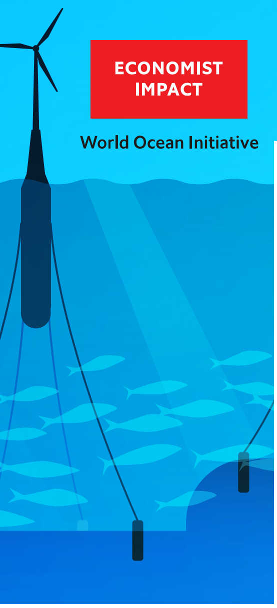

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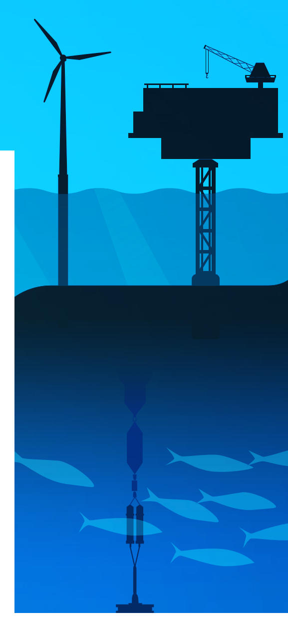


Offshore wind: how green energy depends on ocean observation data

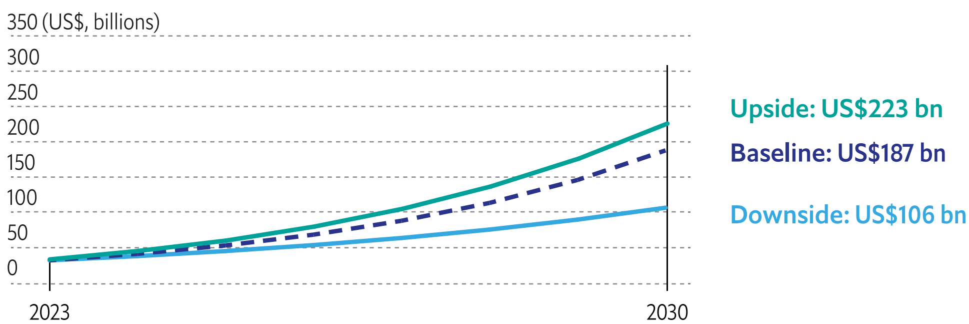
Offshore wind stands as a beacon of promise, offering vast potential for sustainable power generation. However, to fully unlock the benefits of this industry, there is a crucial need for enhanced ocean observations.

As the world confronts the urgent need for sustainable energy solutions, the vast expanses of our oceans have become the canvas upon which a green revolution is unfolding. Offshore wind is crucial in the green energy mix. It offers substantial energy potential, reduces land use conflicts, and leverages a ubiquitous, renewable resource for effective energy generation. Recent research indicates that fully harnessing the usable potential of marine-based wind could, annually, reduce CO2 emissions by approximately 4.5 billion tons in the near future—which is nearly equivalent to the average annual CO2 emissions of the US.

The economic potential of offshore wind energy is also noteworthy. Currently, the offshore wind industry constitutes over 90% of the US$52bn marine-based climate change mitigation economy. Rapid growth is on the horizon. Economist Impact estimates that the industry's gross value-added will quadruple, reaching US$187bn by 2030. In an optimistic outlook—one where countries reach their 1.5°C emission targets—it has the potential to expand to US$223bn, marking a fivefold increase. This expansion of offshore wind energy presents a chance to decrease global carbon footprint and strengthen energy security. It also offers an opportunity to actively improve marine biodiversity at offshore wind sites. (*Detailed estimates and projections are offered in the infographic here.*)

Offshore wind energy holds significant economic potential

Figure 1: Offshore wind, gross value-added, 2023-2030



Source: Economist Impact estimates

However, experts point out that the industry's trajectory is uncertain,[1] and not only due to recent supply chain and financial challenges. Dynamic ocean environments and wind resources are made even more unpredictable by climate change, necessitating accurate, timely data for wind projects and more confident climate forecasts. Access to such data is not

[1] Economist Impact interviewed 13 industry and academic experts to gather insights on the growing role of ocean observation data and its impact on the sustainable blue economy. For further details, please read the reference note

a given. “While publicly-funded data are typically reachable, access to industry-generated data is not assured,” says Jake Kritzer, executive director of Northeastern Regional Association of Coastal Ocean Observing Systems, which is part of the U.S. Integrated Ocean Observing System.

From waves to watts

Ocean observation data (OOD) are the linchpin for the oceans’ condition, weather and climate forecasts. They are therefore also critical for the success and efficiency of offshore wind projects and the large-scale expansion of this industry. These data are crucial for ensuring longevity and the optimal performance of infrastructure designed to last 25 years or more. OOD also play a pivotal role in meeting complex regulatory requirements, such as when reporting on environmental performance—including offshore wind biodiversity, safety and operations.

Economist Impact estimates reveal that 66% of the US$48bn offshore wind industry relied on OOD access in 2023. This means that the industry could lose up to US$32bn in gross value-added without ocean observations. Given the unpredictability in the marine environment triggered by climate change, the industry’s dependence on OOD is projected to reach 100% in the short to medium term as the industry continues to scale up.

“From selecting optimal locations for wind farms to planning construction and operations, decision-making processes rely entirely on ocean observations,” Dr Kritzer notes. “Insufficient or inaccurate data can lead to planning errors, impacting safety of all ocean users, environmental health, and project efficiency.”

For instance, when planning the installation of offshore wind foundations and power cables, project teams need to understand the composition and stability of the seabed. Doing so requires data generated by ocean observation tools including sonar systems, remotely operated vehicles, autonomous surface vehicles and coring devices. Calculating turbine foundation loads begins with accurately monitoring wave and current dynamics. Determining a site’s potential energy production requires wind speed and direction observations. These data are delivered by tools such as buoys, lidar and acoustic sensors, unscrewed surfaced vehicles, and autonomous environmental bottom landers.

OOD remain crucial long after construction wraps up for tracking performance, ensuring structural integrity and monitoring biodiversity impact. Real-time rotor speed and power output data help minimise downtime and boost efficiency. With data providing visibility into extreme weather events, offshore wind farm operators can also take timely steps to protect both personnel and equipment.

Looking ahead, there’s a significant opportunity for advancements in OOD to help a maturing industry realise economies of scale. More and better data could substantially improve the business case for projects, Dr Kritzer says. “There is immense potential to reduce the operational costs per kilowatt of energy produced, while simultaneously improving the cost-efficiency of shipping and fishing businesses that will continue within wind turbine arrays through better navigational and operational planning.”

“From selecting optimal locations for wind farms to planning construction and operations, decision-making processes rely entirely on ocean observations.”

Jake Kritzer, executive director of Northeastern Regional Association of Coastal Ocean Observing Systems

A dual pledge

The industry's global prospects, however, face data-related headwinds.

Limited access to high-quality OOD, especially in emerging countries with prime wind farm sites, hinders project planning. Lack of real-time, accurate data for early detection of extreme weather events heightens the safety and operational risks facing offshore wind farms.

Finally, weak public-private synergies are a missed opportunity to blend private interest in proprietary data with public expertise in scientific research, environmental monitoring and regulatory transparency. Public-private frameworks could incentivise and motivate co-investment in and co-ordination of ocean observations. As of now, public data are accessible, but reciprocal sharing by the private sector most often occurs when mandated by law.

Despite these challenges, there are signs of progress. The UN Global Compact Ocean Stewardship Coalition is working on ways to improve data sharing. Other potential solutions include establishing comprehensive ocean observation networks to encourage global collaboration and investing in artificial intelligence and machine learning technologies to enhance the use of available OOD.

In essence, the growth of the offshore wind industry hinges on continuous commitments from both the public and private sectors towards improving ocean observations. At COP28, 123 countries pledged to triple global renewable energy capacity and double energy efficiency, by 2030. Achieving these goals requires targeted investments in offshore wind, which depend on timely, quality ocean data. This isn't just a necessity for advancing clean energy—but ultimately represents a commitment to a low-carbon future fuelled by renewables.

> **"There is immense potential to reduce the operational costs per kilowatt of energy produced in offshore wind farms, through more well-developed ocean observations."**
>
> Jake Kritzer, executive director of Northeastern Regional Association of Coastal Ocean Observing Systems

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About the research

Economist Impact's World Ocean Initiative has undertaken a unique and vital research programme to estimate the economic value of ocean observation data streams to marine-centred climate-change mitigation activities globally. It demonstrates the benefits that would accrue if public, private, academic and philanthropic initiatives could more effectively unleash the potential of ocean observation data through greater data accessibility and usability, talent development, and public-private partnerships.

By taking a first step towards improving our understanding of the economic linkages that inform and drive the blue economy, we hope to bolster the case for improved and expanded ocean observations, climate-change mitigation efforts, and research on the economic value of data for the blue economy.

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