Ten years on: scour protection turned reef at Teesside Offshore Wind Farm

As the global push toward renewable energy accelerates, offshore wind farms have become a defining feature of the modern energy landscape. While their primary role is to generate clean electricity, attention is increasingly turning to how these large-scale installations interact with marine ecosystems. Can they do more than minimise harm? Could they actively enhance biodiversity?

A recent study conducted at the Teesside Offshore Wind Farm, operated by EDF Power Solutions UK & Ireland, conclusively shows the answer is 'yes'. By integrating innovative scour protection technology, researchers are beginning to uncover how offshore infrastructure can double as a catalyst for marine life, contributing to the growing concept of biodiversity net gain (BNG).

From protection to enhancement

Scour protection is a critical component of offshore wind turbine installation. It prevents erosion around turbine foundations caused by the action of underwater currents. Traditionally, this has involved the placement of rock armour or similar materials around the base of structures. However, newer approaches are exploring how these functional elements can be designed to deliver ecological benefits as well.

One such innovation is the Ridgeway Filter Unit® Rockbags system. These Japanese-engineered Filter Unit® Rockbags are designed not only to stabilise the seabed, but also to introduce structural complexity, an essential ingredient for marine habitats.

Unlike conventional scour protection, the Filter Unit® Rockbags create varied surfaces and voids that can be colonised by

marine organisms. Over time, these features can mimic natural reef environments, offering shelter and feeding grounds for a range of species.

Why Teesside provided the perfect testbed

The Teesside Offshore Wind Farm, operated by EDF Power Solutions, presented a unique opportunity to explore the ecological potential of this technology. Installed over a decade ago, the 27-turbine, 62 MW capacity site has had sufficient time for environmental conditions to stabilise, allowing researchers to observe long-term ecosystem development rather than short-term disturbances.

Crucially, the site offered a natural experimental setup. Out of 27 turbines, 11 required scour protection as advised by Engineering Consultants, Ramboll. These were fitted with Filter Unit® Rockbags. The remaining turbines were deemed not to need additional protection. This provided a balanced comparison between 'treated' and 'non-treated' areas, the latter effectively acting as 'control areas', a key requisite for drawing meaningful scientific conclusions.

With environmental variables such as seabed depth, tidal conditions and proximity to river outflows also considered, the study was designed to isolate the ecological impact of the Filter Unit® Rockbags installations as clearly as possible.

Investigating marine life beneath the surface

To assess the ecological impact, a detailed survey was carried out in partnership with marine specialists FjordStrong. The methodology is centred on the use of Baited Remote Underwater Video systems (BRUVs), a non-invasive technique widely used in marine research.

A total of 27 BRUV deployments were conducted across the wind farm, generating approximately 80 hours of high-resolution stereo video footage. This approach allowed researchers to observe marine life in its natural state, without the disruption associated with traditional sampling methods.

The use of stereo video also enabled accurate measurements of fish size, providing deeper insights into population structure and habitat use. By analysing this data, the research team could assess not just the diversity of species, but also their abundance, biomass and life stages.

Scientific analysis: a positive ecological signal

Scientific analysis of the survey data has revealed encouraging trends. Turbines equipped with Ridgeway's Filter Unit® Rockbags (FURBs) showed noticeable differences in key biodiversity indicators compared to those without.

Among the most significant findings were:

- Significantly higher species diversity: The presence of FURBs resulted in a net increase of 38% more observed species across the entire wind farm.
- Higher abundance of commercial species: (2.2 x higher cod-family fish; 10 x higher edible crab; 3 x higher lobster)
- Role as artificial fish nurseries (AFNs): Perhaps most notably, juvenile fish were frequently observed passing through the mesh, which excluded larger predators, indicating that these structures may be functioning as artificial fish nurseries (AFNs).
- More functionally diverse: Rockbag-associated communities exhibited markedly higher functional diversity, spanning multiple distinct ecological guilds

The presence of juvenile fish is particularly important from an ecological and commercial perspective. Nursery habitats play a critical role in sustaining fish populations, supporting the early life stages that determine future stock levels. If offshore wind infrastructure can contribute to this process, it represents a significant step forward in aligning renewable energy development with food security.

Artificial fish nurseries: a new frontier

The concept of artificial fish nurseries is not new, but its application within offshore wind farms is still emerging. Traditionally, artificial reefs have been deployed intentionally to enhance fisheries or restore degraded habitats. What makes this approach different is that the ecological benefit is gained utilising products that have been integrated into the infrastructure primarily for engineering purposes.

Ridgeway's Filter Unit® Rockbags appear to provide the right combination of shelter and space. The mesh fabric was used by juveniles as a passage that excluded larger predators, repeatedly indicating habitat use.

Lobsters, too large for the mesh apertures, were using the inter-unit crevices between stacked Filter Unit® Rockbags, illustrating a good example of how the FURBs have created a complex 3D habitat. One lobster that was observed measured ~40 cm and weighed around 4 kg, almost twice as long and four times the weight of individuals at the minimum landing size.

This multifunctional approach has significant implications. Rather than viewing offshore developments as a trade-off between energy production and environmental impact, it opens the door to a more balanced model, one where infrastructure actively contributes to ecosystem health, known as 'marine net gain' (MNG).

Measuring biodiversity net gain offshore

Biodiversity net gain has become a central theme in terrestrial development, particularly in the UK, where policy frameworks increasingly require projects to leave natural environments in a better state than before. Applying this concept to the marine environment is more complex, but no less important.

The Teesside study represents a step toward defining how MNG can be measured offshore. While no universally agreed metric for marine biodiversity currently exists, assessments must draw on a combination of indicators. The following aspects are considered fundamental:

- Species richness and community composition
- Abundances and spatial distribution
- Presence of key life stages, such as juveniles
- Functional diversity and ecological interactions

The scientific evidence shows that engineered solutions like Filter Unit® Rockbags do play a meaningful role in delivering measurable biodiversity gains.

The role of collaboration

Projects of this nature rely heavily on collaboration between industry and scientific expertise. The partnership between Ridgeway, FjordStrong and EDF Power Solutions UK & Ireland highlights how cross-sector cooperation can drive innovation and generate valuable insights.

Access to an operational offshore wind farm is no small undertaking. The support of the Teesside operations team was instrumental in enabling the survey to take place, ensuring that data could be collected safely and effectively without disrupting energy generation.

Such collaborations are likely to become increasingly important as the offshore wind sector continues to expand. By embedding research into operational sites, developers can build a stronger evidence base for environmentally beneficial practices.

Looking ahead: from pilot to standard practice

The Teesside project builds on earlier pilot programmes and represents a significant step toward mainstream adoption of biodiversity-enhancing technologies in offshore wind farms. Looking ahead, the results provide an exciting opportunity to broaden the use of Filter Unit® Rockbags into different ecosystems and allow them to benefit from marine net gain.

The publication of a scientific paper is in progress and will be shared when completed.

Key questions for future investigation include:

- How do these habitats evolve over longer time frames?
- Can similar results be achieved in different marine environments?
- What design optimisations could further enhance ecological outcomes?
- How can BNG metrics be standardised for offshore applications?

Addressing these questions will be critical in moving from isolated success stories to widespread implementation.

A shift in perspective

Perhaps the most important takeaway from this study is the shift in how offshore infrastructure is perceived. Rather than being seen solely as an environmental impact to be mitigated, it can be reimagined as an opportunity for ecological enhancement.

This aligns with a broader trend in sustainable development, one that prioritises not just reducing harm but actively delivering positive outcomes. In the context of offshore wind, this means designing projects that contribute to both climate goals and biodiversity targets.

Conclusion

The survey has clearly shown that the introduction of Filter Unit® Rockbags has had a positive effect: delivering a higher species richness, a more resilient and diverse species community, higher abundances of commercial species, resulting in a more complex habitat that serves critical ecosystem functions, all in addition to their primary function of asset protection against scour.

The results clearly indicate that renewable energy infrastructure supports marine life rather than displacing it.

In doing so, it brings the industry closer to achieving increased sustainability, where environmental, economic and ecological objectives are aligned.

As offshore wind continues to grow, innovations like these will play a crucial role in shaping a more balanced relationship between human activity and the natural world beneath the waves.

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