A strategic solution for operating and maintaining floating wind installations in deeper waters

Structural monitoring service overview from Acteon

Tim Eyles, Vice President of marine energy and infrastructure services company Acteon, explains how a risk-based holistic approach can reduce operation and maintenance costs, improve long-term margins and extend asset life.

The opportunities and challenges for floating wind operators

The global offshore floating wind market is set to expand, and with this, there will be numerous challenges and risks for operators pursuing new projects. According to one research study, floating wind capacity is forecast to reach more than 25 GW by the middle of the next decade, from just under 60 MW today.

The UK is projected to be the market leader by 2035, with about 8 GW of total capacity, followed by the USA with close to 5 GW. Some forecasts estimate that floating wind will generate about 260 GW by 2050, equivalent to 15% of all offshore wind energy and 3,000 times greater than the output of Hywind Tampen, the largest floating wind installation at present.

Early performance indicators reveal that floating wind can perform as well as, or better than, bottom-fixed offshore wind. For example, Hywind Scotland, a floating wind installation in operation since 2017, has achieved the highest average capacity factor of all offshore wind farms in the UK.

Furthermore, there is an increased opportunity for site selection and utilising locations further from shore where social and environmental impact is minimised. It should therefore come as no surprise that, when the results of the recent ScotWind offshore leasing round were announced, many of the largest applications contained proposals to build floating offshore wind farms. The successful applicants consisted of established and new developers.

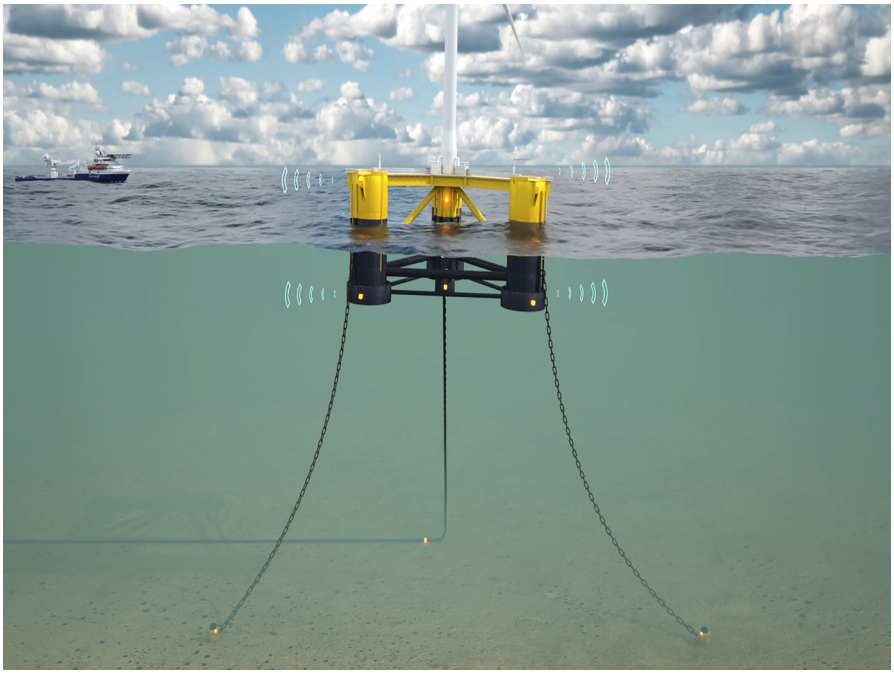
Although floating wind platforms usually share some design characteristics with traditional floating oil and gas installations in terms of their complexity and dynamic loading, the number of assets that require consideration in a floating wind farm is an order of magnitude larger. The floating wind farms of the future are likely to consist of 40 or more installed units, which represents a considerable increase from comparable oil and gas installations.

Additionally, when compared with monopile bottom-fixed wind turbines, the steel mass required for a typical 8-MW floating wind platform comes in at about 2,000 t, which is approximately double the mass required for a bottom-fixed wind turbine.

Clearly, operators of floating wind farm assets are exposed to higher risk, in terms of operation and maintenance (O&M) costs, when compared with the risk of either floating oil and gas installations or fixed wind assets. The sheer quantity of structural members, and their complexity, is much greater, and the increased distance from shore poses logistical challenges if frequent operations are anticipated. Adopting existing analogous approaches from the fixed wind and floating oil and gas production markets is unlikely to be practical or cost-efficient due to the complexity and scale of floating wind installations.

The rationale for a holistic approach to operation and maintenance

Given that the asset lifespan is 25 to 30 years and margins are slim, operators of floating wind installations are keen to reduce the cost of O&M. This is a large part of the overall cost of ownership, and O&M cost projections can help influence whether a project happens or whether it is delayed. It must also be considered that future projects are likely to be lightly staffed and may be run by newer operators entering the sector. These factors combine to increase the



Platform position monitoring

potential risk associated with correctly operating and maintaining an asset for its required lifetime.

Whereas fixed wind installations, which are a more mature technology, typically have established inspection and maintenance schedules that are often prescriptive, floating wind operators would likely benefit from a different approach.

Historically used in the oil and gas sector, a holistic risk-based approach is preferable for the large concrete or steel structures proposed for floating wind. These structures are moored or anchored to the seabed using multiple components, they experience significant wave, current and wind loading, and feature highly dynamic array cables. The approach comprises risk assessment, optimised spares management, monitoring, inspection and the use of a digital twin to enable proactive maintenance.

By adopting this approach, the frequency and duration of visits to distant offshore locations can be reduced while still maintaining an accurate picture of the condition of assets. The approach reduces the cost of ownership and, ultimately, through maintaining an operating history, enables life extension of the asset.

Using risk assessment to drive inspection schedules

The risk assessment process can be used to ascertain the type of information that should be gathered about the structure during operation, and at what frequency. This is achieved by considering critical design aspects, including corrosion, fatigue and wear, and assessing the failure rate and consequences. The necessary inspection, monitoring and maintenance tasks are then identified and an associated schedule set, helping to ensure that such failures do not occur.

The risk assessment is updated periodically during the life of the asset to reflect the actual performance and any degradation that has been identified. The risk assessment can also be input into an optimised spares management strategy with special focus on components like mooring systems and dynamic cables.

Monitoring the structural elements

Sensors that have a low-power design and send data using advanced communications systems can be used to monitor carefully selected critical structural elements and help to provide a continuous long-term picture of their condition. Floating wind platforms can be monitored to assess their state of structural fatigue and loading, the extent of corrosion, and general platform stability and motion. Additional considerations, irrelevant in bottom-fixed wind installations, are the performance of any ballasting system, the moorings and the dynamic cables. The data received can also be used to model the behaviour of the asset, which enables design calibration and reduces measurement uncertainty.

In a ground-breaking project that provides an example of this type of monitoring, Pulse, a structural monitoring brand in Acteon's Data and Robotics division, was contracted to provide structural monitoring services for the TetraSpar floating wind demonstration project. This was the world's first full-scale demonstration of an industrialised offshore foundation, and it showcased the potential for competitive advantage offered by lean manufacturing, lean assembly and installation processes, and low material costs.

The TetraSpar foundation is a tetrahedral structure assembled from tubular steel components, without welding, at Port of Grenaa, Denmark. Following assembly, in July 2021, the structure was towed to the test site 10 km off Karmøy, Norway, where the water depth is 200 m.

Pulse INTEGRIpod SM motion monitoring units were used to gather valuable data and provide insight into the movement and strain the structure experienced during a five-month period in the harsh winter conditions found throughout the North Sea.

VALOR ROV

Desktop performance insight

The information helped to validate the foundation's dynamic model and provided other important lessons applicable to commercial-scale floating offshore wind projects. INTEGRIpod sensors are retrievable by remotely operated vehicles (ROV) and use magnetic holders for ease of installation and removal. Pulse provided and installed three INTEGRIpod units at each of the seven measurement points on the TetraSpar demonstrator.

Digital response twin: the intelligent use of monitoring and inspection data

The understanding of floating asset behaviour, maintenance requirements and anomaly detection is further enhanced using digital response twin technology, which can accurately predict the structural performance and life extension of an entire wind farm using a minimal set of monitoring sensors.

The digital twin is a near real-time dynamic virtual model that uses the inputs from the sensors to build a long-term picture of what normal, and abnormal, asset behaviour looks like. Findings from inspections, for example, loss of steel thickness or increases in marine growth, can also be input into the model. The digital twin can then be used to inform changes in inspection requirements with opportunities to decrease inspection frequency if the response is better than expected. Similarly, rapid intervention can be made if abnormal behaviour is spotted thus avoiding more costly failures.

Inspection with a world-class ROV

The initial risk assessment, together with monitoring data and a digital twin, is used to drive an inspection programme for determining which components to inspect and the frequency of inspection. When subsea inspection is required, it can be carried out by ROVs.

The highly capable VALOR ROV from Seatronics, a brand in Acteon's electronics and tooling segment, is ideally suited to such tasks as the lightest yet most powerful ROV in its class. For a floating wind asset, such inspection would typically involve hull, mooring line and cable assessment, cathodic protection surveys, marine growth removal, cable buoyancy assessment, mooring component inspection and 3D photogrammetry.

Additionally, Acteon is trialling an uncrewed surface vessel (USV) that will be key to reducing ROV inspection and seabed survey costs in the future. The modular USV uses 80% less fuel and can operate from any port, without a mother ship, for up to 20 days when performing inspection and survey operations.

With no personnel on board, and by bringing data-processing tasks onshore, it reduces deployments and associated aviation and other travel costs while retaining access to highly skilled personnel when required. In this way, the sustainability of operations is enhanced, and their carbon footprint is reduced. Improved safety is realised because of a reduced offshore headcount. To reduce the carbon footprint even further, the vessel can be fitted with a propulsion system that runs on 100% biofuels.

Bringing data and insight to all

A key challenge could be managing the volume and frequency of data being collected through monitoring, inspection and digital twin technologies. However, there are several data management and visualisation services available to help the operator manage O&M. For example, Acteon now provides software such as iSite Subsea from UTEC, a geo-services brand in Acteon's Data and Robotics division, that enables visualisation of large subsea inspection and survey data sets through a cloud-hosted solution.

Data that was previously only available to users of specialist locally installed software applications are now available to all, which enables better collaboration and faster-informed decision-making. The management of such data sets over time is also efficiently handled, which is especially important given the life span of the assets being managed.

The benefits for floating, and fixed, wind farm operators

In summary, a risk-based holistic O&M strategy combines symbiotic disciplines with the aim of extending asset life. These include risk assessment, motion, structural and cable monitoring, digital twin technology, optimised inspection and surveys, and maintenance and spares management. By leveraging low-logistics technologies such as USVs, the operational costs, risk and carbon footprint can be reduced. Using inspection, survey and monitoring data, engineers can perform structural assessments to better understand critical risks and make recommendations on remedial solutions to help prolong the life of the asset.

Having a single point of contact for all subsea O&M activities enables operators to be more strategic and proactive in their approach, and provides opportunities to simplify processes, streamline operations and improve the profitability of the floating wind farm. Furthermore, the same process can be applied to larger fixed wind farms, particularly where the assets are in mid to late life.

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Acteon Vice President Tim Eyles will be delivering a technical workshop on 'Reducing OPEX for FOWT projects through a holistic O&M strategy' in the Global Offshore Wind Innovation Theatre at 13:45 on 15 June.

To view a full list of Acteon stand activities and presentations during Global Offshore Wind, visit resources.acteon.com/pes.