Scaling up Europe's Offshore Wind Integration

MARCH 2025

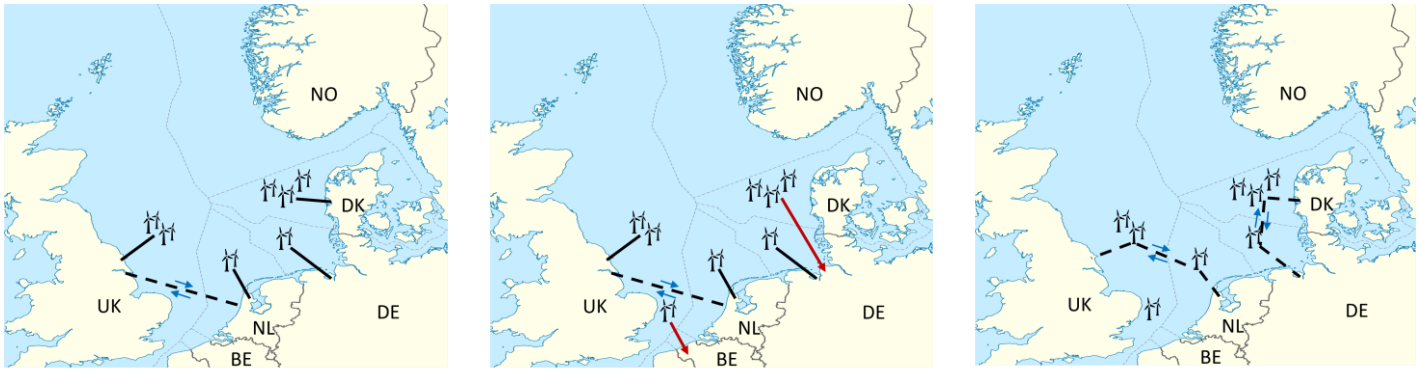
WindEurope

1. OFFSHORE WIND IN EUROPE

EU Member States have set offshore wind targets of 300GW by 2050. However, Offshore Network Development Plans (ONDPs) see a potential capacity of 384GW across the EU and up to 500GW across Europe as a whole. Additionally, a coalition of nine countries has pledged to deploy 300GW of offshore wind in the North Seas by 2050. This underscores the vast potential of offshore wind and its critical role in Europe's efforts to decarbonise its economy, enhance competitiveness and strengthen energy security.

So far Europe has **installed 37GW of offshore wind capacity**, highlighting the need for significant expansion of the offshore grid infrastructure. To meet its targets, Europe needs to consider innovative grid connection options that extend beyond national borders and require stronger regional cooperation within each sea basin.

2. GRID CONNECTION OPTIONS FOR OFFSHORE WIND FARMS



a) Domestic radial build-out b) Cross-border radials c) Offshore hybrids

As it stands offshore wind farms can be connected via three different options to the onshore grid: **a) domestic radial connection, b) cross-border radial connection and c) offshore hybrid asset.**

(a) Domestic radial connection

This is the case where an offshore wind farm (OWFs) is built in a country's territorial waters or Exclusive Economic Zone (EEZ) and directly connected to its onshore grid. This is the standard well-established option regulated at national level without cross-border implications.

However, domestic radial connections will often be insufficient to unlock investments in offshore wind farms aimed at boosting cross-border electricity exports. For example, countries that already meet their domestic electricity demand with renewable energy may have little incentive to back new offshore wind projects through revenue stabilisation schemes like Contracts for Difference (CfDs) or to cover grid connection costs. Yet, these countries may possess excellent wind resources capable of supplying power to industries and households in neighbouring countries.

A key example is Denmark's 3GW offshore wind energy auction in December 2024 which failed to attract any bids. An important reason was that the projects would connect to a system that already meets the country's electricity demand.

Furthermore, offshore grid connection costs are rising for various factors. And often domestic radial connections require significant onshore grid reinforcements to deliver their power to consumers. As a result, they might become financially unviable for developers or too costly for consumers. To address these issues in an efficient and cost-effective way, Europe should also explore innovative, cross-border offshore grid solutions.

(b) Cross-border radial connection

In this innovative and straightforward approach, an OWF is located within the exporting country's EEZ but directly connected to the importing country's onshore grid. This option can accelerate system and market integration, by leveraging a country's strong wind resources to supply clean power directly to a neighbouring country.

Technically this setup is similar to a domestic radial connection. In this case, there is no need to comply with interconnector regulation and to establish an Offshore Bidding Zone, therefore it can reduce the cross-border implications. While no real-life examples exist yet, this option holds good promise as a first step toward stronger cross-border collaboration in offshore wind deployment. In case the OWF needs to be supported by a 2-sided Contract for Difference, the importing country would enable this.

To facilitate this type of configuration, national authorities would need to address key questions regarding the respective costs and benefits sharing. Issues such as build-out responsibility, financing, ownership of transmission assets, potential seabed lease costs, and other factors will need careful consideration.

(c) Offshore hybrid assets

Offshore hybrid assets integrate offshore wind generation with cross-border transmission infrastructure, linking two or more countries. They have the potential to connect multiple national electricity markets and OWFs through a shared offshore grid. This option offers several benefits:

i. it can reduce total system integration costs
ii. it can contribute to optimised grid planning and use of maritime space – less offshore cables and landing points of OWFs
iii. it can increase interconnection and renewable energy uptake for the interconnected countries. This is major contribution to their security of supply and flexibility needs
iv. It can effectively deliver electricity from countries with high offshore wind potential to countries with high electricity demand.

However, significant regulatory and financing challenges remain. OWFs connected via offshore hybrid assets are expected to sell their power in offshore bidding zones (OBZs) which will operate separately from national bidding zones. OBZs introduce market risks and increase investment uncertainty for OWFs due to limited demand within them and reliance on interconnectors to transmit power to consumers. Additionally, OWFs in these assets face a significantly higher volume risk compared to radially connected offshore wind farms or onshore wind farms.

Beyond the risks associated with each grid integration option, additional challenges include volume risk from onshore grid congestion, supply chain bottlenecks and rising costs, higher commodity prices as well

as unclear and non-harmonised grid connection requirements across the EU. Such factors further complicate the connection of offshore wind farms into the grid.

3. RECOMMENDATIONS

1. **Anticipate grid investments and boost electrification to integrate offshore wind:** The reinforcement, expansion and modernisation of offshore and onshore grid infrastructure is crucial to take offshore wind generation to demand centres. National Authorities and Transmission System Operators (TSOs) must coordinate grid expansion and anticipate necessary investments with at least a 10 to 12 year horizon, while ensuring regional collaboration in grid and maritime spatial planning. TSOs and developers should synchronize the development of grid infrastructure and offshore wind farm through transparent cooperation to ensure timely project delivery.

   Meanwhile, Europe must accelerate electrification in fossil-fuel dependent sectors to enable renewable energy use as the electricity's share in the EU has stalled at 23%. Without this, offshore wind's integration and business case will continue struggling.

2. **Develop a collaborative investment framework for offshore energy projects that includes offshore wind:** The European Commission, ENTSO-E together with the wind industry should establish an expert group to develop a cross-border cost sharing framework that includes offshore generation in the cost-benefit analysis at the sea-basin level. This will enable countries to select the most efficient offshore grid and generation projects based on comprehensive assessments. Without early alignment between the offshore grid and generation sectors, Europe risks facing more unsubscribed offshore wind auctions.

3. **Enable effective tools to de-risk offshore grid investments at national and regional sea-basin level:** The European Commission should enable the development of *Offshore Financing Facilities* at the sea-basin level to unlock funding for the grid integration of offshore wind. These could support offshore hybrids or offshore and onshore grid build-out to integrate offshore wind farms with significant cross-border benefits. By combining voluntary financial contributions from participating countries and private capital at an early stage, *Offshore Financing Facilities* could reduce project realisation risks. Additionally, they could mitigate offshore wind market risks by guiding countries on market design and offering revenue stabilisation schemes, such as cross-border two-sided Contracts for Difference.

   The 2024 Electricity Market Design reform introduced the Transmission Access Guarantee (TAG) to de-risk investments in offshore hybrid-connected wind farms bidding in an Offshore Bidding Zone (OBZ). The TAG's implementation should be defined in the upcoming Capacity Allocation and Congestion Management (CACM) guideline revision, expected by the end of 2025. It must effectively cover key risks to shield generators from operational de-ratings and revenue losses. Developers and regulators should be closely involved in this process.

   Offshore wind farms connected via offshore hybrids will face additional costs and risks when they will have to deliver PPAs from an OBZ to a home-market zone. To create a level playing field with wind farms in intra-zonal PPAs market-based risk mitigation tools such as Financial Transmission Rights (FTRs) will be necessary to hedge the price spread risk between two bidding zones. Aligning the

duration of FTRs with the duration of long-term PPAs, typically more than 10 years, can provide long term stability.

However, the structural cost disadvantage of a price spread between zones will remain and the additional cost will be passed on to the offtaker, making OBZ PPAs less attractive. To address this issue, governments can compensate OWFs using market-spread CfDs, an FTR-like mechanism that compensates market price spreads without participating in the actual FTR trading.

4. **Ensure grid capacity for upcoming offshore wind farms:** National authorities and TSOs should ensure that sufficient grid capacity is reserved in a binding manner at onshore substations for the expected offshore wind capacity. Available grid capacity cannot continue to be unthoughtfully allocated based on the f*irst come, first served* principle.

   To support this, national authorities should facilitate the coordination of offshore grid planning, seabed survey and permitting process. This coordination will provide greater certainty and stability for grid connections while streamlining the consenting process.

5. **Optimise grid connection requirements for offshore wind to minimise grid integration costs:** ACER's proposals in the under-revision network codes for grid connection of generators and HVDC, must be justified and carefully assessed to speed up renewable deployment which is crucial for Europe's climate goals and energy security. They must also be well thought to keep grid integration and technology costs down, prioritising cost-effective system integration solutions, to avoid soaring up electricity prices for consumers.

6. **Countries should commit to offshore wind targets to support scalability of offshore grid supply chains:** With the large offshore wind volumes to be installed in the next years, Europe needs a strong European supply chain for electrical grid equipment that delivers timely and at affordable costs. Governments must align auction and construction timelines to ensure clear and stable project pipelines and enable effective planning, scale up of grid equipment manufacturing and cost reduction pathways for grid equipment and projects. In addition, the standardisation of technical requirements across countries would provide predictability for OEMs, helping to streamline production.