Offshore®

SPECIAL REPORT

WIND

Offshore wind moves from ambition to execution:
How can developers build, finance, install, operate and scale projects amid today's economic realities?

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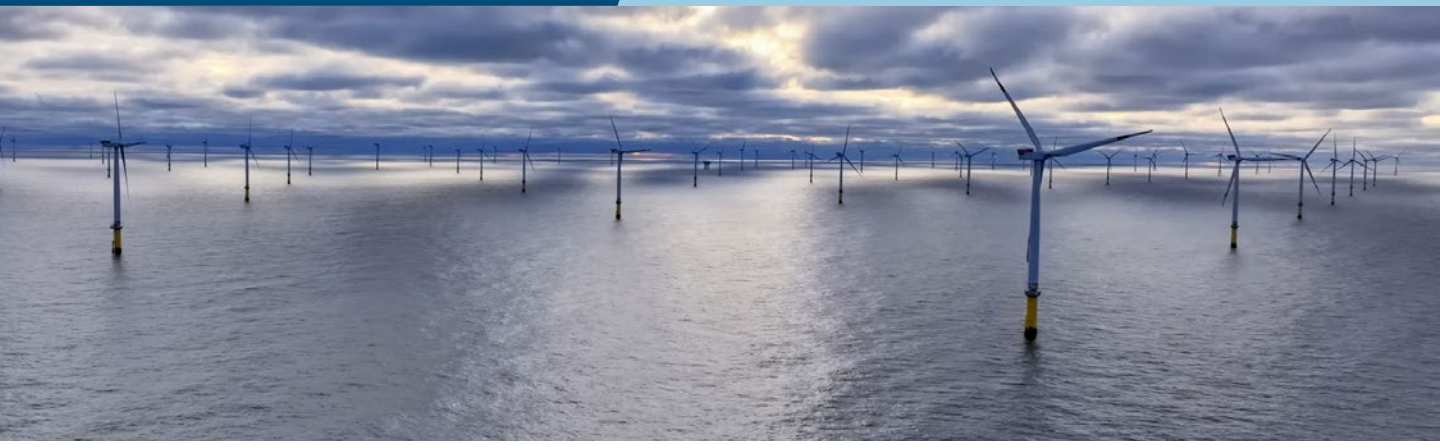

Offshore wind's next growth phase shifts toward emerging markets despite industry headwinds

Global offshore wind capacity is projected to reach 420 GW by 2035, driven not only by established markets in China and Europe but also by accelerating momentum in countries such as the Philippines, Vietnam and Brazil.

NINA MELKONYAN, Global Wind Energy Council (GWEC)

Offshore wind is quietly developing into one of the energy transition's success stories, with a current trajectory that should see 420 GW of offshore wind capacity by 2035. The technology's high-capacity factors, large-scale generation potential and the proximity to many major coastal centers of electricity demand make it particularly well placed to support rising power consumption, strengthen energy security and enable deeper electrification.

Offshore wind can meet the twin demands of clean electricity needed to power emerging industries and drive long-term industrial development, both of which drive economic growth and spur a positive cycle of economic and energy development.

The sector continues to expand despite economic and policy headwinds largely beyond its control; its inherent benefits are seeing the sector through the natural challenges of an expanding industry.

Offshore wind growth continues despite market recalibration

GWEC Market Intelligence reports a total of 9.3 GW of new offshore wind capacity connected to the grid worldwide, which is a 16% increase on 2024's figures. That made 2025 the third-highest year for annual installation.

Photo (above): Offshore wind installations are expected to expand significantly over the next decade, with global capacity projected to reach 420 GW by 2035, according to GWEC Market Intelligence.

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Across the last decade, the global offshore wind market grew by an average of 10% every year. That means at the end of 2025 total installations stood at 92.5 GW, accounting for 7.1% of total global wind capacity.

There are two stories to tell about offshore wind:

- The current mature markets, and
- The rapid advancement of the next wave of offshore wind growth.

Emerging markets poised to drive the industry's next expansion

China and Europe currently dominate offshore wind. At the end of 2025, the countries are 52.3% and 41.9% of global installed capacity, respectively. China leads in APAC, while the UK, Germany and the Netherlands remain Europe's main markets.

The excitement in the offshore sector lies in the emerging markets that are racing to deliver offshore wind as a key part of their energy infrastructure. Strong policy signals and growing investor interest are driving momentum in several key markets

In the Philippines, the Board of Investments committed US$18.9 billion to financing offshore wind with a 3.3-GW target for the country's first auction. This support should start delivering, with the results of the country's first offshore wind auction expected by the end of first-quarter 2027.

China remains the world's largest offshore wind market, accounting for more than half of global installed offshore wind capacity at the end of 2025. ID 470381908 © ARTEM EVDOKIMOV | DREAMSTIME.COM

Vietnam is demonstrating an equally strong political commitment. The country's rapidly growing electricity demand, heightened focus on energy security and increasingly favorable market conditions make offshore wind a perfect fit for the country's ambitious growth plans. The government has announced plans to install 6-17 GW of offshore wind capacity by 2035, rising to 113.5-139 GW by 2050.

Brazil is another market to watch. In 2025, the country adopted a new offshore wind legal framework, supported by the Global Wind Energy Council (GWEC). This set a pathway for offshore wind to diversify the country's power mix while driving industrial and economic development. The World Bank forecast the sector could create more than 516,000 jobs by 2050 and contribute at least US$178.5 billion to the Brazilian economy. The projections highlight why offshore wind is increasingly being viewed as both an energy and industrial development strategy.

Market recalibration lays the groundwork for future growth

For these emerging markets, the next few years are critical to translating ambition into deployment. Clear auction schedules and revenue frameworks set the market on a course to turn targets into turbines. There also needs to be early investment in ports, grids and supply chains to move projects from planning to bankability. The industry is an ally, and sustained government-industry dialogue will maintain momentum and realize the enormous potential of the offshore sector.

Policymakers and markets are now adjusting to the lessons from failed tenders and cancelled projects as the industry grows in scale. This is a necessary period of recalibration that will help establish more resilient market frameworks for future growth. The project pipeline remains inconsistent and uncertain, but fundamentals of offshore wind remain unchanged.

Global offshore wind capacity will continue to grow through this period of adjustment—the industry is working through the gears rather than stalled. A compound average annual growth rate of 24% until 2030 and 13% up to 2035 shows the trajectory is clear.

The industry expects to sail past the milestones of 30 GW of annual new capacity in the early 2030s and reach 50 GW by 2035. GWEC Market Intelligence expects more than 328 GW of new offshore wind capacity to be added over the next decade, bringing total offshore wind capacity to 420 GW by the end of 2035.

Infrastructure investment will determine the pace of future growth

The pace of deployment will increasingly depend on execution capacity. Supply chains, ports, specialized vessels and a skilled workforce must scale alongside the project pipeline, while long-term visibility will unlock early investment in manufacturing, logistics and infrastructure.

Grids can move from being a constraint to an enabler if existing networks are modernized and operated more efficiently through digitalization, storage and grid-enhancing technologies. New transmission capacity must be planned and built ahead of generation. Coordinated investment in existing and new grid infrastructure is critical to offshore wind ambitions translating into electricity delivered to consumers.

Infrastructure investment alone will not be enough; auction frameworks must reflect changing project economics. The industry needs long-term policy visibility, revenue certainty and risks allocated to the parties best placed to manage them. Established markets must adapt while emerging markets can design bankable frameworks now.

Realizing this potential will require decisive action from both governments and industry. Offshore wind is critical energy infrastructure, delivered through bankable auction frameworks, faster and more coordinated permitting, anticipatory investment in grids and ports, and long-term market visibility that can unlock capital and strengthen supply chains. The industry must work collectively to galvanize political momentum and turn ambition into action. ●

Nina Melkonyan is a policy officer with the Global Wind Energy Council (GWEC), based in Lisbon, Portugal. She leads GWEC's Wind Sustainability Initiative and plays a key role in the organization's offshore wind program, including coordination of the Global Offshore Wind Report. Her work focuses on offshore wind policy, sustainable supply chains and industry development. Melkonyan holds a master's degree in public policy and administration from Central European University in Vienna.

Specialized installation vessels play a central role in offshore wind construction as projects grow in scale, complexity and distance from shore. The rendering highlights Cadeler's two new T-class offshore wind installation vessels, which are scheduled for delivery in 2030 and 2031. COURTESY CADELER

IMCA tracking impact of offshore wind expansion on marine operations

Greater guidance is needed to sustain safety in a changing environment.

JEREMY BECKMAN, Editor, Europe

Safety, security and e-fuel directives are issues the International Marine Contractors Association (IMCA) is closely monitoring, as offshore wind development continues to scale up and extend out to deeper waters.

The London-based association represents the interests of more than 800 companies globally, lobbying on their behalf with governments and international agencies as well as promoting best practices in offshore operations via its divisional and regional committees.

As offshore wind projects move farther offshore, increase in scale and expand into new markets, IMCA is focusing on three key areas: operational safety, fleet capability and infrastructure resilience.

Walk-to-work operations

According to Chief Executive Iain Grainger, the association was one of the driving forces behind the introduction from the late 2000s onward of commercial motion-compensated gangway systems for offshore personnel transfers, now used globally by wind farm maintenance crews.

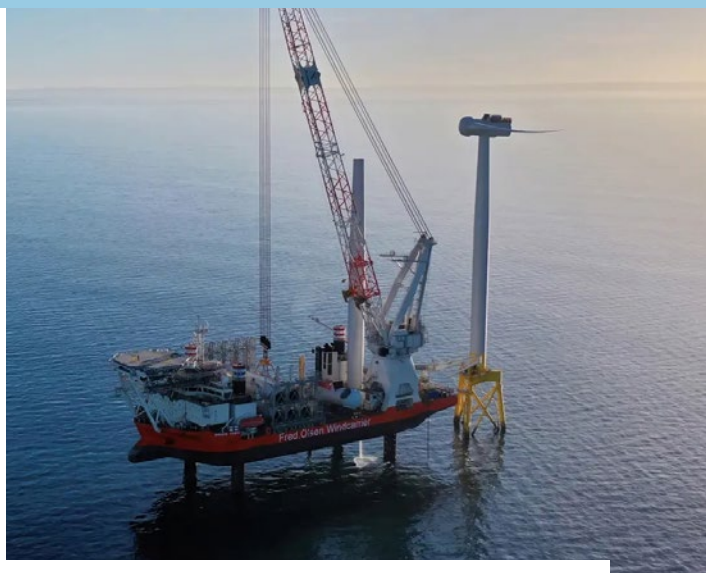
Iain Grainger

An IMCA workshop in 2024, conducted jointly with the G+ (Global Offshore Wind Health and Safety Organisation), examined the scope for further safety improvements in walk-to-work access systems. The conclusions formed the basis of a three-phase initiative now led by IMCA's Offshore Wind Special Interest Group.

Phase 1, overseen by the association's Marine Renewable Energy Committee, was supported by feedback from further workshops held in the Far East, US and western Europe. The team identified a scope for various improvements in gangway operations, including competence and the information that developers require from the vessel operators. This led to a revision of IMCA's guidance for walk-to-work operations.

The current Phase 2 focus is on the competence of users, operator training, potential incident reporting, software updates, telescopic speeds and vessel assurance, with broader involvement of OEMs and contractors. A further revision of IMCA M254 walk-to-work guidelines will follow in Phase 3. The special interest group is also developing competence guidance for diving operations on offshore wind projects.

Jan De Nul's cable-lay vessel Fleeming Jenkin is designed to install long-distance subsea power cables needed for offshore wind grid connections and interconnectors. COURTESY JAN DE NUL GROUP LINKEDIN



Offshore wind installation vessels, like Fred. Olsen Windcarrier's Brave Tern, require increasingly specialized capabilities as turbine components continue to grow in size and weight. COURTESY FRED. OLSEN WINDCARRIER

Lifting and rigging operations

In May 2025, the G+ issued new guidance, prepared jointly with IMCA's Marine division, on sharing and promoting good practice in offshore wind lifting operations. The guidance can be incorporated into company standards, procedures and practices. It can also be included in contract specifications or used in the development of golden rules for frontline personnel, such as the right/duty to cease work if a dangerous situation arises.

As offshore wind components expand in size and weight, this too is presenting issues for lifting and rigging. The updated IMCA LR006 guidelines for lifting operations feature a section on lifting offshore wind turbine components (nacelles, blades and tower sections), and the risks associated with repetitive lifts at height. The guidance also addresses the use of specialist lifting tools and details some of the rigging arrangements for monopiles and transition pieces.

"Aside from the increasing scale of the equipment being installed," Grainger said, "IMCA has noted the limited pool of specialist offshore construction vessels capable of safely handling the largest offshore wind foundations, turbine components and high-voltage direct current (HVDC) converter stations. The next generation of 2-GW converter stations can weigh up to 30,000 metric tons."

He pointed to TenneT as an example, which has entered long-term arrangements with Heerema Marine Contractors and Allseas for the transport and installation of its 2-GW offshore platforms. "This illustrates the demand for the relatively small number of vessels capable of undertaking installations on this scale," he said. "The scale of foundations is increasing too, with the latest XXL monopiles for the largest turbines reaching weights of around 2,000-2,800 metric tons, and lengths of more than 100 m."

He also emphasized the importance of consistent marine assurance. "Vessel suitability cannot be judged by crane capacity, deck strength or class notation alone," he continued. "Assurance needs to consider the complete operation, including vessel configuration, environmental limits, crew competence, lifting and seafastening arrangements, port interfaces, simultaneous operations and credible failure scenarios."

Marine incidents and congestion

Two recent collisions at ports in northwest Europe further underline the need for constant marine assurance, improved operational planning and situational awareness for specialist offshore wind transportation and installation vessels and the cargoes they handle.

In July, Cadeler's jackup installation vessel *Wind Orca* collided with a berthed container ship as it was leaving its dock at the port of Tyne, northeast England. A gantry crane on the quayside was also damaged, with the injured operator taken to hospital. The vessel had been installing monopile foundations for Orsted's Hornsea 3 wind farm in the UK southern North Sea.

In June, Fred. Olsen Windcarrier's *Brave Tern* wind turbine installation vessel was involved in two successive crashes at the Port of Esbjerg in western Denmark. It was reportedly transporting Siemens Gamesa turbine blades for RWE's Thor wind farm development in the Danish North Sea. While exiting the harbor, the blades hit Cadeler's *Wind Keeper* vessel, and *Brave Tern* then collided with the quayside, inflicting further damage on the blades. The cause was said to be insufficient situational awareness on the vessel's bridge during piloting.

Last March, the UK's Health & Safety Executive highlighted a rise in incidents of service vessels colliding with both offshore oil and gas and renewable energy structures in UK waters. It

cited recurring issues such as distraction from non-navigational tasks and poor communication among bridge team members.

IMCA has noted the increasing concentration of offshore wind infrastructure and associated vessel activity across the southern part of the entire North Sea, highlighting the need for more effective operational planning, situation awareness and crew competence initiatives.

The coming wave of floating offshore wind projects will likely exacerbate marine operational complexity, the association adds, in terms of tow-outs, mooring installations hookup, dynamic cables and offshore maintenance.

Dynamic positioning (DP) of vessels operating close to floating wind facilities may also present a hazard; after examining (unrelated) incidents involving DP vessels working close to mobile assets, IMCA's DP Committee raised concerns over the selection and use of position reference systems, notably the risks arising from combining relative and absolute reference systems. These same causes, the guidance noted, could impact floating wind structures in the future.

"As floating wind develops," Grainger added, "IMCA can also bring marine contractors, vessel operators, developers and equipment providers together to establish practical guidance and consistent assurance expectations as these operations move toward commercial scale."

Cable installation and undersea risk

Developers are seeking to expand offshore wind subsea power transmission networks. Marine contractors are responding by commissioning new vessels that can transport and lay much longer cable lengths for offshore grid connections.

Boskalis is investing in a new 24,000-mt cable-lay ship with two 12,000-mt carousels to take on long-distance interconnector and offshore wind projects. Jan De Nul is building two 28,000-mt cable-lay vessels, *Fleeming Jenkin* and *William Thomson,* which the company describes as the largest vessels of their kind.

But as IMCA points out, aside from the capability to install fast-expanding networks of offshore power cables, other specialist vessels, personnel and equipment are needed to repair this critical subsea power infrastructure when damage occurs. Maritime Intelligence group Windward's latest Undersea Cables Risk report highlighted the growing levels of vessel activity around critical subsea routes.

Grainger said, "As we become more dependent on these energy links, our response and recovery frameworks must evolve to match the scale of the infrastructure."

IMCA is calling for a coordinated government and industry response, including:

- Targeted support for repair capability and sector-specific solutions for power cable repairs;
- Policy reform and regulator alignment with fast-track permitting, supported by harmonized processes across jurisdictions; and
- National programs to train and retain specialist cable/jointing engineers, marine engineers and deck officers.

Future fuels

Following the European Commission's call for evidence concerning EU rules governing alternative fuels infrastructure, IMCA responded that policy makers should adopt a "practical and flexible" approach more in line with the realities of offshore marine contracting operations, rather than imposing a one-size-fits-all decarbonization target on offshore fleets. IMCA pointed out that the onus to install the estimated 30,000 new offshore wind turbines and subsea infrastructure needed to meet the EU's long-term offshore wind capacity target will fall on specialized offshore vessels. These ships may operate across 20- to 30-year lifecycles performing specialist roles.

The association called for increased focus on offshore and onshore recharging to support vessel electrification, and greater availability of alternative fuels at ports supporting offshore energy operations.

Floating LiDAR buoys

Another development on IMCA's radar is the deployment and recovery of floating LiDAR (FLiDAR) buoys, used for offshore wind site surveys both pre-development and during commercial operations. Industry discussions have identified concerns over risk management, safe design and the respective responsibilities of manufacturers, operators and developers. IMCA is continuing talks with the G+ and the Workboat Association on the most appropriate way forward.

Emerging offshore wind arenas

Offshore wind activity is expanding rapidly throughout Southeast Asia.

"But for some countries that have not previously had the same scale of offshore oil and gas activity, such as Taiwan, Japan and South Korea, the regulatory framework, specialist vessel capacity and pool of personnel with experience of complex offshore construction operations may still be developing," Grainger said. "Local content and cabotage requirements can add to this challenge, particularly when projects require local vessels and crews, or when international vessels must be re-flagged and crewed locally."

As offshore wind activity increases, Grainger explained that training, competence and operational experience need to develop at the same pace. For this, he said IMCA offers competence frameworks, technical guidance and works with members, helping companies build the skills and operating practices required to undertake increasingly complex marine operations safely.

"Japan is a good example of how the association's presence is growing alongside offshore wind," he continued. "Over the past three years, IMCA has gone from one Japanese member to 15. In South Korea, local membership has increased from three to five companies since the beginning of this year." ●

Ocean Winds CEO: Execution and investment confidence will shape offshore wind's future

Ocean Winds identifies execution, supply chain industrialization and long-term policy certainty as the key factors that will determine whether offshore wind meets global growth targets.

ARIANA HURTADO, Editor-in-Chief

Offshore recently spoke with Ocean Winds CEO Craig Windram about the lessons developers are learning from project execution, where supply chain constraints remain most acute, what floating wind needs to achieve commercial scale, and the conditions required to sustain offshore wind growth through 2035.

Photo (above): An offshore substation serves as a critical link between generation assets and the power grid. Ocean Winds CEO Craig Windram said future offshore wind growth will depend not only on turbines, but also on investment in supporting infrastructure, ports, cables and grid connections. COURTESY OCEAN WINDS

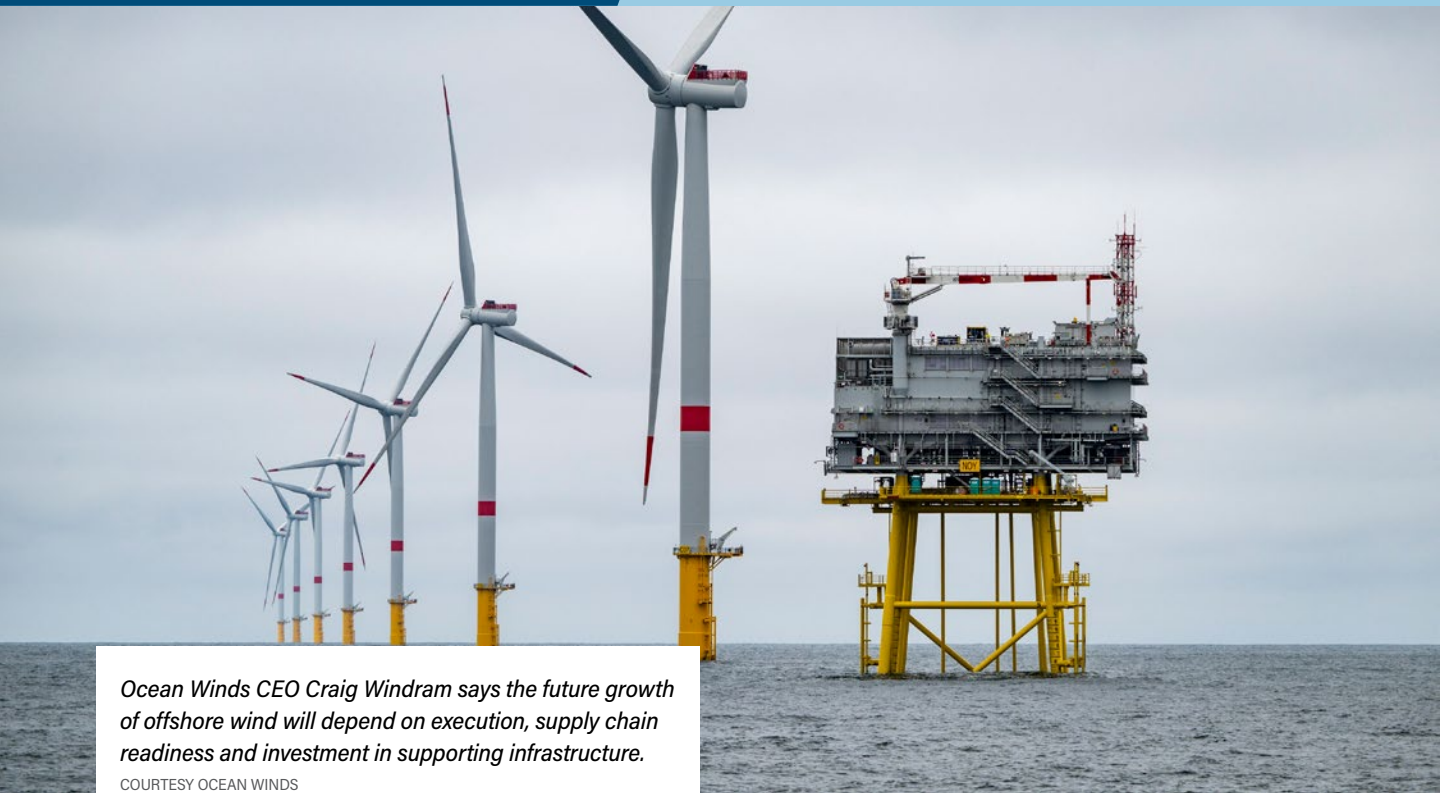
Offshore: As offshore wind projects move into larger-scale deployment globally, what are the biggest lessons Ocean Winds has learned about executing projects on schedule and controlling costs in today's market?

Windram: One of the clearest lessons is probably how important discipline is from the early stages of a project.

Craig Windram

Successful projects will be determined well before a project reaches FID or starts the construction phase. The quality of early surveys, engineering, permitting or procurement strategy is what ultimately determines whether a project can be delivered on time and on budget.

Offshore wind developments are extremely complex industrial programs that will take years and require highly complex planning, bringing together



Ocean Winds CEO Craig Windram says the future growth of offshore wind will depend on execution, supply chain readiness and investment in supporting infrastructure.
COURTESY OCEAN WINDS

turbines, foundations, cables, vessels, ports, grid connections, suppliers, teams and authorities.

Standardization, realistic contingencies, and a clear vision of the risks are all essential and will be critical to ensure cost control. And at the same time, flexibility in areas like vessels, logistics will help also with the preferred business case.

Ultimately, what makes the difference is high-quality preparation, discipline and the ability to work with partners early enough in a long-term strategy to reduce or remove a risk before it becomes a cost or delay.

Early decisions, strong governance and risk management will create the conditions for success years later, because scale is important but scale on its own will not deliver successful projects itself.

Offshore: Many markets are pursuing ambitious offshore wind targets simultaneously. Where do you see the greatest supply chain bottlenecks today, and which parts of the supply chain appear best positioned to support growth over the next decade?

Windram: The tightest constraints today are probably HVDC equipment and turbine manufacturing both now competing for capacity with grid operators, interconnectors and data centers, not just offshore wind.

Installation vessels are equally scarce; building one takes years of confidence in future demand, and that confidence has been inconsistent.

The positive side is real: new suppliers are entering foundations, cables and offshore services, and governments are starting to consider offshore wind as an industrial opportunity rather than just an energy target.

The next decade will belong to the parts of the supply chain that industrialize, moving from bespoke projects to repeatable, scalable delivery. That's where the winners will be found.

Offshore: Floating offshore wind is widely viewed as the next major growth opportunity. What technical, commercial or regulatory milestones still need to be achieved before floating wind can scale beyond pilot and demonstration projects?

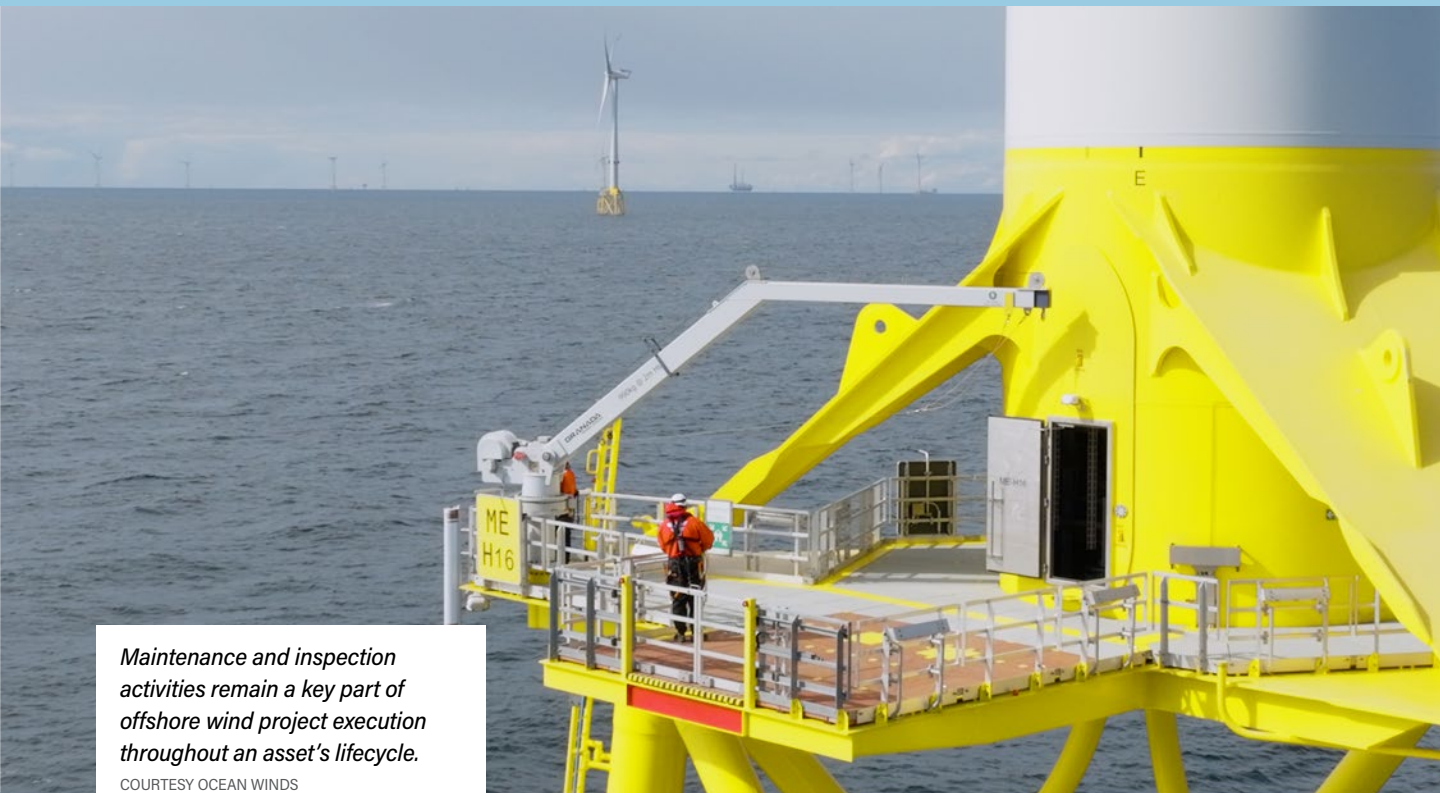
Windram: Floating wind already works, and our projects, WindFloat Atlantic and EFGL, have already proved that.

The question now is commercialization at scale: industrialized manufacturing, port infrastructure able to handle thousands of tons of steel per foundation, and predictable demand to justify new factories.

Like fixed-bottom wind before it, floating wind needs well-designed support mechanisms with a clear route to market and [the] fastest leasing and permitting path to unlock economies of scale and reduce LCOE [levelized cost of energy].

This will be decided by the whole ecosystem (ports, suppliers, governments, developers) scaling together; it is not just an engineering challenge.

Regulation also has an important role to play. We need visibility on leasing rounds, permitting processes and clear revenue frameworks. Floating projects typically involve larger upfront



Maintenance and inspection activities remain a key part of offshore wind project execution throughout an asset's lifecycle. COURTESY OCEAN WINDS

investments and longer preparation periods, making regulatory certainty even more important to ensure bankability.

Offshore: Looking ahead to 2035, what will be the defining factors that determine whether the offshore wind industry achieves its global growth ambitions?

Windram: The industry doesn't have an ambition problem. It will be ready to deliver with the right conditions. In many ways, offshore wind's greatest challenge today is not a lack of technology or ambition. It is creating enough confidence for everyone involved to invest ahead of demand.

That means governments need to go beyond targets and support schemes. They need to provide clear, long-term visibility and ring-fenced budgets, giving industry the confidence to invest in the supply chain, ports, grids and infrastructure needed to deliver secure and affordable offshore energy. This is particularly important in Europe.

What will decide whether that happens is probably execution:

- Can supply chains scale fast enough?
- Can permitting keep pace?
- And can governments and industry align on long-term planning?

One point often missed: the sector's future depends as much on infrastructure, networks, ports, or cables and logistics as on turbines themselves. Get that right, and offshore wind will be transformative for global decarbonization. If we don't, growth will be limited by execution, not ambition.

For the next decade, the countries that provide that confidence will be the countries that capture the economic, industrial and energy benefits of the offshore wind transition. ●

Ocean Winds says long-term policy certainty, infrastructure investment and supply chain growth will be critical to sustaining offshore wind development through 2035. COURTESY OCEAN WINDS

Technicians access an offshore wind turbine at RWE's Nordsee Ost wind farm. Operating experience across multiple wind farms has helped RWE standardize maintenance practices, improve response times and optimize major component replacement campaigns. COURTESY RWE

RWE Offshore Wind COO: Future of offshore wind O&M is predictive, not reactive

Offshore wind operations and maintenance (O&M) have evolved from fixing individual turbines and managing single projects to optimizing performance across entire portfolios through predictive maintenance, digital tools and lifecycle asset management, according to RWE Offshore Wind's COO Thomas Michel.

ARIANA HURTADO, Editor-in-Chief

As offshore wind portfolios expand and the industry's earliest projects move beyond their first decade of operation, operators are increasingly focused on maximizing asset availability, extending equipment life and improving maintenance efficiency. Advances in digital monitoring, predictive maintenance and vessel logistics are helping reshape how offshore assets are managed throughout their lifecycle.

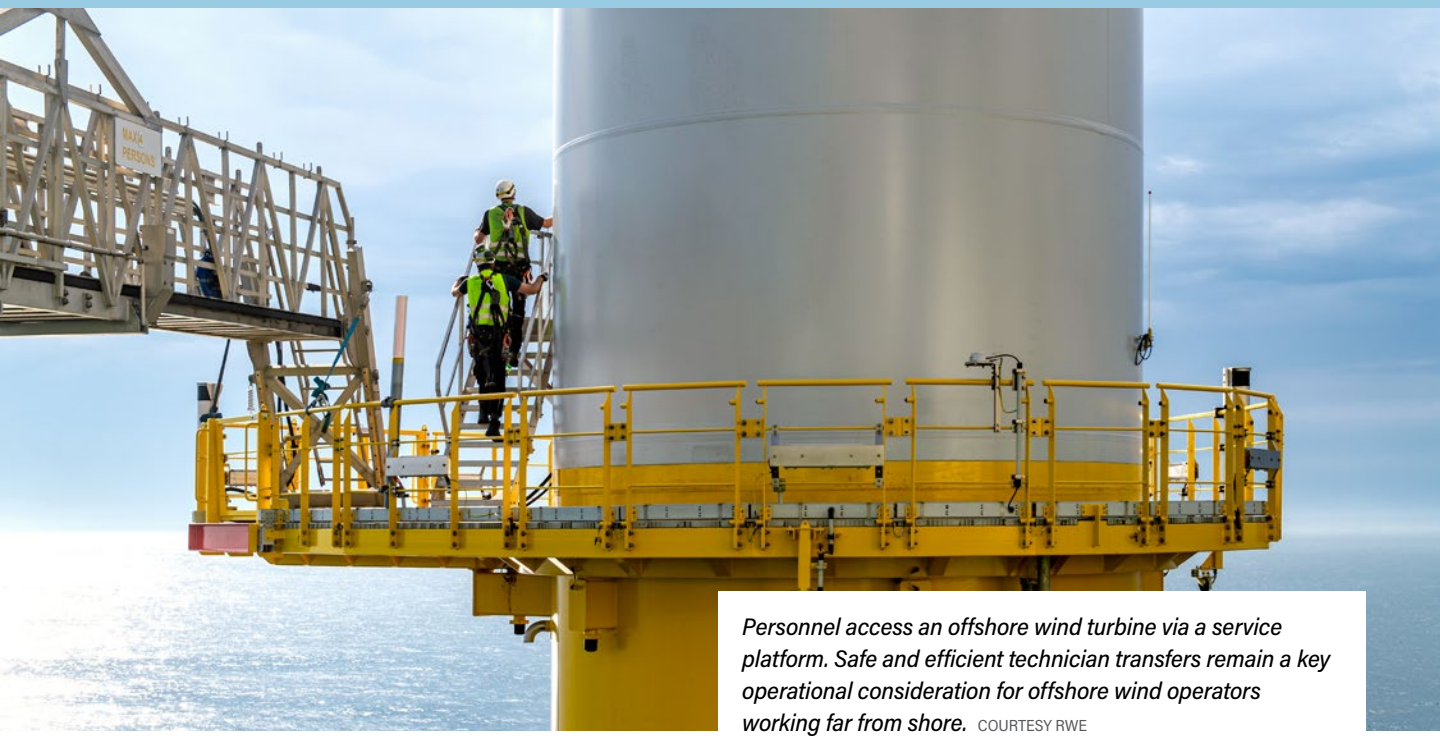
Offshore spoke with Thomas Michel, COO of RWE Offshore Wind, about how operations and maintenance (O&M) strategies have evolved, lessons learned from managing a growing offshore wind portfolio and the technologies shaping the future of offshore asset management.

Thomas Michel

Offshore: How has RWE's approach to operations and maintenance evolved as offshore wind farms move from early-life operation into long-term asset management?

Michel: RWE's approach has evolved from a focus on project-specific maintenance activities for our offshore wind farms to a fleet-wide, long-term asset management model.

Maintenance campaigns offshore are increasingly delivered through standardized vessel operations, dedicated service operation vessels (SOVs), and specialized service teams—long gone are the days of relying on ad hoc solutions.



Personnel access an offshore wind turbine via a service platform. Safe and efficient technician transfers remain a key operational consideration for offshore wind operators working far from shore. COURTESY RWE

At the same time, maintenance strategies have shifted from reactive interventions to preventive and predictive approaches focusing on the full lifetime of the offshore wind asset, where it is at in the asset lifecycle and commercial optimization, for example based on the current revenue scheme.

By leveraging operational experience and campaign data, RWE is increasingly able to anticipate potential issues before they affect asset availability or performance, thereby enhancing reliability and optimizing asset-related decisions for the optimal asset life.

Offshore: RWE operates offshore wind projects across multiple generations of turbine technologies and markets. How have the lessons learned from managing this diverse portfolio influenced your approach to asset reliability, maintenance planning and life-cycle optimization?

Michel: As RWE's offshore capacity continues to grow, O&M have become key drivers of portfolio performance. Vessels, crews and onshore teams now coordinate activities across a steadily growing number of sites and assets. While technicians often spend extended periods offshore, onshore teams ensure that logistics run smoothly, maintenance strategies are synchronized across the portfolio of comparable turbine types, and that the highest safety standards are maintained.

Managing a diverse offshore wind portfolio has highlighted the importance of standardization, strategic partnerships and fleet-wide planning. Lessons learned across different turbine technologies and markets have helped RWE develop more efficient and cost-effective maintenance concepts, improve response times and optimize major component replacements. As a result, the focus has shifted from solely site-specific execution to a coordinated portfolio strategy that enhances reliability, operational efficiency and asset integrity throughout the entire asset lifecycle.

Offshore: What role do digital tools, predictive maintenance, condition monitoring and data analytics play in improving asset performance and reducing downtime?

Michel: Digital tools are playing an increasingly important role in maximizing asset performance and reducing downtime.

Furthermore drone-assisted inspections can improve both efficiency and safety. Inspections that previously required technicians to climb turbines and inspect every meter manually can now be supported by drones, significantly reducing time and risk. In addition, cargo drones can complement traditional logistics by increasing turbine uptime, improving safety, and reducing costs and emissions. At RWE, for example, we have successfully pioneered in a pilot project long-range autonomous cargo drone flights at two of our German offshore wind farms.

Condition monitoring systems and advanced data analytics, increasingly supported by artificial intelligence, provide valuable insights into asset health and maintenance requirements, and are core to optimizing our maintenance strategy. This allows us to take a more proactive approach to anticipating future failures, reducing unplanned downtimes and ensuring that individual works can be bundled together into coordinated campaigns that can be executed more efficiently. ●

An offshore converter platform and wind turbines operate at Germany's DolWin1 offshore wind farm. As offshore wind projects grow in size and complexity, developers and grid planners are exploring multi-terminal HVDC architectures to connect wind farms, energy hubs and onshore grids more efficiently. COURTESY HITACHI ENERGY

Offshore wind growth drives interest in multi-terminal HVDC

ARIANA HURTADO, Editor-in-Chief

Offshore wind ambitions continue to expand across Europe, the US East Coast and Asia-Pacific, prompting a shift in how transmission infrastructure is planned and deployed.

In this exclusive Q&A, Andreas Berthou, global head of HVDC (high-voltage direct current) at Hitachi Energy, discusses why multi-terminal HVDC networks are gaining attention, the challenges of building more integrated offshore grids, and what successful offshore implementation could look like over the coming decade.

Offshore: Why are new schemes like multi-terminal HVDC becoming an important integration of more traditional point-to-point systems for future offshore developments?

Berthou: The offshore energy market is entering a period of unprecedented expansion. Across Europe, North America and Asia-Pacific, governments have announced ambitious offshore wind targets as part of their energy security, industrial competitiveness and decarbonization strategies.

Andreas Berthou

The scale of generation being planned over the coming decades is significantly larger than what existing offshore grid architectures were originally designed to accommodate. As a result, the discussion is increasingly shifting from how to connect individual projects to how to develop integrated offshore energy systems.

I believe the role of point-to-point HVDC is not over and a number of future projects will continue to utilize this solution. At the same time, we see that the scale and nature of offshore wind development is changing, starting from how offshore grids are planned. What we see now is a shift from individual project optimization toward system-level thinking, driven by the need to deliver affordable, resilient and sustainable energy at scale.

We are no longer looking at isolated wind farms, isolated national grid reinforcements [or] isolated interconnectors between nations. Our customers and their stakeholders are looking more and more in a holistic manner to the upcoming needs and planning multi-year and multi-purpose. We are looking at an entire offshore ecosystem.

Offshore converter platforms are becoming larger and more powerful as developers and transmission operators plan for higher-capacity offshore wind connections and future grid expansion.
COURTESY TENNET

In that environment, it becomes more evident the benefits one could achieve through new grid architectures like multi-terminal HVDC. Each point-to-point project requires its own corridor and infrastructure and is often designed to transport power in one direction (i.e., from generation to load).

However, with the need for grids to become more interconnected and dynamic in their operation, and the need to maximize the utilization and minimize the environmental impact, alternative approaches to traditional point-to-point connections will be needed. We simply cannot build the future energy system by repeating yesterday's model.

So the issue is not that point-to-point HVDC is obsolete; it remains essential. But on its own, it cannot deliver the level of system efficiency, flexibility and resilience that future offshore grids will require with the best asset optimization and affordability. Multi-terminal HVDC complements this by enabling a more integrated, scalable and future-ready grid architecture.

Offshore: What role could multi-terminal DC (MTDC)networks play in supporting offshore wind clusters, energy islands and hybrid interconnectors?

Berthou: Multi-terminal HVDC represents the transition from point-to-point connections to integrated networks, enabling a holistic approach that supports the grid's short-, medium- and long-term needs. In many ways, it is the natural evolution of HVDC as we move deeper into the electrification journey.

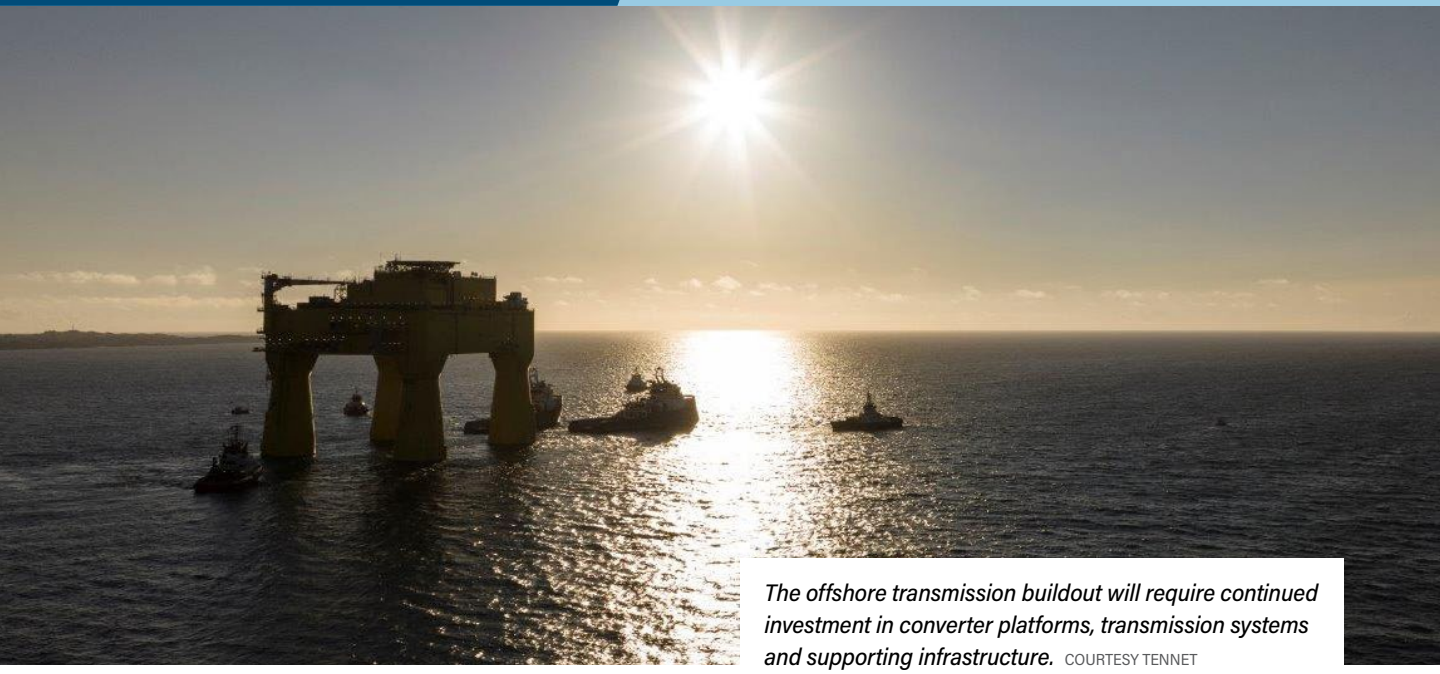
In regions like the North Sea, governments are already planning for offshore wind hubs and energy islands that collect large amounts of green power and dispatch energy to multiple countries. Similarly, hybrid interconnectors—linking wind farms while enabling cross-border exchange—are being deployed as a first step toward more integrated systems. This reflects a broader shift where energy systems are no longer national assets but shared regional infrastructures.

MTDC networks build on that foundation. They allow wind farms, hubs and onshore grids to be interconnected through a shared backbone. That enables the flexibility to harvest power where most abundant at a specific time and also have the possibility to route it where it is needed most, from a grid stability or also from an energy market perspective. This is where technology starts to unlock real system value, balancing markets, improving security of supply and accelerating decarbonization simultaneously.

Offshore: What technical, regulatory and planning challenges still need to be overcome to enable broader offshore deployment?

Berthou: The progress we have seen in recent years is significant, but scaling offshore grids globally requires addressing a few key challenges. If we want to move at the pace required by the energy transition, these challenges must be tackled collectively and proactively.

On the technical side, interoperability is critical. Offshore grids will involve equipment from multiple vendors, across different countries and project phases. Ensuring that converters, control systems and protection schemes can work seamlessly together is essential. This is not only a technical question,



The offshore transmission buildout will require continued investment in converter platforms, transmission systems and supporting infrastructure. COURTESY TENNET

but also about building trust in a multi-vendor, multi-stakeholder ecosystem.

On the regulatory side, alignment remains one of the biggest barriers. Offshore grids often cross national boundaries, but regulatory frameworks are still largely national. Questions around cost sharing, especially for anticipatory investments for greater future asset optimization, market access and revenue models need clearer, more harmonized answers. Without this alignment, we risk slowing down projects that are critical for energy security and competitiveness.

From a planning perspective, we need to move earlier and think bigger. Regions like the North Sea are already shifting toward coordinated offshore planning, but in many parts of the world, development is still project driven. Moving to anticipatory, system-level holistic planning, where the grid is designed ahead of generation is key to unlocking scale.

There is no transition without grids. And ultimately, grids are not a constraint; they are an enabler of growth, resilience and decarbonization.

Offshore: How are developers, regulators, transmission operators and technology providers approaching offshore grid planning and integration?

Berthou: What we see globally is a clear evolution toward stronger coordination. This is one of the most encouraging shifts in the industry today.

In the European region, transmission system operators are increasingly leading offshore grid design, supported by regional initiatives that look at the system as a whole rather than individual projects.

In the US, there is growing momentum toward coordinated transmission planning along the East Coast.

And in Asia-Pacific, governments are beginning to define long-term offshore grid strategies, including grid reinforcement, [and] interconnections for energy trading, alongside renewable targets.

Across all regions, the direction is clear: more integration, more collaboration and more long-term thinking. Developers are adapting to this shift. Grid access is no longer just a connection issue, it is a strategic factor that influences project viability from the outset.

Offshore: What does successful offshore implementation look like over the next decade?

Berthou: Looking ahead, success will be defined at the system level—not by individual projects, but by how well the overall system performs for society.

We will see coordinated offshore grids, particularly in regions like the North Sea, where multiple wind clusters, energy hubs and interconnectors operate as part of an integrated network. Similar models are likely to emerge in other regions with high offshore growth potential, including North America and parts of Asia.

Infrastructure will increasingly be designed for future expansion, not just immediate needs. That means modular solutions, standardized interfaces and a clear pathway from today's hybrid links to tomorrow's larger and even more integrated HVDC networks.

Ultimately, success is not just technical. It is about delivering reliable, affordable and sustainable electricity at scale, while making efficient use of both offshore space and onshore infrastructure. It is about enabling economic growth, strengthening energy security and supporting communities through access to clean power.

And perhaps most importantly, it is about enabling cross-border collaboration, because offshore wind, and the grids that connect it, naturally sit beyond national boundaries. ●

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Offshore grid expansion faces supply chain and permitting pressures, TenneT Germany exec says

As offshore wind targets rise, keeping transmission infrastructure on schedule is becoming just as important as building new wind farms.

ARIANA HURTADO, Editor-in-Chief

TenneT's DolWin epsilon offshore converter platform in the German North Sea collects power generated by offshore wind farms and transmits it to shore for integration into the grid. COURTESY TENNET GERMANY

TenneT Germany is expanding its offshore transmission capacity to support the country's offshore wind ambitions while navigating supply chain constraints, permitting challenges and geopolitical risks.

Offshore spoke with Dr. Stefan Mirschel, TenneT Germany's program director offshore, about the strategic planning, regulatory coordination and technology developments required to support that growth. He discusses the growing role of high-voltage direct current (HVDC) transmission, the importance of aligning grid expansion with wind farm development and the policy measures needed to avoid costly project delays.

Offshore: Is investment in offshore transmission infrastructure keeping pace with deployment ambitions, and where are the biggest gaps?

Mirschel: TenneT Germany already operates 15 offshore grid connections with a transmission capacity of around 10 GW. We are continuing this expansion at industrial scale. Based on the current German Network Development Plan, seven further projects are scheduled by 2033, followed by four projects by 2039 and another in 2042. The seven 2-GW projects currently being delivered will provide a combined transmission capacity of 14 GW. Suppliers have been contracted, and the projects are in planning, permitting or construction.

The key challenge is to keep grid infrastructure, offshore wind farms, supply chains and the onshore network aligned. Grid investments have to be committed years before the associated wind farms reach final investment decisions. If generation projects are not realized, grid connections may temporarily remain underutilized. For this reason, we need greater transparency on project progress and effective regulatory milestones for offshore wind farms.

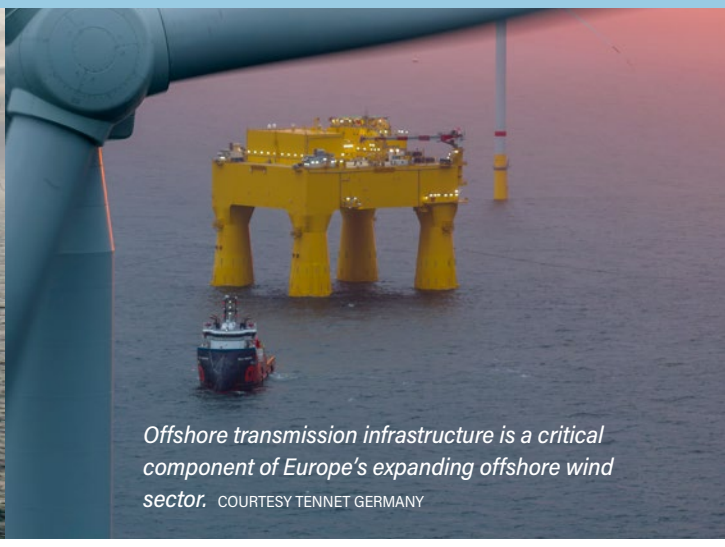
Dr. Stefan Mirschel

Offshore: What are the most significant challenges to delivering offshore grid connections on schedule?

Mirschel: The challenges are closely interconnected. Global demand for cables, converter platforms, specialized vessels, components and skilled workers is growing rapidly, while manufacturing capacity is limited and lead times are long. At the same time, the new 2-GW technology must be scaled industrially. Geopolitical tensions create additional risks for manufacturing and transport routes. Permitting and competing uses of offshore space also affect schedules.

Cable routes must be coordinated with environmental requirements, shipping, other infrastructure and military-use areas. In addition to managing these implementation risks, we must ensure that the available offshore areas and infrastructure deliver the greatest possible energy yield. TenneT Germany supports offshore optimization measures, including higher utilization of grid connections, more flexible spatial planning and counting cross-border connected offshore capacity towards national targets. Reducing

TenneT is developing large-scale offshore grid connections to support renewable energy capacity. COURTESY TENNET GERMANY



Offshore transmission infrastructure is a critical component of Europe's expanding offshore wind sector. COURTESY TENNET GERMANY

wake effects and improving energy yields can help generate more electricity from the available areas while making more efficient use of grid infrastructure.

Offshore: What are the risks if grid expansion and offshore wind development fall out of sync?

Mirschel: A lack of synchronisation can create costs and risks for all parties. If a grid connection is not available by its binding completion date, the associated wind farm may be unable to feed its full output into the grid as scheduled. However, the wind farms are compensated for a large portion of the resulting damage. If, conversely, a grid connection is completed but the associated wind farm is delayed or not realized, consumers may temporarily bear the cost of an underutilized asset. Delays on the generation side can also affect production schedules and investments throughout the offshore supply chain.

TenneT Germany has therefore called for regulatory measures that identify implementation risks at an early stage and enable timely and effective action. Greater transparency on project maturity and binding milestones can help keep wind farm development and grid construction aligned. The objective is to create clarity early enough for transmission system operators, developers and suppliers to adjust their planning and jointly limit the impact on timelines and costs.

Offshore: How is the role of HVDC evolving, and what additional investments will be needed?

Mirschel: HVDC is becoming the backbone of large-scale offshore integration. As wind farms move farther offshore and increase in output, high-voltage direct current transmission enables large volumes of electricity to be transported efficiently over long distances. Our new 2-GW projects set a new standard by more than doubling the rated power of individual connections compared with the previous generation of 900-MW systems. This supports standardization and can reduce the number of platforms and cable routes required per gigawatt.

But transporting electricity efficiently to the coast is only one part of the task. Additional high-capacity DC lines onshore make an equally important contribution by carrying offshore electricity from northern Germany to industrial and consumption centers farther south. Investments in the AC network, substations and system-control technologies are also required. Offshore and onshore infrastructure must therefore continue to be planned and implemented as an integrated system.

Offshore: What policy, regulatory or market changes would have the greatest impact beyond 2030?

Mirschel: The greatest impact would come from closer and more binding coordination between offshore wind auctions, final investment decisions, grid expansion and industrial capacity. Awards should be linked to meaningful milestones so that implementation risks become apparent at an early stage and allocated capacity can be reassigned if projects fail to progress. Two-sided Contracts for Difference are a positive step, as they can improve revenue stability and the likelihood of project realization. Auction design should also limit speculative bids and reflect cost changes over long development periods.

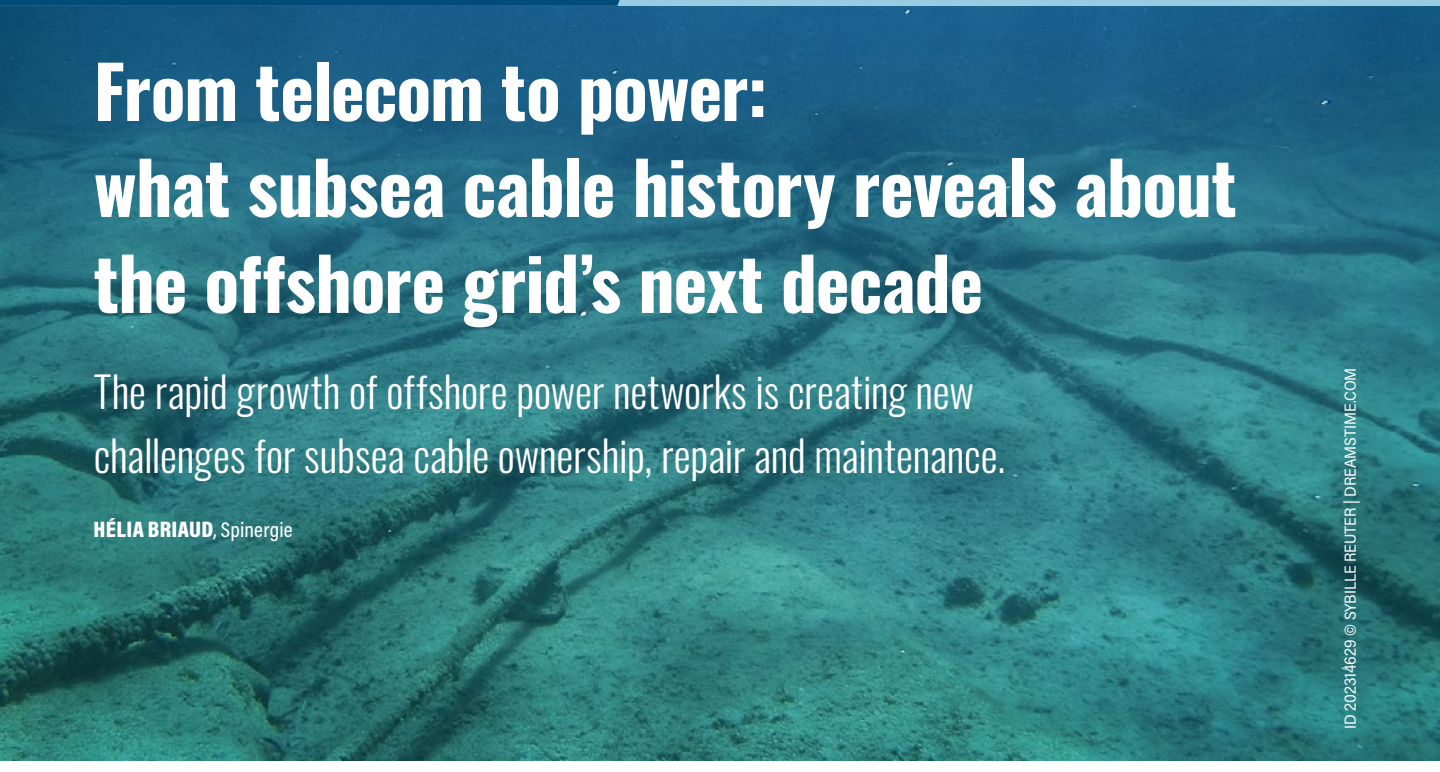
Permitting procedures must become faster and more predictable. In parallel, offshore optimization should enable better use of offshore areas and grid connections. Closer cooperation between the North Sea countries and offshore transmission system operators can complement national expansion efforts. Hybrid interconnectors can connect wind farms and electricity markets simultaneously, but require clear rules for planning and for allocating costs and benefits between the countries involved.

One example is GriffinLink, which TenneT Germany is developing together with the British energy infrastructure company National Grid Ventures. The planned 2-GW hybrid interconnector is intended to connect German and British offshore wind farms while also enabling electricity trading between the two markets. ●

From telecom to power: what subsea cable history reveals about the offshore grid's next decade

The rapid growth of offshore power networks is creating new challenges for subsea cable ownership, repair and maintenance.

HÉLIA BRIAUD, Spinergie



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Subsea power and subsea telecom cables serve different markets, operate at different scales and have almost no overlap in ownership or operations. The telecom sector is well established while the power cable sector enters a new phase of scaling projects, more diverse ownership and a still-to-be-defined maintenance model. Yet, parallels are emerging between the two.

This comparison looks at three aspects of the developing power cable market, with a specific focus on interconnectors, as it scales. In this article, Spinergie examines what can be learned from telecom's earlier growth spurt through the lens of project size, ownership and repair.

Project scale

The interconnector market has progressed from a national to an international to an intercontinental scale.

Historically, interconnectors were used as a domestic element, connecting remote areas, islands and isolated regions to national grids. However, a gradual international shift saw interconnectors moving toward grid balancing and electricity trading. This is a particularly strong trend in Europe with the 1,000-km Nordlink (2021) between Norway and Germany serving as a key example.

Now the first intercontinental projects are emerging. However, to date, only the 4,000-km AAPowerLink between Australia and Singapore is moving after Xlinks, between Morocco and the UK, was canceled by the latter government in 2025. A Morocco-to-Germany alternative is currently being explored.

Intercontinental projects have been the norm in the telecom sector for years. The pioneering TAT-8 project crossed the Atlantic in 1988, but the current generation goes even further. Notable examples include Meta's 45,000-km 2Africa that was completed in 2025 and the 50,000-km Project Waterworth that was announced last year. Each project spans multiple continents.

Governance

Governance has also seen a significant shift from national transmission system operators (TSOs) to state-linked to private.

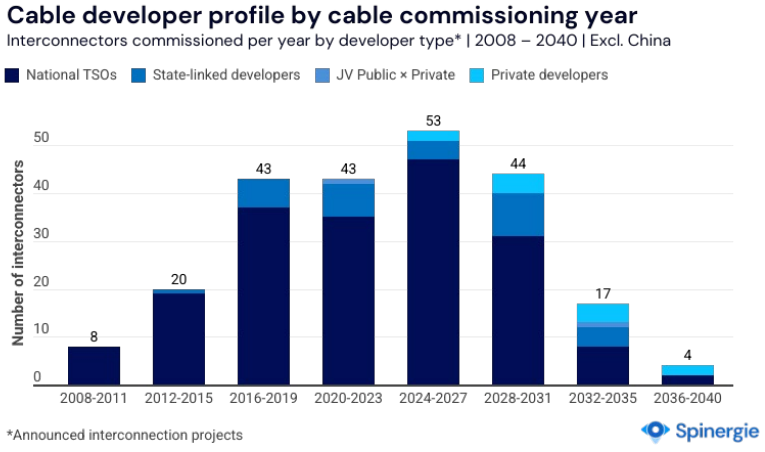
TSOs traditionally dominated the interconnector sector, following a domestic logic of national projects for national grids. TSOs were followed by state-linked developers that had more flexibility than TSOs.

Now, private developers are emerging such as Champlain Hudson Power Express, a North American entity developed by Transmission Developers and backed by Blackstone. In Europe, NeuConnect, a £2.4 billion (€2.8 billion) project currently under construction will create the first direct power link between Great Britain and Germany upon completion. These different methods of governance demonstrate that alternative financing and ownership models can emerge.

Interconnectors also saw the shift from public companies to joint ventures to private hyperscalers (GAFAM). It should be noted that the driving forces and nature of private capital in subsea power cables have key differences compared to telecoms.

The regulatory driver has been inverted. Telecom liberalization was demand-led due to 1990s deregulation and the explosion of internet traffic. On the other hand, power is policy-led following EU green targets and offshore wind development.

With private capital, telecom hyperscaler ownership is vertical and strategically purchased for company use in data centers



or the cloud. In power, private capital is mainly raised through financial infrastructure investment—as demonstrated with Blackstone on Champlain Hudson, and NeuConnect's backers—and not based on the end use of the electricity generated.

Spinergie sees that project scale and ownership are diversifying, but the vessels involved in laying and repairing these cables are not yet following the same path.

The maintenance gap

There is a key difference between the telecom market and the power market: telecom has dedicated repair fleets and pools repair equipment by geographic zone while power uses the same cable-laying vessels (CLVs) for both laying and repair.

The power sector faces some barriers to securing this same kind of "task force mutualization."

Technical barrier

The core technical barrier is the universal joint. While it is standardized in fiber telecom cables, this is not yet the case in power cables in terms of voltage, AC/DC, insulation type or manufacturer.

Volume barrier

Telecom operates a network of more than 1.5 million kilometers across more than 600 active systems. This justifies having dedicated fleets designated by zone. While the volume of subsea power cables is increasing, there is not yet the order of magnitude that warrants a dedicated repair fleet.

Nonetheless, the subsea power cables sector is starting to shift, and this can be demonstrated through two examples.

In 2019, Orsted became the first renewable energy member of the Atlantic Cable Maintenance Agreement (ACMA)—one of the telecom regional repair zones.

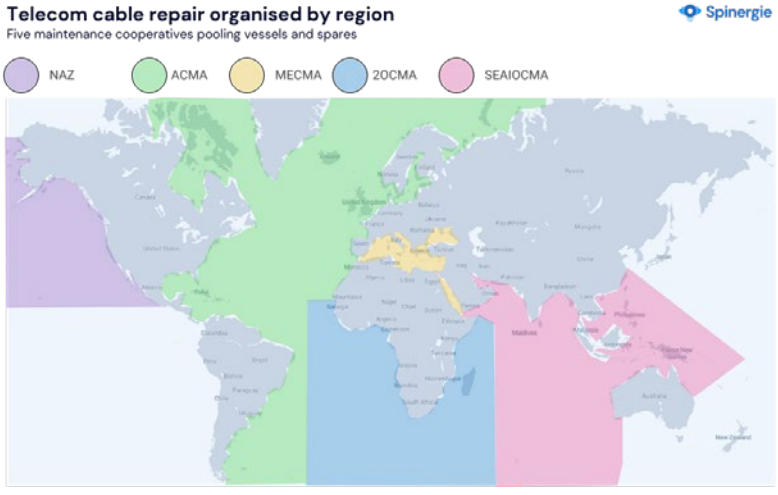
A framework agreement was signed with Global Marine Group for the repair and replacement of inter-array cables but not the laying of them. This overlap is limited to lower-voltage inter-array cables. The laying and repairing of interconnectors and high-voltage export cables remains the domain of manufacturers with dedicated fleets such as Prysmian, Nexans and NKT, and specialized marine contractors like Boskalis, Van Oord, DEME and N-Sea.

A second example came in April this year when a TSO memorandum of understanding (MoU) was signed at WindEurope in Madrid. The MoU is between Elia (Belgium), Energinet (Denmark), 50Hertz (Germany) and TenneT (Germany and the Netherlands). Over an initial exploratory phase of at least one year, five groups will work toward collaboration methods for repair logistics, spare parts and equipment, fault detection, and legal and financial frameworks.

These two examples show the progression from Orsted's individual initiative in 2019, to an attempt at a collective power sector structure, seven years later in 2026.

Telecom may not provide a blueprint for the power sector, but it can be thought of as a preview. Ownership and scale are following similar arcs; however, maintenance continues to lag. Recent moves suggest the maintenance gap is beginning to close, but the next decade will show when the move to a dedicated fleet becomes necessary through sheer volume. Whether there will be a wholescale shift will depend on how quickly installed cable volumes rise and how much repair demand grows alongside. ●

Hélia Briaud is an offshore analyst at Spinergie, specializing in data analytics and market intelligence for the subsea power cable industry. She brings field expertise from her experience as an officer in the French Navy and ongoing service as a reservist, combining operational insight with data-driven analysis. Her work focuses on supply-demand modeling, predictive forecasting and cable repair analysis to support offshore energy stakeholders in their strategic decisions.



What will it take to build floating offshore wind at scale off the US West Coast?

Floating offshore wind should adopt proven offshore oil and gas project development practices instead of reinventing them.

RICHARD D'SOUZA, Richard B Offshore LLC

Global wind power capacity reached approximately 1,300 GW in 2025, including about 93 GW of fixed-bottom offshore wind.

Floating offshore wind remains at an early commercial stage, with less than 0.3 GW installed worldwide, largely in pilot and pre-commercial projects. While fixed-bottom offshore wind has reached commercial scale, floating wind remains significantly more expensive. Several larger floating projects, totaling roughly 1.5 GW, are approaching investment decisions, but none are in the US.

Why the US West Coast is different

The US West Coast nevertheless offers exceptional long-term potential. Strong, persistent winds provide high expected capacity factors and access to an enormous renewable energy resource. California has established a planning goal of up to 25 GW of offshore wind by 2045, and BOEM awarded five commercial leases off California in 2022.

The challenge is water depth. The continental shelf drops rapidly to depths ranging from roughly 100 m to well over 1,000 m, making floating foundations essential for most development areas. These foundations can support the latest generation of 15-25 MW turbines. Combined with strong wind resources and large lease areas, they could support a significant new renewable energy industry.

Most planned offshore wind projects off the US West Coast will require floating foundation technology because water depths are too great for conventional fixed-bottom installations.

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The infrastructure challenge

Realizing that opportunity, however, will require overcoming several significant challenges:

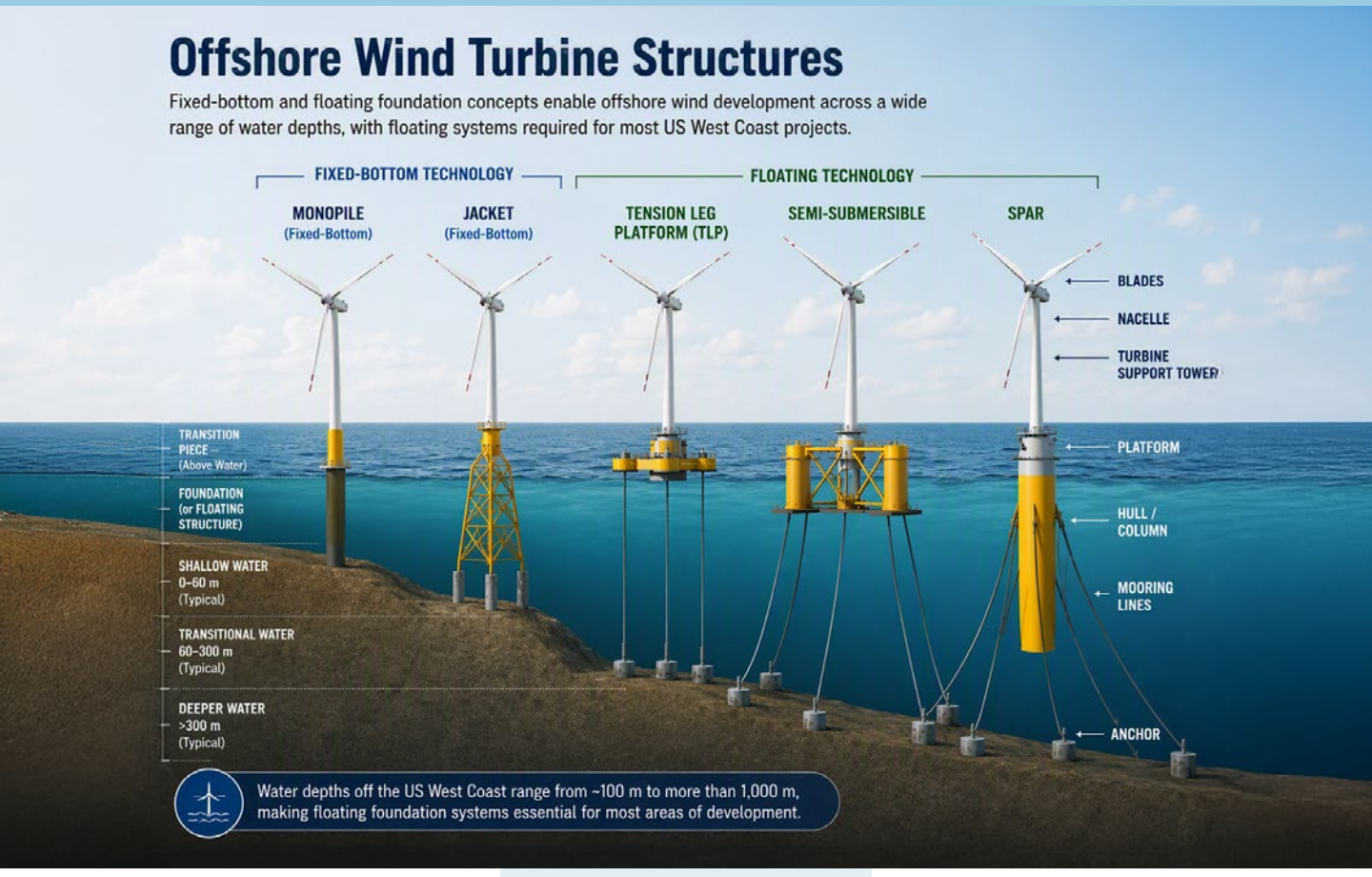
- Developing multiple foundation assembly and turbine-integration sites with adequate quayside capacity, water depth and unrestricted access to the development areas;
- Constructing substantial new transmission infrastructure to move several gigawatts of power to existing load centers and securing bankable power-purchase arrangements;
- Navigating environmental, tribal, military and other permitting requirements while managing federal policy uncertainty; and
- Establishing a supply chain capable of fabricating, integrating, installing and operating floating wind farms comprising hundreds of large floating structures.

These challenges are surmountable, but they must be addressed early and will require substantial investment before projects become financeable.

Lessons from deepwater oil and gas

Developing a 1-GW-plus floating wind farm has important similarities to developing a large deepwater oil and gas field. Both are capital-intensive, have long cycle times from lease acquisition to first production, and demand sophisticated project and risk management, supply-chain coordination and technical expertise. Both also rely on floating structures (e.g., semisubmersibles, spars and tension-leg platforms [TLPs]), and both must operate reliably for decades in challenging offshore environments.

Over several decades, the offshore oil and gas industry has developed a disciplined stage-gate process covering the complete project life cycle, from lease acquisition through abandonment. Each phase progressively defines and de-risks the



project before the next major investment decision.

The industry has also developed contracting strategies, execution models and operating philosophies that make multi-billion-dollar investments in remote offshore environments possible. Floating wind should adapt many of these lessons rather than recreate them.

Floating foundation concepts such as tension-leg platforms, semisubmersibles and spars enable offshore wind development in deepwater areas where conventional fixed-bottom structures are not practical.

COURTESY MICROSOFT COPILOT AI

Critical decisions during project selection

The Select phase is particularly important because it is where many of the most consequential decisions are made. For a floating wind development, one is selection of the foundation concept. Semisubmersible, spar and TLP configurations are among the principal candidates for West Coast conditions, but each must be evaluated against the site-specific metocean environment, fabrication and assembly infrastructure, turbine-integration strategy and available installation vessels. A sub-optimal selection can propagate through later project phases, ultimately appearing as additional capital cost, schedule delay or operational constraints, adversely impacting sanctioned performance metrics.

Station keeping provides another example of transferable offshore experience. Spread-moored systems for semisubmersibles and spars and vertically tensioned systems for TLPs are well-established offshore technologies over a wide range of water depths. The underlying technology is not the principal obstacle. The challenge is industrialization: scaling from perhaps 12-16 mooring lines on a conventional offshore platform to 300 or more lines for a 100-turbine floating wind farm while achieving repetitive, low-cost installation and integrity management.

While floating wind projects have yet to reach commercial scale in US waters, decisions made during the next decade on infrastructure, supply chains and project execution will largely determine how quickly the industry can develop along the West Coast.

Floating offshore wind has progressed substantially in the past decade. However, to successfully execute and fully realize the enormous resource potential of industrial scale wind farm projects off the US West Coast in 10 to 15 years, it must lean heavily into the lessons, learnings and capabilities of the floating oil and gas industry on the Gulf Coast. ●

Richard D'Souza is president of Richard B Offshore LLC and a floating production and wind energy consultant. He is also a member of *Offshore's* 2026 Editorial Advisory Board. In his 50 years of experience, he has executed major offshore field developments in every producing region across the globe. As a deepwater pioneer, he has progressed developments from 300-m to 3,000-m water depths.

Turkiye's offshore wind sector moves from planning to execution

Authorities are preparing a 1-GW offshore wind tender covering priority development zones in the Aegean region.

ATTAURRAHMAN OJINDARAM SAIBASAN, GlobalData

Turkiye is close to tapping into its offshore wind potential. The country has set big goals and the first real steps are starting to take shape, but the road to 2035 will bring both major opportunities and real hurdles.

Turkiye's National Renewable Energy Roadmap calls for wind and solar to reach 120 GW by 2035, and offshore wind is part of that plan. Offshore projects are expected to start adding power to the grid around 2032.

By 2035, forecasts point to about 1.3 GW of offshore wind capacity, generating roughly 2.7 TWh per year. That's still well below the official 5 GW target but getting the first projects built is important to prove the model, build local supply chains, and strengthen the permitting and regulatory process.

The government has already identified four priority coastal areas: Saros Bay, Gökçeada, Bozcaada and Edremit. A 1-GW offshore wind tender is being prepared, expected sometime in the mid-2020s. Early details suggest long-term site leases, required build deadlines and a proposed price cap around $0.07-$0.11 per kWh. Developers that join these early rounds could benefit from being first, learning faster and shaping how the market develops.

Turkiye's technical offshore wind potential is estimated at about 75 GW, especially along the Aegean coast and in the northwest where wind speeds are strong. The challenge is that many of these areas are in deeper water (more than 50 m), which makes traditional fixed foundations harder and increases the importance of floating wind technology.

On top of that, projects will need to avoid or carefully manage constraints like shipping routes, bird migration paths, naval zones and protected marine areas since these can slow permitting or stop projects altogether.

Policy and investment catalysts

So far, most energy investment has gone into solar, onshore wind and nuclear energy. Offshore wind spending is only beginning to show up in a meaningful way in forecasts for the late 2020s. To make offshore wind more bankable, upcoming tenders are expected to include tools like long-term power purchase agreements (PPAs), local content requirements, tariff indexation to protect against inflation and currency swings, and clearer rules for hybrid projects and storage measures meant to reduce risk and attract investors.

Ports and grid upgrades are critical

Offshore wind can't scale without major enabling infrastructure. Many likely project sites are far from where most electricity demand sits, so Turkiye will need new transmission lines, upgraded substations and possibly offshore export cables.

Ports also need to be ready, as handling offshore turbines requires large dock space, heavy-lift cranes, storage yards and assembly areas.

Better wind forecasting, seabed surveys and environmental studies will also play a big role in financing decisions and project schedules.

Priorities for industry stakeholders

- **Developers:** Gather early site and environmental data, and prepare bids before competition ramps up.
- **Ports and logistics companies**: Start expanding capacity—more dock space, heavier lifting equipment and larger staging/storage areas.
- **Investors and lenders**: Structure deals to manage inflation and FX risk, and build multiple revenue sources (e.g., PPAs, grid services, hybrid setups).
- **Regulators and policymakers**: Shorten permitting timelines, coordinate maritime/environment/energy authorities, and align grid expansion plans with offshore zones.

Ambition versus delivery

Turkiye's offshore wind market is moving from idea to execution. The 5-GW target by 2035 is aggressive, but not impossible if policy, grid upgrades, ports and project delivery all move quickly. While current projections suggest closer to 1.3 GW by 2035 under today's conditions, that's better seen as a signal to speed up, not a fixed ceiling. For companies willing to move early with strong engineering, flexible execution and smart financing, Turkiye could become a serious new offshore wind market. ●

Attaurrahman Ojindaram Saibasan is a senior research analyst in the Power department at GlobalData Plc.

Ports, policy and supply chains will determine floating wind's next phase

As floating wind moves from demonstration projects toward commercial deployment, Principle Power's VP-Commercial explains why policy certainty, infrastructure investment and lessons from offshore oil and gas will be critical to the sector's growth.

ARIANA HURTADO, Editor-in-Chief

Floating offshore wind has progressed significantly over the past decade, moving from technology demonstrations to early commercial projects operating in Europe. For Greg Campbell-Smith, vice president of commercial at Principle Power, the industry's focus is no longer proving that floating wind works. The next challenge is creating the conditions needed for widespread commercial deployment.

Drawing on lessons from projects including WindFloat Atlantic in Portugal, Kincardine in Scotland and Provence Grand Large in France, Campbell-Smith told *Offshore* that the sector now has valuable operational experience that is helping developers refine designs, improve execution strategies and prepare for larger projects.

"With proven performance across multiple sites, turbine sizes and fabrication yards, the industry has a handful of validated technologies needed to advance to industrial deployment," he said.

Photo (above): The Éoliennes Flottantes du Golfe de Lion (EFGL) project offshore France is among the early commercial floating wind developments helping validate technology, installation strategies and operating practices for larger projects to come. COURTESY LEFGL / OCEAN WINDS / OCCIDRONE

Demonstration projects have validated floating wind technology

According to Campbell-Smith, one of the most important developments over the past five years has been the accumulation of operational data from floating wind projects operating in challenging offshore environments.

Engineers have used this data to validate and refine numerical models, while operators have gained greater visibility into maintenance requirements and performance trends. The industry's growing experience base is also helping developers design projects around the next generation of 20-plus-MW turbines.

"These projects have helped engineers to validate and refine numerical models, and the lessons are systematically fed back into the design process, ensuring the design of 20+ MW projects start from a very mature basis," he added.

At the same time, developers and fabricators have identified opportunities to simplify component designs, reduce welding requirements and increase modularity. Campbell-Smith said such improvements are helping shorten construction schedules and improve manufacturing efficiency as the industry prepares for larger deployment volumes.

Next barriers are regulatory and commercial

While technology continues to evolve, Campbell-Smith believes the biggest obstacles facing floating wind today are largely outside the engineering realm.

"Floating wind has proven feasible and bankable through the successful deployment of early commercial projects in Portugal, Scotland and France," he said. "With strong technical fundamentals, the main challenges are now mainly related to policy-driven decisions."

He pointed to auction visibility, permitting timelines and regulatory certainty as some of the industry's most pressing issues. Without a clear pipeline of projects, he said developers face challenges making investment decisions, while suppliers and infrastructure owners have little incentive to expand capacity.

"Developers need long-term procurement visibility on auctions, stable regulatory frameworks and streamlined permitting processes," he added.

Campbell-Smith also warns that procurement frameworks focused solely on the lowest price can undermine project viability. Instead, he said governments should place greater emphasis on project deliverability and realistic execution planning, particularly as the industry establishes its commercial foundations.

Ports and supply chains will shape the industry's growth

If policy provides the roadmap, ports and industrial infrastructure will determine how quickly floating wind can scale.

Campbell-Smith described ports and marshalling facilities as a critical part of the floating wind ecosystem, noting that developers, port operators and governments often find themselves caught in a cycle of uncertainty. Port owners need confidence that projects will proceed before investing in upgrades, he added, while developers are hesitant to assume the risks associated with first-mover infrastructure investments.

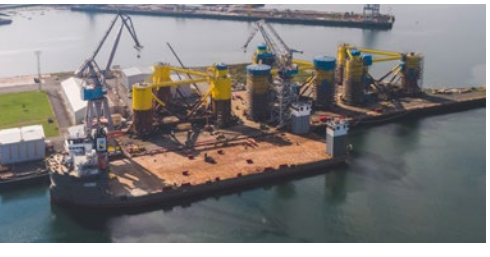
"Projects can only make financial commitments after they have taken the FID decision," he said. "This does not give the facilities adequate time to make the necessary infrastructure investments ready before the work needs to commence."

That challenge extends across global supply chains. While some regions are better positioned than others, Campbell-Smith said relatively few locations currently have the infrastructure needed to efficiently support commercial-scale floating wind assembly and turbine integration.

In France, limited port space and load-bearing capacity remain constraints. The UK faces similar challenges, although government-backed port upgrades are beginning to address the issue. South Korea's floating wind sector is competing with strong demand from shipbuilding, LNG and offshore oil and gas projects, while the US West Coast still requires significant infrastructure development.

"Across all these regions, there's only one common need: policy predictability," he said.

Without long-term visibility, he believes supply chain companies cannot justify the major capex required to expand facilities and manufacturing capacity.



Floating foundations for the Kincardine floating wind project are under construction at a fabrication yard. Developing the port, manufacturing and assembly infrastructure needed to support larger floating wind projects remains a key challenge for the industry. COURTESY NAVANTIA / PRINCIPLE POWER

Offshore oil and gas offers a blueprint for execution

Many of the industry's future gains may come from applying lessons already learned in offshore oil and gas.

Campbell-Smith advocates for early engagement between developers, installation contractors and equipment suppliers, arguing that project teams often focus too narrowly on optimizing individual scopes of work rather than overall project economics.

Using mooring systems as an example, he said the lowest-cost equipment solution on paper is not always the lowest-cost solution to install offshore.

"Working with the industry experts help us derive the lowest overall installed cost with the lowest risk profile," he added.

That same philosophy applies to anchors, installation methods and construction planning. Decisions made early in project development can significantly affect bankability, execution risk and final project economics.

"Performing a clear and well-thought-through pre-FEED that includes early involvement of the supply chain is essential to understand and potentially lowering cost and will also reduce and mitigate risk," he said.

Campbell-Smith summarized the concept with a lesson that has stayed with him throughout his career: "Proper planning prevents poor performance."

Path toward large-scale deployment

Looking beyond 2030, Campbell-Smith sees floating wind following a trajectory similar to that of fixed-bottom offshore wind, though potentially on a compressed timeline.

Over time, larger project volumes, standardized designs, improved infrastructure and technological innovation should drive down costs and improve competitiveness, he said. But unlike the industry's early years, future progress will depend less on proving the technology and more on deploying it at scale.

"The decisive factors will be deployment volume, standardization, port infrastructure and cost of capital," he said.

For Campbell-Smith, the ingredients needed to advance floating wind are becoming increasingly clear. The industry now has operational experience, proven technologies and a growing project pipeline. The next phase will depend on whether policymakers, developers and supply chain participants can create the conditions necessary to turn early successes into large-scale deployment. ●

BW Ideol CFO: Floating wind's biggest hurdle is industrialization, not technology

Lenders want proven technology, execution certainty and predictable delivery schedules.

ARIANA HURTADO, Editor-in-Chief

Floating offshore wind has advanced well beyond the demonstration stage, with pilot projects now operating in Europe and Asia and governments planning gigawatts of future capacity. Yet despite growing momentum, industry leaders continue to debate what will ultimately determine whether floating wind can achieve commercial scale.

BW Ideol CFO Guillaume Faure believes the industry's biggest challenge is no longer proving that floating wind technology works offshore. Instead, he argues that manufacturing capacity, bankability and industrial-scale execution will determine how quickly the sector moves from pilot projects to large commercial developments.

In an exclusive interview with *Offshore*, Faure discusses the lessons learned from projects, including Floatgen and Eolmed; the requirements for attracting investment; and the milestones the industry must achieve over the next decade.

Guillaume Faure

Photo (above): The Eolmed floating wind farm is equipped with BW Ideol's Damping Pool floating foundations. The project is among the early commercial-scale deployments helping validate floating wind technology and operations. COURTESY BW IDEOL

Offshore: The offshore wind industry often speaks about floating wind's long-term potential. From BW Ideol's perspective, what specific conditions must be met before floating wind can be deployed commercially at scale?

Faure: Three conditions need to converge:

- Technology track record proven over years of offshore operation rather than months;
- Dedicated serial manufacturing capacity replacing one-off custom design and fabrication; and
- Commercial terms (order books, EPC-type delivery) that give lenders confidence on cost and schedule.

BW Ideol's own history illustrates that maturation. Fifteen years of R&D eight years of continuous operation at Floatgen and Hibiki; and the Eolmed pilot farm, awarded in 2017 and commissioned in 2026, have shaped both a floater design proven and ready for serial construction.

Offshore: Which barriers pose the greatest risk to commercial deployment today: project economics, supply chain capacity, financing, regulatory frameworks, grid infrastructure or something else?

Faure: Supply chain capacity is the most structural barrier.

European shipyard capacity for steel floaters is scarce and oriented toward high-value, low-volume work. Sourcing from Asian yards exposes projects to price volatility, shipping-lane risk and dependence on a limited pool of carrier vessels for long-haul transport of finished structures.

This bottleneck was visible in France's three pioneering pre-commercial farms (Provence Grand Large, EFGL, Eolmed), all built in steel, where procurement and fabrication capacity, rather than turbine or floater technology, drove schedule and costs pressure.

A rendering depicts the planned Fos3F facility in Fos-sur-Mer, France. BW Ideol and NGE aim to use the site for serial production of concrete floating wind foundations as the industry scales toward commercial deployment. COURTESY BW IDEOL

Financing follows directly from this; lenders want confidence that foundations will be delivered on cost and on time, which needs dedicated production capacity with a credible execution partner rather than project-by-project fabrication.

This is why from the Damping Pool project inception, BW Ideol's response has been to consider concrete, which draws on the existing civil-engineering supply chain rather than shipbuilding, paired with an established construction partner (NGE) for its Fos3F line.

Offshore: What are the most critical requirements for creating a bankable floating wind market, and what are investors and lenders looking for before they commit capital to larger floating wind projects?

Faure: First, standardized and certified products rather than bespoke per-project designs, which shortens engineering lead times. Second, dedicated serial production capacity backed by a credible industrial execution partner. Third, firm orderbook mechanisms that reserve production capacity ahead of final investment decision [FID], giving developers price and schedule certainty, and giving factories the volume needed to run efficiently. This mostly applies to the construction phase of the projects.

For the construction phase of any project, lenders want three things:

- A technology with a genuine offshore track record;
- A recognized execution partner; and
- Visibility on delivery cost and schedule.

The industry as a whole isn't fully there yet. Most floating foundation providers have reached technology validation (TRL 7) but not dedicated industrial manufacturing capacity, which is the piece lenders still find missing on most projects.

Fos3F, BW Ideol and NGE's planned factory in Fos-sur-Mer dedicated to serial production of concrete floating foundations, is designed precisely to answer these expectations. The Damping Pool technology behind it carries eight years of continuous offshore operation at Floatgen and Hibiki, plus the Eolmed 30-MW pilot farm commissioned in 2026.

The 50:50 partnership with NGE, one of France's leading construction groups, puts established civil-engineering delivery capability behind the factory's manufacturing commitments. And preferred supplier agreements, converted into EPC contracts at FID, lock in price and delivery schedule for developers ahead of construction.

Offshore: Several floating wind demonstration projects have now been deployed worldwide. What key lessons from these projects must the industry apply to the first large-scale commercial developments?

Faure: Floatgen is BW Ideol's 2-MW demonstrator off Le Croisic, in operation since 2018, and it provides the clearest lesson: after nearly eight years in the Atlantic, including winter storms with waves up to 10 m, the concrete hull has shown no degradation beyond normal design margins, and maintenance access has proven straightforward in moderate sea states, with the WTG operating at top nominal values and showing no specific wear. That confirms a simple, stable platform stays serviceable over time, not just at commissioning.

Offshore: Looking ahead to 2035, what will define success for floating offshore wind, and what milestones should the industry achieve over the next decade?

Faure: Volumes are set to scale sharply by 2035. On the order, 200 turbines are expected to be commissioned along France's Mediterranean coast alone over the coming decade (France has tendered or announced roughly 3.7 GW of Mediterranean floating capacity through the AO6 and AO10 rounds), with an even larger buildout expected in Scotland, where ScotWind has awarded on the order of 15 GW of floating wind capacity to date.

Success will mean having delivered that volume while creating long-term jobs, at a competitive cost and on schedule.

Milestones to follow this decade:

- Production lines reaching their expected cadence;
- Order books converting from reservation agreements into EPC contracts as projects reach FID; and
- Continued build-out of the pipeline across the Mediterranean and North Sea.

Our Fos3F facility targets roughly 30 foundations per year, close to one every 12 days at full capacity. ●

Standardization can restore offshore wind bankability

Years of growth were driven by larger turbines and low-cost capital, but future gains may require a different approach.

PETER CONSTANTIN BRUN, DNV

The offshore wind industry has encountered serious headwinds in the last 24-30 months. This comes after a period of massive growth and expansion, also to new markets in North America and Asia.

The drivers of the previous growth were a combination of rapid technology innovation mainly driven by expansions of turbine- and farm size, and not least the very low interest rates from 2008-2022 stimulating and encouraging investments. However, since the aftermaths of the COVID-19 crises in 2022, component price inflation and higher cost of capital have challenged the business cases in many offshore wind projects.

Restoring offshore wind's attractiveness and bankability for investors will depend on three principal levers: supportive regulation and subsidies, continued turbine innovation, and greater industrialization and standardization across the industry.

Supportive policies can only do so much

On regulations, many governments have realized that new power generation technology—and not only offshore wind—has become more expensive (at least for some time).

The UK is a good example of timely adjustments of their policy frameworks in this regard with their Auction Round 7, which resulted in more than 8 GW in new projects. Also, Poland, the Netherlands and Denmark's latest successful CfD tender of 2 GW are other examples of successful, needed regulatory changes. However, it is only fair to assume that governments will not want to over-compensate and pass on a too high bill to the electricity consumers, so there are limitations to this measure.

So, what can the industry then offer themselves to lower prices of offshore wind? It is a fact that offshore wind prices were reduced by more than 40% between 2008 to 2022. Apart from the lower interest rates, turbine innovation came from bigger rotors making the turbines much more efficient in capturing the wind resource. This innovation has played a role in price reductions. However, going forward, evidence shows that turbine size will not automatically continue to deliver massive price reductions because bigger turbines also needs more steel, rare metals, etc., and there will be other costly limitations in the rest of the value chain (installation vessels and port infrastructure and availability), not forgetting increased failure rates and more expensive main component replacements for larger turbines.

The next cost-reduction opportunity

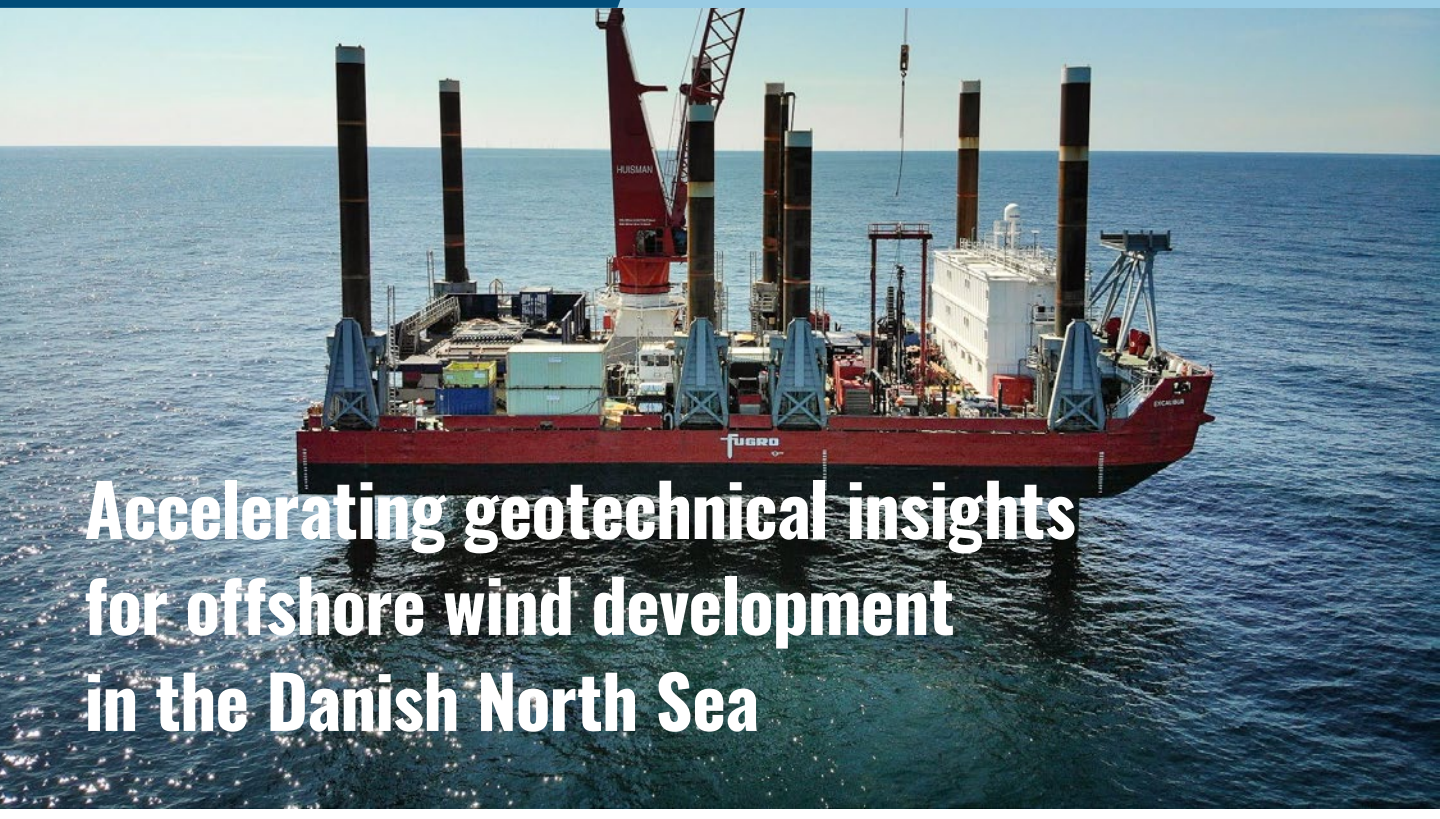
This has increased attention on a third potential solution: standardization and industrialization. Although these concepts have been discussed for many years, the industry today remains characterized by project-specific optimization and bespoke engineering solutions. While such approaches can minimize costs at an individual project level, they also limit opportunities for standardization, repeatability and economies of scale.

Thus, DNV and industry partners launched a joint industry project (JIP) in August 2025 of cost-modeling the unexploited potential of standardization and industrialization for offshore wind in the North Sea. Instead of talking only qualitatively about this, the group wanted to investigate the numerical cost potential of such a new approach for the industry. The goal was to test a fundamental, industry-wide shift in mindset, from continuous incremental turbine upscaling and project-specific engineering toward a more industrialized and standardized approach based on a limited range of wind turbine sizes. By reducing complexity, lowering costs and improving delivery certainty, such an approach could enable greater efficiency and predictability. Through repeatable designs and economies of scale, the industry would strengthen project viability, restore investor confidence and support a more stable and scalable build-out.

The project conclusion was positive: cost modeling, informed by inputs from JIP industry partners, indicated that the collective European supply chain could achieve minimum 20% cost reduction within the next 15 years. Cost reductions arise from cumulative value-chain improvements rather than one measure.

Achieving these benefits would require sustained offshore wind deployment that supports high supply-chain utilization, a substantial increase in annual installation volumes and market conditions that ensure fair competition, enabling the European supply chain to remain competitive alongside non-European suppliers. ●

Peter C. Brun is DNV's global offshore wind segment leader.



Accelerating geotechnical insights for offshore wind development in the Danish North Sea

A large-scale site investigation for Energinet demonstrates how advanced geotechnical tools, offshore laboratory testing and structured reporting can deliver critical seabed data earlier.

A. PADWALKAR, Fugro

Large offshore wind projects are often shaped by decisions made years before construction begins. That was certainly the case for the Danish North Sea development program. In 2022, Energinet, Denmark's national electricity and gas transmission system operator, commissioned Fugro to deliver a geotechnical investigation across a 2,200-sq-km area to support future offshore wind development.

The investigation aimed to support concession tender preparations and provide future developers with a better understanding of seabed and subsurface conditions. This geo-data informed foundation design, cable routing, installation planning and geohazard assessment, helping to ensure offshore structures are safe, stable and cost-effective throughout their lifecycle.

This extensive offshore site investigation program included 384 cone penetration tests (CPTs) and 112 boreholes across two offshore sub-areas. While the scale was significant, another challenge was how to provide meaningful geotechnical insight early enough to influence project planning.

Several initiatives were introduced to accelerate access to geotechnical insights, including an enhanced offshore laboratory, structured interim reporting and investigation methods designed to overcome difficult ground conditions. Together, these helped reduce the time between offshore acquisition and project decision-making.

Photo (above): The Fugro Excalibur jackup barge has enabled safe and reliable investigations in shallow-water areas. COURTESY FUGRO

Gathering better data, sooner

One challenge in accelerating access to geotechnical information is ensuring data can be collected efficiently across a wide range of ground conditions. In parts of the Danish North Sea program, dense soil layers limited the penetration achievable with conventional seabed CPT systems.

To overcome this, Fugro deployed its SEACALF MkV Deep Drive seabed system with Deepcone technology at selected locations, enabling deeper penetration through dense soil layers and achieving an additional 424 m of penetration across 41 CPTs. Seismic Deepcone investigations were also used to obtain deeper shear-wave velocity data and to strengthen the understanding of subsurface conditions.

Part of the survey area was in shallow waters, presenting further operational challenges. To investigate these locations,

The SEACALF MkV Deep Drive seabed CPT system with Deepcone technology achieved deeper penetration in challenging conditions. COURTESY FUGRO

Fugro mobilized the *Fugro Excalibur* jackup barge, which provided a stable elevated platform that enabled reliable operations and helped support consistent, high-quality sample acquisition.

By obtaining a more complete dataset during the initial geophysical, seismic and seafloor campaign, the team was able to optimize the subsequent borehole program, improving investigation efficiency and helping valuable geo-data reach project stakeholders sooner.

Closing the gap between acquisition and interpretation

Collecting offshore data is only one part of the process. Samples must still be logged, tested, interpreted and reported before findings can support project decisions.

An enhanced offshore laboratory onboard *Fugro Voyager* enabled selected laboratory testing to begin immediately after sample recovery. Activities including particle size distribution, Atterberg limits, density and oedometer testing provided early insights into soil characteristics and behavior, allowing geological interpretation and laboratory program refinement to begin sooner than would typically be possible.

At the same time, a structured interim reporting program ensured key findings were delivered throughout the campaign rather than waiting for final reports, providing visibility of site conditions months before traditional reporting milestones.

Digital workflows further improved efficiency by reducing manual data handling and helping information move more quickly through the project lifecycle.

For developers and transmission operators, the greatest value often comes from having reliable geo-data available when critical decisions are being made, not months after those decisions have already been taken.

Designing investigations around project decisions

Large offshore wind developments will continue to demand extensive site investigations, but volume alone is unlikely to be the differentiator. The real challenge is ensuring that project data is available when stakeholders need it, helping to reduce uncertainty, avoid delays and support more cost-effective project development.

For the Energinet program, that meant thinking beyond offshore acquisition and considering how samples would be tested, interpreted and reported throughout the campaign. Earlier access to geotechnical findings helped support planning activities while the project was still evolving.

As offshore wind projects increase in size and complexity, the ability to move useful geo-data through the project lifecycle more efficiently may become just as important as the field investigations themselves. ●

A. Padwalkar is Fugro's project director of Europe and Africa. He has more than 20 years of global experience across project management and commercial key account management, working in multiple roles at the company and leading high-profile projects in the offshore wind, renewables, and oil and gas energy sectors. Now based in the Netherlands, he leads a team of regional project managers to ensure projects meet financial, quality and client goals.

The Fugro Voyager's enhanced offshore laboratory is designed to help accelerate geotechnical testing, interpretation and reporting. COURTESY FUGRO