University of Southampton

SOUTHAMPTON MARINE & MARITIME INSTITUTE

The impact of offshore wind farms in context: the research that can make 2050 wind targets possible

Evidence to accelerate UK offshore wind by eliminating the biggest barriers to progress.

EXECUTIVE SUMMARY

The UK aims to deliver 50 GW of offshore wind by 2030 and over 125 GW by 2050, but current installation rates need to increase four-fold to meet these targets (see Figure 1). Delays in planning and consenting, often involving duplicated assessments and complex regulatory processes, are now one of the biggest barriers to progress.

These delays have real consequences: slower decarbonisation increases climate risks for coastal and inland communities, threatens energy security, and limits economic opportunities.

Our research provides new evidence to help policymakers accelerate offshore wind responsibly. We mapped how UK ocean space is currently used and found that meeting 2050 offshore wind ambitions would occupy less than 5% of the UK Exclusive Economic Zone (EEZ), which is much less than utilized by other ocean sectors including oil & gas, fishing and shipping. Correlations of human activities with ecological measures shows fishing and shipping, not offshore wind, are the human activities with the greatest ecological impact. We also show that most future offshore wind sites for the UK will require floating wind technology, creating opportunities to develop energy infrastructure further offshore and away from many existing users. We identify effective monitoring technologies and decision support tools that enable evidence based, adaptive management[1] as the sector scales.

These insights can help streamline consenting, reduce uncertainty, and unlock the rapid offshore wind deployment required for the UK to meet its climate, energy, and economic goals.

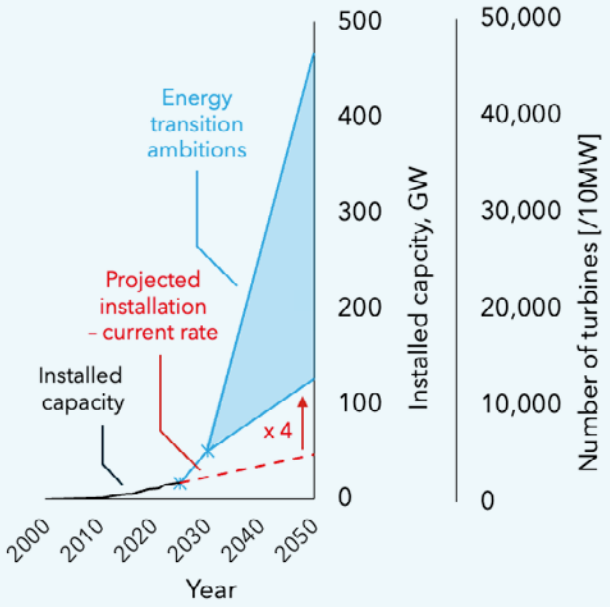

Figure 1. Historic and forecast UK offshore wind capacity showing at current rate of installation less than half of the lowest target will be achieved.

1. Adaptive management uses the best available evidence to guide decisions through a structured, iterative process. Project management is adjusted as learning emerges after construction, with outcomes monitored and actions revised where results differ from expectations.

POLICY CONTEXT

The UK's **Clean Power 2030 Action Plan** sets a goal of **45–50 GW of offshore wind by 2030,** highlighting offshore wind as the "backbone" of the future clean energy system. **The Seventh Carbon Budget** shows the UK will need **88 GW by 2040** and **125 GW or more by 2050** to stay on track for net zero.

The latest auction (AR7) awarded **8.4 GW of new offshore wind,** enough to power over 12 million homes and attract £22 billion in private investment. Ministers have described offshore wind as a major driver of clean energy, economic growth and national energy security.

However, recent policy proposals risk slowing this progress. The **Marine Recovery Fund** and ongoing **Marine Net Gain** consultations aim to improve environmental outcomes, but their benefits are still unproven. Introducing new potentially over cautious requirements without strong evidence may add delay at a time when rapid deployment is essential. In contrast, the impacts of continued climate change, such as coastal erosion, flooding and rising public costs, are well established.

The **Environment Act 2021** requires policymakers to consider environmental risks in a balanced, evidence-based way, and to assess the consequences of both action and inaction. This approach aligns with the UK's legal obligations under the **Climate Change Act 2008,** its **2035 emissions commitments,** and international duties to limit climate related harm. Together, these frameworks support decisions that enable responsible offshore wind growth while avoiding unnecessary barriers, ensuring the UK can meet its climate and energy goals.

Delayed deployment of offshore wind impacts the day-to-day lives of the entire UK population. Coastal communities and port cities on the front line of climate change would face worsening coastal erosion and sea-level rise, while inland communities would experience more severe flooding and other extreme weather events, with knock on effects such as poor agricultural harvests.

Our research provides evidence to allow policymakers to consider risks of offshore wind deployment at scale in a balanced way in order to meet our net zero offshore wind targets.

RESEARCH AIMS

Our research, funded by the UKRI Research Councils NERC and EPSRC through the ECOWIND Programme and ORE Supergen Hub, and by the Royal Academy of Engineering through their Chairs in Emerging Technologies Scheme, has sought to:

1. Identify the range and extent of ocean use to identify locations for future offshore wind deployment.
2. Link human use of the ocean with its ecological health and create tools that help planners make better decisions about where offshore wind should go.
3. Understand how effectively different environmental and structural monitoring technologies and marine management methods work as the number of offshore wind farms and other ocean assets rapidly increases.

RESEARCH FINDINGS

- Geospatial mapping and analysis showed that offshore wind currently uses less than 1% of the UK's EEZ. Meeting 2050 targets would use under 5%. In comparison, oil and gas infrastructure uses 11%, fishing 36% and shipping 84%. We also found that over 90% of the suitable space for future offshore wind is in deep water where floating, non-fixed, turbines will be needed (Figure 2).

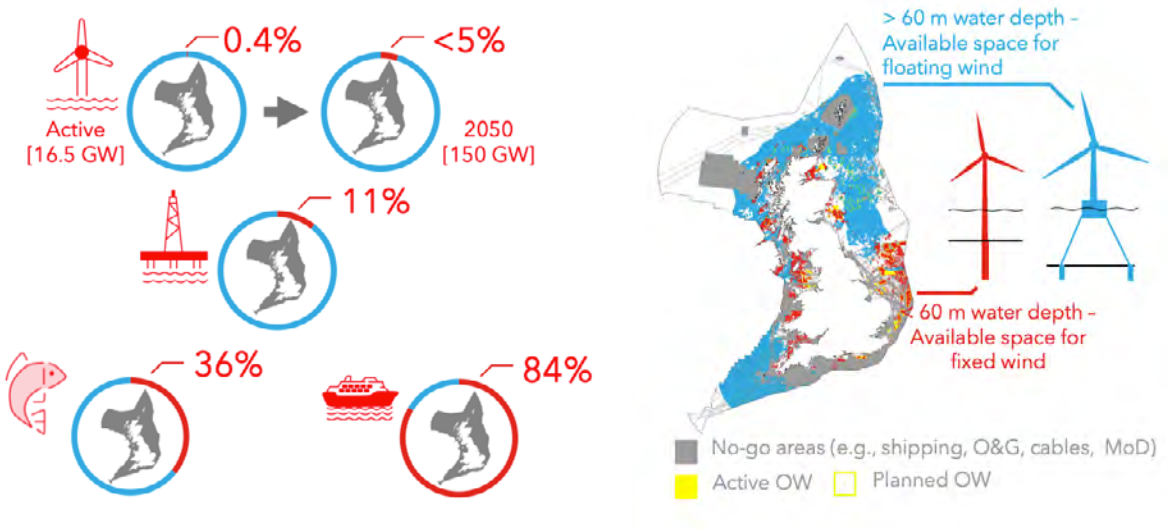

Figure 2 (a). Proportion of UK EEZ occupied by different ocean sectors showing offshore wind requires relatively little space, and (b) map showing > 90% of available space for offshore wind in water depths requiring floating rather than fixed wind turbine technology.

- The combination of human activities rather than the total number of activities has greatest impact on ecological health and resilience. Such that it is not just the less busy areas that should be prioritised, as siting of offshore wind alongside existing cables, pipelines, an MPA and a ship wreck could have less environmental impact than trawling by itself. Some activities may have positive interactions, for example if offshore wind farms created an exclusion zone to some types of fishing. Positive or negative, this underscores the need for integrated, not siloed, management.
- Offshore wind is not strongly correlated with changing ecological functioning – an indicator of ocean health. However, two of the top ten features that affect ecological functioning are fishing and shipping. The other eight features are natural markers, e.g. salinity and air temperature. This analysis shows that for the first time in history, human activities are governing marine ecosystems.
- Right now, we don't have enough scientific evidence to reliably predict the long-term environmental and combined impacts of offshore wind — especially floating wind — or how it interacts with other activities in the wider ocean. We do now have a better understanding of what needs to be monitored, and new technologies to allow us to collect detailed data at scale and interpret it quickly.

KEY MESSAGES

- Relatively little space, < 5% of the UK EEZ, is required for offshore wind to meet 2050 targets compared with other activities such as oil & gas, fishing and shipping.
- Fishing and shipping have a greater negative impact on ecological biodiversity than other human uses of the ocean including offshore wind.
- Most of the areas best suited for future offshore wind in the UK are in deep water, where floating wind technology is needed. This technology is still new, so we do not yet fully understand its combined environmental impacts.
- Monitoring and management must go hand in hand. As offshore activity grows, scalable approaches will be needed, alongside investment in training and modern tools to support the maritime workforce.

POLICY IMPLICATIONS

- Ambitions for offshore wind in the UK are enshrined in law, yet uncertainty is delaying deployment at a rate to meet UK government targets. Timely offshore wind deployment would support the UK in meeting its national and international climate commitments, while maintaining the ability to adjust management as more robust evidence on cumulative effects emerges through ongoing monitoring.
- Offshore wind policy should recognise its comparatively low spatial and ecological impacts relative to other ocean uses, while supporting continued monitoring and research to strengthen the evidence base on long-term environmental effects.
- Adaptive management supported by mandatory monitoring with available technology will create the required evidence base while deploying offshore wind at the rate needed to deliver on 2050 net zero targets.

Global warming won't wait and we can derisk moving fast.

THE RESEARCH TEAM

The **Southampton Marine & Maritime Institute (SMMI)** is a globally distinctive interdisciplinary research institute bringing together academics across disciplines to work in partnership with industry, third sector and government to solve marine and maritime challenges. **Susan Gourvenec** is Professor of Offshore Geotechnical Engineering and Royal Academy of Engineering Chair in Emerging Technologies for Intelligent & Resilient Ocean Engineering (IROE), **Blair Thornton** is Professor of Maritime Autonomy, **Fraser Sturt** is Professor of Maritime Archaeology, **Julian Leyland** is Professor of Physical Geography, **Martin Solan** is Professor of Benthic Ecology, **Hugo Putuhena** is a Research Fellow specialising in Geospatial Analysis and **Wassim Dbouk** is a Policy Research Fellow specialising in Ocean Governance and Justice.

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