The Shape of Future Offshore Wind Production Hubs

The offshore wind industry at a crossroads.

AALBORG RENEWABLES

INTRODUCTION

The offshore wind industry is at a crossroads.

Current global capacity stands at 57 GW[1], increasing exponentially as the world marches closer to reducing 55% greenhouse gases and reaching carbon neutrality by 2050.

However, the industry is behind, especially in Europe. Russia's invasion of Ukraine, ever-evolving climate targets, and production delays are causing national and international supply chain disruptions. Further, offshore wind turbine size and scale continue to increase, as do offshore project pipeline volumes, placing more pressure on production hubs to deliver. So, the real question is: How can future production hubs and the entire offshore wind industry navigate these challenges successfully?

This paper provides a comprehensive insight into future global production hubs and how they can navigate ever-changing policy, supply chain disruptions, space constraints and infrastructure upscaling. This insight is supported by wind industry experts WindEurope, Siemens Gamesa, Groningen Seaports and Delta Wind Partners.

Space to Grow

To meet future offshore wind demand and reach global climate targets, enough production hub space is essential.

Wind turbine components—including blades, towers, nacelles, and generators—are becoming larger, weightier and far less manageable, particularly as offshore wind project size, scale and frequency increase.

The first offshore wind turbines measured 17 metres, and only 11 were constructed in 1991. Today, Vesta's V236-15.0 MW turbine prototype, considered one of the world's largest and most powerful, is six times larger, with a blade size of 115.5 metres and a rotor diameter of 235 metres.

Producing, storing, transporting, maintaining, and eventually decommissioning blades as large, if not larger, than 115.5 metres is no easy task. It requires strategic land expansion investments to soothe logistical headaches.

And with wind turbine height predicted to reach over 130 metres by 2035 and blade size expected to increase significantly over the next decade, there has never been a more urgent need for future production hubs to deliver on these investments.

Measuring the space with the pace

Sufficient storage space – or lack thereof – concerns production hubs, ports and manufacturers, as it's arguably their most crucial asset.

Blades and other turbine components don't follow a straight linear path from a manufacturing facility to a loading boat; quite the contrary. They require short or long-term storage at some point along their journey, preferably within the hub's main grounds and not in an overspill site 3-4 miles away.

Sufficient storage space is one of the biggest challenges. We currently have a large number of active offshore projects. Our factory output has increased greatly over the years, with the flow of components being multiplied many times over. We need optimal storage space to handle this growing offshore wind production volume, says Thomas Mortensen, Head of Transport Offshore Project Execution at Siemens Gamesa.

Mikkel Møller, senior construction project manager at Delta Wind Partners echoes Mortensen's statement, explaining:

- Larger components require a very large hinterland where they can be stored. A wind turbine consisting of 5 tower sections, a nacelle and 3 blades needs approximately 7,500 square metres, which can be reduced if components are designed to be stackable.

Manufacturers must work alongside ports and other production hubs to identify land areas that provide greater storage capacity and will keep components close to factories and the quayside area.

It all comes down to logistics. We need large sites and a carefully planned logistics schedule; otherwise, it's a logistical nightmare.

Erik Bertholet, Groningen Seaports

235 m

Vesta's V236-15.0 MW turbine prototype, considered one of the world's largest and most powerful has a rotor diameter of 235 metres

"Larger components require a very large hinterland where they can be stored. A wind turbine consisting of 5 tower sections, a nacelle and 3 blades needs approximately 7,500 square metres, which can be reduced if components are designed to be stackable."

Mikkel Møller, Delta Wind Partners

A study in 2020 concluded that the European offshore wind supply chain, isn't ready for the renewable transformation. The offshore wind supply chain is challenged by bottlenecks, barriers, and constraints. The bottlenecks are primarily caused by a shortages of installation vessels, making sufficient storage space at production hubs and ports increasingly important, as the vessels must be able to run around the clock[2].

Beside shortages in vessel availability the industry is also challenged by logistical challenges as the supply chain consists of linkages spanning multiple industries which increases complexity and create a need for fine grained coordination between multiple actors. This challenge is experienced by Business Manager Logistics and Offshore Wind at Groningen Seaports, Erik Bertholet. He says that:

- It all comes down to logistics. We need large sites and a carefully planned logistics schedule; otherwise, it's a logistical nightmare.

Another challenge at Groningen Seaports is that the port is close to a world heritage site, making quayside expansion almost impossible.

- We have enough space to expand inland, and our offshore sites boast enough space, but we're limited with what we can do nearer the water, which is the ideal location for offshore wind companies, unfortunately. It's a logistical nightmare especially now that there are two major offshore wind projects currently happening simultaneously in the same port. Prioritizing space and what we can do with that space is crucial.

Bertholet explains that talking with manufacturers and addressing expectations is the most optimal starting point.

Based on the above ports that wants to be production hubs for the offshore wind industry, must ensure that they have plenty of space to expand near the water.

Infrastructure

Global wind capacity is predicted to increase five times from 57 GW to 316 GW by 2030[3]. Europe's wind power is set to increase from 28 GW to 156 GW, accounting for 50% of the predicted global capacity and averaging 27.9 GW annually[4].

Future offshore wind ports and production hubs—widely considered central to wind farm manufacture and installation worldwide—must invest heavily in infrastructure. This investment means upgrading and upscaling services, structures, facilities and solutions to handle a potentially overwhelmed supply chain, especially as global climate targets draw ever closer.

European ports must invest €8.5 billion between now and 2030 to support offshore wind expansion and deliver 165 GW of offshore wind capacity[5]. This investment aims to build or upgrade port facilities, specifically reinforcing heavy loading quaysides and deep-sea harbours, two of the most important aspects of any offshore production hub. It could be paid back in just five years and would bring significant savings for electricity consumers and society as a whole.

US offshore wind investments are predicted to reach $810 billion by 2030[6], and the UK recently announced a £60 million investment in January alone[7], with another £160 million planned to develop and build floating offshore wind ports and factories[8]. Whilst these expansions involve multi-stage pre-planning, long lead times and strategic alignment with manufacturers and project developers, future production hubs must realise that the stakes are high and upscaling infrastructure is more critical now than ever before.

All roads lead to infrastructure expansion

Production hub roads and access routes are the lifeblood of manufacturers and suppliers. Without them, turbine component transportation and eventual installation would be near impossible to perform.

With component and project volume growing yearly, roads and access routes will likely be too narrow and busy to transport components safely and efficiently. Future production hubs and ports must invest in an obstacle-free space to facilitate the growing components if they haven't already done so.

- As components get bigger, heavier and higher in volume, component transportation via road and rail will no longer be possible, which is why all major components such as foundations—whether fixed or floating—require sufficient access to the quay, explains Mikkel Møller, senior construction project manager at Delta Wind Partners.

Road and access route size and scale vary between production hubs. In Eemshaven, all port roads are Class 60 and are reinforced to withstand evenly distributed weights of up to 12 kN per linear metre. All roads are obstacle free with enlarged curves and roundabout bypasses that facilitate safe turbine component transportation.

Therefore, production hubs must quickly risk-assess future component size and weight versus port road size and weight restrictions, with an acute focus on blade rotation parameters and overall movement thresholds.

Similarly, manufacturers and suppliers should examine a hub's road infrastructure and expansion plans to determine whether they accommodate future production requirements.

Decommissioning in the Future

In 2021, Siemens Gameasa launched RecycleBlade, the first-ever wind turbine blade that can be recycled at the end of its lifecycle. Made with a new specialised resin, making the material easier to separate, RecycleBlade is a crucial step towards Siemens Gamesa's ambitious goal to make turbines fully recyclable by 2040. In 2022, the German Kaskasi offshore wind farm became the first to install these blades that are being produced in Aalborg, Denmark.

The importance of renewable energy and circular infrastructure

Future offshore hubs should also consider a renewable energy infrastructure. Despite boasting the lowest carbon emissions, offshore wind isn't carbon neutral and never has been. Wind turbine production emits carbon dioxide, albeit in small quantities.

Wind turbines are scaling up. Production is rapidly increasing in line with demand. And it's expected that 700 MW of installed capacity from approximately 300 turbines (over 15 years old) will likely be decommissioned or repowered within the next ten years[9] (See Figure 2). Therefore, hubs and manufacturers risk emitting more CO2 within the next decade.

Furthermore, bigger turbines might potentially utilise more materials per unit of power generated than smaller-scale turbines in the future[10].

Circular thinking and renewable frameworks promote resource sharing, reusing, recycling and repairing, which counteract productiondriven waste, pollution, biodiversity loss and emissions[11]. Blades manufactured with recycled materials can reduce CO2 output by up to 34 per cent[12]. Hubs are also becoming aware of how marine life is affected by offshore turbine installation.

Global industries—not just in the wind sector—have started to include circular thinking and renewable infrastructure as they face new concerns over decommissioning costs and end-of-use solutions. Industrial symbiosis is a particular focus, whereby two or more companies share, use and recycle surplus resources, including materials, facilities and logistical solutions.

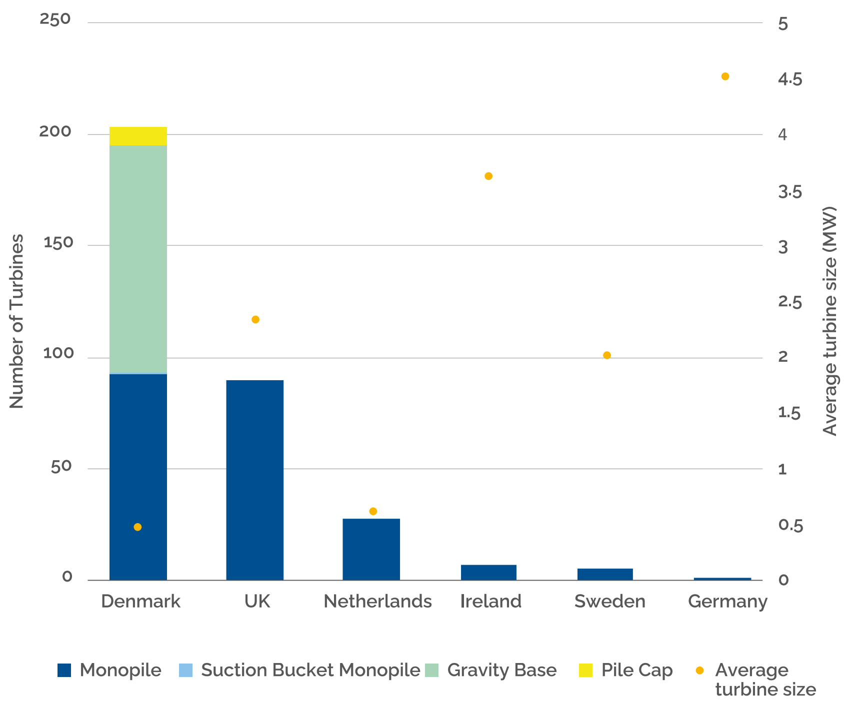

FIGURE 1 Indicates the number of turbines and their components over 15 years old ready for decommissioning or repowering over the next decade.

Source: WindEurope. (2021) A 2030 Vision for European Offshore Wind Ports: Trends and opportunities.

Politics, Business & Climate Regulation

Climate change is the world's biggest challenge. Total global land use and fossil fuel CO_2 emissions have increased from 15.4 gigatonnes of CO_2 (gtCO_2) to 40.5 gtCO_2 since 1959, a 163 per cent rise in over 60 years. CO_2 output today is beginning to flatten with a 0.8 per cent emissions increase from 39.9 gtCO_2 to 40.5 gtCO_2[13].

To meet global climate goals and reduce global warming significantly, flattening the curve is not enough. Global governments are now taking a more radical target-based approach to combat fossil fuel-driven emissions.

The offshore wind industry is a primary focus, and offshore wind production hubs play a critical role in global decarbonisation now and in the future.

All bets are on in Europe
The EU Offshore Renewable Wind Strategy originally set installed capacity targets of 60 GW by 2030 and 300 GW by 2050 to help secure climate neutrality. These targets have since changed thanks to the REPowerEU Action Plan.

REPowerEU is an urgent EU-led plan to make Europe completely independent from Russian gas and oil following the country's conflict with Ukraine and the subsequent global energy and price pressure.

Previously, the EU imported 155 billion cubic metres of Russian gas in 2021, accounting for 40% of its total gas consumption[14]. REPowerEU proposes a two-thirds reduction in the EU's Russian fossil fuel reliance and a wind capacity growth target of 510 GW by 2030 (onshore and offshore). This proposal will require a 210 billion investment between now and 2027[15].

The North Sea countries (excluding the UK) now commit to building 76 GW of offshore wind by 2030, whilst the Baltic Sea countries commit to 20 GW[16]. Outside the EU, Britain recently announced an installed capacity increase from 40 GW to 50 GW by 2030, and Norway plans to install 40 GW by 2040.

However, the entire European continent is not on track to meet these ambitious goals.

- Europe's cumulative offshore wind target has risen from 111 GW to 165 GW of installed capacity by 2030. Today, only 28 GW is installed, which means we require a near-sixfold capacity increase over the next eight years, explains Lizet Ramirez, Offshore Wind Analyst at Wind Europe.

165 GW

Europe's cumulative offshore wind target has risen from 111 GW to 165 GW of installed capacity by 2030.

"The entire industry will be best served by markets where turbine volume continues to be significant enough for factories to operate without year-long gaps between projects."

Mikkel Møller, Delta Wind Partners

There is a silver lining for future production hubs. Increased independence from Russian fossil fuel usage and subsequent renewable energy acceleration policy will likely result in higher wind project volumes.

We are hopefully in a transition phase where the overall demand, investments and appetite for wind energy will give us the certainty of continued project volumes year-in-and-year-out across every market. The entire industry will be best served by markets where turbine volume continues to be significant enough for factories to operate without year-long gaps between projects, explains Thomas Mortensen, Head of Transport Offshore Project Execution at Siemens Gamesa.

Keeping up with the targets
Whether future hubs can meet the demand for offshore turbine installations and keep up with the ever-growing climate targets is somewhat of a contentious issue.

The need for climate reduction is obvious, but ports and other hubs recognise that ambitious—or potentially overambitious—goals bring a wider set of challenges than many realise.

- I'm often congratulated for the recent 70 GW offshore wind capacity goal, but it's currently unrealistic, says Erik Bertholet, Business Manager Logistics and Offshore Wind at Groningen Seaports, referring to the target set by the Dutch government in 2022. He continues:

- There are several things converging on us and the entire Dutch port industry simultaneously, such as expansion, turbine and grid availability, bringing energy to shore, new vessels with crane capabilities and hydrogen bidding. This convergence brings a lot of tension because port timelines and schedules are underestimated.

Bertholet continues saying that ports and other hubs must bypass national governments and address these issues with EU government officials. They can then select the appropriate offshore ports and invest in their operations, which will enable them to scale up and lead the European climate goal ambitions.

Network & Access to Knowledge

Access to production hub knowledge and expertise is crucial to global manufacturers and suppliers but is not always guaranteed. Hubs worldwide are not all created equal.

The most reputable ports have long-standing wind energy experience, boasting partnerships that drive innovation, connections to world-leading universities and research departments, and a carefully selected skilled workforce. New or inexperienced hubs, however, don't necessarily possess these qualities. Partnerships, relationships and skilled employees are created with time and targeted networking.

Manufacturers and developers almost always choose production hubs by carefully looking at what the location has to offer in terms of services, facilities, infrastructure, workforce competence, expansion plans, transportation costs and green energy use.

Siemens Gamesa has North Sea production hubs in Denmark and in the English city of Hull. Asked about the company's production hub in Hull, Siemens' Head of Transport, Offshore Project Execution, Thomas Mortensen, believes it's an advantageous location with many positive benefits.

- We have a hub located on the other side of the North Sea. It guarantees expertise, skills and experience. All these benefits cannot be underestimated, says Thomas Mortensen, Head of Transport Offshore Project Execution at Siemens Gamesa.

Attracting international workers (and keeping them)
Attracting international workers with desirable skills and expertise is one thing; keeping them is another.

Expat workers already acquainted with a certain quality of life typically require new residency opportunities with equal or greater education, housing, infrastructure, social benefits, liveable salaries and English proficiency, all of which make the transition easier and more manageable. Education is especially important. Expats typically prioritise high-class, international and often privately run schools for their children. Future production hub HR departments should communicate with potential or newly-employed international workers regarding job security, family relocation, repatriation, performance benefits and legal issues, including the visa and immigration process.

Local content and international workforce barriers
It's important to remember that policy-led local content laws can affect the hiring of international workers, and all future production hubs must be aware of this pitfall, regardless of their offshore wind experience and reputation.

What's working against future production hubs, particularly when securing a skilled workforce, is the pressure to fulfill government-backed local content laws, whereby companies must employ a specific number of domestic workers per a quota.

Whilst local content in the offshore wind industry has its upsides, including more local job opportunities, manufacturers and suppliers are not guaranteed a skilled workforce, especially for specific tasks that require an equally specific skillset. It also fails to guarantee the most efficient use of existing supply chains[17].

Moreover, regulatory barriers can prevent production hubs from importing skilled international workers, even when their skills and experience outmatch those of a local worker.

Supply chain

Large-scale Polish, British and German wind project pipelines will enter the supply chain from 2024 to 2025. And further wind project numbers are expected to explode between 2027-2030 as several other European countries seek to deliver turbines en-masse to meet their 2030 climate targets (See Figure 3). These pipelines will place significant pressure on future production hubs and supply chains.

As a result, Foundation Installation Vessel (FIV) and Wind Turbine Installation Vessel (MTIV) availability is predicted to decrease between 2024-2025[18] (See Figure 4). This reduced availability will only worsen if something isn't done to prevent it, especially with installations needing to double by the end of the decade.

Increased pipeline project volume and subsequent vessel shortages will cause untold pressure on future production hubs and supply chains, possibly resulting in significant turbine installation delays.

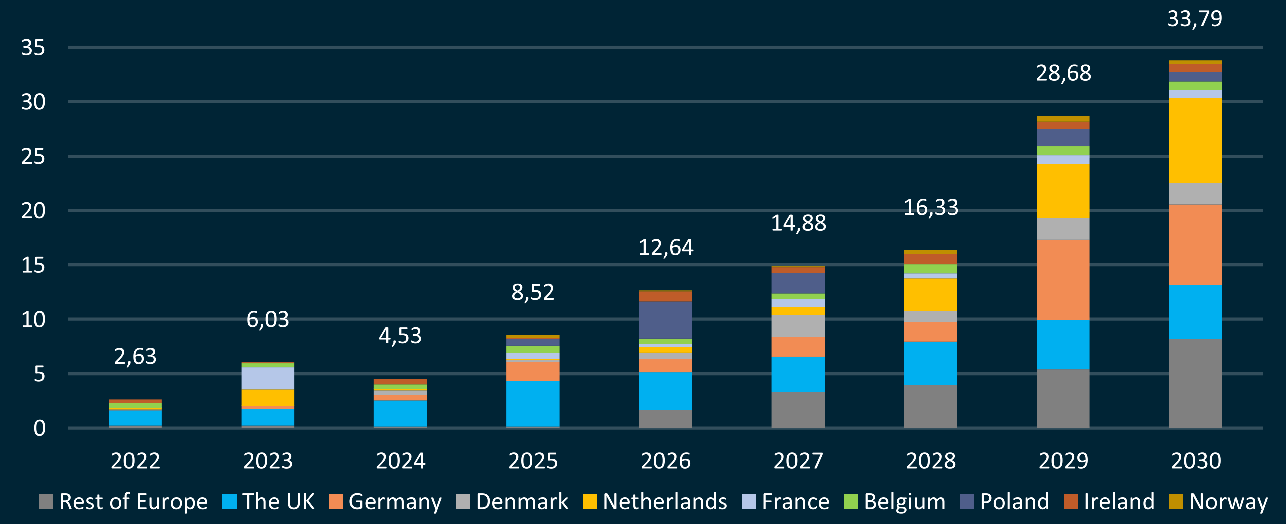

FIGURE 2 Infographic illustrating new installations European between 2022-2030 based on commercial operation date.

Source: H-Blix for Polish Wind Energy Association and WindEurope. (2022). Offshore Wind Vessel Availability Until 2030.

Experienced hubs in, say, Denmark and Germany could share expertise, skills or resources with essential regions like the Baltic Sea and the Mediterranean Sea, thus creating a mutually beneficial industrial ecosystem that replicates best practices.

A cooperative approach
One potentially effective solution to alleviate vessel shortages and control present and future supply chain bottlenecks is a strategic cooperation between neighbouring production hubs and projects:

- Suppose Poland has its approved 5.9 GW project pipeline ready. How can project developers alleviate vessel demand and make the most efficient use of resources? says Lizet Ramirez, offshore wind analyst at Wind Europe, continuing:

- The answer is cooperation and studies confirm it. Poland could incentivise developers to cooperate, plan a route and make a single trip to install all monopiles in one go. Doing this could free up half the vessels needed in Poland, making them available for other countries to reach their upcoming climate targets If done at a European scale, the gap between vessel demand and resource efficiency will be more manageable and everyone can deliver on their targets.

A cooperative approach can also spread across regions. The North Sea comprises some of the most experienced offshore wind hubs in Europe and is expected to account for 66% of all offshore wind installations by 2030. The neighbouring Baltic Sea has a capacity of only 2.8 GW but is expected to reach 35 GW by 2030 (22% total European volume)[19].

Lizet believes creating a mutually beneficial industrial ecosystem is the most advantageous approach.

Today, at least 50 ports are active in offshore wind, mostly in the North Sea, where many of the more experienced offshore hubs operate. Experienced hubs in, say, Denmark and Germany could share expertise, skills or resources with essential regions like the Baltic Sea and the Mediterranean Sea, thus creating a mutually beneficial industrial ecosystem that replicates best practices.

Therefore, production hubs and other industry players must call on governments to push for better cooperation across borders as they move closer to 2030 and 2050.

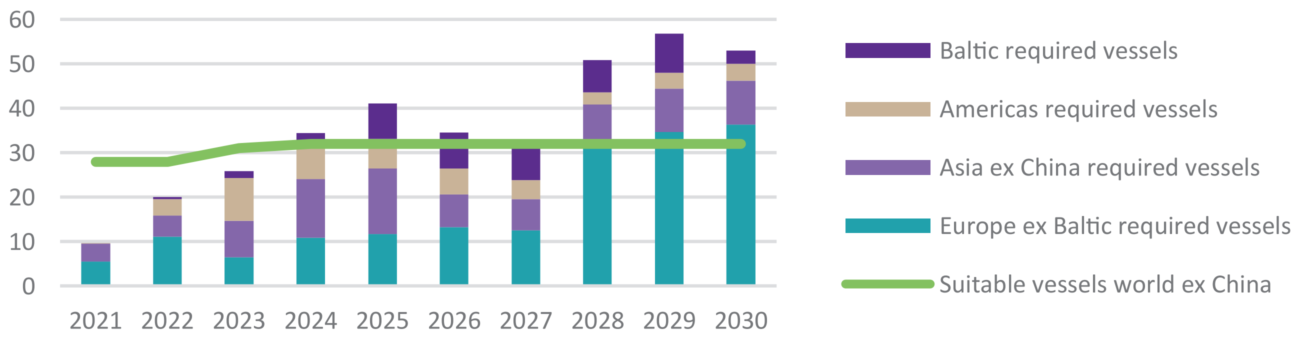

FIGURE 3 Infographic showing FIV supply vs demand worldwide between 2021-2030.

Source: H-Blix for Polish Wind Energy Association and WindEurope. (2022). Offshore Wind Vessel Availability Until 2030.

Bibliography

1 Global Wind Energy Council (2022, 4 April). Global Wind Report 2022.
Retrieved from https://gwec.net/wp-content/uploads/2022/04/Annual-Wind-Report-2022_screen_final_April.pdf

2 Thomas Poulsen and Rasmus Lema (2017). Is the supply chain ready for the green transformation?
The case of offshore wind logistics, Renewable and Sustainable Energy Reviews. https://doi.org/10.1016/j.rser.2017.01.181

3 Global Wind Energy Council (4 April 2022). Global Wind Report 2022.
Retrieved from https://gwec.net/wp-content/uploads/2022/04/Annual-Wind-Report-2022_screen_final_April.pdf

4 H-Blix for WindEurope and Polish Wind Energy Association. (June 2022). Offshore Wind Vessel Availability Until 2030: Baltic Sea and Polish Perspective.
Retrieved from https://windeurope.org/wp-content/uploads/files/policy/topics/offshore/Offshore-wind-vessel-avaiability-until-2030-report-june-2022.pdf

5 WindEurope. Offshore Wind Ports Platform. (n.d). Retrieved from https://windeurope.org/policy/topics/offshore-wind-ports/

6 Adrijana Buljan. OffshoreWIND.bz. (April 30 2021). Offshore Wind Investments to Reach USD 810 Billion by 2030 – Rystad Energy.
Retrieved from https://www.offshorewind.biz/2021/04/30/offshore-wind-investments-to-reach-usd-810-billion-by-2030-rystad-energy/

7 IEA. (2022, 25 March). Investments for Floating Offshore Wind.
Retrieved from https://www.iea.org/policies/14887-investment-for-floating-offshore-wind?region%5B0%5D=Europe

8 UK Government and the Department for Business, Energy & Industrial Strategy. (2022).
Offshore Wind Champion appointed as £160m floating offshore wind fund opens for expressions of interest.
Retrieved from https://www.gov.uk/government/news/offshore-wind-champion-appointed-as-160m-floating-offshore-wind-fund-opens-for-expressions-of-interest

9 WindEurope. (2021) A 2030 Vision for European Offshore Wind Ports: Trends and opportunities.
Retrieved from https://windeurope.org/intelligence-platform/product/a-2030-vision-for-european-offshore-wind-ports-trends-and-opportunities

10 T Eva Topham, David McMillan, Stuart Bradley, Edward Hart. (2019). Recycling offshore wind farms at decommissioning stage. Energy Policy. Vol. 129. pp. 698-709. Science Direct.
Retrieved from https://sfcollege.libguides.com/database-citing/sciencedirect

11 Anne P.M. Velenturf. (2021). A Framework and Baseline for the Integration of a Sustainable Circular Economy in Offshore Wind. Energies. (2021). 14 (17).
Retrieved from https://doi.org/10.3390/en14175540

11 Anne P.M. Velenturf. (2021). A Framework and Baseline for the Integration of a Sustainable Circular Economy in Offshore Wind. Energies. (2021). 14 (17).
Retrieved from https://doi.org/10.3390/en14175540

12 Catapult Offshore Renewable Energy. (July 2022). End of materials mapping for offshore wind in Scotland: Report from phase 1 of the Elmwood Project.
Retrieved from https://ore.catapult.org.uk/wp-content/uploads/2022/07/FINAL-Catapult_ELMWind_Report-online-version.pdf

13 Friedlingstein, P., O'Sullivan, M., Jones, M W., Andrew, RM., Gregor, L., Hauck, J., et al. (2022). Global Carbon Project. Global Carbon Budget 2022. Earth Syst. Sci. Data, 14, 4811–4900.
Retrieved from https://globalcarbonbudget.org/wp-content/uploads/GCB2022_ESSD_Paper.pdf

14 IEA. (2022, 3 March). IEA provides 10-Point Plan to European Union for reducing reliance on Russian supplies by over a third while supporting European Green Deal, with emergency options to go further. [Press release]. https://www.iea.org/news/how-europe-can-cut-natural-gas-imports-from-russia-significantly-within-a-year

15 European Commission. (2022, 18 May). REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition.
Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

16 WindEurope. (2022, 12 September). North Seas Summit focuses on how to deliver new ambitious offshore wind targets.
https://windeurope.org/newsroom/news/north-seas-summit-focuses-on-how-to-deliver-ambitious-new-offshore-wind-targets/

17 Megan Hogan (2021). Local content requirements threaten renewable energy uptake, Peterson Institute for International Economics.
https://www.piie.com/blogs/trade-and-investment-policy-watch/local-content-requirements-threaten-renewable-energy-uptake

18 H-Blix for Polish Wind Energy Association and WindEurope. (2022). Offshore Wind Vessel Availability Until 2030.
Retrieved from: https://windeurope.org/wp-content/uploads/files/policy/topics/offshore/Offshore-wind-vessel-avaiability-until-2030-report-june-2022.pdf

19 H-Blix for Polish Wind Energy Association and WindEurope. (2022). Offshore Wind Vessel Availability Until 2030.
Retrieved from: https://windeurope.org/wp-content/uploads/files/policy/topics/offshore/Offshore-wind-vessel-avaiability-until-2030-report-june-2022.pdf

AALBORG
RENEWABLES

Secretariat
Managed by Port of Aalborg
+45 99 30 15 00
info@forefrontaalborg.com

www.aalborgrenewables.com