volatility, environmental concerns and geopolitical risk have made this reliance not only commercially risky but strategically unviable in some markets.

The axial flux alternative takes a different path. Drawing on proven design principles, it was built from the ground up to enable high torque density in a more compact and modular layout. By rethinking the physical arrangement, the team has delivered a system that can achieve equivalent performance with a smaller footprint and crucially, one not locked to any specific magnetic material.

Being magnet agnostic is not a philosophical position but a practical design choice. It allows optimisation around what matters most in a given context, whether that is cost, weight, sustainability or local sourcing.

Performance through design

The generator platform has been independently validated by the UK's Offshore Renewable Energy Catapult. A system-level review of an 18 MW unit confirmed that the design meets critical industry requirements for mass, efficiency, and manufacturability, placing it in direct competition with the most advanced machines on the market.

Unlike many utility-scale designs, it uses advanced air-cooling techniques that eliminate the need for complex water-cooling systems, even at 18 MW and above. This delivers significant benefits in maintenance, system integration and overall cost, particularly for offshore installations where reliability and ease of servicing are paramount.

The architecture is highly modular. Using a COMSOL-based simulation environment, the engineering team can rapidly iterate design variants to suit different turbine platforms,

Jason Moody

magnet grades or supply chain constraints, typically completing a design loop in just two to three weeks.

That flexibility has important real-world implications. In regions where low-powered ferrites are more readily available, or where environmental standards limit the use of rare earths, a suitable configuration can be delivered. In markets prioritising high power density, such as Asia or floating wind applications, the platform can be tuned for high-grade neodymium magnets. This

adaptability enables local requirements to be met without altering the core design.

Built for manufacturability

A key differentiator is the focus on real-world production. The generator design includes flat windings, simplified lamination assemblies, and minimal dependence on exotic tooling. The architecture is more tolerant of regional supply chain variation and does not require custom machining or casting facilities.

Development took place in close consultation with suppliers to ensure manufacturability in existing facilities, or easy transfer to new ones. This is not an R&D demonstration but a commercially viable system engineered for industrial deployment.

This capability underpins the strategy: enabling localised manufacturing through licensing, without the need for centralised, capital-intensive production lines.

A platform, not a product

The business model has evolved alongside the architecture. Initially structured around a licensing-first approach, offering design, IP and simulation tools to OEMs and regional partners, it now recognises that limited manufacturing may be necessary in some regions to accelerate deployment or demonstrate capability. This does not signal a shift from its core philosophy but reflects a pragmatic view that early market access may require more direct involvement.

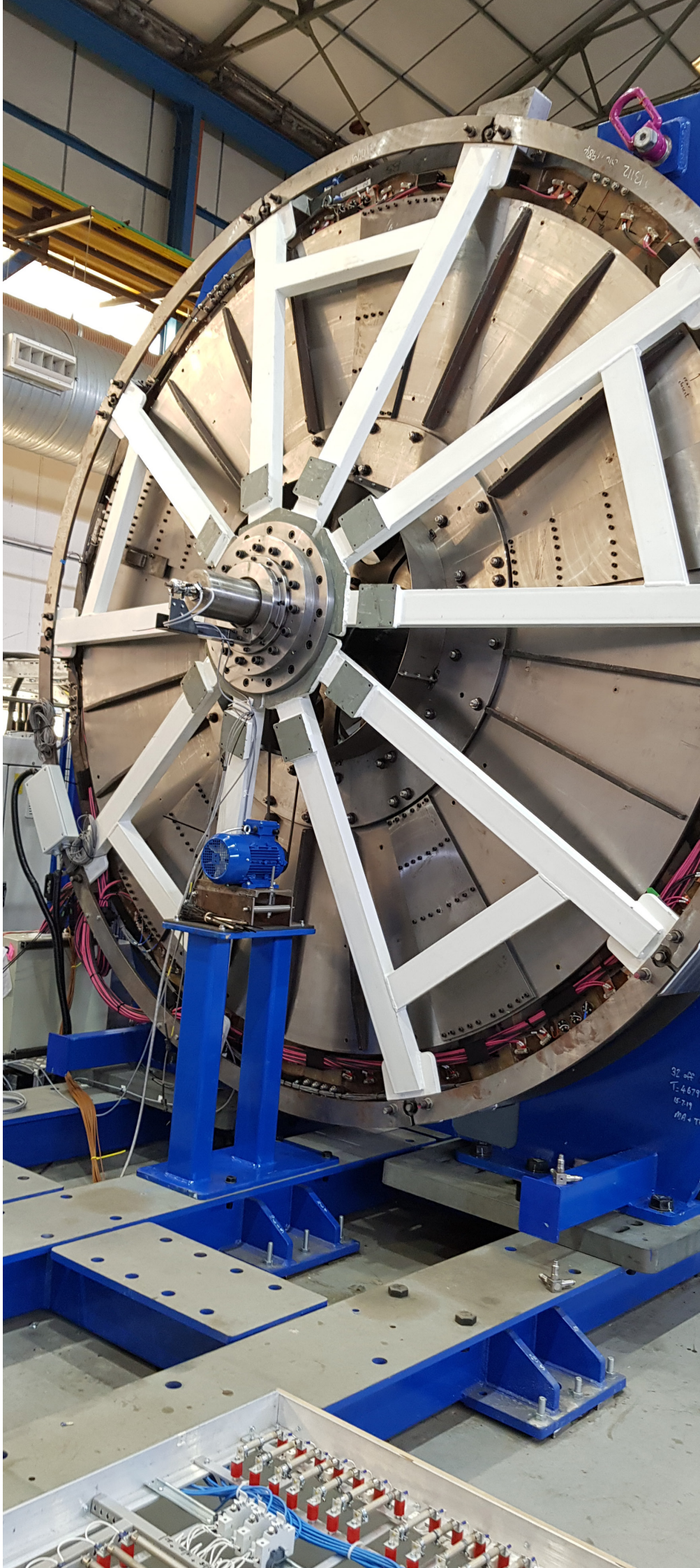
Licensing continues to offer a fast route to scale, reduced capital intensity and easier deployment, especially in markets valuing local content, employment, and production control. It also allows OEMs to trial alternative generator technologies without long-term manufacturing commitments.

The model is shaped by regional needs. In Europe, customers prioritise low-carbon materials and recyclability. In North America, local manufacturing and energy security dominate. In Asia, the focus is on maximum power density and cost. The platform adapts to each.

The technology is protected by nine patent families covering electromagnetic architecture, mechanical configuration, and manufacturing method. This ensures partners benefit from a technically sound and legally secure foundation, while enabling co-development of tailored variants under a clear IP framework.

Supporting a changing energy system

As the offshore wind industry evolves, drivetrain strategies are shifting. After more than a decade of direct drive momentum, the market is now reconsidering geared drivetrains for their cost, packaging, and serviceability benefits, particularly in ultra-large turbines and floating applications.

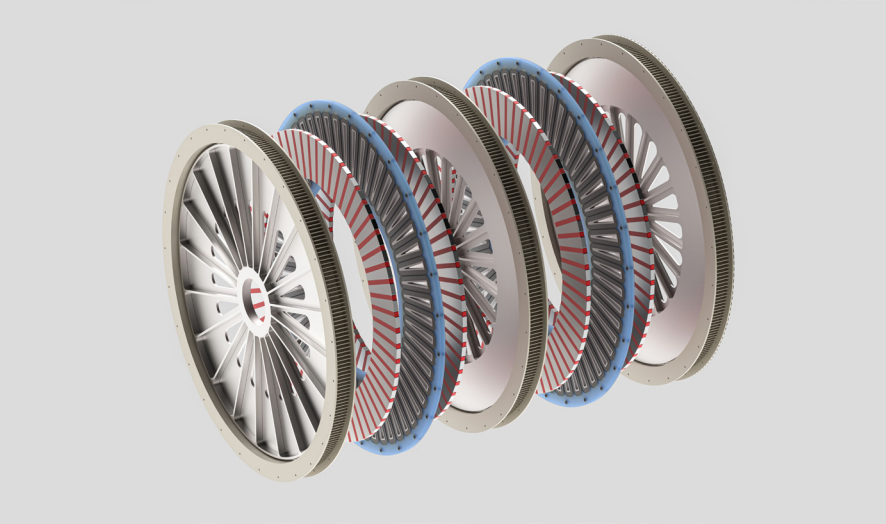


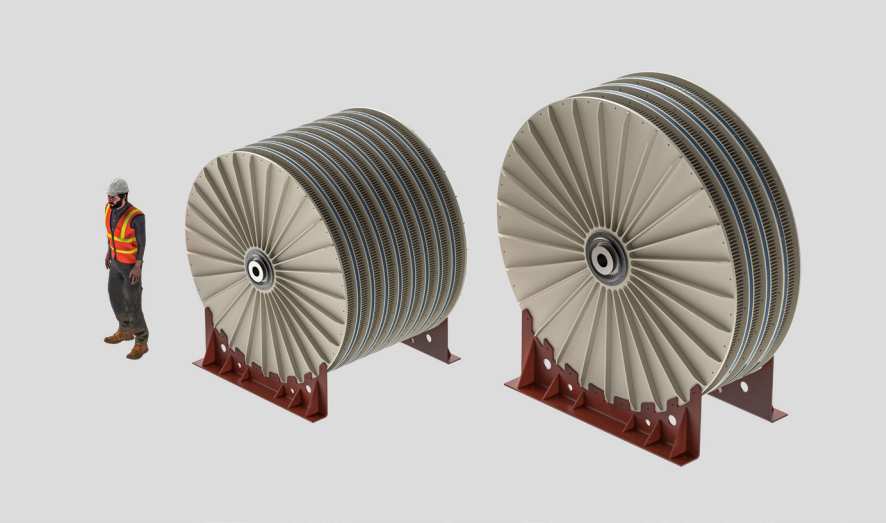
This generator is more than a design; it's a response to the evolving needs of a global wind sector demanding flexibility, scalability and resilience.

Axial flux machines are naturally suited to this trend. In a geared configuration, system efficiencies can approach 99 percent, significantly impacting turbine-level LCoE.

Simultaneously, wider system requirements are becoming more demanding. Grid-forming capability, dispatchability, and integration with hybrid storage systems are becoming part of the design brief. This architecture provides the modularity and adaptability to respond.

While many traditional generator topologies are approaching technical limits, axial flux is only beginning to reveal its potential. Future variants include units for industrial and onshore sectors, compact nacelle-mounted systems for floating platforms, and hybrid designs optimised for mechanical and thermal efficiency.





From innovation to engineering impact

The company is part of the Time To ACT group, a UK listed business focused on clean technologies. The group unlocks value in engineering firms with underused IP or heritage sector expertise. Alongside the generator business, it owns Diffusion Alloys, which applies high-temperature coatings expertise to hydrogen, clean fuels and transition markets.

Jason Moody joined in 2023 to bring operational leadership across the group's companies. This cross-cutting view of technology and strategy has aligned engineering roadmaps with commercial requirements.

The business is not building for a quick exit. Its long-term vision is to support the energy transition technically, commercially, and systemically.

That mindset has helped it navigate a turbulent cleantech environment. Like many in the sector, the company saw investor sentiment cool in late 2024. But with system-level validation secured, ongoing dialogues and energy policy tilting back toward industrial decarbonisation, momentum has steadily rebuilt through 2025.

Next steps

The team continues discussions with turbine stakeholders, exploring alternative generator configurations. These include exploratory engagements, simulation projects and proposals for site-specific design studies. The flexible architecture enables multiple options to be evaluated without long development cycles.

In parallel, a UK-based manufacturing initiative is being explored to complement the licensing model and support expansion into other industrial areas. This would provide domestic production for core assemblies, supported by public sector partners and aligned with national clean energy goals.

While licensing remains the preferred route to scale, offering near-term manufacturing solutions is increasingly vital as national resilience and energy strategy converge.

Built to adapt

This generator is more than a design; it's a response to the evolving needs of a global wind sector demanding flexibility, scalability and resilience. Whether supporting floating platforms, regional supply chains or grid integration, the platform offers a path to cleaner, more efficient generation with fewer constraints.

As turbine systems grow in scale and complexity, drivetrain innovation must keep pace. This technology helps make that possible by rethinking what utility-scale generators can achieve and enabling OEMs to build what they need, where they need it.

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