Offshore Wind Logistics brief report 5

- The impact of increasing wind turbine size on offshore wind logistics

Supporting organizations

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This *Offshore Wind Logistics brief report 5* is part of a series of brief industry-focused reports on the key conclusions from the global wind energy shipping and logistics PhD research project. The reports have been crafted by the Panticon team during the months of January through November 2019 in order to crystalize the main findings from the academic research project in a non-academic language and style which would support industry in implementing the key changes proposed as a result of the PhD research project. The report has been created primarily based on the PhD research project output, i.e. the PhD thesis and the academic publications produced by Thomas Poulsen during the PhD research project. Where necessary, additional data sources have been utilized as well in order to ensure that the findings are relevant and up-to-date (see Reference section).

The report contains forward-looking statements, which by their very nature, address matters that are, to different degrees, uncertain as they pertain to the future. These, or any other uncertainties, may cause the actual future results to be materially different than those expressed in the forward-looking statements as contained within this report. At Panticon we do not undertake to update our forward-looking statements, nor do we assume any liability for actions or dispositions made by firms, organizations, and/or individuals based on information contained in this report.

Panticon is particularly strong in the Offshore Wind and Logistics sectors within the three core disciplines of Strategic Management Advisory, Mergers & Acquisitions, and Market Intelligence.

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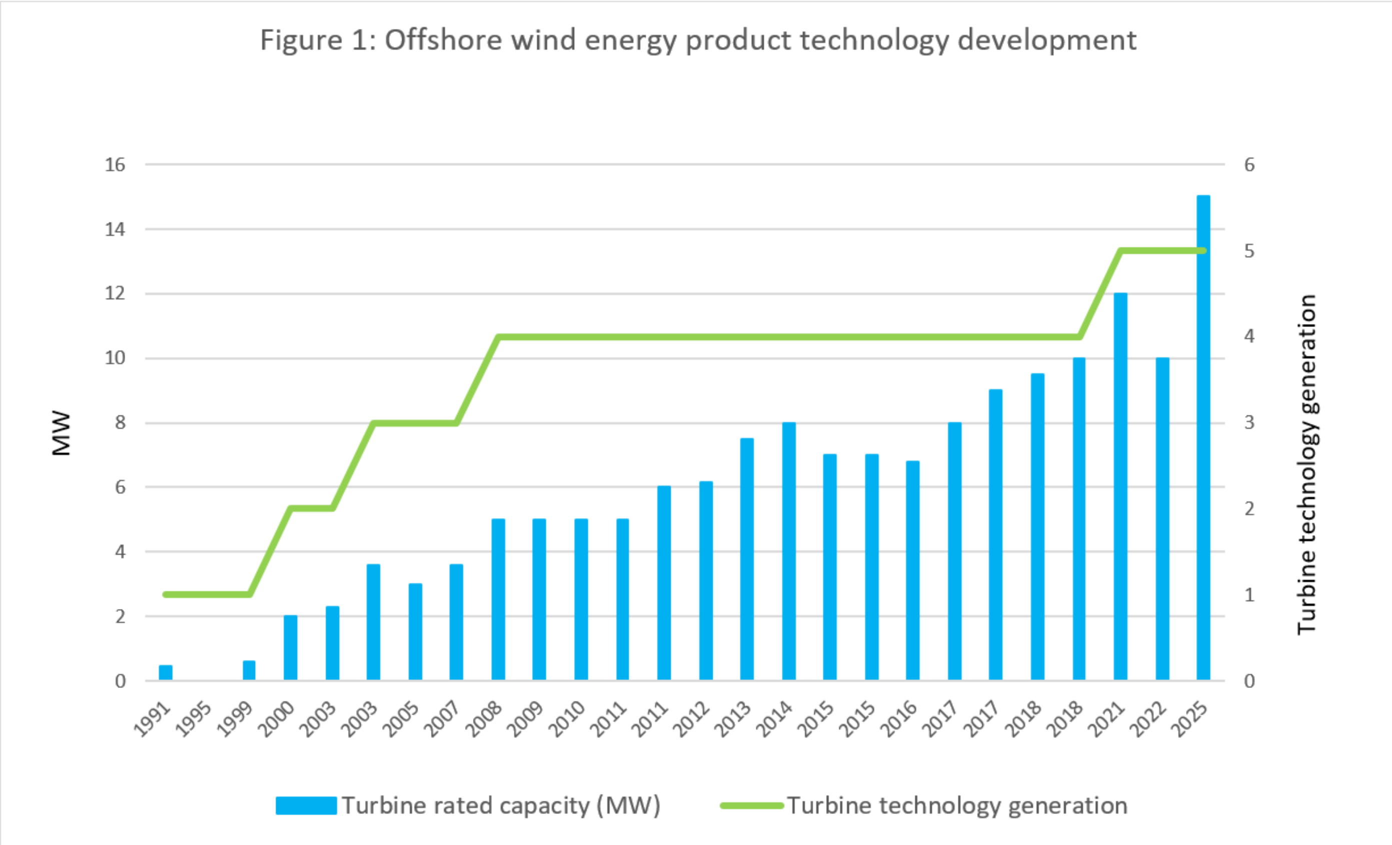
1. Introduction

This *Offshore Wind Logistics brief report* is the fifth in a series of eight short industry-focused reports. The goal of the *brief reports* is to make the latest research in the market for logistics within the global offshore wind industry more accessible and usable for a wide range of constituencies on a global basis. The *brief reports* can be read consecutively or individually.

This *fifth brief report* in the series outlines how the increase in offshore wind turbine size affects logistics developments including vessels, cranes, lifting equipment, and related processes.

2. Why the turbine size has been increasing

Since the first offshore wind farm came into operation in 1991 in Denmark, the size of the offshore wind turbine has increased from 0.45 MW to 8.4 MW – the latter being turbines installed in the spring of 2019. Figure 1 shows the increase in turbine size as well as announced turbine sizes to become available in the decade starting 2020.



Source: Panticon

The primary reason for the increase in size is the offshore wind industry's drive to improve wind turbine performance and produce more energy from the wind. This development is led by the turbine manufacturers as they compete with each other. At the same time, it is a response to competition from other power generation sources. In the European offshore wind markets, governments have started reducing wind energy subsidies by, for example, replacing feed-in tariffs with competitive auctions. Indeed, the resulting decrease in the levelized cost of energy for offshore wind has contributed to the encouragement of markets outside Europe to embrace offshore wind.

3. Impact of turbine size increase

The increase in wind turbine size leads to volume and weight increases of *Wind Turbine Components* as well as *Balance of Plant Components*. This, in turn, affects the entire offshore wind farm life-cycle phases and how logistics is organized. Notable impact is in the *Installation & Commissioning* phase, the *Operations & Maintenance* phase as well as the *De-commissioning* phase (See Table 1).

Table 1: The four offshore wind farm life-cycle phases and corresponding supply chains

Offshore wind farm life-cycle phase	**Development & Consent**	**Installation & Commissioning**		**Operations & Maintenance**		**De-commissioning**
Supply chain	Development & Consent chain	Installation & Commissioning chain - Inbound	Installation & Commissioning chain - Outbound	Operations & Maintenance scheduled	Operations & Maintenance unscheduled	De-commissioning chain
Description (logistics focused)	Site surveys, birds, wildlife, sea, seabed	Inbound assembly parts and components	Outbound wind modules for wind farm site	Personnel, parts, and components	Personnel, parts, components, and modules	Restoration of site for new wind farm or to original condition
Characteristics (logistics focused)	Specialized vehicles (onshore) and vessels (offshore)	Mainly a homogenous flow using sea containers and air; some project cargo	Project cargo; breakbulk	Mainly service boats, crew transfer vessels and some larger vessels	Service boats and helicopters, some larger vessels like multi-purpose vessels, tug & barge, wind turbine installation vessels	Project cargo; breakbulk

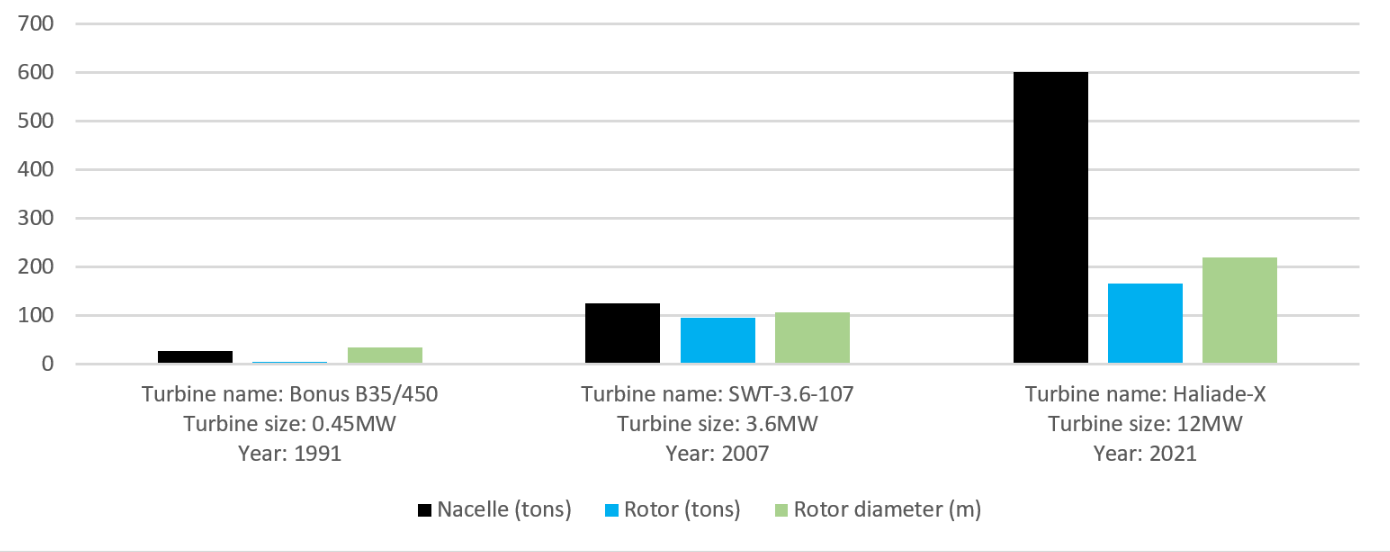
Source: Panticon , based on Poulsen & Lema (2017)

Each supply chain requires corresponding adaptations and adjustments to the turbine size increases. These include port infrastructure, transportation of *Turbine* and *Balance of Plant Components* from manufacturing sites through ports to the offshore wind farm site, among other adjustments. The impact of the adjustments on vessels, particularly *Installation & Commissioning* (and de-commissioning) vessels, is illustrated in Figure 2.

3.1. Offshore wind farm life-cycle phase: Development & Consent

The increase in wind turbine size since 1991 has led to increases in size of *Wind Turbine Components* as shown in Figure 2 below.

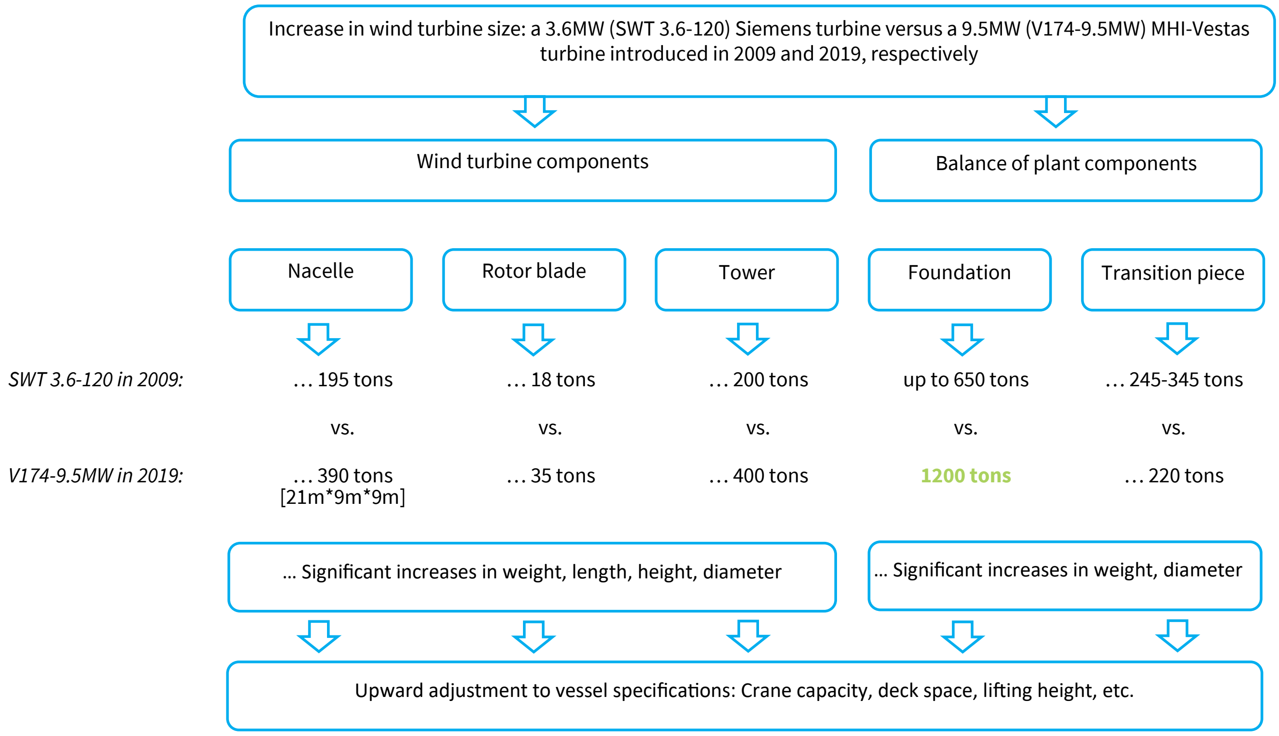
Figure 2: Impact of increasing turbine size on component dimensions



Source: Panticon , based on various sources

Increasing wind turbine size and *Wind Turbine Components* have subsequently translated into increased dimensions of *Balance of Plant Components*, putting pressure on installation vessels. Figure 3 compares weights of two wind turbines: one a 3.6 MW turbine introduced in 2009, another a 9.5MW turbine introduced in 2019.

Figure 3: Impact of wind turbine size on components and installation vessels



Source: Panticon, based on various sources

As Figure 3 shows, foundations put the most pressure on vessels, particularly the crane capacity of the vessels (see marking in green colour on the foundation weight, highlighted in Figure 3). Table 2 shows how vessel specifications have changed in response to the above-mentioned dimension increases.

Table 2: Change in selected vessel specifications in response to increases in turbine size

Vessel Name	Delivery Year	Main Deck (m^2)	Accommoda-tion (Persons)	Maximum wa-ter depth (m)	Maximum lifting (Crane) Capacity (T)	Maximum Lifting Height (m)
Sea Energy	2002	1020	16	24	100	
Brave Tern	2012*	3200	80	7.5 to 45	800	102
Pacific Osprey	2012	4300	111	70	1200	
SeaJacks Scylla	2015	> 5000	130	up to 65	1500 at 17m	
Vole Au Vent	2013	3400	90	50	1500 at 21.5m; 116.6 at 104m	104
Orion	2019	8000	131		5000 at 35m	50
SSCV** Sleipnir	2019		400		20000	129
Alfa Lift**	2021	8100	100		3000	
Voltaire	2022		100	80	3000	165

**Upgraded in 2016*

***Semi-submersible crane vessel*

Source: Panticon, based on various company websites

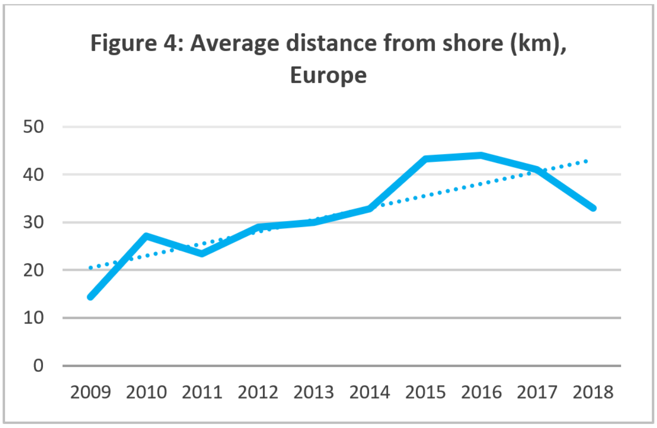
Between 2002 to 2005, the vessel *Sea Energy* installed turbines of size 2MW up to 3MW in waters off Denmark and the United Kingdom. The foundations involved monopiles with diameters of four meters and weights ranging from 180 tons to 230 tons. Meanwhile, the 269MW Deutsche Bucht offshore wind farm in the German North Sea, set for completion by end of 2019, will use 8.4MW turbines. Monopiles weighing 1100 tons each and maximum diameters of eight meters were installed by the vessel *Seajacks Scylla* in January 2019. *Sea Energy* is not capable of executing today's installation tasks and is now engaged in maintenance of oil installations.

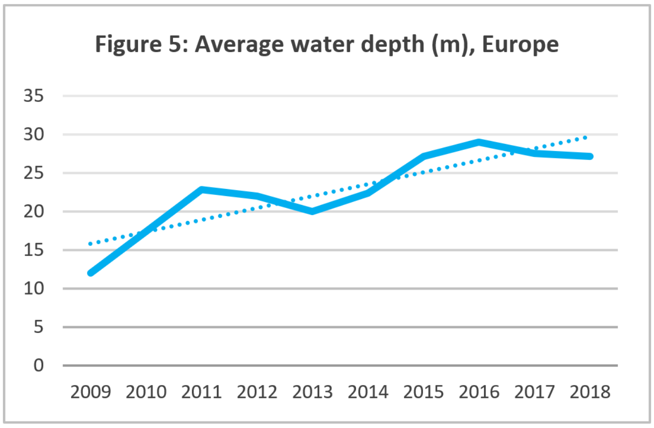
The increase in turbine size has been faster than the investment-intensive vessel construction has been able to keep up with. Vessel suppliers have responded by upgrading existing vessels, including crane capacity. However, upgrades are not enough, especially as the offshore market expands beyond Europe. As a result, at the end of 2018, only about 11 jack-up and heavy lift vessels were capable of installing monopiles for the biggest turbine size on the European offshore wind market. This bottleneck is expected to become more acute once the announced offshore wind installation targets in markets such as China and the US begin to roll out in the early 2020s.

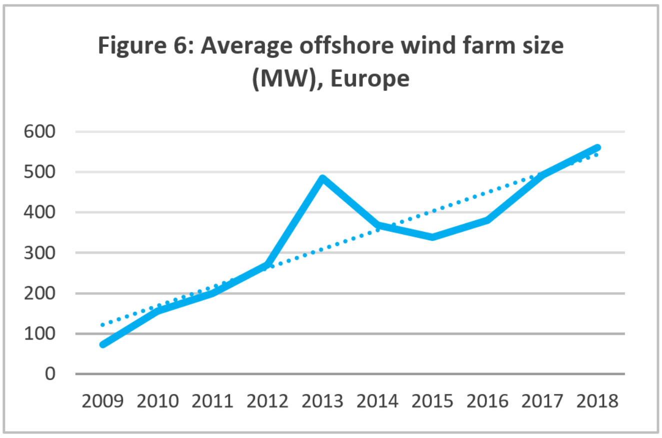
Alongside increase in turbine size, other trends are simultaneously driving the evolution of vessel design. They include:

- increase in distance from shore (Figure 4), partly due to competing interests with coastal residents, fishing groups, or the navy. New vessels are increasing loading capacity so they can transport more components from port to offshore wind farm construction site;
- increased water depth (Figure 5), in some cases due to increase in distance from shore, in other cases due to bathymetry. This calls for increase in leg length for jack-up vessels as well as new types of vessels to cater for floating offshore wind which is expected to take off commercially by 2025.

- increased offshore wind farm size (Figure 6), to take advantage of economies of scale. This results in increase in demand for accommodation vessels as technicians spend more time on sea.
- other market-specific challenges, such as the Jones Act in the USA which requires that a vessel be US flagged, US owned, and manned by US citizens.







Source: Panticon , based on on WindEurope data

3.2. Other impacts of turbine size increase

The impact extends to various aspects of offshore wind logistics and the supply chain. Increase in blade length puts pressure on transportation from inland manufacturing sites requiring to move manufacturing closer to ports. Different original equipment manufacturers, particularly wind turbine manufacturers, require, for example, specialized cranes to lift their respective components. The industry is aware of the challenges this poses and has already started collaborating to address these challenges. An example was the Innovative Offshore Logistics (INNOlog project) which brought together key offshore wind logistics supply chain companies and came up with innovative recommendations to standardize and develop new business models in offshore wind logistics. The recommendations have since been signed off by international classification society DNV GL. The project was sponsored by Energy Innovation Cluster while Panticon's role was project manager.

4. Conclusion

Increase in turbine size leads to better operational performance. At the same time, it has a domino effect that extends to the entire life-cycle of an offshore wind farm. Significant impact is felt on installation vessels which are a high investment cost item. Vessel suppliers have not been able to keep up with the pace in turbine size development. They are reluctant to invest in vessels, fearing that by the time a vessel planned to serve the market for say 20 years is delivered, a higher turbine size will be on the market and likely shorten the vessel's lifespan. Meanwhile, vessel upgrades are not enough and, at some point, become exhausted. Therefore, vessel supply poses a significant risk to continued offshore wind growth, especially once markets outside Europe add to the demand. The new markets each have their own unique challenges. Nonetheless, these challenges are an opportunity to innovate, especially for companies not yet active in the offshore wind industry.

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About Thomas Poulsen

Mr. Poulsen is a seasoned professional who has specialized in crafting strategy coupled with generating both tactical organic and strategic M&A driven growth for companies and organizations, mainly based on his experience in the shipping, transport, logistics, offshore wind, and supply chain industry. During his 30+ years in the business, Mr. Poulsen has lived in 8 countries namely his native Denmark, Indonesia (Jakarta), People's Republic of China (Shanghai), Singapore, Hong Kong (before hand-over to PRC), USA (New Jersey, California, and Florida), UK (London), and the United Arab Emirates (Dubai).

Abstract about Thomas Poulsen's PhD: Logistics in Offshore Wind

The PhD thesis is about offshore wind and focuses on logistics, broadly defined. As such, the research pertains to the offshore wind supply chain from the perspective of transportation and logistics tasks on land, through ports, at sea, and in the air. In addition, the research has dealt with logistics costs seen in relation to levelized cost of energy throughout the entire lifespan of an offshore wind farm project. The research has also dealt with the globalization of the offshore wind market, using China as the main example.

The results of the research have shown that logistics makes up a significant cost item within offshore wind. The results also revealed that it is important to organize logistics in an effective manner within those firms and organizations participating in the offshore wind industry. The eight academic articles which have been published as part of the PhD research project have been framed in the context of strategic management as well as the mergers & acquisition efforts forming part of the offshore wind industry as the market consolidation intensifies.

The research has been conducted in close collaboration with a series of leading offshore wind organizations and companies. The research was funded by Aalborg University and the Danish Maritime Foundation (Den Danske Maritime Fond) through grant number 2012-097.

What we do at Panticon

At Panticon, we are particularly strong in the Offshore Wind and Logistics sectors within our three core disciplines of **Strategic Management Advisory**, **Mergers & Acquisitions**, and **Market Intelligence**. We are mainly focusing on the business side to improve our clients' performance, create value in the long-term, and to create sustainable competitive advantages.

How we create value

- Tailor-made strategies
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- Share knowledge
- Analyse markets
- Advise our clients in every aspect of our three core disciplines

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