

How Predictive Maintenance Can Unlock Offshore Wind Growth

A practical guide to adopting digital technology in wind energy applications

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Offshore wind capacity in 2030 is projected to reach 234 GW, according to the Global Wind Energy Council.

This white paper looks at the key operations and maintenance (O&M) challenges that owners and operators of offshore wind assets face as a result of this expansion, and how digital tools can provide solutions, from day-to-day problem solving and quick wins to future-proof-

ing operations and maintenance (O&M) strategies and long-term gains.

In a tough landscape where strike prices are low and margins are being squeezed, reductions in LCOE have been achieved by increasing turbine size and streamlining the supply chain. However, there is huge potential to achieve significant efficiencies without entering into a race for the biggest turbine or the lowest parts or service costs. This paper identifies short, mid

and long-term opportunities for owners and operators to increase efficiencies, drive down O&M costs/time and boost profitability.

The offshore wind sector is thriving globally. Driven by innovations in turbine design and digital technology, the cost of producing energy from offshore wind is at record lows. Europe continues to set a benchmark, led by the UK, which has committed to power every home through offshore wind by 2030.



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The European Union has added further momentum with a target of 60 GW installed capacity by 2030.

In the US, the American Wind Energy Association projects 9 GW installed capacity by 2026, up from just one 30 MW wind farm now. Asia-Pacific is also set for rapid offshore wind growth: China alone is expected to add 52 GW of capacity by 2030.

From the Baltic Sea to Brazil, offshore wind offers hope as the race to reach net-zero by 2050 gathers pace, requiring cleaner, cheaper and more plentiful electricity.

Offshore wind can deliver on all three requirements. But the sector must look ahead to potential stumbling blocks and take action to minimize them now.

Technical challenges

Owners and operators in the offshore wind sector have many challenges to grapple with and digital tools can help solve them. The goal is to provide a practical guide for the years and decades ahead, which will no doubt see new challenges — and new opportunities.

The offshore wind sector has already proven its resilience during the Covid-19 pandemic, providing a safe haven for investors as oil pricing continues to fluctuate. But the industry is not complacent. Increased budget pressures and a looming skills gap join ongoing challenges around grid integration, storage and port infrastructure.

Budget pressures are part of the industry due to competitive auctions and a drive to deliver affordable clean energy, but the pandemic has intensified this pressure. It has put a

further financial strain on relationships throughout the supply chain and is eating into the budgets needed to ensure technicians are trained and skilled sufficiently to service a new, growing fleet.

Onyx Insight has set out a roadmap for how companies can navigate tricky conditions until 2030, and further establish offshore wind as vital to the fight against climate change.

Short-term: What companies can do now

There is no one easy solution to ensuring the continued resilience of offshore wind. There are, however, simple changes that owners and operators can adopt to drive further operational efficiencies and profitability.

Optimizing logistics

The distinctive costs and challenges of offshore wind result from the need to transport equipment and personnel to wind farms miles out to sea. Vessel hire, offshore cranes, and jack-up rigs present a high barrier to entry for new players, and a significant fixed cost for owners and operators. A single gearbox replacement can cost up to £1M.

Operators can tackle costs now by rationalizing vessel trips, particularly for crew transfer vessels, delivering significant savings in fuel costs while reducing transit times for technicians.

The key is planning — but with a cutting-edge twist. Operators can now tap into weather forecasts, advanced diagnostics, and available technical resource to complete the job and maximize vessel utilisation. Data gathering and sharing unlocks the holistic, supply-chain-wide view needed to release



significant efficiency savings.

One powerful tool that can help owners and operators to achieve greater oversight and control of O&M schedules is predictive maintenance.

This delivers a detailed view of turbine health across large wind fleets, enabling owners and operators to prioritise and optimise maintenance work. Unplanned corrective work accounts for up to 40% of O&M costs, while working with a good predictive maintenance partner can deliver savings of 30% from O&M budgets.

Minor repairs are a major cost

Owners and operators can also make significant savings by refocusing on minor repairs. The most expensive tasks—gearbox, main bearing and blade replacements—are often front-of-mind. However, ONYX Insight estimates that work classed as minor correctives, such as pitch subsystem or yaw drives, accounts for approximately half of scheduled O&M.

Calendar-based instead of production-based scheduled maintenance causes inefficiency, incentivising

maintenance teams to perform the same work on all assets regardless of need. This issue has been compounded by a reliance on often outdated manuals which fail to reflect modern diagnostic advances. Merging and prioritizing this work by moving to condition-based maintenance can deliver significant savings and improve reliability of assets.

Intelligence on asset health is crucial to enable this. What components across a fleet need replacement? Which assets only require monitoring in the short term? To benefit, wind farm owners and operators will need support from a predictive maintenance partner that can answer these mission-critical questions.

The Next Technology Wave

The offshore wind sector is on the brink of a new technological revolution. A new data-focused era beckons, promising a future of intelligent, connected wind assets.

Advances will include instant insights at the touch of a button; remote inspection via drones; and autonomous robotic repairs. It sounds like science fiction—but the groundwork is being conducted today by forward-thinking owners and operators.

Life extension from day one

We must also remember that wind turbines being built today will be operational in 2050. Advanced predictive maintenance is already pushing the envelope on what is considered a useful turbine lifetime. By putting in place a data-driven life extension strategy as the turbine life cycle begins, not at the end of the warranty period, owners and operators stand to maximize the benefits.

Predictive maintenance for life extension can take many forms. Cross-channel data analysis combining insights from oil condition and vibration monitoring is already being rolled out. As more owners and operators become aware of the benefits of multi-channel data analytics, the potential to extend turbine lifetimes will increase accordingly.

Predictive maintenance also maximizes the impact of low cost, simple



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actions, such as performing grease flushing to protect the main bearing and identifying high risk components in advance to replace them at the optimal time. A grease flushing can add years to the lifetime of a component but is only 1% of the replacement cost—crucial for managing annual budgets.

Maintaining assets in peak health for longer has wider benefits for the industry. It can increase the value of a wind farm by up to 12%, unlocking further investment. If the correct predictive maintenance and data management strategies are ingrained into the entire UK offshore and onshore wind market, for example, the savings could be £140 million over the next five years.

The sooner predictive maintenance is implemented, the longer the life of the asset, and the greater the returns. Every KWh of production after the asset cost is paid back is pure profit—and the right predictive maintenance program can extend useful asset life by 25%.

Embracing new technologies

A further revolution in offshore wind will be enabled by investment into automated and remote technologies such as drones, facilitating safe inspections at a lower cost. The most dangerous and costly tasks, such as blade inspections, will be done by automated robotic automotive platforms. This

places technicians out of harm's way as well as reducing logistical costs.

This robotic future comes together with mobile technology. In today's connected world, inspection data need no longer be relegated to dusty storage cabinets. Visual inspections by technicians are a valuable source of information about asset health. The latest mobile applications such as fieldPRO digitize inspection data automatically and create clean data for analysis by expert engineers armed with machine learning algorithms.

Digital tools can also lessen the pressure of skills gaps, by standardizing best practice and supporting operational decision making. Additionally, streamlining data collection can empower experienced personnel to spend more time problem solving, and less time on administrative tasks.

Long term: Growing a healthy offshore wind sector

Promoting sustainable growth in the long-term comes from putting in place best practice now. Ultimately, the most impactful gains for offshore wind will come through large-scale collaboration—through supply-chain wide data sharing and knowledge transfer.

Designing for use

Take the design of wind turbines, the lifeblood of industry growth. Currently, wind turbine designers are tasked with delivering a turbine that can be

easily produced and withstand both the environmental challenges and production expectations of offshore operations. Maintenance or serviceability of the asset is often a secondary issue during design stage, which creates bottlenecks for O&M due to access issues for teams on the ground.

However, by focusing more on the operational requirements of wind turbines during the design process, the industry could see significant efficiency gains throughout the wider asset life cycle. Considering the placement and accessibility of fluid intakes, or the location of access hatches, for example, could streamline processes significantly throughout a maintenance job significantly reducing the cost of owning a wind turbine throughout its life.

Key to unlocking a holistic approach to turbine design is open communication throughout the supply chain. The reality of the turbine experienced by maintenance teams needs to be shared with design engineers, to ensure that from installation, to maintenance, to decommissioning, the asset has efficiency built in.

Collaborative maintenance zones

A further step-change in offshore wind operations will be delivered through a cluster approach to O&M across large offshore sites.

Logistics is the defining challenge of offshore wind. Locational proximity is therefore a key opportunity for



Europe continues to set a benchmark, led by the UK, which has committed to power every home through offshore wind by 2030. (All photos

the sector. As projects are built further out to sea around the world, there is a huge chance for owners and operators to pool resources and drive unprecedented economies of scale.

This can already be seen in giant projects such as the 3.6GW Dogger Bank, owned by Equinor and SSE Renewables and, as tenders involving clusters of assets become more common, operational practices must keep pace. Data sharing and joint maintenance tenders will help to keep unnecessary trips out to wind farms to a minimum—and advanced diagnostics to accurately estimate remaining useful life can support this.

There's a final market dynamic which threatens the efficiency of offshore wind. Competition drives innovation and helps to deliver continued reduction in price. In the onshore industry, the cost of O&M service contracts has halved in the last three years due to multiple offers on the market from OEMs, ISPs and O&M teams looking to self-perform. However, in offshore wind, high barriers to entry favor the larger players, which could stifle the natural inventive spirit of the wind O&M sector.

Fixed costs such as jack-up rigs will limit the extent of downward pressure in practice, but artificially low pricing strategies adopted by some companies are driving margins down and could result in an entrenched oligopoly within the O&M space, limiting the options available to owners and operators for service contracts.

Independent assessments of the true cost of components and maintenance work can provide much needed reassurance to owners and operators. During vital periods such as during major component replacement work, this can be a significant boost.

When owners and operators have been properly informed on the risks of activities and the true condition of their assets, extra knowledge gives them the confidence to choose the right partner to help them save money in the long run.



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Technology & Sustainable Growth

As an industry, there's much that offshore wind can collectively be proud of.

The sector is set to spearhead the green recovery, especially in countries such as the UK where offshore wind represents the best way and example of how to scale renewables.

Investors are confident in offshore wind as an asset class, providing the resources for further innovation and growth. This comes in tandem with increasing interest from oil majors, who are slowly recognizing that the future of energy lies in the sky, not the ground.

With the right people, and the right tools, there is huge potential for the industry to provide affordable and clean energy in the run up to 2050 and beyond.

But to achieve this potential, owners and operators must future-proof operations by seizing on advances in digital tools that enable them to do more with less. Even now, turbine lifetimes of 40 years are within reach for assets installed in the next few years, with the right O&M strategies in place.

This is crucial as the industry tackles the exciting opportunity of floating

wind, which will bring new logistical challenges that will lead to further evolution in O&M.

Ultimately, to ensure the continued success of the offshore wind sector, it is vital to optimize the production of current assets alongside building new infrastructure—and the best way to achieve this is through smart predictive maintenance strategies. **PTE**

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head of engineering, has been working closely with a majority of UK offshore wind farms for many years providing owners (Centrica, SSE, RWE, E.ON, SPR) with data enabled engineering projects focussing on increasingly efficiency of offshore wind farm operation, improving turbine reliability and de-risking major maintenance operations. She is leading the UK engineering team at ONYX focusing on developing data driven methodologies for predictive maintenance: life models for the wind turbine components, advanced diagnostics using various condition monitoring systems, and operations and maintenance cost optimization models.

