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SAILING TOWARDS A SUSTAINABLE FUTURE

A study on the European offshore wind transport & installation industry from a firm perspective

Supervisor: Martin Jes Iversen

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Student no.:

Karl Amandus Witt Brückner - **127352**

Philip Skat Nørrevig - **127758**

Abstract

This paper presents a comprehensive analysis of the European offshore wind transport and installation (T&I) industry, focusing on key trends, challenges, and opportunities shaping its development. Utilizing Porter's Diamond model as the analytical framework, the study investigates the industry's development from 2018 to 2022 and naturally progresses into assessing the industry leader Cadeler's performance relative to its peers in 2021 and 2022. These integrated analyses inform the industry projections for the European offshore wind T&I industry from 2022 to 2030, providing insight into the industry trajectory and subsequently establishing the foundation for identifying strategic actions that T&I firms can adopt to meet the ambitious European capacity targets set for 2030.

The findings reveal rapid growth in the industry, driven by ambitious political targets and extensive project pipelines, while also highlighting the pressing challenge of potential vessel shortages due to the global fleet of installation vessels becoming obsolete and limited new builds. Further challenges encountered by the industry encompass an uneven distribution of risk across the supply chain, a scarcity of skilled labor, and an inflexible and time-consuming tender process. To address these challenges, six strategic actions are identified and evaluated based on their impact on strategic risk, strategic scope, and the firms' ability to support the industry in reaching the European 2030 capacity targets. Of these, fleet expansion, strategic partnerships with developers, and expanding delivery scope are identified as the most critical.

This study contributes to the existing literature on the offshore wind sector by providing insights into the T&I industry's current challenges and opportunities, informed by recent developments and case studies. The findings offer valuable insights and practical strategies for T&I firms to ensure continued growth and success in this vital sector, ultimately contributing to the global transition towards a more sustainable and renewable energy future.

Introduction

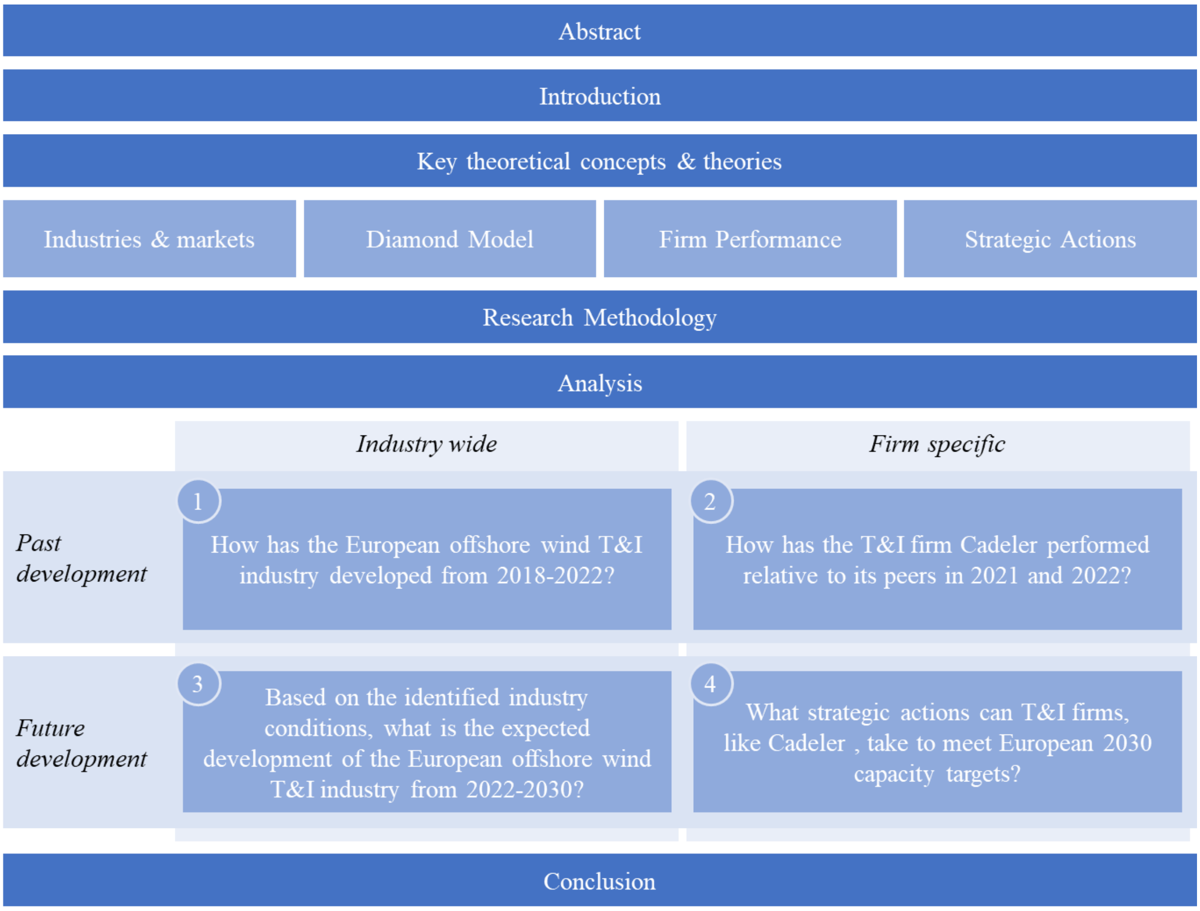
The world is facing unprecedented climate challenges, and the scientific community has called to action for global societies to act to preserve the planet. The United Nations' Intergovernmental Panel on Climate Change warns that failure to take immediate and unified action will result in global temperatures surpassing the 1.5 °C threshold, outlined in the Paris Agreement (United Nations, 2015). As more than 70% of carbon emissions derive from energy production and consumption, the shift to renewable energy sources is crucial for combating climate change (Richie, Roser, & Rosado, 2020). Despite the increasing mainstream adoption of renewable energy, representing over 75% of newly commissioned power capacity (IEA, 2022), the world is not on track to stay within the 1.5°C limit by 2050.

In light of the ever-growing need for renewable energy sources, the offshore wind sector has experienced significant growth in recent years, driven by the global recognition of its potential to combat climate change. Within the offshore wind sector, the transport and installation (T&I) industry plays a critical role in ensuring the efficient deployment and operation of offshore wind farms. This industry encompasses the transportation of turbine and foundation components, the deployment of specialized installation vessels and equipment, as well as the installation of turbines and foundations at sea.

Despite its importance, the T&I industry has faced new challenges in recent years, including difficulties in procuring new vessels, uneven distribution of risk, and labor constraints. These hurdles underscore the need for a deeper understanding of the T&I industry's current state and future trajectory. As the significance of offshore wind power continues to grow, it becomes increasingly vital to identify the opportunities and challenges faced by companies operating within the T&I industry. However, existing research has not thoroughly addressed these issues, leaving a knowledge gap in comprehending the industry's present condition and its path forward.

This paper aims to address how the European offshore wind T&I industry has developed from a firm perspective, and what the necessary actions for offshore wind T&I firms are to meet European 2030 capacity targets. To ensure a well-structured and insightful approach, the paper follows a four-fold structure. First, key concepts and definitions applied throughout the paper are introduced, and existing literature and theories related to industry development are reviewed. Based on these insights, a framework for analyzing the industry and identifying the strategic actions necessary for T&I firms to meet the European 2030 capacity targets is proposed. Second, the chosen research methodology for this study is presented. Third, a thorough analysis of the industry is conducted, guided by four sub-research questions. The findings are discussed in the context of recent developments within the European offshore wind sector. Finally, the paper concludes by addressing the overall research question, exploring the limitations of the study, and highlighting further perspectives relevant to future research.

Figure 1: Paper structure



Source: Own creation

Motivation

This paper seeks to explore the vital role of offshore wind energy in the European shift towards renewable energy, specifically concentrating on T&I aspects. A detailed analysis of the T&I industry is crucial given the multiple challenges the offshore wind sector faces, such as intense market competition and intricate regulatory environments. Offshore wind energy has emerged as a pivotal solution for clean energy generation and economic growth stimulation, driven by concerns about climate change, environmental impact, innovation, and energy security.

A focused analysis of the T&I industry is vital for comprehending not only the industry itself but also the overall trajectory of the offshore wind sector, encompassing government policies, regulations, technological advancements, and market competition. This study aims to investigate the industry's development from a firm perspective and, by estimating its future development, provide actionable strategic recommendations for T&I firms navigating this intricate and rapidly evolving industry. The research will focus on Cadeler, a leading offshore wind farm foundation and turbine installation company, due to its strategic significance and influence on the industry's direction. Evaluating Cadeler's historical performance alongside industry peers will offer valuable insights into the factors shaping the industry's growth and how T&I firms can optimally position themselves for future success while supporting the achievement of the European 2030 capacity targets. In essence, this paper aspires to contribute to a more profound comprehension of the European offshore wind T&I industry and its potential to drive sustainable growth.

Research Question

To analyze the development of the European offshore wind T&I industry and identify the necessary actions for firms to meet the European 2030 capacity targets, this paper addresses an overall research question and several sub-questions. These research questions serve as a roadmap for the research and analysis carried out in this paper, facilitating a comprehensive understanding of the European offshore T&I industry and the necessary actions for firms to achieve the 2030 targets. The following research questions are utilized to guide the analysis in this paper:

Research question: *How has the European offshore wind T&I industry developed from a firm perspective, and what are the necessary actions for offshore wind T&I firms to meet European 2030 capacity targets?*

i. How has the European offshore wind T&I industry developed from 2018-2022?
ii. How has the T&I firm Cadeler performed relative to its peers in 2021 and 2022?
iii. Based on the identified industry conditions, what is the expected development of the European offshore wind T&I industry from 2022-2030?
iv. What strategic actions can T&I firms, like Cadeler, take to meet European 2030 capacity targets?

The first sub-question will analyze the historical development of the T&I industry, focusing on the key trends, dynamics, and challenges that have shaped its evolution over the past few years. In the second sub-question, the paper will conduct a comparative analysis of Cadeler's performance against other leading T&I firms, considering both financial and operational metrics to assess the company's performance and competitive position in the market. Cadeler has been chosen as the focal firm due to its industry-leading position, providing a valuable case study for understanding the challenges and opportunities faced by T&I firms in the European offshore wind sector. This assessment will offer insights into the competitive dynamics shaping the industry while highlighting the critical success factors and challenges faced by Cadeler and its peers. Building on the historical analysis, the third sub-question will estimate the future development of the European offshore wind T&I industry from 2022 to 2030, providing valuable insights for T&I firms and surrounding industry stakeholders, as they navigate the rapidly evolving sector. Drawing on the findings of the previous sub-questions, the final sub-question will identify strategic actions that T&I firms can take to succeed in meeting the ambitious European targets.

The analysis will utilize Cadeler's position and capabilities to develop and validate strategic actions applicable to T&I firms. Through outlining clear strategic actions, this paper will offer a blueprint for Cadeler as well as other T&I firms seeking to capitalize on the opportunities in the industry. By addressing these sub-questions, this paper will present a coherent, thorough, and detailed response to the overarching question concerning the development of the European offshore wind T&I industry and the strategic actions required for T&I firms like Cadeler to successfully meet the European 2030 capacity targets.

Contributions of the Paper

The contributions of this paper are significant to the existing academic research in several ways. Firstly, while previous studies have predominantly examined the development and challenges of the offshore wind sector in specific countries, such as Germany (Dögl, Holtbrügge, & Schuster, 2012) or China (Liu, Wei, Dai, & Liang, 2018), this paper takes a more regional perspective, providing a broader understanding of the industry. Moreover, this paper specifically focuses on the T&I industry, delving into the unique management challenges faced by firms within this industry, which have been largely overlooked in prior research. Secondly, given the rapidly evolving market conditions and regulatory environment of the European offshore wind sector, existing studies may not fully incorporate the most recent data and trends. This paper aims to address this gap by incorporating up-to-date data and trends, providing a more current and relevant analysis. Lastly, this paper provides a thorough analysis of the development of the offshore wind T&I industry and the necessary strategic actions that offshore T&I firms like Cadeler can take to attain the European 2030 capacity targets. These findings may be of even greater importance in the context of the ongoing global transition to renewable energy and the increasing urgency to combat climate change.

Delimitations

In addressing the proposed research questions and considering the vast scope of the European offshore wind T&I industry several delimitations had to be established. The paper adopts a regional focus on Europe and examines the unique market conditions, regulatory environment, and technological advancements that have shaped the offshore wind landscape herein. While the findings may have implications for other regions, the primary emphasis of the analysis is on a European context.

The paper initially and briefly adopts a broad view of the industry, encompassing installation, development, and power transmission. However, it ultimately narrows its focus to specifically examine the T&I industry and the aspects influencing or involving T&I firms like Cadeler. Due to the expansive nature of an entire industry, the paper inevitably cannot cover all aspects in detail. Areas such as wind farm development, grid integration, and energy storage may be mentioned but will not be the central focus of the analysis. Similarly, while the study references various government policies and regulations, it does not delve deeply into the intricacies of specific legal and policy mechanisms.

The paper prioritizes examining the industry's development from a firm perspective, emphasizing factors with managerial implications and the strategic actions that T&I firms can undertake to meet the European 2030 capacity targets and capitalize on growth opportunities in the offshore wind T&I industry. This focus enables a detailed analysis of the factors critical to T&I firms' success in achieving the ambitious European targets.

Key theoretical concepts & theories

This chapter aims to clearly define the essential concepts related to the research project. The chapter comprises of four sections, each dedicated to exploring the relevant theory that corresponds to one of the four sub-questions. In the Market & Industry section, the focus is on understanding what constitutes a market, the critical elements that are necessary for its proper functioning, and how a market relates to an industry. This includes an introduction to various industry definitions and an examination of how those interplay with the market definition. The second section explores Porter's Diamond Model, dissecting its components and relevance in understanding an industry. The third section investigates the concept of firm performance and introduces relevant performance metrics for the comparative analysis. Lastly, the final section seeks to establish a definition of what a strategic action is by reviewing existing literature on strategic actions, strategic scope, and strategic risk.

Market & Industry

Definition of market and industry

Upon reviewing the literature, it is evident that scholars share a common understanding of what a market entails, however, scholars from various schools of thought have provided alternate perspectives and nuances that quickly alter how a market is thought to be functioning. For instance, Fligstein and Calder (2015) provide a definition stating that markets are constructed by societies as arenas where repeated exchanges take place between buyers and sellers. Those actors operate under formal and informal rules governing their relationships with competitors, suppliers, and customers. Similarly, Storr (2010) argues that the market is based on two social phenomena: first, individuals' social actions and needs, and second their socialization into a particular community and their personal experiences with buying and selling goods and services. Another shared feature in these definitions is the emphasis on frequent exchange or trade between two parties, namely buyers and sellers. For example, Fligstein and Mara-Drita (1996) define a market as a social situation where trade in an item occurs, and a price mechanism determines its value.

In this paper, the understanding of markets as socially constructed arenas, as supported by scholars, will be adopted. Specifically, the definition provided by Fligstein and Calder (2015) will be utilized, as it characterizes markets as *"socially constructed arenas where repeated exchanges occur between buyers and sellers under a set of formal and informal rules governing relations among competitors, suppliers, and customers"* (p. 1). This definition acknowledges the significance of repeated exchange and recognizes the presence of market institutions through formal and informal regulations. Furthermore, it highlights the necessity for numerous actors in a network and is thus considered adequate in comprehending the markets within the wind energy sector.

Market Dynamics

The market functions as a platform where buyers and sellers come together to make transactions and determine the appropriate value of goods, which is the result of two curves forming the basis of any market: the supply and demand functions (Pressman, 2014). The equilibrium price is located at the intersection of the supply and demand curves (Greenman, 2002), which also determines the optimal production quantity for the specific commodity. Markets are interdependent and rarely exist in isolation, as one market's balance of supply and demand can have ripple effects on other markets (ibid). In the offshore wind T&I industry, both the supply and demand sides are dependent on a series of factors across different industries, e.g., the production of vessels capable of installing wind turbines or the increasing sizes of turbines.

Market institutions

The debate on whether markets should be controlled or not has persisted throughout their existence. Advocates of free markets, such as Adam Smith and Milton Friedman, argued that market forces would self-regulate in a way that would benefit society, minimizing the need for government intervention (Pressman, 2014; Friedman & Friedman, 2002). However, they recognized the necessity for government regulation to determine and enforce the 'rules of the game' to prevent monopolies and promote competition. As markets have become more intricate, the need for market regulations has become more apparent (Fligstein & Calder, 2015). Institutions, both informal and formal, are required for markets to function effectively (North, 1991). Informal institutions focus on how humans form markets through social networking and interactions (Fligstein & Calder, 2015), while formal institutions involve formal laws, regulations, and state actions that impact market structure (Harrison & Kjellberg, 2014; North, 1991). Regulatory frameworks can help reduce transaction costs and facilitate more efficient trade (Harrison & Kjellberg, 2014).

The role of market institutions intervening may be even more important in a market that has been dependent on subsidies and incentives for the successful development of wind energy systems. For instance, the European Feed-in Tariffs (FIT) provide financial support to renewable energy producers, including wind energy, by guaranteeing a fixed price for each kilowatt-hour of energy produced, which incentivizes investment in the industry. Governments also regulate the industry to ensure fair market competition and prevent monopolies, as well as ensure proper standards are met, such as safety regulations and environmental standards (David, Lehman, Hamrin, & Wiser, 2005).

Industries and Markets

As defined above, a market refers to a group of buyers and sellers who engage in the exchange of goods or services. The market is determined by the demand and supply of a particular good or service, and its boundaries can be defined geographically or by the nature of the product or service.

It is crucial to differentiate between the terms ‘industry’ and ‘market’, as they are often used interchangeably despite referring to distinct aspects of the economy. This ambiguity has persisted since 1930. Andrews (1949), an economist who aimed to define an industry, described it as a grouping of individual businesses relevant to the study of any single business's behavior. After defining an industry, Andrews (1949) emphasized that its primary feature is related to techniques and processes. Individual businesses operate within an industry comprising all businesses using similar processes, suggesting they have equivalent technical resources and comparable backgrounds of experience and knowledge. Thus, the industry's extent is determined by the scope of the analysis, and the appropriate grouping of businesses into an industry varies depending on whether the analysis adopts a narrow or wide perspective.

As noted in the previous argument, the definition of an industry is not fixed. Andrews & Brunner (1975) contributed their perspective to this discussion, observing that even practitioners in the field struggle with the issue of defining industry effectively. In North American literature, there is a tendency to use the terms ‘industry’ and ‘market’ loosely, with ‘industry’ frequently being used as a synonym for ‘market’ (Andrews & Brunner, 1975). The term ‘market’ has been defined to refer to the relationships between sellers and buyers and is not merely another term for industry or an alternative analytical framework. However, according to Andrews & Brunner’s (1975) definition, the sellers in a market are not necessarily confined to a single industry and vice versa.

Building on the definitions of industries and markets, sectors represent a broader classification of the economy, encompassing related industries sharing common characteristics and economic factors. Sectors are divided based on economic activities or the nature of goods and services produced, providing a higher-level perspective on the economy (Porter, 2008).

Industries focus on specific techniques and processes, while markets represent buyer-seller interactions for goods or services. Sectors present a more comprehensive view, allowing for the analysis of overarching trends and factors influencing multiple industries simultaneously (ibid). In the case of the offshore wind T&I industry, it falls under the wind energy sector (IRENA, 2023). Analyzing this industry within the wind energy sector's context helps identify shared trends, challenges, and opportunities across various renewable energy industries and understand the sector's influence by factors such as government policy and technological advancements (European Commission, 2020).

Sub conclusion

This paper seeks to analyze the development of the offshore wind T&I industry in Europe. To fully explain the factors affecting the offshore wind T&I industry, it is deemed necessary to conduct an analysis across the industry examining the broader trends, challenges, and opportunities throughout the supply chain. This includes factors such as government support and incentives for renewable energy, the availability of financing, technological advances in wind turbine and foundation design, and the level of competition within the industry. By understanding these factors, it is possible to reveal more accurate indications regarding how supply and demand for wind farm installations are likely to develop over time and identify potential areas of growth or risk for firms within this industry.

Porter's Diamond Model

The Porter's Diamond Model was developed by Michael Porter in the 1990s (Porter, 1990; 1998). The framework was originally designed to explain the competitive advantage of nations, but it has since been widely applied to the analysis of industries as well (Moon & Lee, 2018; Rugman & Verbeke, 2001). The model is based on the idea that a nation's or an industry's competitiveness depends on the interplay of four factors: (i) Factor Conditions, (ii) Demand Conditions, (iii) Related and Supporting Industries, and (iv) Firm Strategy, Structure, and Rivalry (Porter M. E., 1990). (i) Factor conditions refer to the factors of production required to produce goods and services, such as natural resources, human resources, as well as capital resources. (ii) Demand conditions relate to the characteristics and nature of the market demand for products and services within a specific industry, and how it influences the competitive advantage of firms operating in that industry. (iii) Related and Supporting Industries refer to industries, where companies can collaborate in various supply chain activities, such as technology advancement, supplier networks, marketing, and distribution channels. The competitiveness and efficiency of these supporting industries can impact the competitiveness of the main industry in question. (iv) Firm Strategy, Structure, and Rivalry refer to the nature and intensity of competition, as well as the strategies and organizational structures of firms within the industry, where the model advocates that the conditions of competition can impact the level of innovation and efficiency within the industry.

In the context of Porter's Diamond Model, competitiveness or competitive advantage refers to a country, industry, or firm's capacity to outperform rivals in performance and profitability. Although neoclassical economists argue that competitiveness is well-defined at the firm level, it becomes *"a meaningless word"* at the national level (Mulatu, 2016). Porter's competitive advantage theory counters this argument and provides a more comprehensive understanding of industrial competitiveness than classical comparative advantage theory. He characterizes industrial competitiveness as a specific industry's ability to satisfy customer needs and achieve sustainable profits through higher productivity in international free trade (Porter M. E., 1990). Industry competitiveness primarily stems from domestic industrial productivity. Thus, the competitive advantage of an industry arises from advantageous conditions across the four factors of the diamond that a company capitalizes on to surpass competitors.

For example, an industry benefiting from abundant resources, skilled labor, and cutting-edge technology can produce superior products at lower costs, granting a competitive advantage in global markets. The Diamond Model highlights that competitive advantage stems from a combination of favorable factors.

By understanding these factors, countries, industries, and firms can pinpoint areas of competitive advantage and focus efforts on exploiting them for superior performance and profitability (Porter M. E., 1990).

The Diamond Model was, as mentioned, originally developed to analyze the competitive advantage of nations. However, despite its widespread recognition as a valuable framework the managerial usefulness of the model has been raised due to its limitations. According to Dunning (1990), the primary issue of Porter’s Diamond Model is that it assumes that the nation is the optimal geographical indicator for an industry's success over time, which may not always be accurate. Other geographical levels, such as the local, regional, or global level, may be more significant for specific determinants of international success.

One way of dealing with this issue is to cater the scope of the analysis to target industries instead of nations. Many researchers and practitioners have used the model to analyze industries, as it provides a framework for understanding the sources of competitive advantage and disadvantage within an industry (Moon & Lee, 2018; Porter M. E., 1990). To apply the diamond model to industry analysis, previous papers have focused on the industry-specific factors that impact competitiveness, rather than the country-specific factors that are more relevant in national analysis (Koschatzky, Stahlecker, & Kroll, 2008; Moon & Lee, 2018).

To analyze the competitiveness of a firm or industry using Porter's Diamond Model, it may not always be practical or advisable to study all factors at every geographic level. Instead, it may be more effective to focus on a smaller set of critical influences and analyze their interplay in depth. It is important to note that a firm's or industry's competitiveness may not be determined primarily by factors at the national or subnational level. Factors in the global environment may be equally important as internal factors in a nation, and a firm's ability to respond appropriately to these determining factors, regardless of its geographic location, is critical for international competitiveness (Rugman & Verbeke, 1993).

The scope of the analysis is focused on the European offshore wind T&I industry, rather than at a national level, making the analysis more concise and applicable to the actors in the industry. It is arguably more relevant to look at industry competitiveness rather than national competitiveness when industries span multiple nations as firms within the industry increase their geographical footprint servicing markets on a multinational and often global level. This is especially true for the wind energy sector. The trend towards larger wind turbines and greater GW capacity has driven significant consolidation in the wind energy sector, as companies seek to remain competitive and meet the growing demand for renewable energy. For example, the top ten wind turbine manufacturers in 2022 were all large multinational companies, with the largest company having a market share of around 15% (BloombergNEF, 2022).

By analyzing the four specific factors within the Diamond Model in relation to each other, it is possible to identify the sources of competitive advantage and disadvantage within the industry and to develop strategic actions to enhance competitiveness (Koschatzky, Stahlecker, & Kroll, 2008). As it has become a widely used framework, the Diamond Model is used to provide a structured and comprehensive approach to understanding the sources of competitive advantage and disadvantage within the particular context of the European offshore wind industry (Moon & Lee, 2018; Rugman & Verbeke, 2001).

Figure 2: Porters Diamond Model

Source: Own creation based on Porter M. E. (1990)

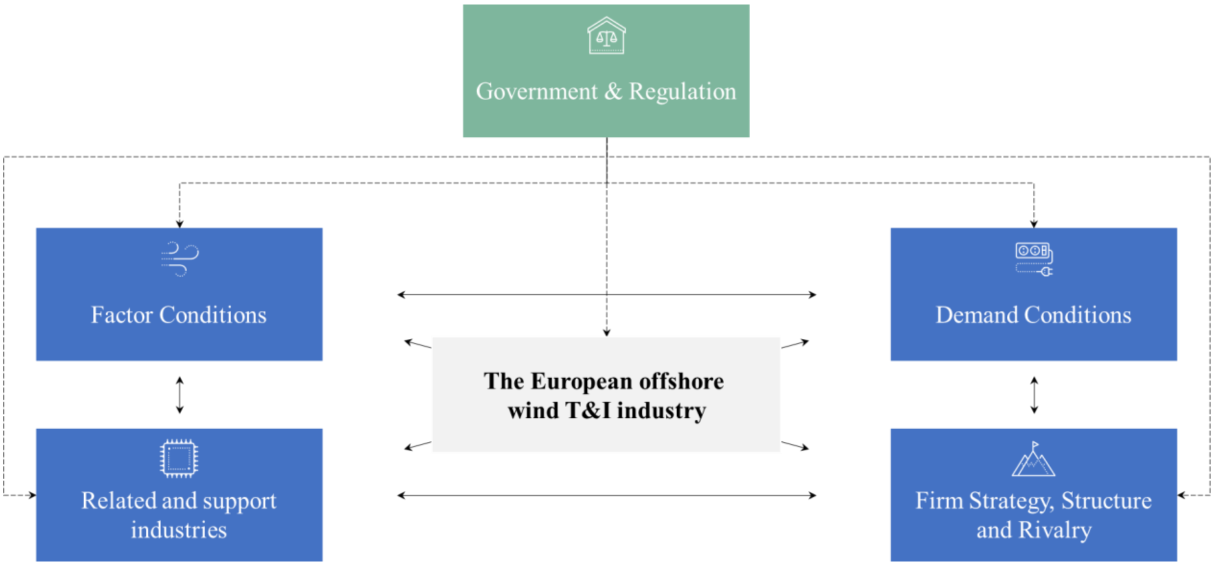
Modifying the Diamond Model

The Porter's Diamond Model consists of the above-described four factors to constitute a comprehensive analysis of industries. However, in relation to wind power, governmental bodies and multinational regulation play a very significant role affecting the four other factors (Liu, Wei, Dai, & Liang, 2018; GWEC, 2023).

Contrary to traditional applications of the Diamond Model, this paper will add Government & Regulation as a fifth factor in the Diamond Model to get a more comprehensive analysis of the industry. This addition is in line with related literature on wind power industry analysis that applies the Diamond Model for analysis (Liu, Wei, Dai, & Liang, 2018). Adding Government & Regulation as a category will cover the role of the governmental influences and regulatory conditions in the offshore wind sector.

The offshore wind sector and hereby the T&I industry is heavily reliant on government policies, incentives, and regulations to support its growth and development. Government bodies play a crucial role in promoting renewable energy, establishing regulations and standards for wind power generation, and providing financial support through subsidies and tax incentives (OECD, 2017). In addition, the EU along with non-EU countries has set ambitious targets for renewable energy generation as part of its efforts to combat climate change and has implemented a range of policies and regulations to support the growth of wind power across its member states (IEA, 2017). Therefore, when analyzing the European offshore wind T&I industry, it is deemed important to consider Government & Regulation as a separate category as it has a significant impact on the industry's growth and development.

Figure 3: Modified Porter's Diamond Model



Source: Own creation based on Porter (1990)

The model illustrated above will constitute the framework for both the historical and forward-looking analysis of the offshore wind T&I industry to assess the competitiveness of the industry. This will enable a discussion on which factors firms can utilize or influence to strengthen the industry as a whole as well as their position in the industry.

Applying the Modified Diamond Model

In relation to answering the first sub-question of how the European offshore wind T&I industry has developed from 2018-2022, we define which aspects that will be analyzed within the five factors of the modified diamond model to ensure a comprehensive and coherent analysis. The historical analysis will form the foundation for the forward-looking analysis of the development of the European offshore wind T&I industry from 2022-2030, which will also be conducted through the application of the modified diamond model as the analytical framework.

Factor conditions play a significant role in the scope of Porter's diamond model as they serve as the input parameters. For the historic analysis, infrastructure and capital are used to measure the factor conditions. More specifically, infrastructure and capital refer to: access to specialized installation vessels, and capital constraints for acquiring installation vessels, respectively. These two components are deemed basic and cannot be ignored, as the renewable energy industries rely heavily on capital due to the long investment return timelines associated with them and given the scale and specialization of assets needed to establish wind farms.

For the forward-looking analysis, the factor conditions for delivering T&I vessels will be examined, including capital considerations, the viability of European wind farm areas, and labor considerations, which are in line with previous studies that have applied the diamond model (Vlados, 2019; Fang, Zhou, Wang, Ye, & Guo, 2018). Other studies have considered including the state of power transmission and distribution networks (Liu, Wei, Dai, & Liang, 2018; Dögl, Holtbrügge, & Schuster, 2012). However, due to the specific focus on the T&I industry rather than the offshore wind sector, only the most important components are researched in depth.

Drawing upon previous research (Liargovas & Apostolopoulos, 2014; Vlados, 2019), the historical analysis of demand conditions investigates two key components: the development in the size and growth rate of the wind farm installation project pipeline and the technological development and response mechanisms within the offshore wind T&I industry. By examining how advancements in wind turbine technology influence the T&I sector, opportunities and challenges that the industry may face in the future can be uncovered.

For the forward-looking industry analysis, an in-depth assessment of the expected demand for specialized installation vessels, given the projected capacity additions from 2022 to 2030 will be conducted. This detailed analysis will provide tangible insights into areas of improvement for the T&I industry and empower firms to better align their strategies, investments, and resources to capitalize on emerging opportunities and address potential challenges. By analyzing the historical growth rates and projecting future capacity additions, a comprehensive understanding of the market size and the expected trajectory can be achieved.

The evaluation of related and supporting industries for the offshore wind T&I industry involves assessing the development of adjacent industry capabilities in line with previous scholars (Chung, 2016; Fang, Zhou, Wang, Ye, & Guo, 2018) through the use of statistics derived from the Competitive Industrial Performance index. Given the complex production structure required for offshore wind T&I, a strong foundation of developed manufacturing capabilities is essential. An indicator of a nation's overall level of industrial development is the percentage of manufacturing value added by medium and high-tech industries, which reflects a country's general manufacturing capabilities. A higher proportion of value added by industries classified as technologically developed signifies a more advanced manufacturing sector (UNIDO, 2017). This, in turn, implies a stronger foundation for the offshore wind T&I industry due to the likely presence of related and supporting industries with advanced capabilities. Furthermore, the overall Competitive Industrial Performance index score is used to assess the overall competitiveness of a country’s industrial activities, providing insights into the potential strength and growth of the offshore wind T&I industry.

Considering the high uncertainty and limited data concerning the future development of domestic and cross-national industries, the forward-looking analysis will examine the evolution of the global industrial supply chain for the offshore wind T&I industry. This will be done by leveraging qualitative input from reputable industry representatives to gain insights into the trajectory of the wind sector's development within the supply chain and its implications for the European T&I industry. This approach will ensure a well-rounded understanding of the potential growth and challenges that the sector might face in the future.

The firm strategy, structure, and rivalry include the competitiveness of firms in the focal industry, and how they interact with each other. To assess this factor in the historic analysis the most prominent contracting strategies employed by developers within the offshore wind sector will be explored in conjunction with the most pressing business models and strategies followed by key T&I firms within the industry in line with previous scholars (Fang, Zhou, Wang, Ye, & Guo, 2018). This is done to assess the factors which contribute to the rivalry and level of competition within the industry in addition to identifying how firms differentiate in structure and strategy from one another.

For the forward-looking analysis, the development in strategy, structure, and rivalry will be examined through the evaluation of strategic actions that T&I firms can take to accelerate Europe's green transition. This will be explored in the 'Strategic Actions for Firms within T&I' section of the paper as it constitutes the fourth and final sub-research question of the paper. This evaluation is conducted as it represents the relevant decision landscape for T&I firms that will impact the development in strategy, structure, and rivalry.

Government and Regulation include the governmental influences that play a significant role in the offshore wind sector. The historical analysis focuses on two critical components: Political goals and targets for European offshore wind capacity, and incentives and subsidies available for offshore wind farm projects, which indirectly affect T&I firms. Like the other factor analyses, this assessment only includes factors that are most pertinent to the industry being studied. In this regard, other components are excluded in line with similar studies (Tsai, Chen, & Yang, 2021) as they are not deemed relevant to the analysis, e.g., licensing and taxation.

The forward-looking analysis will form a natural extension of the historic, as the relevant published tenders up until 2030 will be examined, supplemented by an analysis of how subsidies, power purchase agreements, and non-price criteria impact the tenders. By focusing on these specific aspects, we can better understand the regulatory environment's effect on the offshore wind T&I industry and capture the most significant drivers of change in the sector.

Sub conclusion

In conclusion, a comprehensive understanding of Porter's Diamond Model has been established together with its relevance to industry analysis, particularly the European offshore wind T&I industry. The inclusion of Government & Regulation as a fifth factor enhances the model's applicability for assessing the industry’s complex dynamics. This modified framework will serve as a foundation for analyzing the industry's competitiveness by examining key components within each factor and set the stage for the subsequent in-depth analysis and the identification of strategic actions that firms can employ to bolster their competitive positions within the industry.

Firm Performance

This section seeks to define the concept of firm performance and introduce the relevant performance metrics applied in the comparative analysis section of the paper. The accurate assessment of whether a business is a success or failure is to a large extent dependent on the validity and reliability of the performance measurement. Scholars regard performance measurement as a crucial factor in research, as it enables firms to evaluate the outcome of their strategic decisions and ascertain whether progress has been made or stagnation has occurred (Waggoner, Neely, & Kennerle, 1999; Neely, et al., 2002; Selvam, et al., 2016). Over time, the term has been subjected to various definitions, emphasizing the necessity of defining it as a latent construct. The following section examines project track record and order backlog as relevant operational performance metrics, underlining their applicability for this paper. The second and third subsection investigates the key financial performance metrics utilized for the analysis, further highlighting their relevance and applicability to this paper.

Operational performance

The project track record and order backlog provide key insights into the companies’ past and future performance as well as their strategic focus. The project track record reflects the company's history of completing projects, which indicates its competency and reliability in delivering quality results. This sheds light on the company’s prior strategy and demonstrates its ability to execute projects efficiently and meet customer expectations. The order backlog, on the other hand, represents the total value of work that a company has contracted to perform but has not yet completed. A high order backlog indicates a healthy demand for the company's products or services, which bodes well for its future performance (Feldman, Govindaraj, Livnat, & Suslava, 2021).

In the offshore wind T&I industry, the order backlog is particularly informative, serving as a crucial indicator of a company's future revenue and earnings potential. This is attributed to the fact that offshore wind projects frequently involve long-term contracts and can take several years to complete from inception to completion. Consequently, the backlog of offshore T&I companies provides investors and stakeholders with valuable insights into the company's anticipated revenue and earnings for the upcoming years.

The order backlog is considered a relevant performance metric as it substantiates the company’s competitive position in the market. The company’s ability to secure contracts early and effectively speaks to its reputation and level of customer satisfaction in turn underlining its position in the market. This can be an important differentiating factor for investors when evaluating offshore T&I companies, as a larger backlog can signal greater stability and growth potential. This is consistent with the studies published by various authors including Lev et al. (1993), Rajgopal et al. (2003), and Feldman (2021) who considers order backlog a leading indicator of firm performance and suggest that it projects positive signals of future sales and performance.

In the T&I industry, the term 'backlog' is commonly used as evidenced by its prominence in annual reports, investor presentations, and analysts' reports from prominent firms such as Jefferies, DNB Markets, and Kepler. It is further argued to be increasingly important in this industry as a strong backlog helps offshore T&I companies manage their operations and resources effectively. By knowing the value and duration of future contracts early, companies can better plan their capital expenditures, manage their workforce, and optimize their vessel and equipment utilization rates. This is in line with the findings by Barber and Hollie (2021) who found order backlog to be of significant importance to financial statement users.

The company track record and order backlog are therefore deemed essential performance metrics for this paper, as they offer insights into a company's past performance and future earnings potential. This information aids in understanding the company's strategic direction, growth potential, financial stability, and ultimately its competitive position within the market.

Evaluating the strategic actions

In this study, we use a qualitative multi-criteria decision analysis (MCDA) approach to evaluate the strategic actions of T&I firms in the European offshore wind T&I industry. This is done to provide a systematic and rigorous approach to evaluate and compare strategic actions based on multiple criteria, enabling informed decision-making in the specific industry context (Bisdorff, Dias, Meyer, Mousseau, & Pirlot, 2015).

We assess strategic actions based on the three weighted criteria: strategic risk (25%), strategic scope (25%), and impact on meeting the 2030 offshore wind capacity targets (50%). The impact on meeting the 2030 capacity targets is assigned the highest weight due to its significance for both the purpose of this paper and its importance to the sector and the firm (Simsek, 2007; Nadkarni & Hermann, 2010).

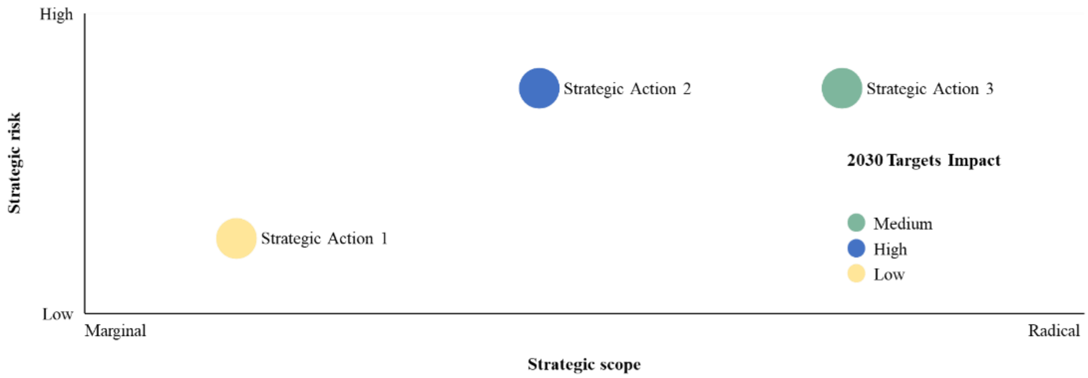
Strategic risk and strategic scope, both crucial for long-term stability and competitiveness, are given equal weights.

For each main criterion, we establish sub-criteria and rate the strategic actions using a 3-point qualitative scale in line with (Kain & Söderberg, 2008). For strategic risk, we consider general environmental risks, industry-related risks, and firm-related risks. In terms of strategic scope, we consider product scope, market scope, and organizational scope. Finally, we evaluate the impact on the industry meeting the European offshore wind 2030 capacity targets through the strategic action's direct contribution to capacity targets. Given the qualitative nature of the evaluation, we state any assumptions made during the process.

To account for the negative impact of higher strategic risk and scope, we adjust the scoring system by having reverse order scores on the scale for scope and risk, i.e., 3: low, 2: medium, and 1: high. Composite scores are obtained by multiplying the scores by their respective weights and summing the results. The evaluation results are visualized in a matrix with strategic risk and strategic scope on the axes, where each strategic action is represented by a bubble. The bubble's position indicates its risk and scope scores, while the color gradient reflects its impact on meeting the 2030 targets (1: low, 2: medium, 3: high).

This concise qualitative MCDA approach enables informed decision-making for T&I firms in the European offshore wind T&I industry, considering trade-offs between strategic risk, strategic scope, and impact on meeting the 2030 capacity targets.

Figure 4: Strategic action matrix



Source: Own creation

Operating profitability

Earnings before interest, taxes, depreciation, and amortization (EBITDA) is a measure of a company's operating profitability, representing its earnings before considering the impact of financing decisions, tax obligations, and non-cash expenses such as depreciation and amortization. It is essentially a company's revenue minus its operating expenses (OPEX).

In the case of offshore wind T&I companies like Cadeler and its competitors, revenue is primarily driven by the demand for their services, which is influenced by the offshore wind industry's growth and the number of wind farm projects under development or construction. Conversely, OPEX is determined by costs related to vessel and equipment maintenance and upgrades, employee salaries and benefits, support services, and utilities. A company's ability to efficiently manage these operating expenses can significantly impact its profitability and financial performance. Consequently, EBITDA serves as a valuable tool for obtaining a transparent view of a company's inherent operating performance, allowing for comparisons of operating profitability among companies within the same industry (Bouwens, Kok, & Verriest, 2019; Galleher, 2020).

There are, however, various arguments against the use of EBITDA as a measure of firm performance. One of which being that it allows managers to manipulate and define the measure in a way that portrays their performance most favorably. This issue arises because EBITDA is not clearly defined or standardized under GAAP or IFRS, as it is not a mandatory reporting requirement, meaning companies are not obligated to disclose it (Bouwens, Kok, & Verriest, 2019). Other critiques suggest that the measure is neglecting value-relevant items such as depreciation and amortization, rendering it less reflective of a firm's overall economic performance. This reasons why the chairman of the International Accounting Standards Board (IASB), Mr. Hoogervorst, rejected the use of EBITDA at the Annual Conference of the European Accounting Association in 2016.

The exclusion of depreciation and amortization does however reason why some authors find it particularly relevant in evaluating firm performance in capital-intensive industries (Li N. , 2016; Bouwens, Kok, & Verriest, 2019). The offshore T&I industry is an example of a capital-intensive industry as high upfront costs are required to purchase and maintain vessels and equipment. Companies operating in the space, therefore, incur significant expenses related to depreciation and amortization that can impact their overall financial performance. EBITDA can hence be argued to provide a clearer view of a company's underlying operating performance and aid in determining its relative competitive position more accurately. This is consistent with the findings by Black et al. (2021) who found that non-GAAP measures, such as EBITDA, improve earnings comparability relative to GAAP earnings when utilized within the same industry.

The measure is, moreover, widely accepted and a commonly used performance metric in the financial industry. This is apparent by the fact mentioned by Branch et al (2011) who highlights that the measure has been used to assess firm performance and determine executive compensation in both private and publicly held companies for years. The metric is thus considered a useful tool for investors and analysts to assess a company's financial performance and compare it to its peers.

In conclusion, EBITDA is a valuable metric for evaluating the financial health and operational efficiency of companies, especially in capital-intensive industries like offshore T&I. It provides a clearer picture of a company’s operating performance by excluding non-operating factors, making it a useful tool for comparative analysis within similar industries.

Financial ratios

Financial ratios serve as essential tools for evaluating a firm's financial performance and situation. These ratios offer insights into various aspects of a company's performance, such as profitability, liquidity, and solvency. Profitability ratios assess the firm's ability to generate profits through multiple measures. Liquidity ratios provide information on a firm's capacity to meet short-term financial obligations. Solvency ratios, or financial leverage ratios, indicate the long-term soundness of the firm by examining its debt load and the degree of financial risk it faces (Goel, 2016). By employing various financial ratios, a comprehensive evaluation of a firm's performance and financial stability can be achieved, which is crucial for investors, analysts, and stakeholders in the decision-making process (Masa'deh, et al., 2015; Gentry & Shen, 2020). To assess the financial performance and situation of the companies, this research will employ the following financial ratios:

Return on assets (ROA) is a profitability ratio that measures how efficiently a company is using its assets to generate profits. It is calculated by dividing a company's net income by its total assets. ROA is commonly used by analysts to assess a firm’s operating performance relative to its investments made without considering how the investments are financed (Stickney, 1996; Pinto, et al., 2015). A higher ROA indicates that the company is using its assets more efficiently to generate profits. In the offshore T&I industry, companies that have a high ROA may be more effective in utilizing their assets, i.e., their vessels, to carry out T&I operations.

$$Return\ on\ assets = \frac{Net\ income}{Total\ assets}$$

Return on equity (ROE) is another profitability measure used to evaluate the return on investment for shareholders. It is calculated by dividing a company's net income by its shareholder equity. A higher ROE indicates that the company is generating more profit for its shareholders relative to the money they have invested in the company (Alexander & Nobes, 2016). It is hence often used as a proxy for measuring a company’s success in maximizing its return to its investors. In the offshore T&I industry, companies with a high ROE may be more attractive to investors who are looking to invest in companies that are generating high returns.

$$Return\ on\ equity = \frac{Net\ income}{Total\ equity}$$

It is essential to clarify that ROA and ROE are calculated using net income rather than EBITDA. Net income represents a company's total profits after all expenses, including interest, taxes, depreciation, and amortization, have been subtracted from its revenue (Brigham & Ehrhardt, 2016). The rationale for using net income instead of EBITDA as the profitability measure in the financial ratios is primarily due to net income being defined under GAAP and IFRS. This definition limits managers' ability to manipulate the numbers in a manner that is most advantageous to them and their firms. Total assets are also defined under reporting standards (Kieso, Weygandt, & Warfield, 2020). Hence, while ROA and ROE are not specifically defined under GAAP or IFRS, they are widely used and calculated using components reported in a company's financial statements which are subject to the accounting principles and guidelines established by GAAP or IFRS.

The current ratio is a liquidity measure that estimates a company's ability to meet its short-term obligations using its current assets. It is calculated by dividing a company's current assets by its current liabilities. Analysts and investors use this measure to determine a firm's financial health and its capacity to meet its short-term debt obligations (Kieso, Weygandt, & Warfield, 2020; Brigham & Ehrhardt, 2016). A higher current ratio indicates that the company has sufficient liquidity to cover its short-term liabilities. In the offshore T&I industry, companies with a high current ratio may be better positioned to navigate the financial challenges associated with the industry's cyclical nature and maintain smooth operations during downturns.

$$Current\ ratio = \frac{Current\ assets}{Current\ liabilites}$$

A leverage ratio is a solvency measure that reflects the proportion of a company's total capital that is financed through debt. It is important to note that leverage ratios can be defined according to specific research requirements (Brigham & Ehrhardt, 2016). In this paper, the debt-to-asset ratio is used as the leverage measure for analysis. It is calculated by dividing a company's total debt by its total assets. The measure is used by analysts and investors to evaluate a firm's financial risk and its ability to meet its long-term obligations (Damodaran, 2012). A higher leverage ratio indicates that the company has a higher proportion of debt in its capital structure, which may increase its financial risk and vulnerability during economic downturns. In the offshore T&I industry, companies with a lower leverage ratio may be more resilient in times of financial stress and possess greater flexibility to adapt to changing market conditions.

$$Debt - to - assets\ = \frac{Total\ debt}{Total\ assets}$$

The utilization of financial ratios as exclusive measures of firm performance does exhibit some underlying shortcomings. The fundamental of which being similar to the limitation of EBITDA, i.e., the inherent concern regarding the inadequacy of the financial information employed to derive the ratios (Miller, 1987; Goel, 2016). Venanzi (2012) further contends this notion and highlights that companies can exploit divergent accounting principles and consolidation techniques to influence their reported figures, thereby compromising the overall reliability of the financial ratios. Moreover, Goel (2016) notes that the lack of universal definitions and industry-specific calculation methods can lead to inconsistencies.

Despite these limitations, Pinto et al. (2015) recognize the value of financial ratios in assessing firm performance when analyzed over time and compared to industry peers. The importance of comparison when using financial ratios is emphasized in this paper, as it compares the performance within the selected peer group and among the leading firms in the offshore T&I industry. Furthermore, the widespread adoption of these metrics by investors and analysts for evaluating the financial health and future performance of companies further underscores their practicality and relevance.

This paper employs these four financial ratios to provide a nuanced and comprehensive perspective on the financial performance of companies in the offshore T&I industry. Examining profitability, liquidity, and debt levels enables a deeper understanding of various aspects of a company's financial health and overall performance in the industry. By incorporating these financial metrics, this paper delivers a robust analysis of firms in the offshore T&I industry, fostering a clearer understanding of their financial performance and resilience within a competitive market environment.

Sub conclusion

To thoroughly evaluate Cadeler and its peers, this paper recognizes the importance of incorporating multiple performance measures rather than relying on a single metric. Consequently, the analysis will encompass both operational and financial performance metrics.

Operational metrics, including project track record and order backlog, will provide insights into a company's historical performance and future revenue potential, shedding light on its ability to secure new contracts and complete projects effectively. Simultaneously, the financial performance of the companies will be assessed through the use of EBITDA and a range of financial ratios, ROA, ROE, the current ratio, and the debt-to-assets ratio. These metrics will facilitate an understanding of the firms' financial performance and stability.

By combining these operational and financial measures, a comprehensive picture of the companies' performance and market position can be obtained, ultimately providing valuable insights into their relative standing in the offshore T&I industry.

Strategic actions

To better gauge the concept of strategic actions prior research has distinguished between strategic and tactical actions. Strategic actions are specific and identifiable activities or tasks undertaken to achieve the strategic objective of improving the firm's competitive ability over time (Chen & Miller, 2012). These actions typically involve a substantial commitment of resources, impact the overall scope of the firm's operations, and often entail a significant level of risk (Wang, Holmes Jr., Oh, & Zhu, 2016; Connelly, Tihanyi, Certo, & Hitt, 2010). In contrast, tactical actions are usually minor and routine changes that can be addressed by middle- and low-level managers. These changes are typically of a smaller scale and can often be addressed through procedural adjustments without necessitating significant structural reconfiguration. Tactical actions usually require fewer resources compared to strategic actions and are generally aimed at achieving short-term objectives and optimizing operational efficiencies (Hitt, Ireland, & Hoskisson, 2017).

The following subsection establishes the connection between firm performance and the concept of strategic action. The second subsection examines the notions of strategic scope and strategic risk, highlighting their relevance and applicability to the paper's topic. Finally, the third subsection outlines the evaluation criteria used to assess the strategic actions of T&I firms in the European offshore wind T&I industry.

Firm performance & strategic actions

Firm performance, defined as a company's economic success (Venkatraman & Ramanujam, 1986), is closely linked to strategic actions. While Hambrick and Mason (1984) acknowledged this relationship, they did not specify whether it was positive or negative. Building upon their work, subsequent research suggests a positive correlation between strategic actions and future firm performance for several reasons, including capitalizing on profitable opportunities (Simsek, 2007) and exhibiting proactivity, risk-taking, and adaptability (Nadkarni & Hermann, 2010).

However, achieving success through strategic actions does not mean that firms can become complacent. Verdin and Tackx (2015) highlight the importance of firms' ability to constantly innovate, uphold, and improve their value proposition to the customer to achieve a sustainable advantage in the market. Firms that remain committed to the status quo risk adhering to outdated products and services, losing market share, and experiencing inferior performance (D'Aveni, Dagnino, & Smith, 2010; McDougall & Oviatt, 1996), particularly as environmental factors change over time (Grewal & Tansuhaj, 2001; Grimm & Smith, 1991). These findings hence underline the importance of integrating strategic actions into the broader discussion on firm performance and its various theoretical underpinnings.

The importance of strategic actions for T&I firms in supporting the green transition and the European 2030 capacity targets is increasingly evident. As the offshore wind industry plays a critical role in the global energy transition, T&I firms serve as vital enablers of this change by facilitating the deployment of wind energy infrastructure (IRENA, 2022). Empirical evidence demonstrates a positive relationship between firms' environmental performance and financial performance (Margolis & Elfenbein, 2009; Arminen, Tuppura, & Jantunen, 2014), indicating that aligning with green transition objectives may translate into tangible business benefits. Moreover, as corporations are increasingly expected to address ESG concerns, T&I firms that adopt initiatives in line with European capacity targets are better positioned to meet shareholder expectations and reflect broader societal values (Friede, Busch, & Bassen, 2015). Research has demonstrated that companies with higher ESG performance have lower cost of capital, reduced volatility, and improved operational performance (Eccles, Ioannou, & Serafeim, 2014; Suto & Takehara, 2017). Thus, aligning strategic actions with the green transition promotes long-term value creation for stakeholders and reinforces the firms’ social license to operate (Sen, Bhattacharya, & Korschun, 2006).

Strategic scope and strategic risk

The conceptualization of strategic actions can be further clarified through the operationalization of two dimensions: strategic scope and strategic risk. Strategic scope pertains to the arrangement of geographic and product markets in which the firm competes. This dimension can be further conceptualized through three distinct yet interrelated aspects: product scope, market scope, and organizational scope (Wang, Holmes Jr., Oh, & Zhu, 2016). Product scope refers to the range and variety of a firm's products or services, with a focus on the extent of diversification within the firm's offerings (Grant, 1996). The market scope encompasses the breadth of target markets a firm serves, including various customer segments and geographic regions (Ansoff, 1957). Organizational scope captures the entirety of the firm’s activities, functions, or operations, including factors such as size, scale, and complexity (Helfat & Eisenhardt, 2004; Pierce & Toffel, 2013).

The strategic risk dimension lacks a universally accepted definition in the literature. However, Miller (1992) defines risk as the unpredictability of corporate outcome variables such as revenues, costs, profit, and market share. He developed an analytical framework considering three categories of risks: general environmental risks, industry-related risks, and internal firm-related risks. General environmental risks encompass the potential impacts of macroeconomic, political, and social factors that are beyond the control of the firm but may influence its performance. Industry-related risks, on the other hand, pertain to changes in demand, supply, and competitive conditions within the industry or market in which the firm operates. This risk category can be further divided into three major classes: input market risk, product market risk, and competitive risk. Firm-related risks encompass various factors such as managerial and behavioral deficiencies, product and market liabilities, operational and value-chain disruptions, development uncertainties, and the quality of receivables that are unique to the internal operations of the firm (Miller K. , 1992; Andersen & Young, 2021). Notably, strategic actions are intrinsically associated with inherent risks that can significantly impact a firm's financial performance and long-term sustainability (Miller & Philip, 1990).

The dimensions of strategic scope and strategic risk provide a framework that captures various aspects of a firm's decision-making and potential uncertainties associated with its strategic actions. By considering the nuances within strategic scope, such as product, market, and organizational scope, and the different categories of risks including general environmental, industry-related, and firm-related risk, a more in-depth understanding of the strategic actions can be achieved.

In this study, strategic actions will be assessed based on these overarching concepts, considering the distinct nuances that contribute to each dimension. The strategic risk level will be evaluated on a continuum from low to high, while the strategic scope will be measured on a spectrum ranging from marginal to radical. Radical actions represent significant changes to the firm's current scope, while marginal actions are consistent with the firm's existing scope. This approach adopts the marginal-to-radical range in accordance with the framework proposed by Verdin and Tackx (2015). By adopting this comprehensive and integrative approach, a thorough and insightful analysis of specific strategic actions can be conducted, ultimately enabling the identification of more informed actions relevant to the firms in the European offshore wind T&I industry.

Sub conclusion

This paper adopts the notion of strategic action to refer to specific steps and measures that firms can employ to accelerate Europe's green transition and achieve its capacity targets. The link between strategic actions and firm performance has been explored with strategic actions being deemed essential for achieving long-term success and sustainability in industries like the offshore T&I industry.

The paper operationalizes the concept of strategic actions through the dimensions of strategic scope and strategic risk to comprehensively understand and evaluate the actions in the context of the European offshore wind T&I industry. The qualitative MCDA approach refines the analysis by facilitating informed decision-making that accounts for trade-offs among strategic risk, strategic scope, and the impact on achieving the 2030 capacity targets. The MCDA rates each dimension of the strategic action on a 3-point qualitative scale, considering the various aspects of each dimension.

This approach allows for the visualization of the strategic action evaluations in a matrix with risk and scope on the axes and a color gradient representing the impact on the 2030 targets (see Figure 4). By integrating these elements, the specific strategic actions proposed in this paper are founded on a strong foundation focusing on identifying the most effective strategic actions for T&I firms in the European offshore wind T&I industry.

Research question revisited

This paper explores the historical development of the European offshore wind T&I industry from a firm perspective and pinpoints strategic actions required for T&I firms to meet European 2030 capacity targets. The literature review has been conducted to explore the key theoretical concepts and theories relevant to the paper, deepening the authors' understanding of the theoretical foundations guiding the analysis.

The modified Diamond Model has been established as the main analytical framework for the industry analysis. The model will provide valuable insights into the historical evolution of the T&I industry and its expected development going forward. The comparative analysis of Cadeler and its main competitors will encompass both operational and financial performance metrics, including the project track record and order backlog, as well as EBITDA, ROA, ROE, the current ratio, and the debt-to-assets ratio. This approach allows for a more nuanced and comprehensive performance assessment.

This will lay the groundwork for the final sub-research question, which identifies strategic actions that T&I firms can take to meet Europe's 2030 capacity targets. These actions will be evaluated using the defined MCDA approach that considers the trade-offs between strategic risk, strategic scope, and their impact on meeting the 2030 capacity targets. This systematic and comprehensive analysis establishes a foundation for identifying the most effective strategic actions for T&I firms in the European offshore wind T&I industry. The thorough understanding of the theoretical concepts that support the analysis and selected research questions not only facilitates the authors' analysis but also enhances the reader's understanding of the paper's underlying analytical framework.

Research Methodology

This chapter presents a detailed outline of the research methodology adopted for this study, outlining the essential components that contribute to the integrity and rigor of the study. The chapter delves into the research philosophy guiding the investigation, followed by a detailed description of the research process, which includes the approach, methodological choices, and data collection strategies. Lastly, the chapter evaluates the validity and reliability of the methodology employed. By providing a comprehensive overview of the research methodology, this chapter aims to give readers a clear understanding of the methods and techniques employed in the study.

Research Philosophy

This paper relies upon the philosophy of pragmatism, which adopts an epistemological perspective that involves determining the meaning of phenomena and knowledge by demonstrating their practical problem-solving abilities. Pragmatism emphasizes the application of scientific knowledge in real-world situations and highlights the importance of experimentation and observation in testing scientific hypotheses (Coghlan & Brydon-Miller, 2014).

The pragmatic philosophy of science is flexible and adaptable to different research contexts, as it rejects the notion of objective truths and instead situates knowledge and phenomena within their unique contexts (Saunders, 2019). This is particularly relevant in the case of the European offshore wind T&I industry as the dynamics and challenges are constantly evolving. The pragmatic research philosophy, therefore, enables the researchers to consider the ever-changing context of the industry and identify specific actions to address the challenges that T&I firms face in meeting the European 2030 capacity target.

The analysis of the European offshore wind T&I industry development will provide valuable insights that will serve as the basis for recommending strategic actions that T&I firms can take to meet the European targets. This understanding will serve as a solid foundation to guide firms in formulating effective strategies that align with the industry's goals and requirements, ensuring a practical and informed approach to achieving the European targets. It hence aligns with the pragmatic philosophy's emphasis on practical problem-solving and the importance of empirical data in informing decision-making. According to the pragmatic philosophy of science, scientific theories should be evaluated based on their ability to solve practical problems and generate useful predictions (Coghlan & Brydon-Miller, 2014). The pragmatic approach is thus well-suited to address the practical issues surrounding the development of this industry from a firm perspective.

Overall, the pragmatist research philosophy is considered appropriate for the given research question, as it aligns with the research focus on practical problem-solving and empirical data gathering, while also providing the necessary flexibility to address the ever-changing context of the European offshore wind T&I industry.

Research Process

The research design for this paper is carefully tailored to ensure that the approach to theory development aligns with the chosen philosophical position and methodology. We employ an abductive research approach, utilizing mixed methods that incorporate both qualitative and quantitative data for inductive and deductive purposes. Our research strategy is a multiple case study with a cross-sectional time horizon, which has been pre-established by the paper's guidelines as they are laid out in the following paragraphs. The following sections will delve deeper into these choices and provide a more comprehensive understanding of the research process.

Abduction

The abductive approach has been deemed most relevant for the paper as it enables the researchers to move between induction and deduction (Saunders, 2019). This was found essential to effectively answer the sub-research questions guiding the paper.

For example, the first sub-research question on the development of the European offshore wind T&I industry has a deductive underpinning as a version of Porter's Diamond Model is utilized. This follows the deductive research approach, which starts with a theory or framework and subsequently collects data (Kennedy & Thornberg, 2017). The second sub-question regarding Cadeler's performance relative to its peers employs a more inductive approach, examining specific data points over a certain time period. This allows the authors to collect data on the companies' performance, analyze it, and draw conclusions about their relative standing. The third sub-question adopts a deductive research approach, using existing data and information to develop hypotheses about the expected development of the offshore T&I industry from 2022-2030. Finally, the fourth sub-research question on strategic actions that T&I firms like Cadeler can take to meet European 2030 capacity targets has a more abductive underpinning. This is because the answer relies on data regarding the offshore wind T&I industry, including T&I firms' resources and capabilities, as well as relevant industry trends and best practices. Based on this information, it is possible to develop hypotheses about the specific actions that T&I companies can take to meet these targets and improve their position in the market.

Thus, the approach taken in this analysis transitions between inductive and deductive reasoning, making abductive reasoning an appropriate fit. This approach allows for a comprehensive and informed analysis of the industry's past and future development and the strategic actions T&I firms can take to align with the European 2030 capacity targets.

Multiple case study

A multiple case study approach is employed in this research to facilitate a comprehensive analysis of the European offshore wind T&I industry (Saunders, 2019). This research strategy enables a detailed examination of the industry's development from a firm perspective, with a focus on Cadeler and some of its peers. By considering multiple cases, the research can better identify specific actions that offshore T&I companies can take to meet the European 2030 capacity targets and provide a more robust understanding of the industry dynamics (Schoch, 2019).

Mixed methods

This paper employs a mixed methods approach, combining both quantitative and qualitative research methods, which is consistent with the pragmatic philosophy of science (Morgan, 2014). This approach provides flexibility by allowing the researchers to utilize the most appropriate research methods for specific situations (Creswell & Clark, 2018; Saunders, 2019). Consequently, the research questions that require both numerical and descriptive information can be adequately addressed, aligning with the research question of this paper. The mixed methods approach is deemed suitable for the purpose of this research as it enables a comprehensive understanding of the complex nature of the European offshore wind T&I industry. Additionally, this approach facilitates the triangulation of findings across different data sources, thereby enhancing the reliability of the results (Creswell & Clark, 2018).

Time horizon

A cross-sectional time horizon was considered most appropriate for this paper as the phenomenon in question, the European offshore wind T&I industry, is examined at a particular point in time, specifically during the first half of 2023.

The data collected for sub-question one covers a five-year time horizon, while the data for sub-question two spans a two-year time horizon. Despite these time frames suggesting a longitudinal study, it is important to note that the data collection occurred at a single point in time, maintaining the cross-sectional nature of the study (Saunders, 2019).

The five-year time horizon for sub-question one allows for a comprehensive analysis of trends, patterns, and changes in the industry. This was found especially relevant in the context of the offshore wind sector and the T&I industry given the considerable time required for offshore wind farm development and operationalization. This approach provides a robust and holistic understanding of the phenomenon under investigation.

For the comparative analysis of Cadeler and its peers, a two-year time horizon was chosen, reflecting Cadeler's recent public listing in October 2020 and the significant industry changes during this period. Notably, the dry bulk shipping firm Scorpio Bulkers divested its fleet and entered the T&I industry under the name Eneti. Another notable T&I firm, Seaway 7, was established through the merger of OHT carriers and Subsea 7's renewable business unit, creating a single supplier offering comprehensive solutions to the offshore wind industry. These events both occurring in 2021 marked the start of a new and distinct industry separate from the long-running and developed offshore oil and gas industry. Hence, by examining data from a two-year period, the analysis captures the emergence of the T&I industry as well as relevant up-to-date information on company performance, industry transformations, and potential trends.

Data Collection

The following section aims to demonstrate how primary and secondary data for the paper have been collected. Primary data is obtained through semi-structured interviews and quantitative data collection, while secondary data comprises academic literature, as well as market and industry reports, gathered through desktop research. These diverse data sources enable the authors to effectively address the sub-research questions and provide a comprehensive analysis.

Primary sources

Interviews

The contextual data for the conducted interviews are assembled in Table 1.

Table 1: Interviewee overview

#	*Organization*	*Interviewee*	*Date*	*Citation*
1	Energinet	Bjarne Brendstrup, Senior Director	9/3/23	Appendix 1: Energinet
2	Copenhagen Infrastructure Partners	Casper Torres Karlsmose, Strategy Manager	28/3/23	Appendix 1: CIP
3	Naver Energy	Niels Nielsen, Director	29/3/23	Appendix 1: Naver Energy
4	Ørsted EPCO	Wouter Steenbeek, Senior Category Manager	30/3/23	Appendix 1: Ørsted
5	Cadeler	Simon Harder, Head of Strategy	31/3/23	Appendix 1: Cadeler
6	Copenhagen Offshore Partners	Vilius Vaisnoras PMO Manager	5/4/23	Appendix 1: COP
7	Clarksons Platou	Olivier Candeel, Transport & Installation Manager	5/4/23	Appendix 1: Clarksons

The interviews were all conducted following a semi-structured interview approach with the aim of reaching a balance between confirmation of initial research and further elaboration. The approach enables the respondent the opportunity to elaborate on topics deemed particularly valuable for the paper. This results in the ability to obtain a more comprehensive and detailed dataset, while also increasing the comparability of interviews *(Rubin & Rubin, 2012; Adams, 2015)*.

For a successful semi-structured interview, it is important to develop an interview guide that covers all relevant topics and questions related to the research question. The guide should be flexible and designed to allow for interesting and relevant conversations to flow naturally from the respondent. However, the approach requires a significant commitment from researchers during the preparation phase, as it is necessary to think and develop appropriate follow-up questions to support and explore the topics discussed during the interview (Brinkmann & Kvale, 2009; Flick, 2022). The general interview guide utilized by the researchers can be found in Appendix 2.

The interviews were conducted via online platforms, specifically, Microsoft Teams, which provided audio recording and webcam functionalities for data collection purposes. This decision was made considering the geographical dispersion of the participants and the convenience it offered to the interviewees. The interviews were scheduled through email correspondence, in which the overarching purpose and research agenda were introduced, allowing ample time for the interviewees to prepare for the subject of conversation.

Following the completion of the interviews, the audio recordings were transcribed to facilitate a thorough analysis of the collected data. The researchers ensured trustworthiness by practicing reflexivity and discussing findings and interpretations. This iterative analysis process helped identify connections between the interview data and research questions (Magaldi & Berler, 2020), enhancing the understanding of the European offshore wind T&I industry.

Quantitative data

To accurately assess the relative performance of Cadeler and its peers, quantitative data was utilized. This data was derived from primary sources such as annual reports, company presentations, and other materials published by the respective companies. Primary sources are considered original and provide firsthand, unmediated information directly from the study's objects, in this case, the selected companies (Persaud, 2010). The quantitative data includes financial information, such as company earnings, expenses, assets, and shareholder equity. Additionally, input from interviews was incorporated into the quantitative analyses conducted. These interviews provided valuable insights and contributed to the overall understanding of the companies' operations and performance as well as the industry trajectory. By combining data from quantitative data sources and interviews, a comprehensive comparative analysis was conducted. This approach enabled triangulation and validation of the findings with greater confidence, ensuring a robust and reliable assessment.

Secondary sources

Academic literature and peer-reviewed articles

The paper is underpinned by an extensive literature review, aimed at establishing a robust theoretical foundation for the research. The primary objective was to conduct a comprehensive analysis of prior research through a narrative review, with a focus on identifying the strengths and limitations of existing literature (Bryman, 2015). This approach was deemed appropriate as it facilitates a comprehensive overview of the different perspectives in the literature, enabling the selection of the most relevant perspective for this paper. The literature review predominantly drew from secondary sources, including peer-reviewed books and academic journal articles accessed through reputable databases such as ResearchGate, ScienceDirect, and SAGE, available through the CBS library.

Market- and industry reports

The authors have collected data and information from organizations and companies such as WindEurope, Global Wind Energy Council (GWEC), and International Energy Agency (IEA). The sources were collected to facilitate a better understanding of the energy sector, developments within offshore wind, environmental and political considerations, and the main risks facing the industry. The authors have strived to use reports from renowned and credible sources.

For example, the IEA is an intergovernmental organization that operates independently of any commercial or political interest. This helps ensures that the data and analysis are impartial and unbiased thereby increasing the reliability and validity. WindEurope is the leading association for wind energy in Europe, representing more than 400 companies involved in wind energy production, development, and distribution, including manufacturers, developers, utilities, and research institutes. WindEurope's industry expertise, reputation, and influence make it a credible source of information and analysis.

There are, however, some industry reports that are partially sponsored by industry participants which could lead to biases in the data and analysis. For example, the annual Global Offshore Wind Report published by GWEC is partly sponsored by Siemens Gamesa, a leading industry participant, which could potentially influence the objectivity of the report's findings. The authors have, therefore, utilized a wide variety of different reports to cross-reference findings and select the most appropriate data sources for the paper.

Evaluation of research methodology

To adhere to general research ethics and ensure the quality of the study, it is necessary to evaluate the reliability and validity of the research design. Reliability refers to the consistency of the research, ensuring that the same research design produces the same findings. Validity, on the other hand, refers to the extent to which the study accurately measures what it is intended to measure. It concerns whether the research methods and instruments used to collect data are appropriate and whether they capture the phenomena of interest in a way that is accurate and unbiased (Saunders, 2019). Both reliability and validity were prioritized throughout the research process.

Reliability

Reliability can be divided into two categories: internal and external reliability. Internal reliability is concerned with ensuring consistency during research. The researchers have sought to meet this criterion by having both researchers present at all interviews, sharing notes, and evaluating and discussing the key findings to ensure agreement about the data and its analysis. External reliability, in contrast, refers to the consistency of research findings when data collection techniques and analytic procedures are replicated by other researchers. To ensure external reliability the authors have provided a detailed explanation of the methodology, procedures, and inputs used in the research project. This has been carried out to increase the transferability of the research (Bryman, 2015). The specific interview guides and transcripts from the semi-structured interviews are provided in the appendix to increase the transparency of the research (ibid). The authors have moreover paid much attention to verifying data and ensuring its dependability in line with the best practices mentioned by Saunders (2019).

Validity

In research, there are two types of validity to consider: internal and external validity. Internal validity refers to the extent to which a study is well-designed and well-executed, while external validity pertains to the generalizability of the research findings (Saunders, 2019). To enhance internal validity, the authors have utilized data triangulation by conducting interviews with diverse stakeholders from various companies and organizations, while reviewing a broad selection of industry reports and peer-reviewed articles, actively mitigating potential research bias.

The external validity of the study may, however, be questioned due to the inherent limitations of case studies in producing generalizable findings, particularly across different regions or situations. The study's sensitivity to the regional choice of Europe is noteworthy, as the governmental and regulatory factors impacting the offshore wind industry vary significantly between countries. Nevertheless, Europe's standing as the leading region for offshore wind (GWEC, 2023) justifies the study's focus, as the insights gained can serve as valuable indicators for the global sector as a whole.

Furthermore, the study's emphasis on Cadeler and its peers is deemed appropriate, as they are sizable and well-positioned within the industry, making them reasonable representatives of companies within the offshore wind T&I industry.

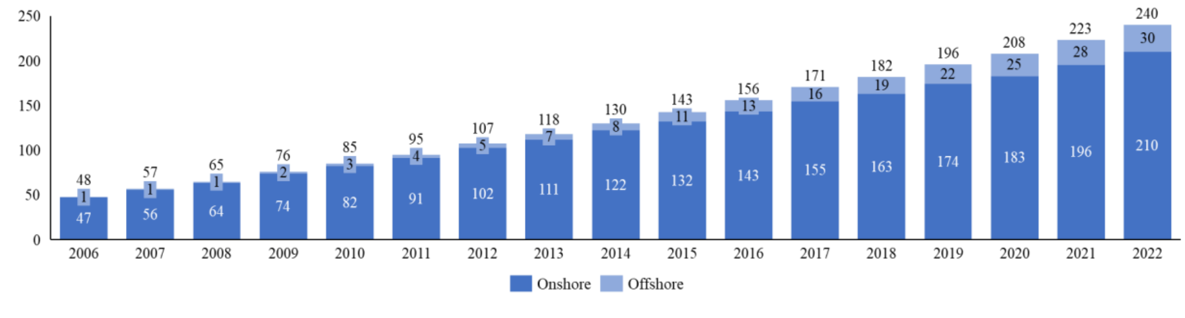
European Offshore Wind T&I Industry Analysis

The offshore wind sector has emerged from the onshore wind sector as a promising solution to access even greater power potential to address the world's growing energy demands and combat climate change. In the year 2009, the offshore wind sector was underdeveloped, with few offshore wind projects and a lack of established energy companies dedicated to offshore wind. However, the industry has since scaled partnerships and made significant advancements in wind turbine technology, leading to decreased costs, and making offshore wind a competitive and efficient source of energy.

Out of the 837 GW of wind capacity installed globally in 2022, 93%, was comprised of onshore systems, leaving the remaining 7% to offshore wind farms (GWEC, 2023). Onshore wind technology has been well-established and is currently utilized in 115 countries globally, whereas offshore wind is still in its early stages of expansion and is only present in 19 countries. Nevertheless, the reach of offshore wind is projected to grow in the upcoming years, as more countries are in the process of developing, or have plans to develop, their first offshore wind farms (IEA, 2023).

The offshore wind sector began to emerge in the late 1990s and early 2000s. The first offshore wind farm was installed off the coast of Denmark in 1991, but it wasn't until the late 1990s that larger offshore wind farms began to be built. In 1999, the world's first large-scale offshore wind farm, Middelgrunden, was built off the coast of Copenhagen, Denmark, with a capacity of 40 MW. This project was followed by several other large offshore wind farms in Denmark, the UK, Germany, and the Netherlands in the early 2000s, which helped to establish offshore wind as a viable source of renewable energy. Since then, the sector has grown rapidly, with increasing numbers of offshore wind farms being built in Europe and other regions around the world.

Figure 5: Total installed wind capacity in Europe 2013-2022 (GW)



Source: Own creation based on data from IRENA (2023)

The offshore wind sector has only been in a developed state for a relatively short period, with a history of around 15-20 years. Compared to onshore wind, which has been around for much longer and has been more widely adopted, offshore wind is still in development. As a result, many actors, such as developers, contractors, and investors, have only entered the offshore wind space within the last few years, as the industry continues to expand and gain momentum. This has created a dynamic and rapidly evolving landscape, with many new players competing alongside established industry leaders. As the demand for renewable energy continues to grow and offshore wind becomes more competitive, it is expected that even more actors will enter the offshore wind space in the coming years.

Offshore wind supply chain

The supply chain of an offshore wind farm is a complex and multi-faceted process, encompassing six primary stages. Each stage involves various stakeholders and actors, who contribute their specialized knowledge and expertise to ensure the successful development, operation, and decommissioning of the offshore wind farm (Dedecca, Hakvoort, & Ortt, 2016; Seeverens, 2017). Figure 6 summarizes these stakeholders and highlights their involvement in each of the six stages.

Figure 6: Offshore wind farm supply chain

	Planning & Development	Production Of Wind Turbines	Production Of Foundations	Installation And Grid Connection	Operation And Maintenance	Decommissioning
Description	Define areas for development as well as windfarm design	Supply of wind turbines from OEMs. Critical component supply by OEM, non-strategic by sub-contractors	Delivery of foundations, substations, inter-array and export cables.	Installation of foundations, turbines cables and substation.	Daily operation, and maintenance. Includes scheduled and unscheduled services.	Removing all infrastructure to fully restore project site (seabed)
Developers	✓	(✓)	(✓)	✓	✓	✓
OEM contractors		✓	✓			✓
Steel fabrication		✓	✓			
T&I firms				✓		
EPCI contractors	✓	✓	✓	✓	✓	✓
Consultants	✓					
Governments	✓	(✓)	(✓)	(✓)	(✓)	(✓)

Source: Own creation based on Dedecca, Hakvoort, & Ortt (2016) and Seeverens (2017)

Planning and Development commence with the government playing a crucial role in granting permits and designating locations for offshore wind farms. Wind farm developers carry out initial surveys, determine feasibility, and define the first concept designs for the wind farm and its components. Engineering, Procurement, Construction, and Installation (EPCI) contractors support the developers by providing expert advice based on their in-house offshore engineering knowledge. In the Production of Wind Turbines phase, wind turbine manufacturers are responsible for the design and production of the wind turbines. They collaborate with steel fabricators and EPCI contractors to ensure efficiency, reliability, and adherence to the project's specific requirements. During the Production of Foundations stage, Original Equipment Manufacturer (OEM) contractors, steel fabricators, and EPCI contractors collaborate to design, test, and produce foundations that support the wind turbines and maintain their stability in harsh offshore environments. The Installation and Grid Connection phase involves grid operators being responsible for integrating the wind farm into the national electrical grid, ensuring there is enough capacity to handle the additional energy supply. Wind farm developers, OEM contractors, and T&I firms collaborate to transport and install wind farm components. EPCI contractors offer support in the installation of turbines and foundations by applying their in-house offshore engineering knowledge. T&I firms supply specialized vessels for transportation and installation. For Operation and Maintenance, wind farm owners are responsible for the offshore wind farm's operation and maintenance (O&M). They work closely with service providers, T&I firms, and EPCI contractors to maintain the wind farm in optimal condition. Wind turbine manufacturers also influence this stage due to the design choices they make, which can impact maintenance requirements and procedures. In the Decommissioning phase, wind farm owners are responsible for arranging the decommissioning of the offshore wind farm. OEM contractors, T&I firms, and service providers collaborate to dismantle and remove the components, while EPCI contractors offer support by providing expert advice on decommissioning procedures and environmental compliance. The government may also be involved in ensuring that decommissioning aligns with relevant regulations and guidelines.

Vessels in T&I

During the transport and installation phase of offshore wind farm projects, a variety of specialized vessels play crucial roles in facilitating the process. These vessels are designed to serve specific purposes, such as transporting components, installing turbines and foundations, and accommodating crew members. The primary vessel types and their respective functions are described in the following paragraphs (Thomsen, 2012; Jiang, 2021; H-BLIX, 2022). Figure 7 below summarizes these vessel types and their primary functions. Of special interest for this paper are heavy-lift vessels and jack-up vessels, as they are capable of installing foundations and turbines due to their crane capabilities.

Figure 7: Vessel types and their main function within the T&I process

The focus of this thesis

Vessel types	Component Transport	Foundation Installation	Turbine Installation	Cable Laying	Operation And Maintenance
Heavy-lift vessels	✓	✓			
Jack-up vessels		✓	✓		
Tugboats	✓				
Barges	✓	✓			
Cable-laying vessels				✓	
Service operation vessels					

Source: Own creation based on Thomsen (2012), Jiang (2021), and H-BLIX (2022)

Heavy-lift vessels are engineered for the transportation and installation of large and heavy components, including wind turbine nacelles, blades, and tower sections. Equipped with heavy-lift cranes, dynamic positioning systems, and spacious deck areas, these vessels can accommodate the size and weight of the components. Jack-up vessels are also essential for the installation of wind turbines and foundations. These vessels possess legs that can be lowered to the seabed, elevating the vessel above the water surface and providing a stable working platform. The vessel's onboard crane is employed for installing wind turbines and foundations, while dynamic positioning systems ensure precise maneuvering and positioning. Tugboats are employed to tow other vessels, such as barges, to the installation site. They play a supporting role in the transportation of large and heavy components while ensuring safe and efficient navigation. Barges transport heavy and bulky components, such as wind turbine towers, nacelles, blades, and foundation structures. They are often towed by tugboats to the offshore installation site. Cable-laying vessels are designed for the installation of subsea cables connecting the offshore wind farm to the onshore electrical grid. These vessels feature equipment for cable storage, handling, and laying, as well as dynamic positioning systems. Service operation vessels (SOVs) are employed for the operation and maintenance of offshore wind farms. They offer accommodations for crew members, workspaces, and storage for spare parts and tools. Many SOVs are equipped with a motion-compensated gangway or walk-to-work system. Crew transfer vessels (CTVs) are fast and maneuverable vessels that transport technicians, equipment, and supplies between the shore and the offshore wind farm. Each vessel type fulfills a specific function within the T&I process, contributing to the smooth and efficient deployment of offshore wind farms.

The historic development of the European offshore wind T&I industry

Factor Conditions

In this section, an exploration of factor conditions related to the European offshore wind T&I industry will be undertaken. The analysis will specifically focus on two critical aspects: the availability and production of specialized vessels, and the conditions for acquiring these vessels. As a key determinant of competitiveness within the industry, understanding factor conditions helps to shed light on how companies in this sector secure the necessary resources and assets for their operations.

Availability of vessels

Between 2000 and 2009, the offshore vessel market experienced a significant increase in deliveries, primarily driven by rising oil prices and the need for fleet replacement. This led to a more than threefold increase in offshore vessel deliveries between 2004 and 2009. Despite a consistent drop in oil prices, the number of offshore vessel deliveries remained elevated due to high order books for new offshore supply vessels. However, the persisting negative trend in oil prices after 2014 resulted in an oversupply of offshore vessels, low rates, and lay-ups for the following 6-7 years (Menon Economics, 2021).

As the global energy transition continues, the offshore wind segment is expected to overtake the oil and gas sector in importance (GWEC, 2023; Appendix 1: Clarksons). A part of this transition lies in upgrading existing offshore vessels used for oil and gas-related purposes for handling wind turbines.

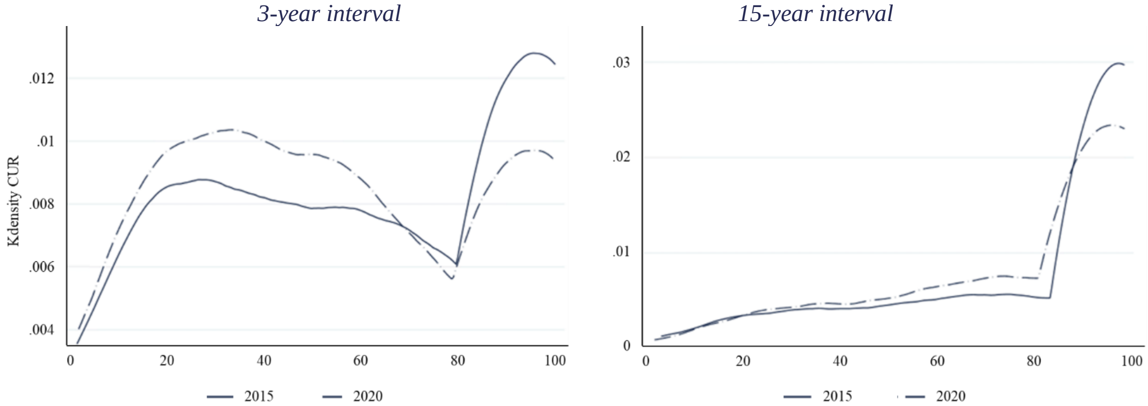
While retrofitting older vessels can extend their operational life and adapt them to the requirements of modern offshore wind farms, these upgrades often involve substantial structural modifications, such as reinforcing the hull, enhancing crane capacity, and installing advanced positioning systems. The production capacity for upgrading older vessels is therefore inherently limited by the original design and specifications, often resulting in trade-offs in terms of performance, efficiency, and cost-effectiveness when compared to their new build counterparts. However, the upgraded vessels still contribute significantly to the overall capacity of the industry (Appendix 1: Cadeler).

For new-build vessels, one of the primary challenges lies in shipyard capacity. The construction of specialized vessels tailored for the offshore wind industry requires specialized shipyards with the necessary infrastructure and technical know-how. In 2020, China held the largest shipbuilding capacity, accounting for around 45% of the global capacity, followed by Korea with 30% and Japan with 20% (OECD, 2022).

The latest OECD analysis indicates a decline in overall global shipyard capacity, though conversely significant excess capacity in the shipbuilding industry in the years 2018 to 2022, on an aggregate global level, which suggests an increased potential for manufacturing offshore service vessels, such as wind turbine installation vessels (WTIV). This can be seen as estimates for capacity utilization rates that suggest a larger share of yards with lower rates in 2020 compared to 2015, indicating an increase in excess capacity for many yards (see Figure 8). However, as the lead time for constructing an offshore wind installation vessel generally ranges from 18 months to 3 years (Appendix 1: Ørsted; OECD, 2022), depending on factors such as vessel complexity, shipyard capacity, and supply chain dynamics, access to newbuild vessels and vessel upgrades can be limited.

Figure 8: Kernel density of estimates of shipyard-level capacity utilization rates in 2015 and 2020,

3-year interval *15-year interval*



Source: OECD (2022).

Note: The Kernel density estimate of capacity utilization rates for a set of shipyards estimates the likelihood of different utilization rates occurring. The area under the curve represents the percentage of shipyards that have a utilization rate equal to or less than a certain value on the horizontal axis.

In the offshore wind T&I industry, there are two main types of projects: wind turbine installations and foundation installations. Over the past five years, the industry has witnessed an increasingly clear divide between these project categories, each characterized by distinct features and requirements. This paper will provide an in-depth analysis of the differentiation between these two types of installations, focusing on their respective complexities, profit margins, and implications for the future demand for vessels. This discussion will be further elaborated upon in the context of addressing the third sub-question.

In recent years, the size of turbines and foundations has posed a significant financial risk to vessel investors, according to Sarker and Faiz (2017) and Stentoft et al. (2016). As turbines have become larger, installation vessels with limited deck space and lifting capacity have become obsolete well before the end of their expected lifespan, as noted by Poulsen and Lema (2017). Consequently, these vessels may need to be repurposed for smaller older turbines, adapted for bridge construction, or utilized in other marine construction projects. Appendix 8 provides a comprehensive list of vessels worldwide excluding Chinese-owned vessels that are capable of installing or have participated in the installation of wind turbines and/or foundations. It is important to note that China has been excluded from this analysis, as both their market and vessels are generally considered not available to the rest of the world since they do not operate internationally (H-BLIX, 2022; Smart Energy International, 2021).

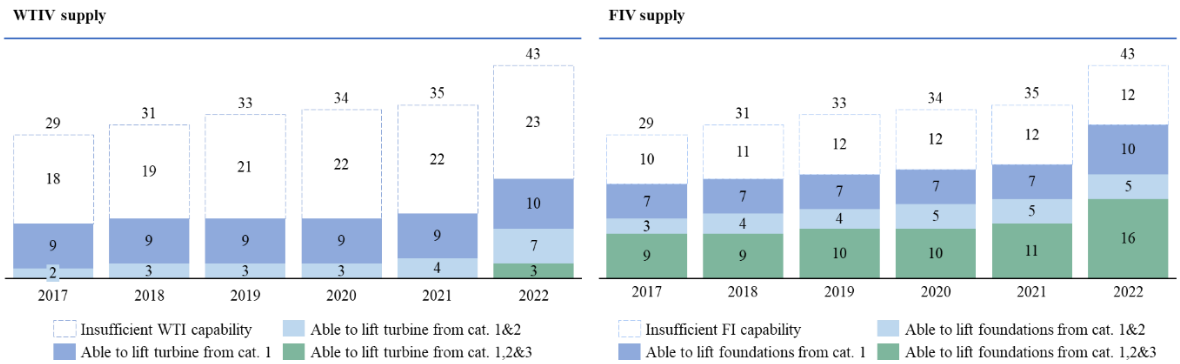
Among the identified vessels a decreasing number have the capacity to install both turbines and foundations. However, some heavy-lift assets have the potential to perform both functions in the future due to crane upgrades. Out of the total number of identified vessels available as of the end of 2022, 15 can handle both turbines and foundations, five are exclusively suitable for turbine installation, and 16 are viable for foundation installation. The worldwide installation fleet, excluding China, currently consists of approximately 43 vessels, with a significant portion of them being outdated or nearly so for their intended purpose of installing turbines or foundations. Many of these vessels operate in China, rendering them inaccessible to other markets, as per IHS Markit (2021).

Out of the 43 vessels identified, seven are considered obsolete as they are unable to handle turbines greater than 12 MW or foundations weighing more than 1500 tons. These lower bounds are based on the average offshore wind farm project requiring turbines and foundations at or larger than these levels with an average turbine size and foundation weight in 2022 of 10.0 GW and ~1200 tons, respectively (WindEurope, 2023; 4C Offshore, 2022).

To facilitate the analysis, the identified vessels are categorized into three distinct groups based on their respective capacities. For WTIVs, Category 1 vessels can accommodate turbines with a capacity of up to 12 MW, Category 2 vessels can manage turbines with a capacity between 12-15 MW, and Category 3 vessels can handle turbines with a capacity of 15 MW and above. Recent vessels predominantly fall into Category 3, boasting more expansive deck spaces, superior crane capacities, and increased transit speeds. It is important to acknowledge that Categories 1, 2, and 3 are less insightful when examining the historical development, as the turbines installed have generally been below 12 MW, and foundations have been under 1,500 tons up until 2022. Nevertheless, the analysis in a subsequent section of this paper will utilize these categories, given the rapid growth in foundation and turbine sizes. Hence to present a uniform analysis the same categorization is employed here.

Regarding foundation installation vessels (FIV), there are three categories based on their lifting capacity and the types of foundations they can install for varying turbine capacities. Category 1 vessels, possessing a lifting capacity of 1,500 tons, are suitable for installing monopile foundations in shallow water and jacket foundations in deep water for turbines in the 14-15 MW range. Category 2 vessels, with a lifting capacity of 2,000 tons, can accommodate monopile installations in shallow water for turbines between 18-20 MW and can manage deeper monopile installations for 14-15 MW turbines. Category 3 vessels have a lifting capacity of 2,500 tons and are specifically designed for installing monopile foundations in deep water and jacket foundations in ultra-deepwater, both for turbines in the 18-20 MW range. The following section presents depictions of the current fleet of installation vessels.

Figure 9: Wind turbine installation vessel and foundation installation vessel development 2017-2022



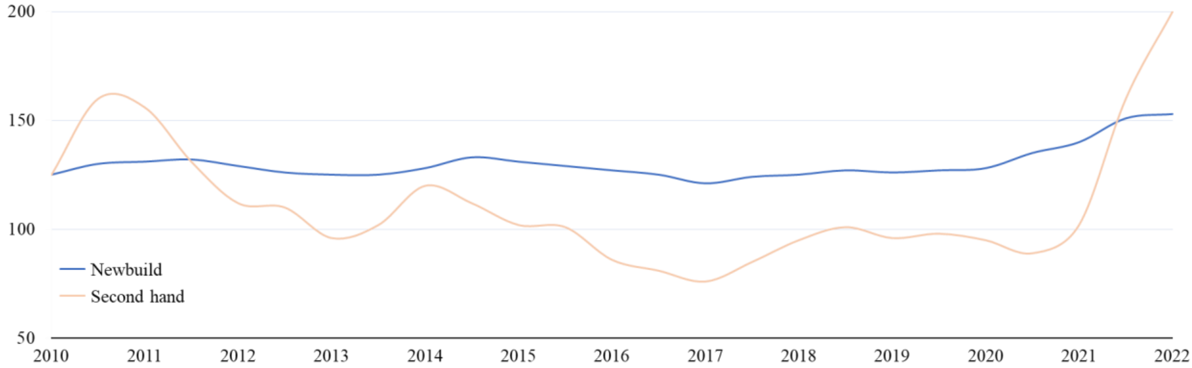
Source: Own creation based on publicly available data.
Category 1 WTIVs handle up to 12 MW turbines, FIVs 1,500-ton capacity; Category 2 WTIVs manage 12-15 MW turbines, FIVs 2,000-ton capacity; Category 3 WTIVs accommodate 15 MW+ turbines, FIVs 2,500-ton capacity.

Capital constraints for vessels

Vessel prices, like other goods, are influenced by the equilibrium between supply and demand. Building a new ship is a time-consuming process, often taking two to three years from order to delivery. As a result, the worldwide demand for ships can shift significantly during the construction period. Moreover, investing in a new vessel, such as for example a tanker with an economic life of 18 to 25 years, represents a long-term commitment. The uniqueness of individual ships, even within the same category and size, creates a complex and diverse market (Adland, Norland, & Sætrevik, 2017) leading to vessel prices exhibiting a high level of volatility.

The Clarkson Price Index, depicted below, illustrates the global indexed development in the price of new-build vessels and second-hand vessels across vessel types (OECD, 2022). The chart clearly displays the volatile price of second-hand vessels. Despite the price fluctuating significantly over the period, the value of second-hand vessels has seen an unprecedented increase from 2020 onwards. Although less volatile, newbuild prices have reached their highest point in ten years, driven by a strong demand for vessels.

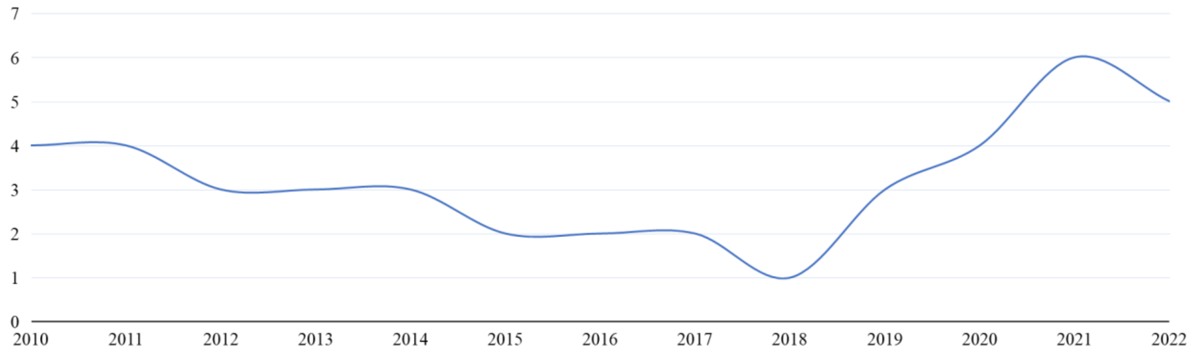
Figure 10: Clarksons Price Index



Source: Own creation based on Clarksons Shipping Intelligence Network and OECD (2022)

Looking solely at offshore wind installation vessels, including both newbuilds and upgrades, the global order book experienced a general decline from 2010 to 2018. However, starting in 2018, the market saw a sharp turnaround, with order books rapidly expanding and reaching a peak around 2021 (Figure 11). This surge in demand for offshore wind installation vessels coincided with the uptick in vessel prices observed from 2020 to 2022, as indicated by the Clarkson Price Index. Several factors have contributed to this resurgence in orders, including the expansion of offshore wind projects, and the need for specialized vessels capable of handling increasingly large turbines (GWEC, 2023; IEA, 2023). Consequently, this revitalized demand has had a significant impact on orders of offshore wind installation vessels despite the increase in vessel prices. Figure 11 displays the global WTIV and FIV newbuilds and upgrades ordered from 2010 to 2022.

Figure 11: WTIVs and FIVs global newbuilds and upgrades ordered (2010-2022), excluding China



Source: Own analysis based on publicly available data

Acquiring installation vessels involves substantial financial investments. Data from one installation vessel ordered by Cadeler in 2022 indicates that the expenses for construction in Asia will fall within the USD 335-355 million range (Cadeler, 2022). In certain countries, such as Japan and the United States, where a domestic flag is obligatory, the capital expenditure is markedly greater. Shimizu's forthcoming newbuild, to be constructed in Japan, necessitates a CAPEX of USD 450 million, whereas the anticipated CAPEX for US-built vessels is expected to surpass USD 500 million (DNB Markets, 2022). Despite this, several well-established firms have managed to raise capital through financial markets and obtain debt for their newbuild initiatives (Appendix 1: Clarksons). Consequently, access to capital is regarded as a hurdle to market entry, albeit not the most significant one (Appendix 1: Cadeler).

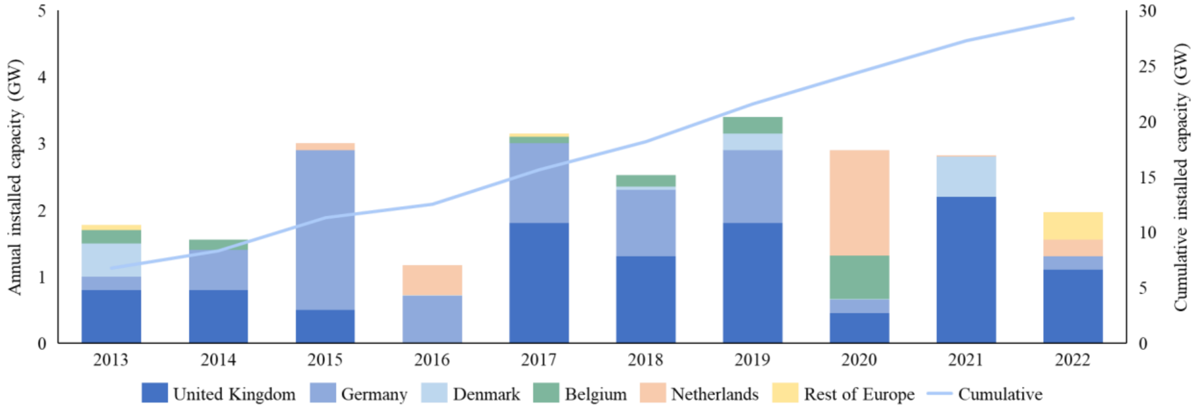
Demand Conditions

The following section will investigate the demand conditions of the European offshore wind industry. The following two components will provide the foundation for the analysis: the development in the size and growth of the wind farm installation project pipeline and the demand response mechanisms within the industry.

Development in offshore wind demand from 2018-2022

The period between 2018 and 2022 has witnessed significant growth in the development of offshore wind farms in Europe. As per data provided by WindEurope, the cumulative capacity of offshore wind power reached 30.3 GW of installed capacity in 2022, compared to 18.8 GW in 2018. This corresponds to a total of 5,954 offshore wind turbines distributed among 126 wind farms, with the majority concentrated in the UK, Germany, and Denmark. Notably, these three countries account for approximately 45% of the total number of offshore wind turbines connected to the grid in Europe (WindEurope, 2023).

Figure 12: Annual offshore wind installation by country (left axis) and cumulative capacity (right axis) (GW)



Source: Own Creation based on Wind Europe (2023)

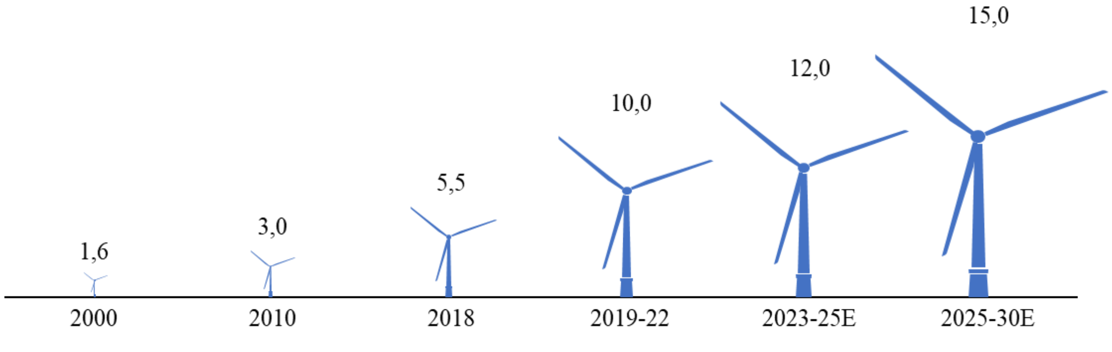
Figure 12 above illustrates the variability in the annual offshore wind capacity connected to the European grid in recent years. Since 2018, the average annual installed capacity has been 2.9 GW, with the highest installation occurring in 2019 when 3.6 GW of offshore wind energy was installed. This corresponded to 10 new wind farms becoming commercially operational and being connected to the grid in that year (GlobalData, 2020). However, the annual capacity has experienced fluctuations over time, reflecting the dynamic nature of offshore wind energy development in Europe.

The substantial growth of the offshore wind industry in Europe is attributed to several factors, including technological innovation, industry maturity, and competitive incentives (Wiser, Rand, Seel, & Beiter, 2021). Notably, technological advancements have, as mentioned, played a pivotal role by driving down costs, thereby facilitating governments in raising their offshore wind targets as part of their renewable energy expansion strategies (GWEC, 2023). These advancements have led to substantial cost reductions, rendering offshore wind energy more financially viable and appealing to both policymakers and investors, thus driving the expansion of the industry in Europe.

Technological development and response mechanisms

The industry's drive towards reducing cost and making offshore wind a more competitive source of energy has, as mentioned, led to significant technological advancements. The most prominent outcome of these advancements has been the increasing size of wind turbines. With larger turbines featuring higher power ratings, longer blades, and taller towers, resulting in enhanced technical capacity and annual energy production (GWEC, 2023).

Figure 13: Global weighted average turbine size (MW per turbine)



Source: Own Creation based on 4C Offshore (2022), GWEC (2022), and Rystad (2022)

In 2022, the average rated capacity of new turbines installed in Europe was 8.0 MW, which represents an 18% increase compared to 2018 (WindEurope, 2023). Increasing the size of the turbine has significant implications for T&I vessels used in offshore wind projects as the vessels must be capable of accommodating and handling the larger turbines (Lysne, 2022).

The transition towards larger wind turbines has had implications for the first-generation installation vessels as many of these have transitioned into operations and maintenance (O&M) services for installed turbines as they are unable to accommodate the size of the turbines currently being installed. Alternatively, vessels nearing the end of their productive life in Europe are often repurposed for projects in Asia, where the offshore wind industry is still emerging, and installation requirements are less advanced than in European markets (GWEC, 2023; Appendix 1: Cadeler; Ørsted). This transition allows the vessels to continue contributing to the growth of the offshore wind sector, while also supporting the development of the renewable energy industry in emerging markets.

In light of these developments, some operators have opted to upgrade the cranes onboard their vessels to remain competitive in the market (Lysne, 2022). For instance, Van Oord's offshore T&I vessel, Aeolus, underwent a retrofit in 2018, including the installation of a new crane, just four years after the vessel was originally built. The new crane was necessary to maintain competitiveness in the rapidly evolving market (Van Oord, 2018). Similarly, other companies like Swire Blue Ocean, now Cadeler, followed a similar approach by upgrading the crane onboard Pacific Osprey six years after its initial construction. Originally designed to carry 12 3.2 MW turbines, the vessel underwent a crane update in 2020, enabling it to install and transport turbines of 12 MW capacity. However, due to the larger size of these turbines, the vessel's transport capacity has been reduced to a maximum of three turbines (Buitendijk, 2020).

These developments have not only prompted established companies like Jan de Nul and Cadeler to invest in newbuilds but have also attracted several new players to the industry, such as OIM Wind, Offshore Heavy Transport (OHT), and Eneti (MacFarlane, 2021). However, the lengthy construction time of these new vessels, averaging between two to three years limits their effectiveness as a response mechanism to changing market dynamics and demand fluctuations (Wiesener, 2022). This lead time hinders companies' ability to adapt quickly and effectively to changes in market demand, further emphasizing the challenges faced by the industry in accommodating the rapid growth of offshore wind.

Related and Support Industries

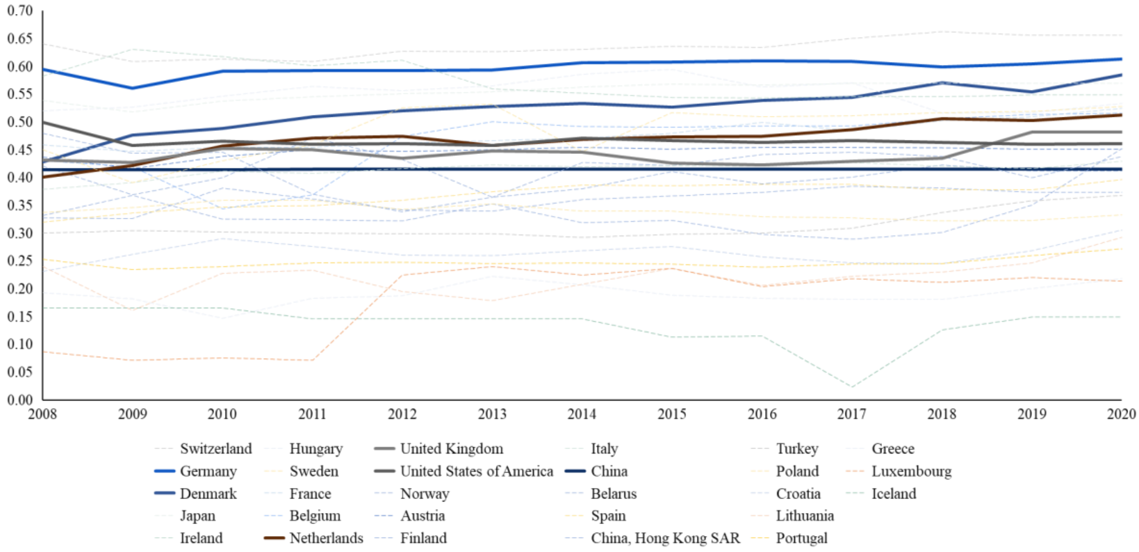
The concept of related and supporting industries refers to companies that have a direct or indirect impact on a specific industry. According to Porter (1990), if a country possesses a competitive advantage in related and supporting industries, it is more likely that the focal industry will experience national success. The presence of successful supporting industries within the domestic market offers opportunities for technical exchange and communication. Furthermore, the success of the focal industry on an international scale may create a demand for complementary products. In the case of renewable energies, it can be argued that high-tech industries are particularly relevant. The spillover effects of these industries may improve the technology innovation in the wind industry, thereby providing a competitive advantage for companies operating in these industries.

To assess the strength of related industries, we utilized several of the United Nations Industrial Development Organization's (UNIDO) metrics from the Competitive Industrial Performance (CIP) index database. Of all the available metrics, the ones most closely related to the characteristics of the offshore wind sector have been chosen. Most indicative of the strength of related and supporting industries is the metric of measuring the proportion of medium- and high-tech value added to the overall manufacturing output in a country (MMHVA). Furthermore, the metric manufacturing value added share in total GDP (MVA GDP) is used to indicate the general manufacturing capabilities of a country as a share of GDP. Lastly, the composite Competitive Industrial Performance Index score (CIP Score) is used as this metric is indicative of the overall competitiveness of a country’s industrial activities (UNIDO, 2023).

The analysis of MMHVA within a selection of European countries, as well as China and the US for comparative qualities, reveals insights into their potential to support the increasingly complex offshore wind sector. As offshore projects grow in complexity with larger turbine sizes and more intricate requirements compared to onshore initiatives, a well-developed and technologically advanced manufacturing sector becomes even more critical. Steenbeek emphasizes that *"the industry is developing so fast that it is just not profitable for the supply chain contractors to develop new technologies because they will be outdated by the time they get delivered"* (Appendix 1: Ørsted). This underlines the necessity for the supply chain to closely follow the rapid development of the offshore wind sector. Karlsmose’s comment on the emerging hurdles of transmission grid development, supply chain strain, and workforce shortage further underscores the importance of synchronization between these elements for successful sector development (Appendix 1: CIP).

Nevertheless, countries known for their offshore wind industries, such as Germany, Denmark, and the UK, consistently exhibit a higher MMHVA compared to China, the US, and other European nations. Despite China and the US having substantial manufacturing sectors, their MMHVA has shown stagnant development, placing them in the middle of the pack among the selected developed countries. This higher MMHVA in European countries indicates a more favorable environment for the development and expansion of the offshore wind sector. In essence, the presence of a robust and technologically advanced manufacturing sector, reflected by higher MMHVA, in these countries provides a strong foundation for the growth and success of the offshore wind T&I industry, as it may be equipped to handle the increasing demands and complexities associated with the evolving offshore projects.

Figure 14: Medium- and high-tech manufacturing value added share in total manufacturing value added



Source: Own Creation based on UNIDO (2023)

In Appendix 10 the MVA GDP for various countries between 2008 and 2020 is showcased. China has consistently had the highest share in manufacturing, reflecting its status as the world's manufacturing powerhouse. Developed nations like Germany, Japan, and the US have also maintained relatively high manufacturing shares, although they have experienced fluctuations over the years. In contrast, countries like Greece, Croatia, and Portugal have had comparatively performed well below on MVA GDP.

When examining the relationship between the development of manufacturing and the offshore wind energy sector, it is important to consider the level of technological advancement and industrial capacity in each country. Developed countries with a strong manufacturing base, such as Germany, Denmark, and the Netherlands, are the same countries that have established a robust offshore wind energy sector. On the other hand, countries with less developed manufacturing capabilities may face challenges in building a competitive offshore wind energy sector. Such countries may lack the necessary infrastructure, technical expertise, and resources to support the development and deployment of large-scale wind energy projects (Appendix 1: COP).

Although many European countries have a strong presence of firms in the offshore wind sector, looking at firm-level performance along the supply chain suggests a reversal of the trend of reduced costs along the supply chain (ibid). European developers have seen decreasing margins with an average EBITDA margin of 27% in 2020 falling to 20% and 13% in 2021 and 2022, respectively (Appendix 11). Similarly, the largest turbine manufacturers have seen a recent drop in orders and already slim EBITDA margins going on average from 5% to -3% from the record year 2021 to 2022, showcasing a shift in the European offshore wind supply chain in recent times (ibid).

The aggregated CIP Scores of the selected countries included in Appendix 10 provide further insights into their industrial competitiveness and potential to support the offshore wind energy sector. Generally, European countries such as Germany, Denmark, and the UK exhibit high CIP Scores. However, China and the US are scoring high among the top countries, indicating a strong industrial environment. According to Nielsen from Naver Energy *“China is going to overhaul the European Offshore Wind industry in the coming years”* (Appendix 1: Naver Energy), while *“in the United States wind energy is perceived as the coal industry is perceived in Europe. They don’t want it”* (ibid). Relative to the data provided, this comment indicates that China will see a positive development in MMHVA to accommodate the increasing demands for a strong support structure for a complex supply chain.

In sum, the presence of strong related and supporting industries is a key determinant of the success and growth of the offshore wind energy sector in the geographical region. European countries like Germany, Denmark, and the UK, with well-developed medium- and high-tech manufacturing industries, have established robust offshore wind sectors due to their favorable environment for innovation and technological advancement. On the other hand, countries like China and the US have the potential to impact the offshore wind sector significantly, as they possess strong industrial environments. However, their ability to support the complex supply chain of the offshore wind sector may depend on the development of their medium- and high-tech manufacturing capabilities.

Firm Strategy, Structure & Rivalry

The offshore wind T&I industry is highly competitive, with a limited number of companies offering these services. Currently, the industry is dominated by two types of contractors: EPCI contractors and T&I contractors. EPCI contractors are responsible for the complete offshore wind farm supply chain, whereas T&I contractors are solely focused on the transportation and installation of wind turbines and foundations (see Figure 6). Both types of contractors can be further divided into two categories: focused and diversified. Focused firms concentrate exclusively on windfarm activities, while diversified companies operate in other industries (oil and gas, offshore construction/engineering, etc.) and deploy other types of vessels (dredging, offshore construction support vessels, etc.). Figure 15 below provides an illustration of the companies within the industry split across the two identified dimensions.

Figure 15: Main offshore wind turbine & installation industry firms

Source: Own creation based on information derived from company websites validated through interviews

To evaluate the firm strategy, structure, and rivalry condition of Porter's Diamond Model, an examination of the business models and strategies employed by these types of contractors will be conducted.

Business model and strategy

Traditionally, there have been two main business models to consider when examining the project lifecycle of an offshore wind project: the EPCI model and the developer-managed multi-contracting model. In the EPCI model, the developer engages a single or very few engineering firms to take on the comprehensive responsibility for the wind farm project, spanning from design and engineering to procurement, construction, and installation (Winkler, Kilic, & Veldman, 2022). EPCI contractors possess extensive expertise in project management and coordination, along with the technical know-how to ensure proper installation and compliance with safety and performance standards. Oil and gas (O&G) operators such as BP and Total have traditionally favored this approach, as it minimizes their overhead costs and allows them to focus on their core services, which involve acquiring and selling land, as well as marketing the energy resources generated by their assets. Furthermore, these companies may lack the necessary capabilities to effectively manage the entire project lifecycle themselves (Floating Energy Systems Ltd, 2021).

On the other hand, the developer-managed multi-contracts approach is preferred by many larger developers, such as Ørsted and Vattenfall. In this model, the developer assumes direct control over the entire project lifecycle and contracts specific contractors for each stage of the process, including foundation installation, cable laying, and wind turbine installation. This approach enables the developer to maintain greater control over the project and reduce costs, albeit at the expense of a higher management burden (Appendix 1: Ørsted).

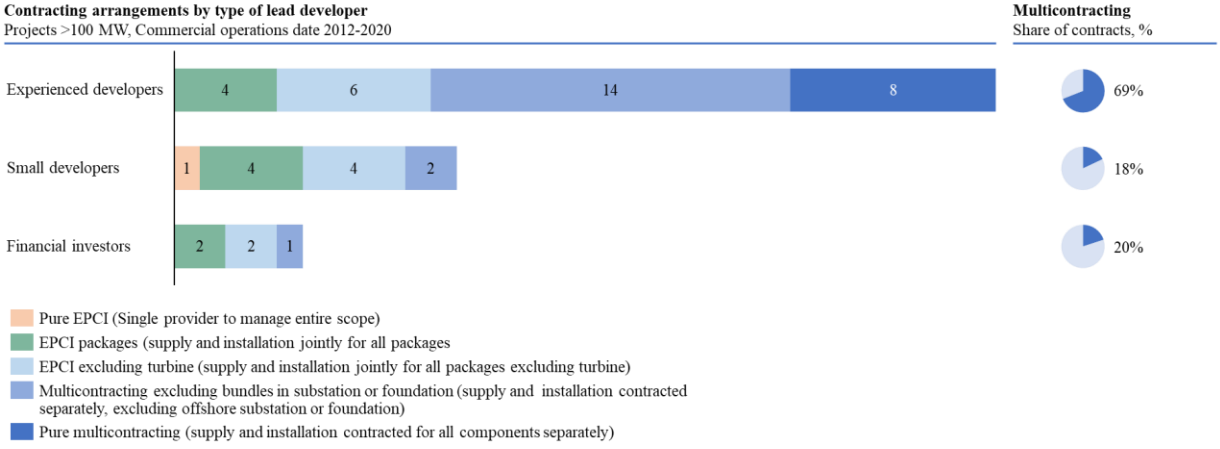
Historically, EPCI contractors have played a pivotal role in the development of offshore wind projects, particularly as wind farms have grown in size and complexity. In the early stages of offshore wind development, projects were relatively small, and companies with onshore wind expertise could manage the installation of offshore turbines. However, the increasing scale and intricacy of wind farms have necessitated the involvement of EPCI contractors with specialized knowledge. As a result, several renowned EPCI contractors from the O&G sector have expanded into the offshore wind sector, capitalizing on their expertise in project management, engineering, and construction (Loos, et al., 2021).

The rapid expansion of the offshore wind sector and the synergies between the O&G and offshore wind sector have enticed major O&G companies to enter the offshore wind sector (Aponte, et al., 2021). For instance, Saipem, a traditional O&G EPCI contractor, ventured into offshore wind in 2019 by acquiring the vessel and renewable energy installation company Naval Energies (Saipem, 2023). Boskalis, Jan De Nul, and Van Oord are other examples of companies that have diversified from dredging, land reclamation, and offshore engineering into offering end-to-end EPCI solutions for offshore wind.

T&I contractors have also significantly contributed to the development of offshore wind projects by providing specialized transportation and logistics services for moving and installing turbines and other components. As the need for specialized vessels capable of transporting and installing turbines and foundations has grown, so has the demand for such services. Companies like Cadeler, Fred Olsen Windcarriers, and Eneti possess specialized knowledge of deploying and operating vessels, cranes, and other equipment, making them highly sought after in the industry. These companies are further in demand as some developers prefer the flexibility of working with T&I contractors instead of committing to a full EPCI contract (Catapult, 2023).

The choice between EPCI and T&I contractors largely depends on the developer's strategy, as both types of contractors have their advantages and drawbacks. Securing offshore wind capacity is typically the initial step in a lengthy process, with the subsequent phases involving the effective execution of EPCI processes to achieve the cost targets established during the auction strategy. For instance, in a full EPCI model, the developer contracts both supply and installation for each group of components, while in multi-contracting, the developer contracts out supply and installation separately for all components.

Figure 16: Contracting arrangements by type of lead developer



Source: Own creation based on data from 4C Offshore (2022)
Note: Less common ownership structures such as developers and installation companies, developers and municipality, etc. are excluded. Split between experienced and small developers is based on track record

Different developer categories have historically exhibited distinct preferences for contracting arrangements. Experienced developers have demonstrated a stronger inclination towards multi-contracting, as seen in their use of multi-contracting excluding bundles in substation or foundation, and pure multi-contracting. This preference suggests that experienced developers tend to leverage their in-depth understanding of the offshore wind supply chain and strong in-house project execution capabilities to optimize costs and manage risks through multi-contracting strategies.

In mature markets, experienced offshore wind developers have often achieved cost advantages using a multi-contracting approach, procuring key components or packages directly from suppliers and managing installation separately. However, this strategy has been attributed to having a comprehensive understanding of the offshore wind supply chain, good availability of supply and installation resources, and strong in-house project execution capabilities. Moreover, not all local markets provide the supplier landscape necessary to contract out in packages using this strategy (Mckinsey, 2022).

In contrast, small developers have shown a more balanced distribution between multi-contracting and alternative EPCI approaches. Notably, they have not employed the pure multi-contracting strategy, which implies that small developers may be more cautious when adopting multi-contracting strategies due to their limited experience and resources. Financial investors have generally demonstrated a preference for alternative EPCI approaches over multi-contracting. They have primarily opted for EPCI packages and EPCI excluding turbines.

Risk distribution among developers and contractors

The allocation of financial and operational risks between developers and contractors in offshore wind projects has a considerable impact on the development of the T&I industry. In Europe, where multi-contracting is favored by developers, T&I firms are incentivized to deliver more slim project scopes, thus taking on a smaller share of risks and potentially realizing higher profit margins. However, this risk-sharing model can result in squeezed margins for developers, who bear the brunt of the risk associated with contractors' inability to deliver on specific project scopes (Appendix 1: COP). This risk has been increasingly evident in the financials of developers as they have seen declining returns. Across the six largest European renewables developers, the average EBITDA margin was 13% in 2022, which was down from 20% and 27% in 2021 and 2020, respectively (Appendix 11), reflecting the increasing pressure on developers.

As the supply chain for components such as turbines, cables, and vessels approach capacity (Appendix 1: COP, CIP, Clarksons, Cadeler), developers face increasing potential financial liabilities, due to increased risk of suppliers' inability to deliver on their scopes, which can hinder the overall growth and development of the industry. This growing strain on the supply chain has led some developers to consider alternative strategies, such as procuring for multiple projects at once and engaging partners and assets on a longer-term portfolio basis. For instance, one installation vessel could be contracted to a multitude of wind farm projects from the same developer, thereby distributing risks across a broader portfolio (Appendix 1: COP). While this approach can alleviate some pressure on individual projects, it can introduce new risks, such as the potential for a domino effect if one project fails, impacting the entire pipeline (ibid).

The evolving landscape of offshore wind projects demands a careful balance between the interests of developers and T&I contractors. As Harder from Cadeler emphasizes, it is essential for both parties to understand the symbiotic nature of their relationship, as overly onerous demands from one side could undermine the viability of the entire industry (Appendix 1: Cadeler). Achieving this balance requires T&I firms to consider their optimal position within the supply chain and determine the appropriate level of risk that supports the broader goals of the green transition while maintaining profitability and industry growth.

Risk-sharing arrangements between developers and contractors can either inhibit or enhance the development of the T&I industry, depending on the balance of financial and operational risks assumed by each party. Ensuring the sustainable growth of the industry requires careful consideration of risk allocation, as well as a commitment to fostering mutually beneficial relationships that support the broader goals of the green energy transition (Appendix 1: Cadeler).

Government & Regulation

Government & Regulation will, as mentioned, be incorporated as a fifth factor in the Diamond Model. The focus will be on two crucial aspects: political goals and targets for offshore wind capacity, as well as incentives and subsidies available for offshore wind farm projects.

European 2030 target ambitions

The European Union has established ambitious renewable energy targets to address climate change and reduce greenhouse gas emissions, as detailed in its Renewable Energy Directive (RED) and the Clean Energy for All Europeans package. The EU's Fit-for-55 package raises the 2030 target for gross final energy consumption from renewable sources to 40%, while the REpowerEU initiative further increases the European renewables target for 2030 to 45%. In addition to the overarching renewable energy targets, the EU's 2030 Climate and Energy Framework sets specific targets for the deployment of offshore wind energy, aiming to achieve at least 59 GW of installed capacity in European waters by 2030. Alongside these EU-wide ambitions, individual European countries have also established their own 2030 targets, as detailed in Table 2 below.

Table 2: Government targets for offshore wind energy by 2030 (GW)

Country	UK	Germany	Netherland	Denmark	France	Poland	Belgium	Ireland	Other*
Target (GW)	50.0	30.0	21.0	10.0	6.8	5.9	5.8	5.0	12.1

Source: Own creation based on information provided by WindEurope (2022)
*(*Other: Greece, Italy, Lithuania, Norway, Romania, Spain)*

This paper adopts a total European 2030 capacity target for offshore wind power of 146.6 GW, based on the individual national targets showcased in Table 2. By subtracting the existing European capacity of 30.3 GW, a capacity addition target of 116.3 GW for Europe by 2030 is obtained, which will be the capacity addition examined to address this paper's research question.

Overall, the commitment of EU and non-EU European countries to transition to a low-carbon, sustainable energy system is reflected in their renewable energy targets and ambitions. The EU's policies and initiatives to promote renewable energy are expected to have a significant impact on the energy sector and its transition towards a low-carbon economy, particularly for offshore wind energy, which is a key component of the EU's renewable energy strategy (European Commission, 2020).

Support and incentive schemes

In pursuit of its ambitious targets, the EU has established several support and incentive programs to promote the development of renewable energy sources, including offshore wind. Projects like offshore wind farms can leverage a range of subsidies and incentives to attain financial viability and long-term revenue stability. These measures include feed-in tariffs, investment grants, green certificates, tax incentives, and competitive tenders, among others. The following section will delve deeper into the most significant.

Competitive offshore wind tenders

The competitive tender process is a mechanism used to award contracts for the construction and operation of offshore wind farms. The process typically involves a government or another authority inviting bids from developers to establish an offshore wind farm, with the contract being awarded to the bidder who offers the lowest price for electricity generation (EENA, 2019). The process is designed to promote competition and ensure that the development of offshore wind projects is done at the lowest possible cost. The competitive tender process is used by many European countries, including the UK, Germany, the Netherlands, and Denmark.

There are three distinct types of wind farm projects within the competitive tender process: development projects, lease auctions, and centralized auctions. Development projects involve developers taking on the responsibility of project initiation and management, while lease auctions require developers to purchase the rights to a specific area and assume responsibility for its development. Centralized auctions are characterized by the government managing the project development, reducing the uncertainties faced by developers (Appendix 1: CIP).

Presenting alternative ways to develop a wind farm, these three project types ensure a diverse range of opportunities for developers, catering to various risk profiles and expected returns. The tender process includes several stages, including pre-qualification, where interested bidders submit information about their technical and financial capabilities, and a bidding stage where eligible bidders submit their final proposals. These proposals typically include detailed information about the wind farm's design, the expected energy production, and the proposed price for electricity generation (European Commission, 2023).

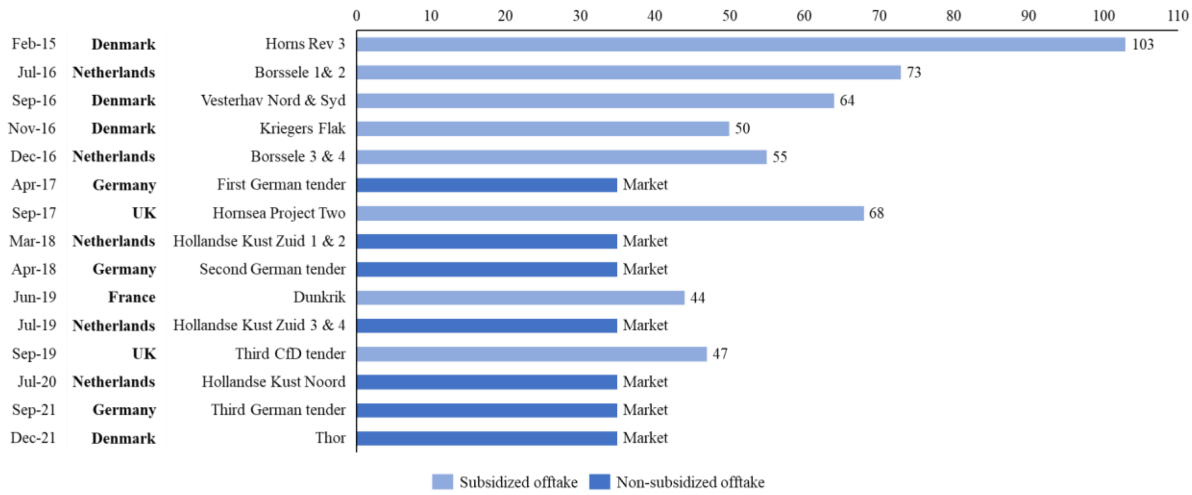
The competitive tender process is widely regarded as an effective way to encourage cost-effective development of offshore wind energy. Furthermore, it promotes competition and drives innovation in the industry by incentivizing companies to develop more efficient and cost-effective solutions to meet the growing demand for renewable energy (EENA, 2019; Jacobsen, Hevia-Koch, & Wolter, 2019).

However, permitting bottlenecks have been a significant barrier to wind energy expansion in Europe, with complexities in the offshore wind tender process constraining project development. These delays hinder progress and hamper investment in offshore wind power development (GWEC, 2023). The challenges stem from a multi-layered decision-making process involving different institutions and the need to secure permits from various levels of government. Developers often face opposition from stakeholders such as fishing organizations, conservation societies, and local residents, which exacerbates delays. Legal disputes and an imbalance between conservation and renewable development interests add to the complexity (WindEurope, 2023).

European governmental bodies are actively working to address permitting bottlenecks through the implementation of new REPowerEU rules, which are expected to streamline the process. However, investments in new wind farms declined in 2022, with Europe announcing 17 bn EUR of new investments, which was less than half the amount invested in 2021, and no large-scale offshore wind farm reached a final investment decision in 2022. Factors such as high inflation in input costs and unhelpful market interventions by national governments have undermined investor confidence (ibid).

The competitive tender process has evolved over time, with initial winning bids being awarded to the bidder offering the lowest price for electricity generation, thus requiring the least amount of subsidy from the government. However, as the offshore wind industry has matured and technological advancements have reduced the cost of generating electricity, the economics of these projects improved substantially. This progress has led to some developers being able to submit zero-subsidy bids for contracts to construct and operate offshore wind farms.

Figure 17: Recent offshore wind tenders in Europe and winning bids (€/MWh)



Source: Own creation based on information from McKinsey (2022) and WindEurope (2022)

For example, in 2018, the Dutch government awarded a contract for the construction and operation of the Hollandse Kust Zuid 1 & 2 offshore wind farm to a consortium led by Swedish utility company Vattenfall. The bid was a zero-subsidy offer, meaning that the consortium would not receive any government subsidies for the project. More recently, RWE Renewables, a German utility company, was awarded the contract for the THOR offshore wind park in Denmark. Notably, RWE's final bid was not only subsidy-free but also included an obligation to make payments totaling DKK 2.8 billion to the Danish state (Falbe-Hansen & Andersen, 2021; Frandsen, 2022). This demonstrates a novel approach to the financial arrangements for offshore wind projects, where the developer assumes the responsibility for supporting the project costs and makes payments to the government, as opposed to receiving subsidies.

Financial support

The EU not only offers guidelines for the competitive tender process and sets ambitious targets for renewable energy, but also provides a range of support mechanisms. These mechanisms include schemes that developers can utilize to secure funding. For instance, the EU provides funding for research and development through programs like Horizon Europe and EU Innovation Council with 25 billion EUR of grants to be deployed by 2027, which aim to support the advancement of new technologies, reduce costs, and enhance the efficiency of offshore wind (European Commission, 2023).

Furthermore, financial support for offshore wind farm projects can be accessed through institutions such as the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), which work towards facilitating access to capital, mainly through debt, and mitigating financial risks (ibid).

In addition to EU-level support, there are also various national-level financial support structures available to offshore wind developers and projects, which vary depending on the specific policies and regulations of each country. These incentives include a range of policy instruments, such as feed-in tariffs, Contracts for Difference, tax incentives, and grants. Feed-in tariffs, for example, provide a guaranteed price for electricity generated from offshore wind farms. In some cases, governments may also offer tax incentives to offshore wind developers, such as lowering tax rates or providing tax credits, as a means of further supporting their projects. However, as evident from Figure 17 these financial mechanisms are employed less and less.

In summary, it becomes evident that the EU has put in place a comprehensive framework of support and incentive schemes to foster the development of renewable energy and assist Member States in achieving their ambitious renewable energy targets. This framework includes general guidelines for the competitive tender process used by many European countries to award contracts for offshore wind farms. However, permitting bottlenecks, stemming from complex decision-making processes and opposition from various stakeholders, have hindered the progress of offshore wind projects. In addition to addressing permitting obstacles, the EU provides financial support mechanisms through various programs and institutions to promote renewable energy development, aiming to promote environmental sustainability and social acceptance of renewable energy projects throughout the region.

Sub conclusion to i. How has the European offshore wind T&I industry developed from 2018-2022?

Tracing the development of the European offshore wind T&I industry from 2018 to 2022, the analysis displays the profound changes and the diverse influences that have collectively fueled its growth and competitiveness.

Factor conditions, such as the availability of vessels and capital constraints, have significantly steered the industry's trajectory. A rise in offshore vessel delivery in the early 2000s was followed by an oversupply of offshore O&G vessels after 2014, due to falling oil prices. These vessels were converted for wind T&I, contributing to a fleet capable of supporting offshore wind projects. However, the analysis uncovered the challenges related to shipyard capacity and the financial risks associated with the increasing sizes of turbines and foundations. Furthermore, the downturn in the global order book for offshore wind installation vessels from 2010 to 2018 experienced a reversal, peaking around 2022, which coincided with increased vessel prices.

Demand conditions evolved significantly from 2018 to 2022, with Europe's cumulative capacity escalating from 18.8 GW in 2018 to 30.3 GW in 2022. The increasing size of turbines and foundations has driven the need for new and upgraded vessels capable of handling these components. Despite this, the analysis underscores the constraints of these response mechanisms in addressing evolving market dynamics and demand fluctuations, owing to lengthy construction times for new vessels.

Related and supporting industries have played a pivotal role in fostering the industry's development. Evidence suggest that countries with firmly established medium- and high-tech manufacturing industries, such as Germany, Denmark, and the UK, have cultivated robust offshore wind sectors, thereby promoting a rapid expansion of the industry within these European nations. However, this strong competitiveness might experience a reversal, given the emerging strain on the offshore wind supply chain.

Government and regulation have been influential factors in the industry's growth. The ambitious targets set forth by the EU and individual European countries have accelerated the deployment of offshore wind energy. These national-level targets result in a cumulative capacity addition target of 116 GW for Europe by 2030. Furthermore, the analysis reveals the role of competitive tenders and financial support in fostering industry development and reducing the cost of offshore wind electricity generation. However, the sector continues to grapple with divergent and complex tender processes, which ultimately affect the T&I industry, due to difficulties in delivering their services efficiently.

In summary, this investigation into the historic development of European offshore wind T&I industry offers an in-depth understanding of its growth and provides a solid foundation for understanding its future trajectory.

Performance Analysis of Cadeler and Peers

This section seeks to examine the performance of Cadeler in comparison to its relevant peers, Eneti, Seaway 7, and Fred Olsen Windcarrier (FOWIC). Referring back to the Firm Strategy, Structure & Rivalry section, these firms are deemed relevant as peers due to their similar focused scope within T&I services, except Seaway 7 who is an EPCI contractor, although only exposed to offshore wind. The other identified companies offering T&I services are exposed to other industries and sectors, such as O&G, hence, the comparability of performance will not provide relevant insights.

The analysis will focus on key performance measures such as operational performance, operating profitability, and key financial ratios. Initially, the operational performance of each company will be examined by assessing their historical track record and future pipeline of projects, offering insights into their strategic focus areas. Subsequently, each company's financial performance will be analyzed using EBITDA, ROA, ROE, the current ratio, and the debt-to-assets ratio. These metrics serve as critical indicators of the effectiveness of their chosen strategies and their ability to capitalize on existing capabilities. Findings from both sections will provide insights into the companies' ability to gain a competitive advantage in the market (Nijssen & Frambach, 2001). Figure 18 below presents an overview of each company within the investigated peer group.

Figure 18: Overview of Cadeler and peer group

	CADELER	seaway7	ENETI	Fred. Olsen
Founded	2008	2006 (2021)	2014 (2021)	2008
Public vs Private	Oslo Stock exchange	Oslo Stock exchange	NYSE stock exchange	Private
Main shareholder/owner	BW Group (~30%)	Subsea 7 Blue Space Ltd (~72%)	Scorpio Holding Ltd (~27%)	Bonheur ASA
Headquarter	Copenhagen, Denmark	Oslo, Norway	Monaco, Monaco	Oslo, Norway
# of vessels	2	12	5	3
# of employees	~228	~565	~276	~250
Contractor	Focused T&I	Focused EPCI	Focused T&I	Focused T&I

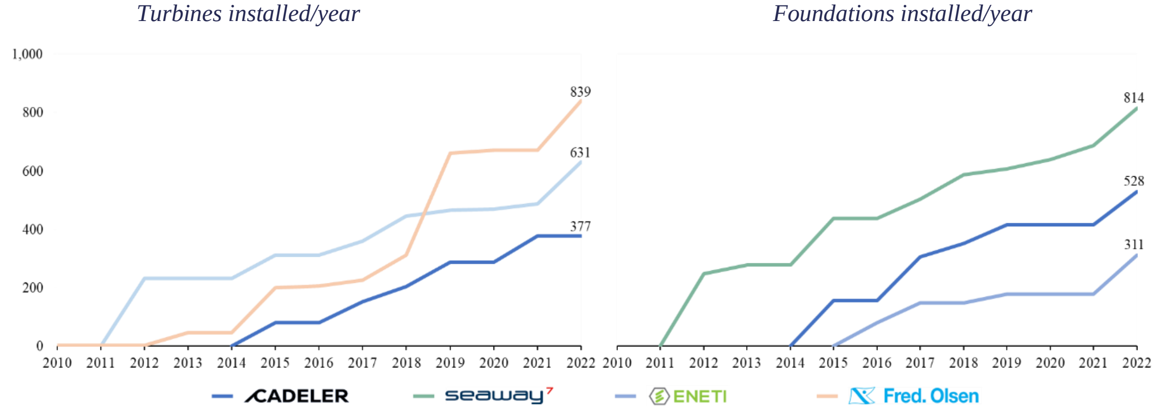
Source: Own creation based on information derived from company websites & presentations

Operational performance

Project track record

The following graphs display the project track record of Cadeler and the identified peer group, denoting the total number of turbines and foundations installed as of the end of 2022.

Figure 19: Peer group track record, 2010-2022



Source: Own creation based on information derived from Jefferies (2022)

Figure 19 highlights the varying strategic focuses within the peer group. FOWIC stands out as the most experienced turbine installer, having installed 839 turbines by 2022, which is 208 more than the runner-up Eneti. FOWIC has strategically positioned itself as a pure-play turbine installer and is as a result yet to install a single foundation.

Through the acquisition of Seajacks, Eneti has successfully leveraged the company's extensive experience in both turbine and foundation installation. Consequently, Eneti boasts the second most comprehensive track record within the group, having installed 631 wind turbines. Moreover, as of 2022, Eneti ranks third among the investigated companies for the total number of foundations installed, with 311 installations to its name.

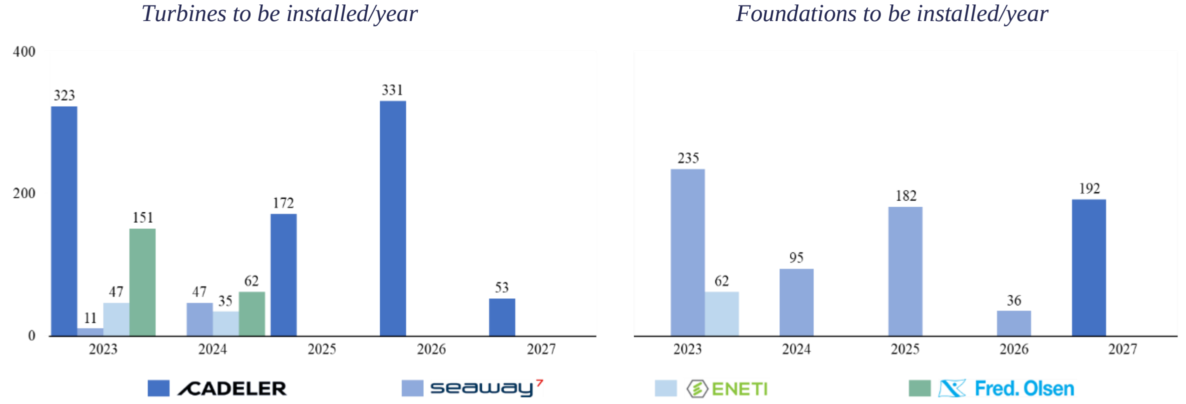
The graphs clearly display Seaway 7's historic focus on providing solutions for bottom-fixed offshore wind farms including foundations (Seaway 7, 2023). Furthermore, due to the current limitations of its vessels incapable of installing wind turbines, Seaway 7 has no turbine installations in its track record. However, Seaway 7's emphasis on foundation installation has made it the most experienced company within the group, with 814 foundations installed as of 2022. This expertise aligns with the current composition of its fleet, consisting of three vessels capable of providing foundation installation services.

Cadeler has maintained a diverse strategic focus over time, as evidenced by its experience in both turbine and foundation installation. As of 2022, the company has installed 377 wind turbines and 528 foundations. Cadeler's commitment to both markets underscores its objective and strategic focus on providing flexibility to its customers and fostering strong partnerships (Appendix 1: Cadeler).

Project backlog

The following chart display the project backlog of the peer group, denoting the total number of turbines and foundations in the pipeline, as of the end of 2022, and the scheduled installation year.

Figure 20: Peer group backlog:



Source: Own creation based on information derived from Jefferies (2022)

The data establishes Cadeler as the front-runner in terms of projects announced, with the largest pipeline among the group, which reflects the strong trust and relationships that the company claims to have cultivated with customers in recent years (Appendix 1: Cadeler). Cadeler has a backlog of 879 turbines and 192 foundations scheduled for installation up until 2027. This ongoing commitment to serving both markets aligns with the company's philosophy of providing flexibility to its customers. The company's new building program further underscores this, as both F-class vessels will have the versatility to serve both markets. The company’s pipeline does, however, suggest a strategic emphasis on wind turbine installation moving forward, potentially due to the perception that these projects involve less risk, require fewer components, and a smaller team, ultimately yielding higher profit margins (Appendix 1: Cadeler).

The graph further reveals Seaway 7’s entry into the turbine installation space. The company is set to receive its first WTIV in 2023 and has already secured contracts for the installation of 11 turbines in 2023 and 47 in 2024. The introduction of the WTIV Seaway Venture, scheduled for delivery in 2023, aligns with the company’s goal of offering a range of services tailored to specific client needs, as the company is currently unable to provide this service and hence has to source contractors to do so if needed (Seaway 7, 2023). However, the foundation space will remain the company’s primary focus in the coming years, with 548 foundations in the pipeline through 2026 and an additional Heavy Lift Vessel capable of installing foundations, Seaway Alfa Lift, currently under construction.

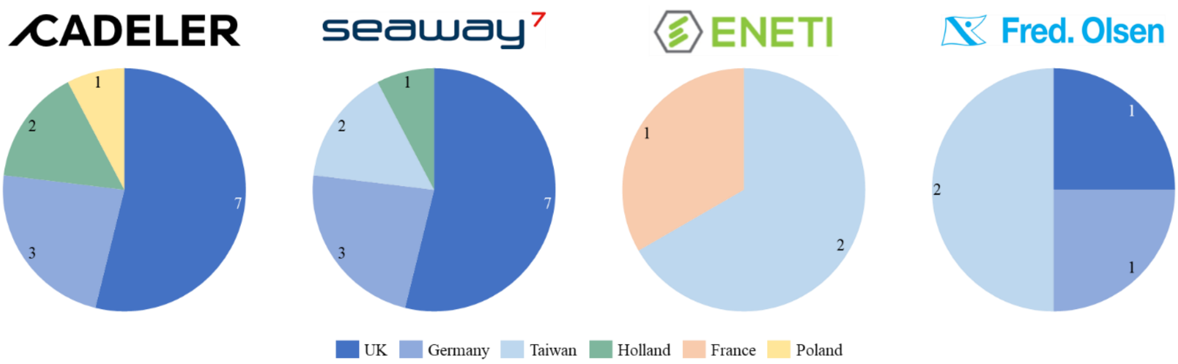
Eneti’s diversified strategic focus will remain intact in the coming years, as the company has a backlog of 62 foundations and 82 turbines scheduled for delivery for installation through 2023 and 2024, respectively. Finally, the data demonstrates FOWIC’s continued commitment to being a pure-play turbine installer as it has an additional 213 turbines in its pipeline through 2023 and no foundations.

Geographic distribution of backlog

In the offshore T&I industry, companies' revenue primarily hinges on the terms of short-term and potential multi-year time charter contracts for wind farm installation projects. These contracts, subject to various terms and conditions, such as cancellation events, termination, amendments, and delays, can limit, delay, or prevent revenue altogether (Alizadeh & Nomikos, 2009). Factors like inflation, rising interest rates, and political risk affect project feasibility, posing significant implications for offshore T&I companies as their project backlog may be at risk if developers decide to abandon their offshore wind projects.

The surge in wind turbine prices, driven by inflation, and higher financing costs due to rising interest rates are jeopardizing some of the wind project auctions won in recent years. This is mainly because of the difficulties in delivering these projects at the previously agreed-upon prices (Thomas, 2023; Appendix 1: Clarksons). A clear example of this is the political disputes in the UK over a stimulus package for the Hornsea 3 project, which have put Cadeler's contract with Ørsted at risk. If the project is canceled, Cadeler stands to lose potential operating earnings of EUR 49-55 million in 2026 (Holmstad, 2023). Understanding the geographic distribution of offshore T&I companies' backlog can, therefore, provide valuable insights into the riskiness of their future revenue streams, as well as their geographic focus moving forward.

Figure 21: Geographic distribution of pipeline (turbines & foundations)



Source: Own creation based on data from (Jeffries, 2022)

Figure 21 illustrates the geographic distribution of the project pipeline as of 2022 for the peer group. The companies vary in the number and timing of their projects. Cadeler and Seaway 7 have the largest backlog, with projects extending into 2027 and 2026, respectively. Eneti and FOWIC have only three and four T&I projects confirmed, set for delivery in 2024 (Appendix 5).

It is apparent from Figure 21 that Cadeler's strategic focus remains on the European market, as all its projects are located in this region. This aligns with Cadeler's extensive experience and strong presence in the European market, where most of its key clients and projects are based (Appendix 1: Cadeler).

Concentrating its portfolio in this region helps mitigate operational risks, as the company is familiar with the local conditions. Moreover, having projects in the same region minimizes project transitions, reducing time wastage and expenses as the vessels need to sail less, leading to decreased wear and tear, and overall cost savings (ibid).

The UK and Germany are ranked 5th and 6th, respectively, out of 40 countries investigated in the latest Renewable Energy Country Attractiveness Index (RECAI) report published by EY in 2022. The RECAI provides an assessment of the investment attractiveness of different countries for renewable energy projects, considering a range of factors that affect the development and deployment of renewable energy technologies, including policies, regulations, infrastructure, and natural resources (Warren & Giovanni, 2022). The rankings of the UK and Germany underscore their commitment to renewable energy, well-established regulatory framework, and favorable investment climate. These factors, along with the strong national ambitions highlighted previously, help secure Cadeler's pipeline as projects are unlikely to be scrapped given the robust support for renewable energy.

In contrast, Taiwan ranks 30th in the RECAI despite having a strong potential for renewable energy, especially offshore wind. This is due to the difficulty in navigating the country's regulatory environment, particularly for foreign investors (Warren & Giovanni, 2022). Taiwan's offshore wind industry is also in its infant stages which increases the risk of doing business here even further (Appendix 1: COP). The ongoing political tensions between Taiwan and China further heighten the uncertainty and risk, as geopolitical risks have been shown to potentially constrain the development of offshore wind energy (Aswani, Sajith, & Bhat, 2021). Consequently, the pipelines of Eneti, Seaway 7, and FOWIC may be considered riskier than Cadeler's due to their exposure to Taiwan.

However, Taiwan's political stability is higher than both the UK and Germany, according to the World Banks Political Stability Index. The index is based on several factors such as the likelihood of political instability, government effectiveness, corruption, and the risk of violence or civil unrest (Kaufmann, Kraay, & Mastruzzi, 2010). Taiwan ranks 50th closely followed by Germany at 52, whereas the UK ranks significantly lower at 68 (World Bank, 2023). Taiwan's high ranking can be attributed to several factors, including the broad support of the ruling Democratic Progressive Party (DPP), the well-established democratic system, and the relatively low level of political violence or civil unrest (EIU, 2023).

The UK has, on the other hand, faced significant political instability in recent years due to Brexit-related issues, fractures within the ruling Conservative Party, and public discontent with the condition of public services, among other things (EIU, 2023). Germany's ranking is influenced by the rising political polarization, increasing anti-immigrant sentiment, and the departure of Angela Merkel after 16 years in power (EIU, 2023). Both the UK and Germany have furthermore experienced political protests and occasional violent incidents, which contribute to a lower ranking in terms of political stability.

Despite the higher political stability in Taiwan, the pipelines of Cadeler and Seaway 7 are still considered more secure than those of Eneti and FOWIC, which are concentrated in Taiwan. Due to the maturity of the European offshore wind industry and its strong offshore wind ambitions. Seaway 7's recent operational challenges in Taiwan further underscore this point, as the company has faced delays and project disruptions (Seaway 7, 2023). These challenges will be further discussed in the upcoming section.

In conclusion, the analyzed companies display significant differences in their track records and order backlog, with Cadeler emerging as a prominent industry leader backed by a strong track record and a substantial pipeline of projects focused on the European market. FOWIC and Cadeler demonstrate a robust strategic focus on wind turbine installation, while Seaway 7 excels in foundation installation. Eneti has a more diversified project track record and backlog following the acquisition of Seajacks.

The analysis further underscores the stability and security of future projects in Europe, highlighted by the region's political stability and commitment to renewable energy. In contrast, the offshore wind industry in Taiwan faces challenges due to a cumbersome regulatory environment and geopolitical tensions with China. These challenges combined with Cadeler's experience and familiarity with Europe reasons why their future revenue streams are considered the most secure among the peer group.

Financial performance

Operating profits

Figure 22 presents the Revenue, OPEX, EBITDA, and EBITDA margin for the peer group during the fiscal years 2021 and 2022. However, 2022 data for FOWIC is not publicly available.

Figure 22: EBITDA

	CADELER		seaway7		ENETI		Fred. Olsen	
mUSD	*2021*	*2022*	*2021*	*2022*	*2021*	*2022*	*2021*	*2022*
Revenue	72	112	1260	1119	144	199	139	n/a
OPEX	40	46	1246	1101	138	121	77	n/a
EBITDA	32	66	14	18	6	79	62	n/a
EBITDA margin	45%	59%	1%	2%	4%	40%	45%	n/a

Source: Own creation based on data derived from Capital IQ

The financial performance of the peer group during 2021 and 2022 reveals an increasingly competitive market landscape, with players showcasing varying degrees of profitability and growth. Cadeler has emerged as a dominant player in the industry, demonstrating impressive operating profitability with the highest EBITDA margin across the period. The company achieved a 45% margin in 2021 and continued to expand, reaching an outstanding 59% margin in 2022.

Similarly, FOWIC established itself as a dominant player in the industry, reporting EBITDA margins comparable to Cadeler, with 45% in 2021. Moreover, FOWIC recorded USD 30m higher total EBITDA than Cadeler, solidifying its position as a leading force in the industry. A primary factor contributing to FOWIC's higher EBITDA figures is its more extensive fleet of three vessels compared to Cadeler's two. This larger fleet allows FOWIC to undertake multiple projects simultaneously, leading to increased revenue generation. These figures illustrate the strength of both Cadeler and FOWIC in the market, substantially outpacing their peers during the period analyzed.

Analyzing the performance across T&I firms and EPCI contractors, T&I firms reported larger EBITDA margins in 2021-2022, with T&I firms achieving an average margin of 39%, while EPCI contractors recorded an average margin of 5%. Only two EPCI contractors, DEME and Jan De Nul, reported EBITDA margins above 10% (Appendix 9).

The success of Cadeler and FOWIC in establishing themselves as dominant players in the industry reinforces the notion put forth by various industry experts, who emphasize the importance of partnerships and expertise as differentiating factors in the industry (Appendix 1: Cadeler, Naver Energy, Ørsted). While experts acknowledge price as the primary factor influencing developers' decisions when choosing T&I firms, partnership and expertise rank as close seconds. Cadeler and FOWIC, both emerging in 2008, are the most established players in the industry. The companies have evidently managed to forge strong relationships with developers and optimize installation processes, ultimately leading to higher EBITDA margins.

The data further underscores that Seaway 7 and Eneti have grappled with substantially lower levels of profitability compared to their peers. Seaway 7 reported EBITDA margins of a mere 1% and 2%, while Eneti posted 4% in 2021 and a more substantial 40% in 2022. Eneti's low margins in 2021 can primarily be attributed to its involvement in the dry bulk shipping segment until August of that year. This involvement resulted in additional expenses for the company, such as charter hire and voyage-related expenses. Charter hire expenses involve the cost of leasing a vessel, while voyage-related expenses encompass expenses incurred during a specific voyage (Alizadeh & Nomikos, 2009). These expenses fall under the category of operating expenses and contributed to higher overall costs compared to the following year.

However, it is crucial to note that Eneti no longer incurs charter hire expenses, as the company now owns its entire fleet after divesting from the dry bulk segment. Furthermore, voyage-related expenses are typically reimbursed by the developer under the contract agreement within the offshore T&I

industry, rendering them inapplicable for Eneti. The company's overall OPEX is now primarily driven by vessel operating expenses, which are ongoing expenses incurred by the vessel owner regardless of whether the vessel is under contract or not. Eneti's improved operating profitability in 2022 is further a result of the favorable market conditions within the offshore wind T&I industry, as the company’s revenue grew 38% year-on-year.

The data further underscores the improving market conditions in the offshore wind T&I industry, as all companies, except Seaway 7, reported increased earnings from 2021 to 2022. Among the various factors influencing the revenue of T&I firms, the overall rise in revenue can largely be ascribed to an increase in vessel utilization across the companies' fleets in conjunction with the 32% uptick in day rates that the offshore market has observed since 2021 (Gordon, 2022).

For example, Cadeler's substantial revenue growth can be attributed to a 10% rise in vessel utilization from 2021 to 2022 (Cadeler, 2023). Similarly, Eneti reported enhanced utilization across all three of its vessels during this period (Eneti Inc., 2023). The escalating day rates, associated with tightening market conditions and clients' concerns regarding the availability of adequate WTIV and FIV capacity to complete projects, further contributed to the revenue growth (Fremming, 2023).

Despite experiencing a similar increase in vessel utilization, from 70% to 76% during the period (Seaway 7, 2023), Seaway 7 was unable to capitalize on this and boost revenue as its competitors did. Instead, the company faced an 11% decline in revenue, primarily due to the company's current project portfolio, which was tendered during a period of heightened competition from new market entrants, resulting in a skewed risk-reward balance (ibid). The operational challenges encountered by Seaway 7 will be further explored in the subsequent section.

Financial ratios

Figure 23 below illustrates the selected financial ratios for the peer group, based on the financial data available for the years 2021 and 2022.

Figure 23: Financial ratios

	CADELER		seaway7		ENETI		Fred. Olsen	
	2021	*2022*	*2021*	*2022*	*2021*	*2022*	*2021*	*2022*
ROA	1,8%	5,2%	-4,5%	-5,9%	2,5%	13,0%	4,0%	n/a
ROE	2,4%	6,5%	-7,2%	-8,2%	3,3%	14,8%	6,7%	n/a
Current Ratio	0,46	5,04	0,70	0,78	1,45	3,87	0,82	n/a
Debt-to-assets	17,3%	17,2%	9,2%	10,1%	17,7%	8,2%	26,0%	n/a

Source: Own creation based on data derived from Capital IQ

The financial ratios shed light on the relative immaturity of the offshore wind T&I industry, as companies vary greatly in the returns generated relative to their assets and equity base. However, better market conditions in 2022 compared to 2021 have allowed some companies to showcase improvements. A drastic change in the asset base of all peer group companies, apart from FOWIC has marked the entry and establishment of the T&I industry. Cadeler increased its assets in 2021 and 2022 by 17% and 48%, respectively, while Eneti sold off assets in 2020 and stabilized around 800m USD assets, which amounts to half of what they had the year prior. Seaway 7 doubled its assets from 2020 to 2021.

Eneti showcased the most significant change in its reported figures across the peer group, increasing its ROA by 10.5% and ROE by 11.5%. This highlights the company's successful transition from the dry bulk shipping segment. Cadeler also demonstrated improvements, with ROA rising from 1.8% to 5.2% and ROE increasing from 2.4% to 6.5%. The company's asset base grew by 48% from 2021 to 2022, driven by the down payment for two new F-class vessels under construction (Cadeler, 2023). The 56% improvement in revenue helped offset the increased asset base leading to an improved ROA.

In contrast, Seaway 7 faced challenges in generating sufficient profits relative to its assets and equity, as indicated by negative ratios for both years. Seaway 7's involvement in the wider offshore wind supply chain makes it more susceptible to external factors and market dynamics. Although their project portfolio and services allow for diversification, they also increase the company's reliance on specific projects.

Seaway 7's wider geographic exposure, particularly in Taiwanese projects, adversely affected its performance due to unfavorable site conditions and delays, resulting in higher costs. The company's broader engagement in the offshore wind supply chain also elevates its risk profile compared to its peers, exposing it to a more comprehensive range of project-related risks. Evidently, Seaway 7's performance suffered in both years due to slower-than-anticipated progress on Hornsea 2 and Hollandse Kust Zuid projects, for which Seaway 7 manages the larger project scope including the transport and installation of inter-array cables and foundations. Delays in Seaway Alfa Lift's new build program further compounded these issues, as Seaway Strashnov had to stand in on the Dogger Bank projects in the UK, leading to additional expenses, including mobilization costs from another site (Seaway 7, 2022; 2023).

FOWIC reported the highest ROA and ROE among the peer group in 2021, at 4.0% and 6.7%, indicating efficient utilization of assets and equity investments to generate returns. This superior performance can be partially attributed to FOWIC's strategic approach to its asset base. Rather than pursuing new builds, the company has effectively leveraged its existing fleet and organizational resources to optimize operations, leading to superior efficiency and returns.

The current ratio, which measures a company's ability to pay short-term liabilities using short-term assets, has displayed volatility among the peer group companies in the offshore wind T&I industry. Cadeler has successfully achieved a healthy current ratio in 2022 of 5.0, indicating a strong liquidity position. Eneti also shows a similar trend, consistently demonstrating a robust liquidity ratio. In contrast, Seaway 7 has persistently experienced current ratios below 1, approximately 0.75, suggesting potential liquidity risks for the company. A low current ratio may impact T&I firms' ability to meet short-term financial obligations, potentially affecting their operational efficiency and financial stability in the industry. As a result, both Eneti and Cadeler appear better positioned to fulfill their short-term obligations compared to their peers.

In the context of the offshore wind T&I industry, the peer group generally exhibits stable debt levels, averaging 16% total debt to total assets with minimal spread among the companies. This moderate level of debt allows the firms to maintain financial flexibility while pursuing growth opportunities. FOWIC holds the highest leverage ratio within the group, at 26%, indicating a higher reliance on debt financing.

EPCI contractors typically follow a similar trend in debt-to-assets, averaging 21%, which is a mere two percentage points higher than the 19% average leverage ratio of T&I firms (Appendix 9). However, EPCI contractors maintain a substantially larger asset base partly due to their broader project and service scope, with their total asset bases being seven times larger than those of T&I firms on average (ibid). This distinction highlights the varying scales of T&I firms and EPCI contractors within the offshore wind industry. The disparity in asset bases can impact the companies' ability to secure financing, manage risk, and pursue expansion strategies, ultimately shaping their competitive positions in the market.

The financial performance of the peer group in the offshore wind T&I industry reflects favorable market conditions, increased vessel utilization, and rising day rates. FOWIC and Cadeler emerged as dominant players, outperforming their peers with the highest EBITDA and operating profitability. Eneti experienced substantial improvements in its financial performance, signifying the company's successful transition from the dry bulk shipping segment. Seaway 7, however, encountered challenges, including negative financial ratios due to operational difficulties and unfavorable contract signings. Despite these challenges, 2022 was generally a better year for the peer group compared to 2021, as all companies demonstrated improvements in their financial figures, except Seaway 7.

Sub conclusion to ii. How has the T&I firm Cadeler performed relative to its peers in 2021 and 2022?

The above-conducted analysis demonstrates the distinct differences between Cadeler and its peers in terms of historical track records and future pipeline of projects. Cadeler has emerged as a leader in the industry, with a commendable track record of successfully installing numerous turbines and foundations, and a project pipeline extending until 2027, making it the longest among the group. The company's strategic focus on providing flexibility to its customers is further highlighted as it will continue servicing both markets in the years to come. However, its pipeline is heavily skewed towards the turbine space most likely due to the relative ease of servicing this market compared to the foundation space.

FOWIC has, on the other hand, established itself as a pure-play turbine installer and its pipeline suggests a continued commitment to this approach. Seaway 7 has robust foundation installation capabilities, whereas Eneti has a more diversified project portfolio following the company's acquisition of Seajacks.

The examination of the respective project pipelines also underscores the stability and security of upcoming projects in Europe, a region marked by political stability and a strong commitment to renewable energy. In contrast, the Taiwanese market, which most of the peer group faces exposure to, is challenged by a complex regulatory environment and ongoing geopolitical tensions with China. Given Cadeler's extensive experience and familiarity with the European market, combined with the aforementioned factors, the company's future revenue streams are considered the most reliable within its peer group.

Finally, the analysis reveals that Cadeler has been able to translate its dominant position into superior financial performance, demonstrating impressive operating profitability and a strong liquidity position. Eneti has successfully transitioned from the dry bulk shipping segment, displaying significant financial improvements. However, Seaway 7 faces challenges due to operational difficulties and risk-reward imbalances, resulting in poor financial performance. The relative immaturity of the offshore wind T&I industry is further highlighted, as most companies vary greatly in the returns generated relative to their assets and equity base.

It becomes evident that Cadeler distinguishes itself as a leader in the industry with a robust track record, substantial project pipeline, and secure revenue streams. Overall, Cadeler’s strategic focus, extensive experience, and familiarity with the European market have enabled the company to outperform its peers and establish itself as a reliable player in the industry.

Expected Development of the European Offshore Wind T&I Industry

Like answering the first sub-question on the historic development of the offshore wind T&I industry, we will analyze the future development for the industry through the lens of the modified Diamond Model. To ensure a clear thread through the analysis, this section will cover future demand for vessels (Demand Conditions), conditions for delivering on the demand for T&I vessels (Factor Conditions), development in the global industrial supply chain for the offshore wind sector (Related & Support Industries), projected tenders and development in the tender process (Government & Regulation), and projected development in strategy, structure & rivalry for T&I firms (Firm Strategy, Structure & Rivalry). As the following sub-question of this paper is focused on what strategic actions T&I firms must take to meet European 2030 capacity targets, the projected development in strategy, structure & rivalry will be naturally expanded upon in the answering of the fourth sub-question.

The expected development of the T&I industry in Europe

Future demand for vessels

The future demand for offshore wind T&I vessels is expected to be influenced by a multitude of factors, as the industry adapts to new technologies and market conditions. For one, technological advancements play a crucial role in shaping the future demand for T&I vessels. As wind turbines and foundations become larger, the need for specialized vessels capable of handling these massive structures increases. This is further complicated by the lack of standardization and the industry's struggle with cost reduction pressures and the financial difficulties of turbine manufacturers and contractors. Moreover, the emergence of new technologies, such as floating foundations, has expanded the range of viable sites for offshore wind farms, thereby creating additional opportunities for T&I vessels to support the installation of wind turbines in previously inaccessible or unprofitable locations.

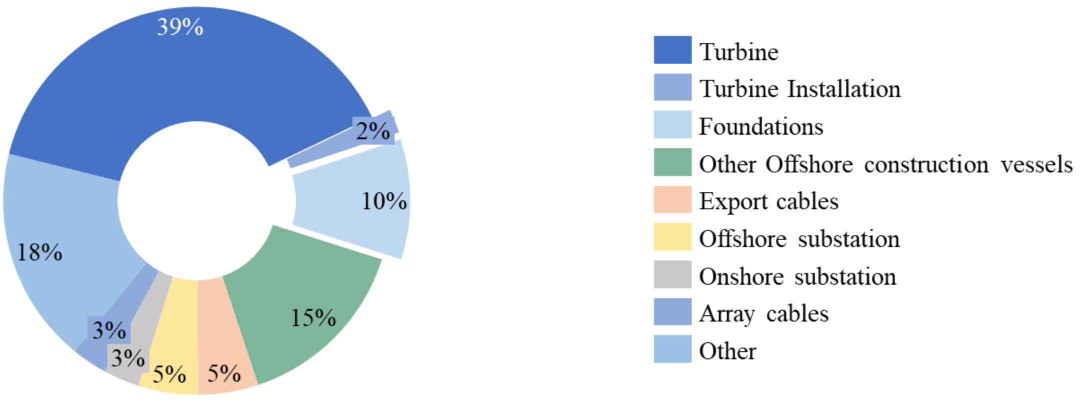
As previously highlighted, there are two primary project scopes in the offshore wind T&I industry: wind turbine installations and foundation installations. These project types exhibit significant differences in terms of complexity, profit margins, and contract values, which can greatly influence the demand for future vessels and contractors' choice of operations (Appendix 1: Cadeler; Ørsted; Naver).

Wind turbine installation projects are characterized by their relative simplicity, requiring smaller teams and involving lower risks. In this context, contractors are not responsible for logistics, engineering, or sea fastening – the process of securing equipment on the vessel to ensure stability during transport. Consequently, the value of the ship comprises 75-80% of the total contract value, with the remaining 20-25% originating from sea fastening, engineering, and related tasks (Appendix 1: Cadeler). Notably, this project type features higher profit margins, primarily due to the capital-intensive nature of the ships and the revenue they generate.

Foundation installation projects are, on the other hand, more complex, necessitating larger teams. Contractors in this area are responsible for a broader range of tasks, including harbor logistics, engineering, and sea fastening. Additional engineering capabilities are required as each project demands custom-designed sea-fastening solutions specific to that project (Appendix 1: Cadeler). In this case, the ship's value represents only 25-30% of the total contract value. Although foundation T&I projects have higher overall contract values, profit margins are lower. This outcome arises from the reliance on third parties for numerous secondary work streams resulting in smaller margins.

The demand for future vessels in the offshore wind T&I industry is highly contingent on the contractors' preferred operational areas, which are ultimately determined by their risk tolerance and capabilities. Contractors who prioritize lower risks from simpler project scopes and fewer cross-firm interfaces may opt for wind turbine installation projects, while those who are willing to assume greater risks in pursuit of larger contract values may choose foundation installation projects (Appendix 1: COP, Cadeler). Hence, the contractors' risk appetite and profit objectives shape the landscape of the offshore wind T&I industry, driving the demand for different vessels and the direction of future operations.

Figure 24: CAPEX breakdown for offshore wind project



Source: Own creation based on information from 4C Offshore (2022), GWEC (2022), Rystad Energy (2022)

Despite the existing availability of installation vessels in the industry, many vessels are being phased out of installation operations due to their limited capabilities in handling increasingly larger turbines and foundations. As Steenbeek from Ørsted points out, *"at the moment when you design [a vessel], you need to design it for the future (...) and so far, all the predictions have been underestimated. So basically, by the time the vessel hits the water, it is already too small and too old to handle the generation of turbines and foundations."* (Appendix 1: Ørsted). Consequently, vessels are often repurposed, for example, installation vessels typically transition to O&M roles once their original function is no longer viable. While vessels have a finite lifetime for their designated purpose, according to industry experts, they rarely cease operations prematurely, as the high demand for other projects unrelated to T&I ensures their continued utilization (Appendix 1: Clarksons).

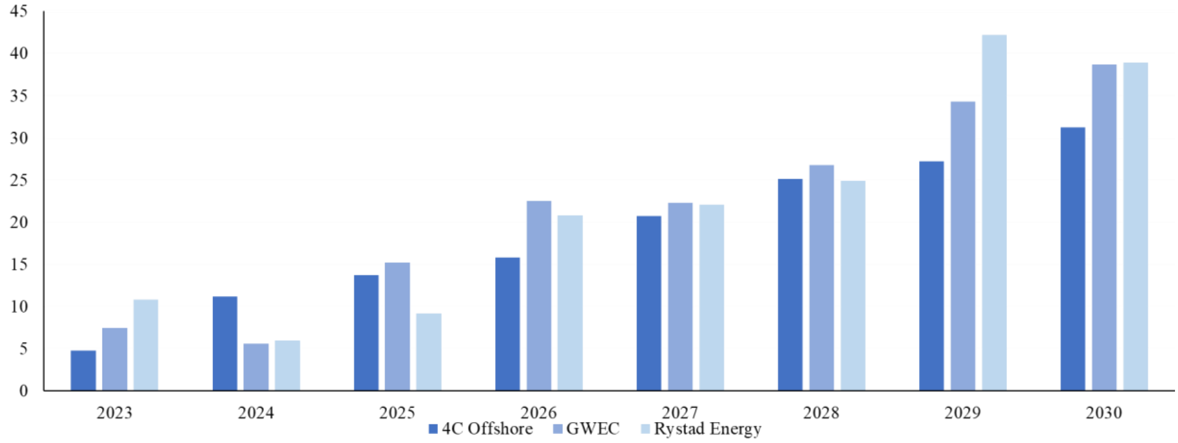
Furthermore, the emergence of newbuild vessels reveals a trend toward specialization, as vessels are increasingly being designed specifically for either foundation or turbine installation to address the growing complexity of project scopes. For instance, Cadeler's two new F-class vessels are primarily designed for foundation installation, illustrating this shift toward specialized vessel design in the industry (Cadeler, 2023). Given these factors, this analysis will concentrate on the demand for foundation and turbine installation vessels, estimating the projected supply and demand for each type of vessel in the coming years.

Global capacity additions and the European share

As previously described, countries all around the globe have committed to ambitious targets for offshore wind power capacity, particularly led by European countries. The three leading market intelligence agencies, 4C Offshore, GWEC, and Rystad Energy, have projected an average of 166 GW capacity additions globally, excluding China, between 2023 and 2030. These projections are consistent with European targets of 116 GW capacity additions by 2030. Looking across estimates in yearly capacity additions in GW from these agencies, the average capacity addition is expected to be around 8 GW in 2023 and expected to quadruple in 2030. The projected capacity additions vary significantly among the agencies, reflecting differing assumptions and methodologies. The data indicate a general trend of increasing annual capacity additions over the forecast period. Notably, the growth accelerates after 2025, suggesting a potential tipping point for the offshore wind sector as it gains momentum in T&I.

Given the numerous factors influencing variation in estimates between market intelligence agencies, such as differing assumptions, methodologies, and data sources, it is important to consider the key reasons for discrepancies. These include diverse interpretations of market conditions, policy changes, technological advancements, project pipelines, supply chain constraints, macroeconomic factors, and learning curves for cost reductions. Offshore wind installation vessels are considered global assets, as they are not limited to operating in a specific region, except for Chinese vessels that have been excluded due to their inaccessibility. Hence, the following section addressing the supply and demand of installation vessels will be done from a global perspective.

Figure 25: Global offshore wind power capacity additions, excluding China (GW)



Source: Own creation based on information from 4C Offshore (2022), GWEC (2022), and Rystad Energy (2022)

To accurately assess the future demand for offshore wind FIVs and WTIVs, it is important to consider several assumptions, including the projected average turbine size, installation times for both foundations and turbines, and average sailing durations to and from ports. These factors enable the derivation of a qualified estimation to determine the average number of vessels required to meet future demand.

In this analysis, it is assumed that wind turbines are installed within the same year as the intended annual capacity addition. The pipeline is determined by projecting annual installation capacities and average turbine sizes. As previously noted, China has been excluded from the global assessment, as both their market and vessels are generally considered not available to the rest of the world (H-BLIX, 2022). The number of required WTIVs is calculated based on the average productivity of a WTIV installing average-sized projects, expressed in GW/vessel/year. Similarly, the number of required FIVs has been calculated based on the productivity of an average FIV, installing average-sized projects, expressed in GW/vessel/year.

Yearly capacity addition data for the offshore wind sector have been obtained from 4C Offshore, GWEC, and Rystad Energy, to construct reliable demand scenarios. Furthermore, to enhance the precision of utilization and installation averages, cross-referencing with industry experts from organizations like Clarksons, Cadeler, and Ørsted has been conducted (Appendix 1). This approach ensures that the analysis is grounded in industry norms and trends. The number of wind turbines installed annually is projected to increase from approximately 870 in 2023 to roughly 2,520 in 2030 worldwide. As projects become larger, necessitating a greater number of installation days, the average number of projects completed per WTIV per year is anticipated to decrease slightly as we approach 2030. For FIVs, it should be noted that oil and gas occupation for the identified vessels has not been considered. From the given data, the installation capacity is assumed to increase significantly from an average of 0.68 GW/vessel/year in 2023 to 1.16 GW/vessel/year in 2030, mainly due to increasing project and turbine size as well as the expected increase in installation efficiency (H-BLIX, 2022; 4C Offshore, 2023).

Towards 2030, the number of foundations installed per year increases slightly from 62 to 67. This is explained by the increasing size of projects and the consequent increased installation time per project, resulting in fewer vessels executing multiple projects in one year.

The average installation time for each turbine is determined by considering factors such as round trips for loading new turbine batches at the marshaling port, mobilization, and demobilization, transit to the project site, weather-related delays, maintenance, and logistical inefficiencies (ibid). The average installation time per foundation has been calculated with a weighted average of installation time for jackets and monopiles, considering an expected monopile market share of 80% up to 2030 (Appendix 1: Cadeler; 4C Offshore, 2023). Installation efficiency is expected to increase towards 2030, mainly because monopile installation is assumed to become significantly more efficient due to the expected market entry of floating installation assets, able to handle more foundations. This is expected to reduce transit time, even though the effect is expected to be slightly dampened by increased sizes of foundations.

Efficiency improvements are expected due to larger project sizes, as relatively less time will be spent on factors such as mobilization and demobilization, and transit to the project site. Based on expert input, a 10% increase in efficiency is projected by 2030 due to technological advancements, such as turbine feeders (Appendix 1: Clarksons; H-BLIX, 2022). Given that each turbine requires a vessel and considering that installation times and vessel capacity for foundations and turbines are similar, the number of required vessels for both are close to each other. However, it should be noted that, given the long-time horizon of offshore wind projects and the need to first install a foundation before installing the turbine, the demand for foundation installation vessels is slightly higher on average in a given year, as capacity additions are expected to increase year over year until 2030.

A demonstration of the demand calculation methodology is provided in short below and in full in Appendix 6. This illustration showcases the process by which these various factors are integrated to form a comprehensive projection of future demand for offshore wind installation vessels. The resulting vessel demand is seen below. This approach considering various factors such as installation times, vessel capacity, and efficiency improvements, ensures that the analysis provides an accurate estimation of future demand for offshore wind foundation and turbine installation vessels.

Figure 26: Global WTIV and FIV Demand Scenarios 2023-30, excluding China

WTIV Demand

WTIV Demand Example Calculation		2023	2024	2025	2026	2027	2028	2029	2030
Turbines per trip	#	4	4	4	4	4	4	4	4
Installation days per turbine	#	3	3	3	3	3	3	3	3
Sailing time	Days	0.6	0.5	0.5	0.4	0.3	0.2	0.2	0.1
Total time per roundtrip	Days	12.6	12.5	12.5	12.4	12.3	12.2	12.2	12.1
Effective working days	#	300	300	300	300	300	300	300	300
Fleet Utilization	%	80%	80%	80%	80%	80%	80%	80%	80%
Active days per year	#	240	240	240	240	240	240	240	240
Total roundtrips per year	#	19.0	19.1	19.3	19.4	19.5	19.6	19.7	19.8
Turbines per trip	#	4	4	4	4	4	4	4	4
Turbines per year	#	76.1	76.6	77.0	77.5	77.9	78.4	78.9	79.3
Turbine size	MW	10	10.9	11.8	12.7	13.6	14.5	15.4	16.3
MW per vessel year	MW	761	835	909	984	1060	1137	1214	1293
Installed capacity	MW	7,500	5,600	15,200	22,500	22,300	26,800	34,300	38,700
Number of turbines	#	750	514	1,288	1,772	1,640	1,848	2,227	2,374

WTIV Demand

		2023	2024	2025	2026	2027	2028	2029	2030
4C Offshore	#	6.3	13.4	15.1	16.1	19.5	22.1	22.4	24.1
GWEC	#	9.9	6.7	16.7	22.9	21.0	23.6	28.2	29.9
Rystad Energy	#	17.7	9.8	11.6	24.0	26.8	28.0	46.6	43.7
Average	**#**	**11.3**	**10.0**	**14.5**	**21.0**	**22.5**	**24.6**	**32.4**	**32.6**

FIV Demand

		2023	2024	2025	2026	2027	2028	2029	2030
4C Offshore	#	7.0	15.0	16.9	18.0	21.9	24.7	25.0	26.9
GWEC	#	11.0	7.5	18.7	25.6	23.6	26.4	31.6	33.4
Rystad Energy	#	15.8	8.0	11.3	23.7	23.3	24.5	38.8	33.5
Average	**#**	**11.3**	**10.2**	**15.6**	**22.4**	**22.9**	**25.2**	**31.8**	**31.3**

Source: Own creation based on information from 4C Offshore (2022), GWEC (2022), Rystad Energy (2022)
Note: Example calculations based on WTIV with GWEC (2022) capacity addition data

Conditions for delivering on the demand for T&I vessels

When the development of installation vessels' availability between 2018 and 2022 was examined, it was important to note that most of the FIV and WTIV fleet was delivered between 2011 and 2014. These vessels were designed with capabilities that matched the projected growth in foundation and turbine sizes during that period. However, looking back, the installation contractors underestimated the actual growth in sizes, resulting in vessels that were built too small. For example, much of the existing fleet has a maximum lifting height of below 130 meters, which makes it difficult for them to install turbines with a capacity of more than 11 MW (Early, 2021). Consequently, the existing vessels require upgrades to remain competitive in the installation market. Nevertheless, only the largest vessels from that period are considered suitable candidates for such upgrades, while the rest are likely to serve the O&M market for wind turbines ranging from 8 to 10 MW in capacity. Even though it might be feasible to improve the cranes on these vessels, the constraints posed by their jacking systems present significant challenges to their upgrade potential. Overall, this has led to a discrepancy between the capabilities of the existing installation fleet and the growing demand for more advanced and larger installation vessels in the offshore wind industry between 2018 and 2022 (DNB Markets, 2022).

Development of the global installation vessel fleet

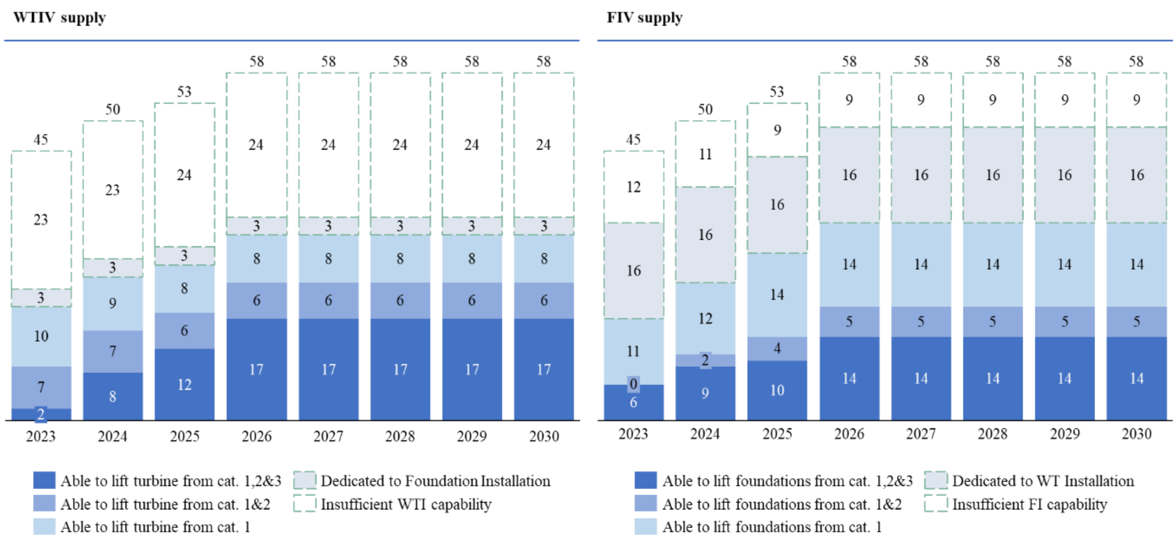
In analyzing the supply of T&I vessels for the offshore wind sector, it is crucial to consider the interplay between the existing fleet and the anticipated growth in turbine and foundation sizes. As of the end of 2022, the global T&I fleet comprises 43 vessels, with a gradual increase expected due to the construction and commissioning of new builds in the years to come (see Appendix 8). However, as evident from the analysis of the historic development of the T&I industry, a bottleneck in reaching capacity lies in the fact that upgraded vessels are likely to become irrelevant as wind turbine sizes continue to grow. Consequently, newbuilds emerge as the only viable option for meeting future installation needs. Supply bottlenecks may be further exacerbated by the increasing geographical distribution of offshore wind projects, as *"much of the growth is happening in other regions"*, with reference to regions outside developed areas in Europe and Southeast Asia (Appendix 1: Cadeler).

Lengthy transportation times between regions, such as Europe and Asia, can be resource-intensive and unsustainable due to the wear and tear on the vessels, and according to Harder *"absolutely not sustainable"* (Appendix 1: Cadeler), which speaks against dedicating vessels to multiple distant geographical regions. Furthermore, in certain regional offshore wind markets, such as the US and Japan, the legislation prohibits foreign vessels from executing projects within their territorial waters (Musial, et al., 2023). In these markets, the number of compliant vessels allowed to operate is typically lower than the number needed to achieve set targets. Consequently, the remaining offshore wind projects will need to rely on foreign installation vessels, which must circumvent these limitations through legal dispensations or innovative solutions, such as feeder barges. It is anticipated that location-compliant vessels will not move to foreign markets, while free-market vessels may enter these restricted markets. Hence, vessels may be assigned to specific regions to reduce the need for long-distance vessel deployment, but industry experts posit that regional distribution has a limited impact on the global market vessel supply, given the long time frame of projects (H-BLIX, 2022).

The quantity of appropriate WTIVs and FIVs is determined annually, factoring in the necessary features based on projected wind turbine and foundation sizes. With the continuous growth of turbine sizes, vessels in Categories 1 and 2 are expected to be obsolete from 2025 to 2029, as the turbine installation height surpasses their maximum hook height. This will result in a decrease in the number of suitable installation vessels. Given the lead times of approximately four years, new builds after 2026 are currently uncertain or unconfirmed, exacerbating the potential decline in suitable vessels as foundation sizes continue to grow.

The current fleet from 2023, consisting of 45 vessels, faces a challenge as an increasing portion becomes unsuitable for T&I activities due to the continuous growth in wind turbines and foundation sizes. As of 2023, 23 vessels are unable to install the average wind turbines, and 12 vessels are incapable of installing the average foundation. Over the next four years, 14 newbuilds and four upgrades are scheduled to be commissioned, which will help address the increasing demand for suitable vessels (Appendix 8). However, no projects for additional newbuilds have been confirmed beyond this point. Some of these newbuilds are capable of installing both foundations and turbines, but to develop a realistic scenario analysis, the available cross-functional vessels are assumed to be dedicated to either foundation installation or turbine installation tasks. The expected development of the global fleet is depicted below in Figure 27.

Figure 27: Global T&I vessel supply, excluding China (vessels)



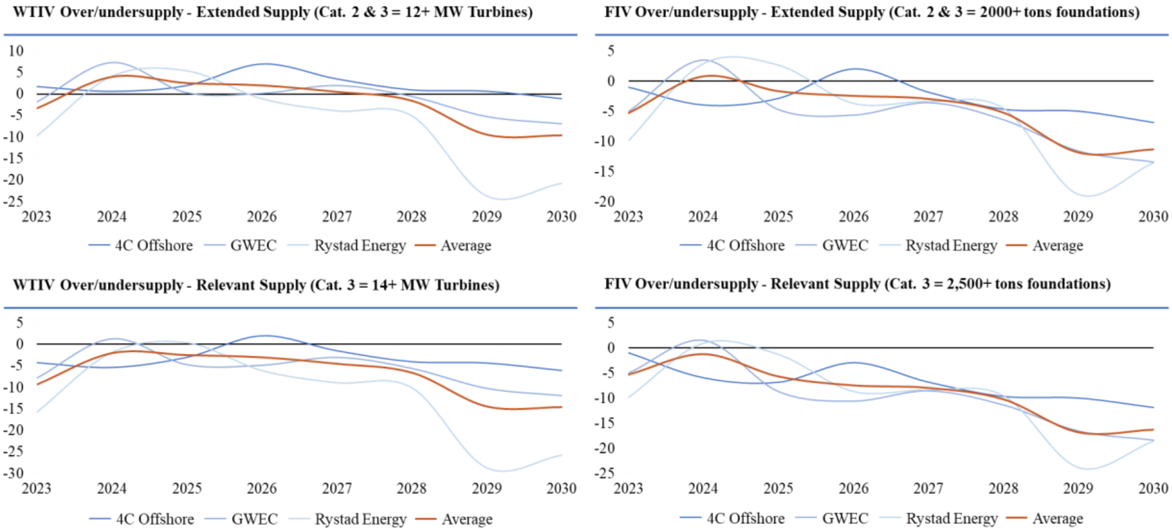
Source: Own creation based on public firm information.

Category 1 WTIVs handle up to 12 MW turbines, FIVs 1,500-ton capacity; Category 2 WTIVs manage 12-15 MW turbines, FIVs 2,000-ton capacity; Category 3 WTIVs accommodate 15 MW+ turbines, FIVs 2,500-ton capacity.

Figure 27 provides an overview of the global supply of T&I vessels from 2023 to 2030, categorized by their capabilities in wind turbine and foundation installation. For WTIVs, the number of vessels with insufficient capability remains consistent at 24 throughout the period, while the number of vessels able to lift turbines from categories 1, 2, and 3 increases from 2 in 2023 to 17 by 2026, staying stable until 2030. This increase in capable vessels corresponds to the growing demand for larger turbines. Conversely, the number of vessels able to lift only turbines from Category 1 decreases from 10 in 2023 to 8 by 2025, due to Cadeler's two scheduled upgrades, and remains constant thereafter. For FIVs, the number of vessels with insufficient foundation installation capability decreases from 12 in 2023 to 9 in 2025 due to vessel upgrades. The number of vessels able to lift foundations from categories 1, 2, and 3 steadily increases over the period, reaching 14 vessels by 2026. This growth demonstrates the industry's shift toward larger foundations. The data highlights a trend of increasing the capacity of T&I vessels to accommodate the evolving offshore wind industry, characterized by larger wind turbines and foundations.

Figure 28 presents a comprehensive view of the over/undersupply of T&I vessels from 2023 to 2030, synthesizing both the compiled vessel supply and demand data. This visualization enables the identification of potential bottlenecks and excess capacity. The chart provides insights into the global vessel allocation.

Figure 28: Global transport & installation vessel over/undersupply, excluding China (vessels)



Source: Own creation based on public firm information.

As previously stated many vessels are expected to become obsolete around 2025 due to the average turbine size surpassing 11 MW. Hence, the over/undersupply data is depicted using relevant supply and extended supply with extended supply including Category 2 installation vessels.

The average WTIV over/undersupply for extended supply shows a surplus of 4.0 vessels in 2024, followed by diminishing surpluses until 2028, and ultimately, a shortage of 9.6 vessels by 2030. In contrast, the relevant supply scenario shows an average undersupply across the entire period, with a shortfall of 14.6 vessels by 2030. For FIVs, the extended supply scenario demonstrates an average oversupply of 0.8 vessels in 2024, followed by a steadily increasing undersupply, reaching a deficit of 11.3 vessels by 2030.

The relevant supply scenario reveals a more pronounced undersupply throughout the entire period, with a shortage of 16.3 vessels by 2030. These trends suggest that there are bottlenecks in the availability of WTIVs and FIVs for offshore wind projects, which could impact the pace of development and capacity additions. Notably, the global fleet will expand 31% from 2023 to 2026, but the data suggests a short supply across vessel types already from when this expansion is realized.

Capital considerations

Capital considerations are critical aspects for T&I firms in the offshore wind sector when deciding to order new installation vessels. According to Harder, there is sufficient capital within the industry to purchase the necessary vessels, however, market volatility makes it challenging to realize a return on investment in newbuilds, increasing the associated risk (Appendix 1: Cadeler). Contributing to this risk is the short lifetime of vessels due to constantly changing requirements for handling increasing turbine sizes, which affect foundation specifications, port specifications, and other related factors (Appendix 1:

Clarksons). When evaluating the feasibility of investing in new installation vessels, financiers consider factors such as the owner's experience in the sector, appetite for risk, cash flow, quality of the management team, and asset quality (PwC, 2020).

The demand for WTIVs is on the rise, with projections indicating the need for more newbuilds by 2026. However, the increasingly evident short-term nature of employment for WTIVs and FIVs creates challenges for financiers, who may seek lower debt levels, putting pressure on the required equity (Appendix 1: Clarksons). Due to the relatively large risk profile of specialized installation vessels, financiers may look for corporate or collateral support from parent companies with substantial balance sheets (ibid).

In addition to these financial challenges, technology risks, such as alternative fuels and installation methods, will also impact financiers' decisions. As the industry evolves, T&I firms must consider the future technological requirements and capabilities of newbuild vessels. For instance, there is a lot of hesitation in deciding the next generation of vessels, such as whether they should have bigger cranes, decks, or enhanced stability features (Appendix 1: Clarksons). High demand for installation projects and a limited supply of vessels provide T&I firms the upper hand, as they can more easily secure a sufficient return on their chartered vessels and installation project contracts.

The limited supply makes chartering the existing fleet to developers possible to be done at higher day rates, as developers push to complete projects. However, this advantage may lead to long-term strain on developers in the industry, making them more exposed to risk or facing difficulties in realizing returns on wind farm projects (Appendix 1: Cadeler; Clarksons). This tension between T&I firms and developers may create a bottleneck in the sector, as it aims to rapidly expand. Companies seeking to enter the T&I space, in a similar fashion to Cadeler or Eneti, must secure contracts to build next-generation foundation installation vessels. This need comes at a time when capital providers are hesitant to invest speculatively in an uncertain economic environment (Appendix 1: Clarksons).

Global port capacity

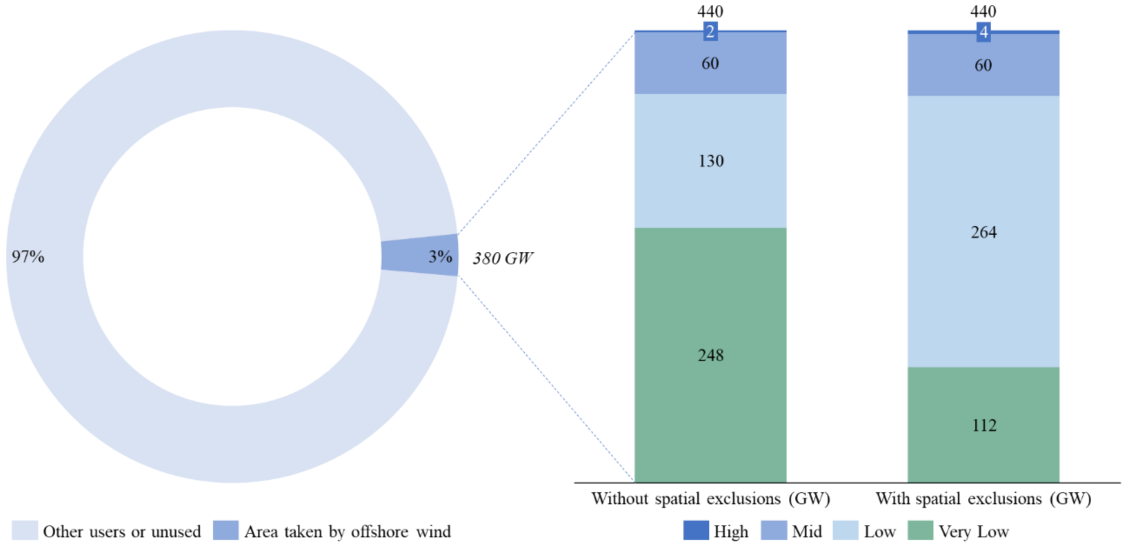
Current book orders from global shipyards suggest that new orders for newbuild installation vessels will not be possible before 2026 (H-BLIX, 2022). Industry representatives, including both firms consulting T&I firms and T&I firms themselves, note that only a very limited number of shipyards possess the capabilities to manufacture these specialized vessels due to their unique requirements (Appendix 1: Naver Energy, Cadeler). As noted by Harder, *"There will always be a trade-off between price, quality, timeline, payment terms, geopolitical interests, etc. For the X-class, a handful of shipyards were identified that could produce the specific design within the requirements."* (Appendix 1: Cadeler). This statement highlights the complexities and challenges in securing newbuild installation vessels, emphasizing the importance of planning and strategizing in the context of fleet expansion and meeting market demands. The insights on global shipyard capacity underline the need for industry stakeholders to be aware of the limited availability of specialized shipyards and the potential impact on project timelines.

Viability of European wind farm areas

The T&I industry faces challenges when installing offshore wind farms in complex and harsh environments. Factors such as water depth, seabed conditions, and distance from shore impact installation and maintenance costs, foundation designs, and project complexity (Appendix 1: Cadeler, Naver Energy). As shallow water areas become scarce, floating turbine technology becomes essential, though costlier. Projects closer to shore have lower costs but face greater visual and environmental impact concerns, conflicts with marine activities, and adverse weather conditions (Appendix 1: Cadeler). Furthermore, busy maritime routes, environmental restrictions, and installation methods add to project complexity and costs (Appendix 1: Naver Energy).

All these factors are limiting the viable areas in Europe and around the world to install offshore wind farms. However, Vaisnoras underscores the potential of the European offshore wind market, despite perceived saturation, pointing to the ambitious targets set by the EU and its member countries. He also emphasizes the role of innovation, stating that *"new technologies, such as floating [foundations], are opening up opportunities"* for regions previously unsuitable for offshore wind (Appendix 1: COP). Thus, as these technologies mature, the European market will continue to present substantial rewards for those willing to assume the risks associated with new market entry.

Figure 29: Allocation of offshore wind area in 2050 by sea and LCOE in scenarios with and without spatial restrictions



Source: Own creation based on WindEurope (2019)

A 2019 study conducted by WindEurope highlights the vast potential of offshore wind areas in Europe, capable of producing the targeted 380 GW capacity by 2050 (WindEurope, 2019). The 2050 wind area scenario analysis confirms the presence of adequate viable offshore wind areas to meet the 2030 targets of 116 GW in a financially sound manner. A report from the Danish Energy Agency indicates that the North Sea alone possesses a gross potential of 250 GW capacity that is economically viable (Energistyrelsen, 2022).

However, the 2019 WindEurope analysis identifies an issue of spatial exclusion, which restricts the availability of economically viable offshore wind areas required to achieve the 2050 target capacity. Presently, exclusion zones prevent nearly 75% of future offshore wind capacity from being built at very low LCOE in the North Seas. Hence, to meet the more long-term targets, an urgent call for attention from policymakers and marine planners is still needed to ensure a cost-effective energy transition.

In sum, there is enough offshore wind area available using existing technology, meaning significant innovation in vessel design and capability is not essential to achieve the required capacity in an economically viable manner. However, the development of new technological solutions that make more challenging area conditions viable for offshore wind farms may still hold promise in realizing the full potential of Europe's offshore wind capacity.

Labor considerations

The outlook of labor in the offshore wind sector is critical to address for the successful delivery of components and installation of wind farms. As companies like Cadeler build their organizations, they must rely on the maritime-related expertise of long-standing organizations and their employees. The challenge lies in identifying the necessary types of employees and their origins. According to Nielsen, *"For the development of a one-gigawatt project, developers typically have 150 people on a team for such a project."* (Appendix 1: Naver Energy). However, securing experienced talent in the offshore wind can be a significant hurdle, especially in new markets. As mentioned by Vaisnoras from COP, *"Even here in Denmark, it's quite challenging to find relevant people with a suitable background quickly.*" (Appendix 1: COP).

The development of labor conditions in the EU has been challenging due to the rapid growth of the renewable energy sector. As the demand for skilled labor increases, the supply of qualified workers struggles to keep up. This has led to the intensification of competition for workers in related industries and an overall strain on the labor market. In addition to the shortage of qualified personnel, the renewable energy sector is faced with the challenge of retaining and upskilling its workforce to meet the evolving needs of the industry. This labor scarcity is further exacerbated by the growing need for workers, estimated to triple from 2020 to 2030, to operate and maintain global renewables projects, especially the lack of technicians (Mckinsey, 2022).

These labor challenges need to be addressed through a coordinated effort between governments and industry stakeholders. By promoting local employment, and training opportunities, and balancing global talent, a skilled workforce can be fostered to support the industry's expansion. Governments play an essential role in addressing this issue by setting local employment thresholds and providing training opportunities for their citizens. Vaisnoras cites Taiwan as a prime example, where *"Their government did an excellent job of pushing the developers and companies that are developing offshore wind to find spots for local people, provide training opportunities, and invest in that area."* (Appendix 1: COP).

Nonetheless, meeting local hiring targets is not always feasible. Vaisnoras explains, *"You can have the best intentions of hiring only locally and trying to meet these targets, but sometimes it's just simply impossible, because in order to meet particular deadlines (...) you do have to rely on foreign contracts and expats."* (Appendix 1: COP). The interplay between government intervention and company investment in local talent is crucial for addressing labor challenges in the offshore wind T&I industry. The sector's future success relies on fostering a skilled workforce, balancing local and global talent, and adapting to the dynamic landscape of offshore wind development. Perspectives on local content requirements will be explored further in the Projected tenders and governmental influences section.

Development in the industrial supply chain of the offshore wind sector

The historical development of offshore wind-related and support industries demonstrates a significant expansion of the global supply chain, addressing not only the enhancement of individual component capabilities, such as turbine size but also the overall scale of projects. This includes the number of wind turbines per wind farm and the diversity of suppliers involved in these ventures (Appendix 1: Naver Energy). As Steenbeek observed, there has been a *"massive shift in the market just in a few years"* with the cost of offshore wind being reduced by 65% (Appendix 1: Ørsted). However, he also noted that the *"steep decline in cost of offshore wind has come to a halt and it's currently trending upwards a bit again"* (ibid).

To maintain a stable supply of T&I vessels and support the supply chain, it is critical to secure final investment decisions with consistent manufacturing and installation rates for at least a decade. This long-term stability allows suppliers of components, vessels, port services, and operation and maintenance services (OMS) to effectively amortize their investment costs over a reasonable timeframe (Appendix 1: Naver Energy). Vaisnoras from COP highlights potential strains on the supply chain, emphasizing the interconnectedness of various components in the offshore wind sector. He notes that rising steel prices due to scarcity geopolitical factors affect the business cases for many projects, while expressing concerns regarding the limited capacity of the three main turbine manufacturers, questioning if *"their capacity can be delivered"* (Appendix 1: COP).

As the capacity of offshore wind power increases, so does the demand for the entire supply chain, from component manufacturing to marshaling ports to power transmission and so forth. Candeel from Clarksons stated that *"everybody is fighting to be competitive, but we don't have the assets, companies, and people anymore to do it"* (Appendix 1: Clarksons). The rapid development of the industry presents challenges for supply chain contractors, as the fast pace of technological advancements can render new solutions outdated by the time they are delivered. Steenbeek explains *"the market is developing faster than the supply chain can keep up with. That's both damaging for the developer and for the contractors"* (Appendix 1: Ørsted). This issue is further compounded by the increasing trend towards utilizing specialized contractors rather than broad-scope contractors, which can lead to heightened risks of delays and lower-quality deliveries (ibid).

In addition to addressing the challenges of manufacturing and installing offshore wind components, the power transmission grids in individual nations require significant upgrades to handle the increased capacity generated by offshore wind power. Karlsmose from CIP emphasized that *"your entire transmission grid must be able to take the power from the coast to the places that need the power"* (Appendix 1: CIP). A study from BloombergNEF (2023) suggests that a staggering $5.8 trillion needs to be invested in the global electricity grid by 2030 to support a net-zero trajectory for the world. In 2022 alone, $274 million was invested in global power transmission and distribution grids, emphasizing the scale of the challenge at hand.

The offshore wind sector has witnessed substantial growth in both the global and European-specific supply chains, characterized by advancements in component capabilities, increased project scales, and rapid technological innovations. Despite these accomplishments, the industry faces a multitude of challenges, such as rising costs, capacity constraints in manufacturing, and the trend toward specialized contractors, which may result in project delays and compromised quality. Moreover, the requirement for considerable investments in power transmission infrastructure underscores the complexities of achieving ambitious renewable energy objectives.

Projected tenders and governmental influences

Offshore wind tenders

European countries have committed to a total of 116 GW of added offshore wind capacity by 2030. The upcoming tenders within Europe, as summarized in Appendix 7, signify a path towards an ambitious expansion in offshore wind capacity. However, the sum of capacity in these published tenders shows a shortfall. Due to the lengthy permitting and construction timeline averaging at least 4 years (Iberdrola, 2023), the published tenders up to and including 2026 are deemed relevant for reaching the 2030 target. From 2023, nations such as Portugal, launching a 7 GW fixed lease tender, will spearhead growth, with combined capacity being auctioned amounting to 33.4 GW. However, the momentum decelerates into

2024, with 10.7 GW combined capacity auctions, and by 2025, the annual capacity will total to 25 GW. The 2026 outlook reveals a waning commitment to renewable energy growth, with a combined capacity of just over 12 GW. Hence, a full realization of the tendered capacity by 2030 will amount to 82 GW, falling short of the targeted 116 GW by 30%.

This emphasizes the need for a substantially increased number of tenders to be published to meet the ambitious 2030 targets. Harnessing advancements in fixed and floating offshore wind technologies to reach otherwise unviable wind farm areas may be part of closing the gap. Nonetheless, as the renewable energy landscape evolves, policy support and permitting optimization leading to more tenders will play a critical role in shaping the sector and fostering supply chain development, ultimately contributing to bridging the gap and achieving the 2030 target.

Subsidies and power purchase agreements

Governments have, as mentioned, played a pivotal role in shaping the offshore wind sector through the implementation of financial support and policy instruments, such as feed-in tariffs. These support mechanisms will likely continue to stimulate investment in offshore wind projects, which in turn drives the demand for T&I vessels to support the installation and maintenance of new wind farms. However, the industry is projected to face shortages in materials, manufacturing capacity, skilled workers, and vessels, and these issues are expected to worsen as the number of turbines to be deployed increases.

One argument that seems to permeate the industry, is that a sector-wide demand for wind power will strain the existing capacity for all parts of the supply chain (Appendix 1: Cadeler, Clarksons, Naver). As noted by Candeel from Clarksons when asked about who should address these issues: "*They [politicians] should up the price for either subsidies or tariffs because everything has gotten much more expensive, but nothing's been adapted.".* This has far-reaching consequences for the concessions won merely two years ago, as the overall increase in costs has made it exceedingly difficult for these concessions to secure adequate funding (Appendix 1: Clarksons).

Furthermore, this development also has significant consequences for offshore T&I firms, a significant number of which typically secure contracts well in advance. Seaway 7 is a prime example of a company whose operating profitability has been adversely affected by this situation, as a substantial portion of their contracts for 2020 and 2021 were inked during a period of intense competition in the industry (Seaway 7, 2023). This, coupled with the rise in costs, has severely limited their profitability for the period as highlighted in sub-question two.

The strain on the supply chain due to sector-wide demand for wind power highlights the challenges surrounding low or zero-subsidy projects in volatile market conditions. In economic downturns, these projects struggle to secure funding to cover escalating costs, exposing T&I firms to considerable losses, as they often commit to contracts well in advance. This financial instability jeopardizes project completion and affects the profitability of T&I firms as they cannot adjust their pricing and contract terms to account for increased costs and market volatility (Thomas, 2023). The susceptibility of low or zero-subsidy projects to market fluctuations adds uncertainty to the entire offshore wind sector, potentially leading to delays in project development, contractual disputes, and hesitancy among investors to finance new ventures. Policymakers, developers, and T&I firms must reconsider the feasibility of low or zero-subsidy projects and explore alternative strategies to ensure the long-term viability and profitability of the offshore wind sector.

In times of volatile energy prices and zero-subsidy environments, developers may consider approaching a commercial power purchase agreement (PPA). A commercial PPA is a contract between an offshore wind power generator and a non-governmental buyer (such as a utility company, power trader, or corporation) in which the buyer agrees to purchase a specified amount of electricity generated by the offshore wind project for commercial purposes (Michalski, 2019).

The potential for developers in doing more commercial PPAs lies in securing long-term revenue streams, reducing project risks, and attracting investments. By signing PPAs with creditworthy buyers, developers can ensure a stable income, improve project bankability, and potentially access more favorable financing options, ultimately supporting the growth and expansion of renewable energy projects.

In a report made for the European Commission, states that with the EU targeting 55% of power generation from renewable sources by 2030, the role of commercial PPAs in the offshore wind sector becomes increasingly significant (Baringa, 2022). But to capitalize on the potential of the PPA market, the sector must confront various barriers that currently impede the growth of commercial PPAs. One significant barrier is the limited price risk appetite among off takers, particularly in sectors with tight margins and stiff competition, such as the offshore wind sector in question (ibid). Long-term commercial PPAs often exceed the natural business cycle of these off takers, making them hesitant to commit to such contracts. Moreover, offshore wind projects involve long construction times and substantial investments, which may deter corporates from signing PPAs that they can market as being 'additional' – meaning that the PPA enables the project to proceed. Hence, there is an incentive for the offshore wind sector to explore strategies for minimizing construction times and reducing investment reducing order to render PPAs more appealing to potential off takers.

The discussion on the challenges surrounding low or zero-subsidy projects and the potential benefits of commercial PPAs set the stage for examining non-price criteria. These criteria, aimed at evaluating various aspects of a project beyond its cost, such as technical expertise, environmental impact, and social benefits, introduce another layer of complexity for policymakers, developers, and T&I firms navigating the offshore wind sector.

Non-price criteria

As Europe accelerates its transition towards climate neutrality, non-price criteria in wind energy auctions play a crucial role in balancing various policy objectives. These criteria not only promote sustainable practices, biodiversity protection, and system integration but also incentivize innovation and support the development of the European wind supply chain. By incorporating non-price criteria in auction design, policymakers can drive growth in green jobs, enhance energy security, and address short- and long-term challenges, all while fostering a more robust and sustainable wind industry.

T&I firms are indirectly affected by non-price criteria in wind energy auctions, as these criteria shape the overall landscape of the offshore wind sector. T&I firms will potentially need to adapt their practices to align with projects prioritizing sustainability, biodiversity, and system integration, but also need to accommodate specific project requirement demands from developers seeking to procure T&I services.

Some European nations have already embraced various non-price criteria in offshore wind auctions to address their distinct policy objectives and contexts. Notably, France's Normandy auction allocates 25% of the scoring to managing environmental impacts and promoting local economic development. The Netherlands' ongoing Hollandse Kust West auction emphasizes environmental factors and energy system integration. Germany's draft Offshore Wind Law considers energy yield, PPAs, and blade recyclability, while Belgium's consultation for the new Princess Elisabeth Zone encompasses citizen participation, local benefits, sustainability, nature preservation, and innovation and system integration (WindEurope, 2022).

An increased focus on non-price criteria scoring will lessen the focus on price and put a stronger focus on quality and other aspects, which potentially leads to less tightly squeezed margins for developers and a stronger likelihood of projects being completed profitably (ibid). The European Commission's State Aid Guidelines for Energy limit the non-price criteria scoring to 30% in Contract for Difference (CfD) auctions, where renewable energy projects compete for financial agreements that ensure a fixed price for their generated electricity. However, by not employing CfDs and rather doing a zero-subsidy auction, governments can assign even higher rates to non-price criteria, allowing them to better evaluate bids based on objective and measurable criteria. This approach incentivizes investments in technology development and sustainable practices that align with the government's broader policy objectives. (WindEurope, 2022).

Local content requirements

Local content requirements (LCRs) have emerged as a prominent policy tool in the offshore wind power sector. One of the primary benefits of LCRs is their potential to foster domestic economic growth and job creation by incentivizing investment in local infrastructure, workforce training, and manufacturing capacities (ISOC, OECD, UNESCO, 2011). By requiring or encouraging the use of locally sourced components, services, and labor, LCRs can stimulate the development of a homegrown offshore wind supply chain. Additionally, by promoting local sourcing and reducing reliance on long-distance transportation, LCRs can help lower emissions associated with logistics and contribute to the sustainability of the offshore wind sector. In this regard, Harder from Cadeler pointed out, *"You cannot spend 3 months sailing to Asia and 3 months sailing back again just to complete a project. While you may be paid for the trip, it wears on the ship and is absolutely not sustainable."* (Appendix 1: Cadeler). This highlights the importance but also the challenge of having dedicated ships for different regions, which would also contribute to the sustainability of the offshore wind sector.

However, LCRs also present several challenges for the T&I industry. According to a study by Van der Loos et al. (2022), local content regulations can exacerbate the risks associated with supplier selection, as they have been found to stimulate the selection of lower-value local suppliers. This can lead to higher costs, longer lead times, and compromised quality due to a lack of competition or limited local expertise. In the context of T&I, these factors can have significant implications for project timelines, budgets, and overall efficiency. On the other hand, the same study suggests that selecting local lead firms in the project country can encourage the selection of local high-value suppliers, ensuring that lead firms do not favor potentially inferior suppliers from their home country instead of global market contractors (van der Loos et al., 2022).

WindEurope (2016) highlights another challenge posed by LCRs, stating that they push the industry to invest in production facilities that might not be economically viable over the long term, thereby contributing to higher costs for end consumers. The establishment of local manufacturing facilities and workforce training programs required to meet LCRs can entail substantial upfront investments, which may be difficult to recoup in the short term. To remain competitive, the industry needs to draw on a lean and efficient global supply chain, with which LCRs may be incompatible.

Projected development in strategy, structure & rivalry for T&I firms

The evolving conditions surrounding tendering, market dynamics, supporting industries, and technological advancements will undoubtedly impact the strategy, structure, and rivalry among T&I firms in the offshore wind sector. While the precise outcomes of these changes can only be speculated at this stage, it is clear that T&I firms will need to adapt their business models and competitive strategies to navigate the shifting landscape. In this context, firms will likely face increased pressure to optimize their supply chains, improve operational efficiency, and capitalize on emerging market opportunities.

The development in strategy and structure for T&I firms will be further explored in the following section, which will provide a more in-depth analysis of strategic actions that can be taken by firms within the T&I industry. These actions include investing in new capacity, expanding operational capabilities, and forging strategic partnerships to meet the growing demand for offshore wind installations. Ultimately, the ability of T&I firms to adapt to the changing market conditions will play a crucial role in determining their competitiveness and long-term success in the rapidly evolving offshore wind sector.

Sub conclusion to iii. Based on the identified industry conditions, what is the expected development of the European offshore wind T&I industry from 2022-2030??

The European offshore wind T&I industry is expected to accelerate throughout the decade, despite sector-wide challenges. The period from 2022 to 2030 will be marked by a transition from cost reduction to managing the exponential expansion of offshore wind projects. Immediate solutions are needed to overcome uncertainty surrounding turbine size and technology advancements, align vessel availability with project timelines, and adapt to evolving market conditions.

The sector as a whole, as well as the T&I industry, face challenges such as vessel shortages, labor shortages, combined with insufficient tenders to meet targets. Emerging trends in newbuild vessels demonstrate a shift toward specialization, with designs tailored for either foundation or turbine installation to accommodate increasingly complex project scopes. To maintain competitiveness in the face of rising demand for more sophisticated and larger installation vessels, upgrades to existing vessels will be required. However, these upgrades are not a definitive solution, as a significant portion of the global fleet is outdated and may not be suitable for T&I activities. This is due to the continuous growth in wind turbine and foundation sizes, which is rendering many older vessels increasingly unsuitable for such tasks. The over/undersupply of WTIVs and FIVs from 2023 to 2030 reflects a potential shortage of 10-15 and 11-16 vessels by 2030, respectively, which likely will impact day rates and strain developers in the long run.

Although current technology allows for the exploitation of a sufficient amount of offshore wind areas, further technological advancements harnessing more challenging regions have the potential to unlock Europe's full offshore wind capacity. This is essential as the current tendered capacity in Europe amounts to 84 GW falling 30% short of the capacity target set for 2030. The rapid industry development presents supply chain challenges, with the pace of technological advancements potentially outstripping contractors' ability to deliver updated solutions.

The strain on the supply chain highlights the challenges surrounding low or zero-subsidy projects in volatile market conditions. Increased focus on non-price criteria scoring could lead to less tightly squeezed margins and a higher likelihood of profitable project completion. LCR, however, may exacerbate risks associated with supplier selection, leading to higher costs, longer lead times, and compromised quality.

In summary, the offshore wind T&I industry must navigate a complex landscape of challenges and opportunities to support its expected growth towards 2030. Flexible strategies, continuous innovation, and adaptability will be crucial for firms to thrive in this dynamic environment.

Strategic Actions for Firms within T&I

The above-conducted analysis demonstrates not only the looming shortage of WTIV and FIV by 2030 but also the range of challenges that the entire supply chain faces when delivering offshore wind farms. These challenges include the unequal distribution of risk throughout the supply chain, labor shortage, and a slow and rigid tender process. Tackling these issues is essential for ensuring the success of the industry and its role in achieving the European 2030 capacity targets. Although the offshore T&I industry might appear to be a relatively minor player in the overall energy transition, several strategic actions can be taken by T&I firms like Cadeler to contribute to accelerating the transition.

The following section is organized within three themes: (1) enhancing capabilities, (2) increasing capacity, and (3) fostering collaboration within the industry. These three themes encompass a variety of more specific strategic actions and have been identified as the core dimensions of the action space that T&I firms can navigate. Through examining these themes, this paper strives to provide a comprehensive and in-depth understanding of the strategic actions available to T&I firms in support of the green transition. The evaluation of the strategic actions is summarized in Figure 30 as part of the sub conclusion to this question, where the composite scores used in the evaluation are showcased in Appendix 3

Enhance capabilities

The offshore wind T&I industry, although rooted in longstanding organizations, remains a relatively nascent industry. Consequently, firms like Cadeler must invest in expanding and solidifying their organizational capabilities. The existing distribution of risk throughout the supply chain has contributed to a hindrance in executing certain projects, which can be partially attributed to the uneven spread of competencies across various stakeholders. To address these inefficiencies and ensure high-quality project delivery, firms must reassess and refine their organizational capabilities.

One key strategic action to consider involves scaling the current organization within its existing scope to effectively deliver on current commitments. This can be achieved through optimizing the operating model and enhancing project execution, which will ultimately lead to improved performance and a more streamlined approach. By refining internal processes and strengthening existing capacities, T&I firms will be better equipped to meet the demands of the rapidly growing offshore wind sector.

Another strategic action is the expansion of delivery scopes, which can facilitate a more equitable distribution of risk and foster greater knowledge sharing and development within the industry. By broadening their range of expertise, T&I firms can leverage their operational experience in areas where it may be more advantageous to maintain in-house capabilities, rather than relying solely on external contractors. This approach not only fosters a more collaborative and efficient supply chain but also supports the wider offshore wind sector in its pursuit of European ambitions and efforts to address vessel shortages and supply chain challenges.

Scaling current organization within the current scope

The scaling of the current organization is a strategic action that is essential for the long-term success and sustainability of T&I firms. Successful offshore wind projects require well-structured organizations and detailed strategies for balancing in-house and outsourced activities. Organizational structure, staffing model, and governance must be designed considering the company's core competencies and specific opportunities.

For individual projects, the differences between established and newly founded companies are crucial. Factors such as crew experience, design optimization (including sea fastening, lifts, jetting systems, etc.), processes, and general know-how contribute to the ability of established firms to complete projects significantly faster than newcomers. As efficiency is a critical aspect in the industry, even seemingly minor optimizations, such as saving 10 or 15 minutes per installation, can quickly accumulate and add substantial value when considering larger projects involving, for example, 200 turbines (Appendix 1: Cadeler). Thus, the experience and expertise of established companies play a pivotal role in addressing supply chain challenges and achieving greater efficiency in the offshore wind sector. This is especially relevant in times of high raw material and service prices as this will strain project business cases.

To effectively participate in the face of increasing variability and uncertainty, offshore wind participants must build capabilities in several areas. Talent attraction is a crucial aspect of organizational development, and companies need to establish a presence in areas with abundant talent. For example, Cadeler is in the process of opening an office in South East Europe in Poland, where there is both T&I project activity and a large talent pool (European Training Foundation, 2020). The importance of talent is further solidified by the following quotes in Cadeler’s 2022 annual report “*We need to attract the right talent to support our clients (…)”* (p. 4) and “*The Company's ongoing investment in talent enables it to maintain a competitive edge in the market and position itself for long-term success*.” (p.14). Strengthening and expanding the organization within the current scope of operations will thus solidify T&I firms' position in the supply chain as relatively new organizations mature.

The examination of T&I firms' performance reveals that several firms have faced negative or low ROA and ROE in recent times which underscores the relative immaturity of the industry. It is hence crucial for firms to enhance their capabilities and scale their current organizations as this could improve their financial returns. By doing so, they can optimize organizational structures and streamline processes to increase profitability. Additionally, T&I firms will benefit from the collective expertise and know-how of a larger, more experienced workforce, enabling them to execute projects more effectively, minimize risks, and reduce downtime. Improved competencies and greater industry experience contribute to better financial outcomes, positively impacting ROA and ROE. FOWIC's positive ratios exemplify this, as the company has a workforce similar in size to both Eneti and Cadeler yet focuses solely on providing T&I of wind turbines. In contrast, both Eneti and Cadeler have a broader scope, including both turbine and foundation installation. This suggests that increasing capabilities is essential for improved financial performance.

Nevertheless, scaling and hiring additional talent could negatively impact profitability due to increased salary expenses, benefits, and costs related to attracting and retaining top talent in a competitive industry. This rise in expenses is exemplified by Figure 22 which displays a 15% increase in Cadeler's operating expenses between 2021 and 2022, during which the company expanded its average onshore workforce by 21% (Cadeler, 2023). Despite these cost increases, the prevailing environment of vessel scarcity and surging demand for heightened capacity allows T&I firms to command premium rates for their vessels. Consequently, Cadeler's EBITDA margin has not declined; in fact, it has experienced a 14 percentage points increase, even with the larger OPEX base.

The advantageous situation currently enjoyed by T&I firms within the industry with surging day rates and the ability to exercise enhanced discretion in project selection due to the significant amount may exert long-term strain on developers and financiers. This underscores the importance of bolstering operational efficiency and organizational capacity within T&I firms to ensure the long-term sustainability of the offshore wind sector.

In summary, the strategic action of strengthening operational resilience and efficiency within the current scope of operations represents a marginal increase in scope as it is a natural extension of current operations. While this approach requires substantial efforts in talent attraction and operating model optimization, the level of strategic risk associated with this action is primarily firm-related and can be considered moderate. Given that the action focuses on enhancing the company's capabilities rather than directly contributing to capacity additions, its impact on the 2030 target is considered an enabler rather than a concrete action.

Although the action does not directly contribute to capacity additions, it is essential for meeting the targets, as it lays the groundwork for the company's ability to successfully participate in and support the offshore wind sector's growth. This strategic action has, as a result, not been given a composite score. Nevertheless, the action's substantial importance necessitates careful consideration and planning in its execution to ensure that the company remains competitive and well-positioned to capitalize on emerging opportunities in the offshore wind sector.

Expanding delivery scopes

Expanding the delivery scopes is a critical strategic action for T&I firms to meet European ambitions, address vessel shortages and tackle supply chain issues. Offshore wind projects have, as mentioned, historically seen an increasing use of multi-contracting to save costs on the developer side. However, developers like Ørsted are expressing a strong interest in seeing T&I firms expand their capacity and capabilities, taking on more risk and responsibility, by handling both foundation and turbine installation, rather than just providing vessels (Appendix 1: Ørsted, COP, Cadeler).

Before embarking on the expansion of their service offerings, T&I firms must conduct a thorough assessment of their capabilities, pinpointing areas where they can effectively leverage their expertise and concentrate on enhancing in-house knowledge. Cadeler, whose current approach has been characterized as a *"taxi arrangement"* (Appendix 1: Cadeler), could transition from merely being a vessel provider to assuming the responsibilities of a T&I contractor. As highlighted by Steenbeek, *"what we're lacking at the moment is a good number of T&I contractors who can do actual engineering and who will take on the risk and responsibility involved and also install the foundation "* (Appendix 1: Ørsted).

Adopting a T&I contractor model would entail transferring the risks associated with a specific scope of installation to the T&I firm, resulting in several benefits for the developer. These include streamlining project management efforts, the potential for improved project execution and schedule adherence, and the ability for developers to exercise greater control over costs.

The rationale behind this strategic action is that T&I firms can leverage a strong organization to deliver a riskier scope, potentially securing a higher payout, while enabling developers to allocate resources and attention to other critical aspects of the project. Industry experts emphasize that risk-sharing across the supply chain is crucial for the industry's growth and the acceleration of the green transition (Appendix 1: Ørsted). Recent trends demonstrate the industry's move towards this strategy, as seen in Cadeler's latest commitment to deliver full-scale T&I contractor services for the Hornsea 3 offshore wind farm (Cadeler, 2023), which means operating the vessels for the installations in-house rather than sourcing a contractor to do so. This transition will require a significant expansion of its internal capabilities, extending beyond simply providing the ship and crew for sailing, to assuming the responsibilities associated with logistics and installation. Furthermore, better dispersion of risk across the supply chain is expected to decrease the number of projects left on the drawing board, ensuring a more efficient and resilient industry.

Adopting the strategy of expanding delivery scopes presents certain limitations that T&I firms must consider before implementation. First, it increases the demand for engineering capabilities and a larger workforce. Managing a larger scope requires the ability to manage complex projects, possess specialized knowledge, and employ skilled personnel. Consequently, T&I firms must invest in developing their existing workforce and recruiting new talent to ensure the organization is well-equipped to handle the increased responsibilities.

Second, the decision to expand delivery scopes is contingent upon the company's risk appetite and financial resilience. Firms must evaluate their ability to absorb potential losses or liabilities, as taking on larger risks may expose the company to significant financial challenges. For instance, Cadeler is reluctant to assume the risk of becoming a full-scale EPCI contractor, as potential project failure could result in bankruptcy unless the company has a robust balance sheet given the size and complexity of an EPCI scope delivery (Appendix 1: Cadeler). Thus, T&I firms must carefully evaluate their financial stability before deciding to expand their scope of services.

Seaway 7's poor financial performance as a full-scale EPCI contractor underscores the importance of ensuring financial resilience and acquiring the necessary capabilities before accepting additional risk. The company has, since entering the T&I space in 2021, struggled to generate profits, as evidenced by its negative ROA and ROE. The increased risk associated with an extended delivery scope is further emphasized by the operational difficulties and thin EBITDA margin encountered by the firm during this period.

Third, as T&I firms expand their delivery scopes, they might face increased competition from other industry players seeking to expand their service offerings. This can lead to a more competitive industry landscape, with firms competing for the same projects and clients. Consequently, to maintain a competitive edge on EPCI contractors, T&I firms must strike a balance between a focused T&I vessel provider and delivering wider scopes for wind farm projects.

In summary, the strategic action of expanding project delivery scopes represents a radical shift, significantly impacting both the product and organizational scope of the firm. This expansion involves vertical integration across the supply chain, resulting in profound implications for the firm's size, scale, and complexity. Consequently, the level of strategic risk associated with this action is substantial, given the significant commitment of resources required and the uncertainty of the corporate outcome.

The potential 2030 target impact is rated high because the strategic action enables better risk-sharing across the supply chain, contributes to the industry's growth, and ensures that more projects move from the drawing board to actual implementation. By expanding delivery scopes, T&I firms can play a crucial role in addressing supply chain issues, ultimately supporting the offshore wind sector's ambitious growth targets. The composite score of 2.0 for this strategic action reflects the high-risk, radical nature of the action, but also highlights its potential for significant positive impact on the 2030 targets. Therefore, careful consideration and planning are crucial in executing this strategic action to ensure the successful transformation of T&I firms and their ability to support the offshore wind sector's growth.

Increase capacity

One of the most apparent strategic actions T&I firms can undertake to accelerate the green transition is to expand their fleet by investing in newbuilds. Investing in newbuilds and ensuring that these become operational as swiftly as possible and before 2030 will reduce the projected vessel shortage.

Expanding the fleet of installation vessels not only addresses capacity constraints in the market but also introduces more efficient vessels, contributing to a more sustainable offshore wind industry. The newbuild vessels are designed with the latest technology and advancements, offering improved operational efficiencies and performance compared to older vessels. As Harder highlights, Cadeler's new vessels are over 35% more effective than their competitors' current vessels (Appendix 1: Cadeler). The increased efficiency leads to reduced overall installation time, which in turn reduces the construction costs incurred by developers or wind farm owners, potentially incentivizing additional wind farm construction. Furthermore, with more efficient vessels, installation times are shortened, allowing T&I firms to complete more installations per year and address the anticipated shortage in the offshore wind market.

In addition to addressing capacity constraints and improving operational efficiencies, expanding the fleet offers several advantages. Enhanced flexibility can be achieved by deploying multiple vessels to work simultaneously on projects, meeting client demands for rapid project completion. Economies of scale become more significant with fleet expansion, as increased purchasing power can be leveraged for bulk procurement of fuel, spare parts, and consumables, leading to cost savings. Moreover, resource optimization across the fleet, such as streamlined personnel allocation, equipment sharing, and spare parts management, contributes to overall cost efficiency and reduced downtime.

Risk mitigation is another advantage of a larger fleet, as it provides redundancy and safeguards business continuity in case of equipment failure or other operational issues, given that having multiple vessels available to step in and continue the work if one experiences an issue ensures that projects can proceed without significant delays. Lastly, an expanded fleet enhances the firm’s competitiveness in the market, enabling the company to offer better pricing, faster service, or more comprehensive solutions to clients.

As the offshore wind industry continues to grow, it becomes essential for Cadeler and other T&I firms to expand their fleets to address the anticipated undersupply of vessels, of which WTIVs and FIVs are projected to have shortfalls of 10-15 and 11-16 vessels, respectively, by 2030. Cadeler, the market leader in the number of vessels, currently has two vessels set for upgrades and plans to add four installation vessels to its fleet between 2024 and 2026. This expansion will materially increase industry capacity.

However, even with Cadeler's six-vessel fleet, the industry will still face an undersupply, with vessel shortages expected to begin in 2026 and worsen yearly until 2030. This supports the argument for adding even more vessels to their fleet. Though, several risks and limitations must be carefully considered before committing to ordering additional vessels. One key constraint is the limited shipyard capacity available for constructing specialized WTIVs and FIVs. With a lengthy installation time and a backlog of vessel orders, firms are likely not able to obtain newbuild installation vessels until 2028 at the earliest (Appendix 1: Cadeler).

If the company successfully addresses these limitations and manages to expand its capacity, it will contribute positively to the capacity targets. This strategic action is considered marginal in scope as it aligns with the firm's existing product and market scope, requiring only incremental changes in the markets served and the range of services offered. The company is merely augmenting its current fleet, which necessitates similar internal resources and capabilities. It will, however, affect the organization by requiring more personnel both onshore and offshore to operate the vessels.

Although being a marginal action, it entails medium-level risks due to the significant resource commitment, uncertainty in shipyard capacity, and the challenge of attracting and retaining skilled personnel. These factors increase the unpredictability of corporate outcomes, such as revenues and market share. Despite these risks, the impact on the 2030 target is considered high, as expanding the fleet will directly address capacity constraints in the market, introduce more efficient vessels, and foster growth within the offshore wind sector.

By evaluating this strategic action based on strategic risk (medium), strategic scope (marginal), and the impact on the 2030 target (high), a composite score of 2.75 is obtained. This score reflects the balance between the risks and benefits associated with the action, emphasizing its position in the strategic action evaluation matrix (Figure 30). The composite score demonstrates that increasing capacity is a valuable strategic action, albeit with associated risks, that can significantly contribute to the European offshore wind industry's ability to reach the 2030 capacity targets.

Industry collaboration

To further support the European 2030 targets, T&I firms should aim to strengthen their collaboration with industry stakeholders. As previously highlighted, there is an apparent uneven distribution of risk between firms in the supply chain, where developers bear a large portion of the risk associated with establishing a wind farm. This inherent imbalance can limit the effective scaling of the offshore wind sector and hinder the attainment of target capacity additions. Therefore, this section examines how collaboration between T&I firms and other key players in the offshore wind sector, such as developers, operators, and financiers, can foster collective efforts toward sustainable practices and accelerate the transition toward renewable energy.

Strategic partnership with developers

Establishing long-term strategic partnerships with developers has the potential to address some of the challenges confronting the industry effectively. One strategy to achieve this partnership involves entering into long-term contracts that assign a specific vessel to a developer on a portfolio basis, as opposed to the current industry model of project-based contracts. This arrangement could potentially foster a compelling business case for both parties.

This commitment will ensure the consistent utilization of the T&I firms' vessel over a predetermined timeframe, ensuring a stable cash flow and solidifying their financial position. This financial stability helps firms maintain a robust financial position, enabling them to plan and invest more effectively in their business. Moreover, it addresses one of the previously mentioned challenges concerning the difficulty of securing financing for newbuild vessels. As stated by Candeel, *"(...) there are no financiers that will give out capital speculatively."* (Appendix 1: Clarksons). Thus, offering a concrete contract outlining the vessel's long-term utilization allows T&I firms to acquire funding more efficiently.

Furthermore, long-term contracts provide T&I companies with greater operational certainty by ensuring a consistent demand for their services. This predictability allows them to manage resources more efficiently, optimize vessel utilization, and reduce downtime. Consequently, long-term contracts mitigate the risks associated with fluctuations in demand and industry unpredictability, allowing T&I companies to focus on delivering quality services and maintaining a stable business operation.

Developers, on the other hand, benefit from having a dedicated vessel secured through a long-term contract, increasing confidence in their ability to execute the T&I scope of wind farm projects in a timely manner. This arrangement addresses one of the primary challenges that developers face by ensuring reliable access to the necessary T&I capacity, ultimately reducing project risk, and enhancing overall project success. As emphasized by Candeel, this becomes increasingly important for developers with a substantial pipeline: "*Build strategic partnerships, long-term ones if you have enough in the pipeline*." (Appendix 1: Clarksons).

The partnership between Cadeler and Ørsted exemplifies how strategic partnerships strengthen T&I firms and developers' relationships, driving industry success, as highlighted by Ørsted's VP Patrick Harnett (Cadeler, 2023). Collaborating on projects like the Hornsea wind farm series has improved communication, efficiency, and project execution. By understanding each other's needs and challenges, they enhance project planning and risk management. For Hornsea 3, Cadeler specifically designed its

F-class vessels and has committed to build a skilled team to meet Ørsted's requirements, demonstrating their commitment and strong relationship with Ørsted (Lindhardt, 2023).

However, this action might exert additional pressure on an already constrained industry, as it would tie up available T&I capacity, potentially exacerbating the existing shortage (Appendix 1: Ørsted). When T&I firms dedicate their vessels to specific developers for extended periods, it can limit the available capacity for other projects, making it more challenging for other developers to secure the necessary resources for their projects.

Long-term contracts might also be disadvantageous for T&I firms compared to signing individual contracts, as the overall contract value might be lower. Nevertheless, considering the current market conditions characterized by pipeline uncertainty and a shortage of installation capacity, these contracts can be financially robust. Thus, underlining why industry experts estimate long-term strategic partnership to be in the best interest of both parties, as the risks otherwise incurred increase significantly (Appendix 1: Cadeler, COP, Clarksons).

Drafting and negotiating long-term contracts can be challenging due to their inherent complexity. Both parties must collaborate to accommodate each other's interests, risks, and expectations in a mutually beneficial agreement. As the CEO of Cadeler recently emphasized, establishing a long-term contract with a developer requires patience and thorough effort, as it presents a significant amount of added complexity stemming from uncertainties related to expanding the scope and time horizon (Gleerup, 2023). The process involves addressing many extensive provisions, such as defining the scope of work, determining pricing structures and payment terms, setting liability and indemnification clauses, outlining termination conditions, and integrating dispute resolution mechanisms.

The strategic action of establishing long-term partnerships between T&I firms and developers moderately impacts the European 2030 capacity targets by addressing developers' primary concerns, ensuring reliable access to T&I resources, and contributing to successful wind farm project execution. However, the direct acceleration of capacity addition is limited, as the action mainly optimizes the allocation and usage of existing T&I resources. Furthermore, the industry-wide benefits may be restricted to the parties involved in these agreements. Consequently, while long-term partnerships offer several benefits for both T&I firms and developers, their overall impact on the 2030 targets remains moderate due to the limited direct contribution to capacity additions.

Following the establishment of long-term partnerships, T&I firms and developers may face moderate strategic risks due to the closer collaboration and potential organizational challenges that may arise. In the context of strategic scope, long-term partnerships between T&I firms and developers result in a moderate change. While these partnerships may deepen existing relationships and necessitate organizational adjustments, they are not expected to significantly alter the firms' product offerings, target markets, or overall organizational structure. As such, the change in strategic scope is moderate, focusing on optimizing current operations and client relationships rather than pursuing radical transformations.

In conclusion, the composite score of 2.0 for this strategic action reflects its moderate added strategic risk and scope, and impact on the 2030 targets. Despite long-term partnerships offering several benefits for both T&I firms and developers, the overall impact on the 2030 targets remains moderate due to the limited direct contribution to capacity additions and the somewhat restricted scope of industry-wide benefits.

Horizontal collaboration

The analysis of vessel availability conducted in sub-question one unveiled a distinct division of vessels among companies, with each firm owning a limited number of vessels. As a result, there is considerable potential for industrial knowledge sharing and horizontal collaboration between firms. In the T&I industry, horizontal collaboration involves sharing scopes of work, such as joint tenders, where two T&I firms collaborate on delivering a comprehensive scope - for instance, wind turbine installations - rather than dividing the installation scope. By actively pursuing increased collaboration with competitors within the industry through joint efforts like these, the deployment of offshore wind energy can potentially be accelerated.

A key difference between established and new T&I firms is the ability of incumbents to complete projects quicker and more effectively, due to their know-how and optimized processes (Appendix 1: Cadeler). By sharing knowledge and best practices across the industry, companies can identify and adopt leading approaches for delivering optimal projects. As noted by Karlsmose from CIP "*a crucial part of collaboration involves sharing knowledge and experiences with partners to develop the best possible projects*" (Appendix 1: CIP). By collectively adopting and implementing best practices, Cadeler, and its peers can optimize operations and support the achievement of European targets.

However, firms might be reluctant to engage in horizontal collaboration due to the desire to maintain a competitive advantage and retain knowledge internally. It is important to note that horizontal collaboration does not necessarily entail sharing intellectual property or research and development work, rather, it involves sharing scopes of work. T&I firms often consider their expertise, technological innovations, and operational know-how as key differentiators in a highly competitive market. While they may be apprehensive about sharing valuable assets, fearing it might compromise their market position, the focus on horizontal collaboration on shared scopes should alleviate these concerns.

The potential impact of horizontal collaboration is perceived as low, with a composite score of 1.5, due to the moderate strategic risk and scope, as well as the limited effect on accelerating the green transition.

The moderate strategic risk arises from potential competitive risks and the need for changes to firms' organizational structures and internal processes, which could result from knowledge-sharing and joint efforts. Although the strategic scope remains moderate since the action does not fundamentally change the firm's product, market, or organizational scope, it does enhance its ability to deliver products and services more efficiently.

Horizontal collaboration may lead to improvements in wind farm installation projects' efficiency and sustainability; however, these enhancements might not be substantial enough to significantly contribute to the European 2030 targets. Nevertheless, minor improvements can still positively impact the environment and support long-term climate goals. The actual impact of this collaborative approach depends on the extent of collaboration, the scope of knowledge-sharing, and the successful implementation of best practices and technologies developed through joint efforts.

Collaboration with financiers

To overcome barriers and challenges in the offshore wind industry, T&I firms can strategically collaborate with financiers such as financial institutions, investment funds, or private equity firms. Establishing strategic partnerships enables these firms to secure long-term capital for fleet expansion and upgrading projects, thereby enhancing their capabilities and market position.

Engaging in joint ventures with financiers helps distribute costs and risks associated with building, owning, and operating offshore wind installation vessels. Various options such as passive co-ownership, direct joint venture configurations, leaseback arrangements, or earn-out provisions can be considered to facilitate these partnerships.

The high capital intensity of newbuild vessels, costing upwards of USD 450 million, does present a challenge. Liquidity risks could arise from the substantial financial obligations required for vessel payments. Cadeler, in particular, faces potential liquidity pressure due to the concentration of financial obligations towards ordered vessels amounting close to 1 billion USD across the coming five years (Cadeler, 2023). Ordering additional vessels may increase liquidity risk, which in the short term is higher for Cadeler than peers Seaway7 and Eneti, mainly attributed to the already ordered vessels. Ensuring access to adequate financing is crucial to fulfill these obligations and mitigate liquidity risks.

For recently ordered installation vessels, they have been tied to project contracts that cover the cost of the vessel before becoming operational. Securing contracts early is especially vital in the rapidly evolving industry which raises concerns about existing vessels becoming obsolete as larger wind turbines are deployed. Financiers may adopt a more cautious approach to investing in new vessels due to historic underestimations of future requirements and needs. While significant capital investments are required to build a vessel, the more significant challenge lies in the ability to successfully operate these vessels.

The most substantial entry barrier in this industry is the trust and credibility established by incumbent firms (Appendix 1: Cadeler). Their experience and proven track record provide them with a competitive advantage that new entrants may find challenging to overcome. As such, the abundance of capital in the market and strong support for the green transition somewhat alleviate concerns regarding securing the necessary financing.

Collaborating with financiers not only addresses the financial barriers but also reinforces the credibility and trust required to succeed in this highly competitive market. This strategic action can help accelerate the sector's growth and contribute to Europe's renewable energy transition. It is important to note that while creative financing options are available, firms with robust financial capabilities in both loan and equity markets may not need to rely on them (Appendix 1: Cadeler).

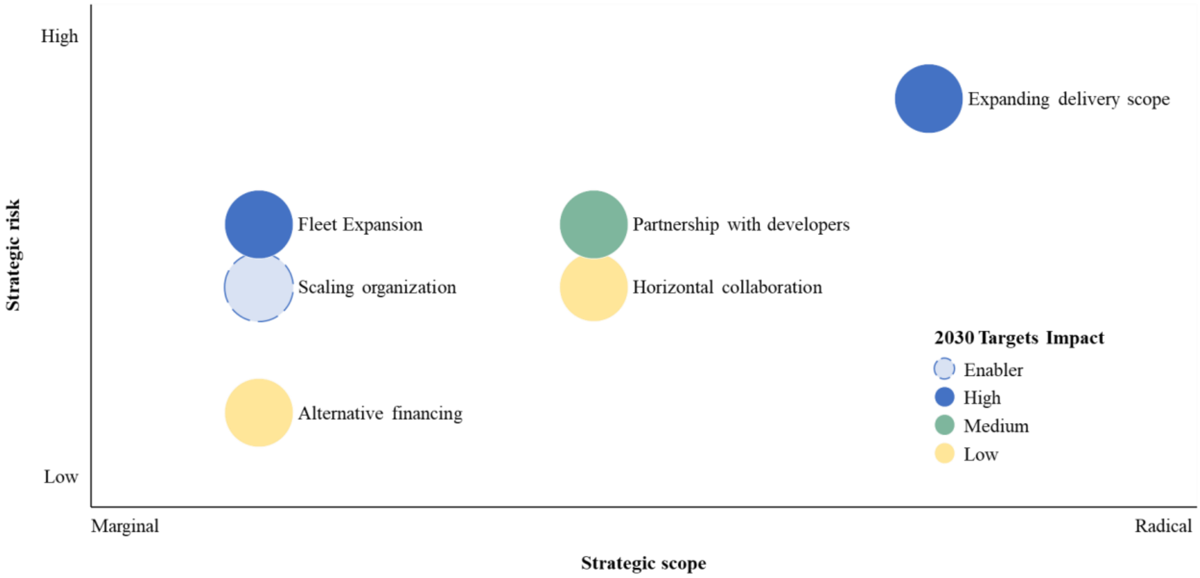
The strategic scope of collaborating with financiers is considered marginal, as it primarily impacts the T&I firm's financial standing by enabling access to capital for fleet expansion and upgrade projects, without fundamentally changing the product, market, or organizational scope. This collaboration focuses on financing aspects and does not significantly alter the breadth of markets served or the range of company services. However, partnering with financiers does contribute to a more balanced distribution of strategic risk by sharing costs and risks associated with vessel ownership. It is worth noting that the financing aspect of vessel acquisition is of less strategic importance, given the high demand for investment and the abundance of employable capital in the industry.

The 2030 target impact is perceived as low, as the collaboration primarily affects the T&I firms' financial capabilities with minimal influence on the overall offshore wind industry's capacity and efficiency. The composite score of 2.0 is obtained by considering strategic risk (low), strategic scope (marginal), and the impact on the 2030 target (low). Despite its limited effect on significantly accelerating the green transition, collaborating with financiers can enhance access to financing and thereby promote growth in the offshore wind sector. This demonstrates that collaboration with financiers is a valuable, albeit limited, strategic action that can contribute to a sustainable and competitive offshore wind sector in the long run.

Sub conclusion to iv. What strategic actions can T&I firms, like Cadeler, take to meet European 2030 capacity targets?

The above-conducted analysis identified six strategic actions that T&I firms like Cadeler can take to help accelerate the green transition and meet European 2030 capacity targets. Figure 30 summarizes the six actions in the strategic action matrix across the two dimensions strategic scope and risk, as well as the estimated impact in reaching the European 2030 capacity targets. A summary of composite scores is provided in Appendix 3. The analysis identified fleet expansion, partnerships with developers, and expanding delivery scope towards being a full-scale T&I contractor as being of high impact. Additionally, scaling the organization has been identified as an enabler for succeeding with other strategic actions.

Figure 30: Strategic actions summarized



Source: Own creation based on analysis

Conclusion

This study has thoroughly examined the European offshore wind T&I industry from a firm perspective, identifying crucial actions for T&I firms to meet the European 2030 capacity targets. By analyzing the historic development and future trajectory of the T&I industry, the research provides valuable insights for stakeholders, equipping them with the knowledge and strategies needed to navigate this complex landscape.

Recognizing that the transition to sustainable energy is a crucial driver for reversing climate change, the increasing reliance on offshore wind is a key driver of this transition, leading to ambitious targets set by the EU and non-EU European nations amounting to 116 GW of added offshore wind capacity by 2030. High demand and intense competition have made operational excellence and cost efficiency vital drivers for the success in the industry, which has resulted in an increasing number of zero-subsidy projects but has also led to considerable strains on the supply chain.

The analysis underscores the pressing challenge of potential vessel shortages, set to emerge from 2026. This challenge is driven by the rapid obsolescence of the global installation vessel fleet attributed to the increasing sizes of turbines and foundations with the size of installed turbines increasing 18% from 2018 to 2022 and similar increase observed in foundations. By 2030, the undersupply of vessels is anticipated to be 10-15 WTIVs and 11-16 FIVs. This issue is further complicated by the costly and risky nature of investing in new vessels and upgrades, which demands both operational efficiency and a secure pipeline of projects for firms to recoup their investments.

The industry is further challenged by an uneven distribution of risk throughout the supply chain, labor shortages, and a slow and rigid tender process. These challenges coincide with the broader concern of the tendered capacity in Europe falling 30% short of the ambitious offshore wind capacity target set for 2030. The situation could worsen if T&I firms leverage the favorable market conditions of vessel scarcity and high demand for their services to exert pressure on developers, potentially leading to an overall decline in the industry's health.

The performance analysis underscored the relative immaturity of the industry with the peer group realizing diverse profitability ratios ranging from -8% to 15%. The importance of partnership and expertise within the industry is underlined as the two most established companies, Cadeler and FOWIC, have risen as pivotal players. The companies obtained the highest EBITDA margin averaging 48% for the period, owing to their client-centric approach and strong project track record. The study also draws attention to the heightened risk involved when venturing beyond traditional T&I chartering evidenced by the operational difficulties and subpar financial results that Seaway 7, a leading EPCI contractor, has faced in recent years. Moreover, the analysis highlights Cadeler's impressive project pipeline extending until 2027 and its secure European revenue streams, which further solidify its dominant position within the industry.

Finally, this paper identified and evaluated six strategic actions based on their strategic risk, strategic scope, and projected impact on the European 2030 capacity targets. The most crucial actions include fleet expansion, entering strategic partnerships with developers, and expanding delivery scope towards being a full-scale T&I contractor consequently lessening the burden of risk incurred by developers. Additionally, the paper highlights the importance of scaling the organization as a key enabler for successfully executing other strategic actions.

By offering a comprehensive analysis of the T&I industry and incorporating recent developments, this paper contributes to the existing literature on the offshore wind sector. The findings reveal an increasingly challenging yet exciting environment for the T&I industry, necessitating extensive investments and collaborative efforts from various stakeholders, including T&I firms, developers, policymakers, and other contractors, to achieve the ambitious European 2030 capacity targets.

Limitations and further perspectives

This paper has investigated the development of the European offshore wind T&I industry and the necessary actions for T&I firms to meet the European 2030 capacity target. The pragmatic research philosophy and abductive reasoning employed in this study necessitate continuous verification or falsification of the identified strategic actions' applicability. As a result, it is recommended that future research examines a broader range of geographical areas, strategic actions, and industry stakeholders to validate the findings and deepen the understanding of the industry dynamics.

While this paper utilizes Porter's Diamond Model for analyzing the European offshore wind T&I industry the authors acknowledge that alternative concepts and frameworks, such as Porter's Five Forces, could have been employed. Moreover, since the study investigated specific T&I firms and their performance, the authors recognize that frameworks like Barney's Resource-Based View (RBV) or Osterwalder's Business Model Canvas might provide additional insights into the key resources and capabilities of these firms as well as their ability to achieve a competitive advantage in the industry. These observations highlight the opportunity for further research adopting different methodological and theoretical approaches, enriching the understanding of the European offshore wind T&I industry and its various dimensions, ultimately advancing the development of effective strategies.

A large component of the global offshore wind sector and the T&I industry has been excluded from the scope of this paper, namely China. As mentioned, China possesses a large vessel manufacturing capability and an extensive fleet of wind installation vessels. But due to the regulatory and political climate, the vessels and the offshore wind projects are deemed inaccessible to international firms. In light of the global as well as European transition towards green energy sources, further research is needed to shed light on the political, regulatory and economic dynamics of this issue and explore potential challenges and opportunities of leveraging the Chinese capabilities and capacity in supporting the global offshore wind sector.

Expanding on this, the current geopolitical landscape, characterized by heightened tensions and conflicts such as the ongoing situation in Ukraine, challenges the stability of the industry and raises questions warranting further examination in future research. This context, coupled with the energy crisis and the increasing emphasis on the green energy transition to achieve independence from Russian oil and gas, underscores the importance of continued research and analysis to inform decision-making by industry stakeholders and policymakers. Additionally, the evolving geopolitical situation may necessitate increased security risk measures in the future, as it is expected to dramatically shape the industry's and sector's trajectory. In light of the evolving geopolitical landscape and pressing industry challenges, continued research of the offshore wind T&I industry are crucial to inform decision-making, accelerate the green transition, and ensure energy security in pursuit of the ambitious 2030 capacity targets.

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Appendix

Appendix 1: Transcribed interviews

Interview w. Bjarne Brendstrup from Energinet (Appendix 1: Energinet)

Hvor er jeres beslutningsret og råderum? Kan I bare sige ja kaptajn, når nogen vil bygge en vindmøllepark, eller kan I sige nej og komme med input til, hvordan tingene skal sættes op?

Brendstrup

Vores regler er, at vi er forpligtet til at lade folk komme på nettet, og vi må ikke diskriminere, hvad vi synes er en god eller dårlig idé. Vi skal håndtere det inden for rimelig tid, og så er det altid et spørgsmål, hvad der er rimelig tid.

Karl Amandus Witt Brückner

Det er meget simpelt, men jeg kunne forestille mig, at det kommer med nogle komplikationer, når der så er mange, der banker på døren og vil have det.

Brendstrup

Ja, det er det. Vi skal have 3 eller 4 gange så meget produktion inden for de næste par år, så der er meget, der skal bygges, og hvordan får man gjort det? Vi er et monopol, men vi kan ikke sige nej til kunder som et normalt monopol kan. Vi skal forpligte os til at betjene dem, uanset hvor godt eller skidt de opfører sig.

Karl Amandus Witt Brückner

Hvad er jeres erfaring med den åbne dør politik og tidligere forløb?

Brendstrup

Jeg tror, den åbne dør politik blev standset så tidligt, at det måske ikke gør den helt store forskel. Generelt er der nogle, der er meget aktive i pressen, som er irriterede over, at de ikke kan få deres vilje hurtigt nok. Men de 90% der går godt, hører vi ikke noget om. Det fylder meget, og det kommer også til at sætte mange ting i gang i de politiske debatter. Det betyder ikke, at vi ikke skal forbedre os og sådan nogle ting.

…

Philip Skat Nørrevig

Ja, i forhold til det du snakkede om før, må I nogle gange sige nej til kunder? Er der nogle begrænsninger på det nuværende net? Altså, vil I kunne håndtere, lad os sige, 5 nye vindmølleparker i forhold til den energi, der vil blive genereret? Er der nogle constraints man skal tage højde for her?

Brendstrup

Vi kan ikke bare sige nej, men vi kan sige, hvor lang tid det tager, og nogle gange skal vi etablere ekstra net for at noget kan komme ind. Hvis der er meget store projekter, kan det tage lang tid, især hvis vi skal bygge en luftledning på tværs af landet. Vi skal have godkendelse fra forsyningsministeriet for at lave store investeringer, og der skal vi lave en såkaldt paragraf 4 ansøgning, hvor vi skal argumentere for, hvorfor det er nødvendigt at bygge den pågældende del af nettet. Vi skal finde den rigtige balance mellem at bygge ud på forkant og vente til der er mere sikkerhed.

…

<u>Interview w. Casper Torres Karlsmose from Copenhagen Infrastructure Partners (Appendix 1: CIP)</u>

Philip Skat Nørrevig

Hvordan identificerer og vurderer I disse vindmølleprojekter til mulige investeringer? Hvilke kriterier kigger I på?

Karlsmose

Vi ser på forskellige kategorier af projekter, f.eks. aktionsmuligheder eller tendermarkeder, hvor forskellige lande eller stater driver processen. Det er den største del af markedet i dag. For eksempel har Danmark, Holland, Tyskland og USA auktioner. Der er to typer af tenders leaseauktioner og centrale aktioner. Leaseauktioner indebærer, at du som udvikler køber dig retten til et stykke hav eller et stykke land ved havet og selv står for at udvikle det, hvilket indebærer en del risiko forbundet med projektet. Der er også centraliserede aktioner, hvor en stat tager hatten for udviklingen af projektet for dig, som udvikler, og når du køber dig ind i projektet, er det mere eller mindre klar til at blive bygget. Derudover er der developer-led opportunities, hvor udvikleren kan gå ind i et land og udvikle inden for et specifikt tender eller helt frem til nogle opportunities. Vi skal nå en stor volumen af projekter, hvis vi skal nå vores investeringsmål, så det handler primært om, hvor store projekterne er, hvor hurtigt de kan opnå financial close, og generelt hvor gode chancerne er for forskellige projekter. Det er også vigtigt at vurdere, hvor dyrt det er at komme ind i projekterne, hvor dyrt det er at opføre projekterne og hvad man kan forvente at sælge strømmen til i sidste ende.

Karl Amandus Witt Brückner

Og når vi sammenligner disse tre centrale tilbud – lease-tilbud og centraliserede auktioner – kan vi opstille de tre separat og vurdere, hvilket af dem der er mest risikofyldt og sværest at opnå succes med.

Karlsmose

De mest risikofyldte er udviklingsprojekter, efterfulgt af lease-tilbud og sidst centraliserede auktioner. Og selvfølgelig har de projekter med højest risiko også højt forventet afkast i samme rækkefølge.

Philip Skat Nørrevig

…

Karl Amandus Witt Brückner

I forhold til disse Capex-investeringer og i forhold til, om det her site er på meget dybt vand eller det er langt væk fra kysten, er der så nogle nemme måder at tænke på, hvilke størrelsesforhold man skal tænke ind i. Hvad er det for nogle overvejelser, i har der?

Karlsmose

Ja, så partnerskaber spiller en stor rolle i vores forretningsmodel. Vi arbejder sammen med forskellige udviklingspartnere, og det er vigtigt at have en stærk tilstedeværelse i de specifikke markeder, hvor vi søger efter projekter. Det er også vigtigt at finde de rette partnere med de rette kompetencer og erfaringer. Så i forhold til vores strategi for at vælge partnere, så kigger vi på deres track record, hvor er deres ekspertise, og hvordan passer det ind i vores egne strategiske interesser. Og så er der også en vigtig del af samarbejdet, som handler om at dele viden og erfaringer med vores partnere, så vi sammen kan udvikle de bedst mulige projekter.

…

Philip Skat Nørrevig

Hvor stor en rolle spiller eventuelle tilskud og incitamenter fra regeringer for jer?

Karlsmose

Når vi starter på en business case for et projekt, fokuserer vi på cost-siden og ser på site characteristics osv. for at vurdere om projektet kan løbe rundt og matche vores hurdle rate. I mange tilfælde vil det være for risikabelt at satse på markedspriser og derfor vil vi have en sikkerhed om prisen på forhånd. Det kan ske ved at gå sammen med et corporate som Amazon eller Google, som køber strøm fra vores projekt til en bestemt pris. Det kan også ske ved at staten køber strømmen til en specifik pris eller støtte for at vi er sikre på at opnå det afkast vi har brug for. Jeg tror at det betyder noget, men mindre i dag end for mange år siden hvor omkostningerne for offshore vind var betydeligt højere.

…

Karl Amandus Witt Brückner

Når en spiller som CIP i hele den værdikæde har en stor risiko, når I bliver større? Jeg kunne forestille mig, at I ikke har så mange aktiver, så det gør måske jer så forfærdeligt meget, hvis det lige pludselig bliver lidt mere besværligt. Eller hvordan hænger det sammen?

Karlsmose

Altså man kan sige, i værdikæden, når møller bliver større, er der mange andre ting, der også skal følge med. Der er selvfølgelig fundamentet, som skal blive større for at kunne passe til større møller. Og hvis du øger spændingen, så skal du også have større kabler og større substations med. Der er også potentielt behov for større skibe til at installere møllerne, og du skal have høje krav til havnene, så de kan understøtte større vægte osv. Så der er mange ting, der skal gå op. Og det er noget, vi skal finde ud af sammen med leverandørkæden og sammen med dem, der ejer infrastrukturen omkring havnene og vejerne. Det er noget, vi skal veje op mod hinanden, men man kan sige, vi indkøber jo alle disse ting. Så det er ikke os, der sidder med risikoen på investeringer som sådan. Det vil være leverandørkæden, der gør det muligt.

…

Philip Skat Nørrevig

Ud over den flydende energi, hvordan tror du så, industrien vil udvikle sig over de næste par år?

Karlsmose

Mest vokser den ekstremt hurtigt. Kan ikke huske tallene sådan lige i hovedet, men vi kigger nok på lidt over 60 gigawatt installeret lige nu på verdensplan, som er kommet over de seneste 30 år, og det volumen skal nok fem-seksdobles over de næste mindre end 10 år, så det er en helt ekstrem vækst. Vi ser inden for offshore vind, så klart det største fokus det kommer til at ligge på, hvordan hele leverandørkæden er klar til at levere det, og det er også det, alle snakker om, når man går til konferencer. Og det er så videre, så vi kan sørge for, at leverandørkæden kan levere på de enormt store volumener, der er behov for, og at infrastrukturen kan komme på plads. Fordi hvis man lige skal levere al strøm fra havet igennem og så vinde projektet, jamen så er det jo klart, at hele dit transmission grid skal jo kunne tage strømmen fra kysten ind til de steder, der er brug for strømmen og så videre, så det kombineret med et PtX bliver nogle store trends, der kommer til at virkelig betyde noget i de næste årtier.

Karl Amandus Witt Brückner

Hvis du skulle sætte en finger på den vækst, hvad er den største hurdle skulle være? er det at få opgraderet infrastrukturen eller at få tiltrukket medarbejdere eller hvad? Hvad er den toneangivende hurdle?

Karlsmose

Jeg tror, den allerstørste hurdle er grid i virkeligheden. Altså transmissionen, og så på en andenplads vil jeg sige leverandørkæden, og på en tredjeplads også arbejdskraft. Men alle 3 er supervigtige.

Philip Skat Nørrevig

I forhold til leverandørkæden, hvad mener du med det? Tænker du på alt fra udvikling af vindturbiner til levering og opsætning af vindmølleparker, eller er der noget specifikt, du tænker på?

Karlsmose

Det er primært manufacturing, altså at lave komponenterne. Hvis du kigger på vindmøllefabrikker, tårnfabrikker og vingefabrikker, findes der ikke tilstrækkelig kapacitet i markedet i forhold til, hvor meget der skal leveres. Og endnu mere, hvis du kigger på de forskellige elektriske dele, som skal på substations og kabler og så videre. Alle kategorierne vil se, at der ikke er nok kapacitet i markedet.

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<u>Interview w. Niels Nielsen from Naver Energy (Appendix 1: Naver Energy)</u>

…

Karl Amandus Witt Brückner

Det er en meget, meget lang proces at få sådan et her fra start til slut, og det vil så også sige, at det lyder som om, at der kommer en øget kompleksitet. Jo længere man kommer i, fordi man starter med at kradse i overfladen, så er det fint nok at man lige kan se Der er noget potentiale, men når man så kommer ind i dybden, så er der lige pludselig en masse faktorer man skal tage højde for. Ville i kaldte det en kompleks verden I arbejder i eller er det måske bare en lang proces og så det næste delspørgsmål skulle så være kan man kunne man forkorte den proces eller gøre den mindre kompleks.

Nielsen

Jeg tror jeg ville svare klart ja til begge dele. Altså det. Det overhovedet at vinde projekt er ekstremt komplekst, altså som ellers han har siger ikke altså den her med at guide ud fra at vide, hvordan er forholdene på sitet. Jeg har været med til et projekt i Korea for eksempel hvor der var ret så store udfordringer med at få det her projekt installeret, altså et eksekveringsteam er det ikke på grund af, at man ikke havde tilgang til materiel og bådene og alle de her ting her og nu snakker vi igen. Projekter først ville blive installeret om et par år, men det her, Det var så et par år siden. Så da vi sad i de her planlægningsfasen, men simpelthen på grund af jordbundsforholdene på det her givne site dybden var fin, så man kunne fint finde jackups, der kunne hive det op i den her dybde, og der var ikke udfordringer med broer og ting og sager man ikke kunne komme igennem og så videre og så videre. Men fordi at der var simpelthen så kraftigt så dybt et lag af mudder simpelthen Der er jo kæmpe forskel på hvordan undergrunden er rundt omkring. Jo, men lige her der var der så dybt mudder at da man egentlig havde fundet en installation vessel som faktisk godt ville kunne jakke op selvom at jamen Niels kan det passe, at Det har været 15-20 meters mudder man skulle igennem, altså at se.

…

Karl Amandus Witt Brückner

Men det lyder som om at offshore er et helt særligt område lige på den her kompleksitet. I hvert fald når du, når du beskriver det Sådan her.

Nielsen

Det er det Det er. Det er meget, meget komplekst. Altså Det er jo ikke uladsiggørligt. Det er jo, Der er jo ting, der hele tiden bliver smartere. Man bliver klogere. Hele industrien lærer jo hele tiden af altså

altså ja sig selv og fra fra olie gas og alle de her ting her. Men Det er klart, Det er altså i forhold til den her med. Med processor og permits og så videre. Der er rigtig mange ting, der godt ville kunne forbedres, og Det er jo også det. Jeg ved ikke om i har fulgt med i Sådan nogle ting i Nyhederne her på det sidste. Men altså, Det er jo Sådan noget der også er ved at virkelig være snak om at man er nødt til fra politisk side nu og oppe sit game i forhold til hvis Det er man vil have den her grønne transition, altså hvis Det er man vil have vindmøller, så er industrien Sådan set klar, men til at kunne eksekvere på de her ekstremt store vækstrater. Det er et større overordnet set. Der er stadigvæk problemer, men Det er et større problem at permit processerne i de enkelte lande tager ufatteligt lang tid. Så er room for improvement.

Karl Amandus Witt Brückner

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Karl Amandus Witt Brückner

Ja, så der er måske en konflikt i, at vi gerne vil udføre store projekter for at imødekomme den enorme efterspørgsel, som alle forventer vil komme snart. Men mange af de parter, der er involveret i værdikæden, er ikke så interesserede i at påtage sig den store risiko og stille deres skibe og andre aktiver til rådighed for projekter, som måske ikke bliver realiseret i fremtiden.

Niels Christian Kokkenborg

Ja altså både og fordi det er jo selvfølgelig hvis vi er tidligt inde i opgaven, så kan vi jo også rådgive Vores kunder og så sige prøv at høre der er en vis risiko for at markedet måske ikke synes, at det her projekt lige så spændende som du synes, så en af mulighederne kan det jo være, at du rent faktisk laver kontrakter meget tidligt, og du gør dem bindende. Det vil sige, du kan selvfølgelig garantere du i sidste ende bygger noget, men måske tror du så meget på det at du er villig til at sige, hvis Jeg er nødt til at ringe og sige hov det blev ikke til noget, så vil jeg også betale jer for det. Og Det er jo noget man kan gøre i en meget tidlig fase, men du kan gøre det 3 år, for så er det for sent. Men du kan måske gøre det udviklingsfasen og sige, prøv at høre. Vi skal først installere det her projekt i 2029, hvis vi går til markedet og se prøv og hør. Der er jo en vis risiko og så siger de jamen, så skal vi i hvert fald hvis I annullerer kontrakten inden det her år, så skal vi have 20 millioner, hvis Det er året efter, så Det er 50 millioner og så videre. Det er nogle af de ting, vi kan gå ind og rådgive kunderne om os.

Nielsen

Og Det er jo faktisk egentlig lidt den situation, som både indenfor TN altså specielt dem der ejer de har installations skibe jo, men også vindmølleproducenterne, tårn fabrikanterne, kabelplus fabrikanterne og så videre. Så den her med local content, hvis der skal investeres i det et eller andet arbejder jeg et sted. Jamen, det kræver jo en kæmpe capex investering for den virksomhed der nu skal tage den er det l møllerne? Jamen, så er det jo en Siemens eller Vestas eller et eller andet som skal ud og bruge 2-300 millioner euro på at etablere en ny nacelle fabrik for eksempel. Og det vil man jo ikke gøre. Virksomhedsmæssigt, inden at man også er sikker på at kunne afskrive denne investering igen, og den investerings afskrivning, den er nødt til at komme fra projekter, som man kan sælge sine Møller på, så det virkelig Sådan hønen eller ægget ikke og og de her projekter her. Jamen de har større chance for at vinde i auktionerne eller få sine projekter kørt igennem de her parenteser og så videre. Hvis Det er de kan vise at de har en lokal produceret med for eksempel, så så Det er Sådan hvem man tager første skridt ikke, og Det er samme som næste der siger jamen 3 år hvis Det er 3 år inden det skal installeres så er det for sent, fordi så er de der skibs kontrakter, så er de lige længe lukket og så kan man sige jamen så er der jo et kæmpe blue Ocean, måske endda næsten for at komme ud og og bare købe sig et skib og så at komme ud og leje det ud. Det kunne godt se Sådan ud, men de der skibs investeringer er jo ekstremt dyre. Jeg ved du ved alle sammen hvad Sådan et nyt installationssæt til en 15 megawatt møllen koster. Det er helt flot med mange penge.

Niels Christian Kokkenborg

De bygger nu Det er om, og Det er helt op til 2025 megamæt turbiner de kan installere, men Der er snakker vi cirka 350 millioner euro for at bygge det Og Det er det at have en virksomhed som Cadeler for eksempel eller en eller anden. De går jo ikke ud og lægger en ordre på det skib, inden at de faktisk også er sikker på, at Det er skib vil kunne blive og kunne tjene de her penge ind igen. Det er jo, Det er jo en kæmpe pose penge der skal ligge deroppe front. Ellers så Det er Sådan det Det er den her balance med at få hele værdikæden i indenfor Sådan et projekt til at udvikle sig nogenlunde medløbende.

Karl Amandus Witt Brückner

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Karl Amandus Witt Brückner

Har i nogen indikation af, hvor mange projekter der går i vasken? Sådan I et stadie, der måske er noget om, at man har lavet en aftale og så ryger i vasken.

Nielsen

Kommer an på hvad? Hvad? Definitionen af en aftale er fordi at altså den måde de fungerer på igen når når du jo længere hen du kommer og under den her kontrakt fase jamen så er der en masse mellemstop altså det her det. Det tager jo mindst et år at lukke bare en mølle kontrakt. Jeg ved ikke hvad i forhold til Sådan en vestlig kontrakt med eller Det kan være du kan kommentere på den altså selve mølleindkøbsafdelingen, når du har egentlig valgt den leverandør du vil have om du er vaccineret eller g eller hvem Det er, men hvis du siger du har valgt. Vestas for eksempel så tager det jo et år at lukke den her kontrakt, fordi Det er jo ikke Sådan 3 sider ligesom man køber en bil. Det er jo 5 8000 sider kontrakt, så der sidder jo 2 hold altså på en på developers side og en på Vestas i det tilfældes side på 5 til 20 mand i altså i perioder og simpelthen bare forhandler på tværs af bordet og. Og der har de jo de her medlemsstat hvor at man så når man et eller andet altså Mølle stående siger okay, jamen, hvis projektet ikke bliver til noget nu, jamen så koster det 50 millioner euro. OK bum så går man fra hinanden eller okay, nu er vi så kommet videre hen, så nu koster det måske lige pludselig 50% af af total projektprisen altså mølle kontrakt prisen ikke. Og så er der så nogle datoer hørt, at det bliver Sådan helt. Men overordnet set altså hvis man tager et reference projekt på én gigawatt Det er Det er den typiske størrelse af de projekter, der sidder og bliver solgt i dag. Så så 1000 megawatt og Sådan et projekt. Det koster cirka 4 milliarder euro. Det er plus minus alt efter hvilket land Det er og hvornår Det er og Sådan nogle ting, så Det er jo nogle ret store. Overordnede projekt summer, Der er der, der kommer, og Jeg tror, hvis man skal se lidt på en lidt på lidt større makroperspektiv også, så kommer materiale både tilgang, men også prisen jo deraf den den bliver svær, når vi kommer en 5 år ud i fremtiden. Der kommer til at være en shortage på at kunne at kunne levere, og Det er bare Sådan en råmateriale, og når man så begynder at skære derefter at finde leverandører som der Sådan set kan levere komponenterne som for eksempel et. Så en gearkasse en generator så videre, jo flere der ønskes og og få den fra lokal folk altså med local content i forskellige lande. Jamen, det skal bygges op med investeringer i nye Møller i nye produktionsfaciliteter og så videre og så videre, og de har investeringer, de skal afskrives og som renter niveauerne de er i dag, og det gælder jo også for de store virksomheder. Det er jo ikke kun os på privat forbruger, jo Det er det nogle enorme summer, som der lige pludselig skal afskrives på ret kort tid, og Der er der tror jeg, at den mere etablerede industri fra Vesten kommer til at opleve et et ret hårdt pres fra Kina fra combien til leverandører derovre. Det er ikke ellers så både på Møller og tårn. Og hvad pokker det måtte være. Jeg tror man kommer til at se et ret stort shift og komponentleverandører i dag. De er de er presset altså ikke kun hvis Siemens dem der har hele møllen, men også dem der producerer gearkasserne til dem og generatorerne til dem og alle de enkelte underkomponenter. Det er en meget presset surprise chance, men man har i dag og. Altså i er herren i ved afkast gråden fra fra developers side er jo også faldet markant over de sidste 5 år, og Det er jo ikke fordi de sidder med med tocifrede afkast grader længere. Det han ligger de nede på 8 måske niende de hellige typisk i de her projekter i dag og skal jo også have den risiko II tingene som der jo også er.

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<u>Interview w. Wouter Steenbeek from Ørsted EPCO (Appendix 1: Ørsted)</u>

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Karl Amandus Witt Brückner

Can you maybe elaborate a bit on the divide between the secondary aspects and the wind turbine installation aspects, which seems like we have this divide here.

Steenbeek

There is not necessarily a divide. We have these more traditional scopes like foundation installations, turbine installations and OS installations where developers like Orsted previously would get a project, and then go out and source a specific installation vessel to install the foundation and then the developer would only deal with one contractor like for instance DEME, Van De Oord, Boskalis. They would take the entire scope of transporting the monopiles from the supply port to the feeder port. And then from the feeder port offshore to site and there they would install the foundations plus all the equipment. Now we have seen some change in the market where we are being forced to also source our Tier 2 contracts. So, like sourcing, for instance, the transport of foundation separately or the installation of some of the smaller items. Secondary steel is for example currently being sourced separately for many projects.

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Karl Amandus Witt Brückner

In which of the different foundations types do you see the biggest potential?

Steenbeek

Yeah. So currently the vast majority installed is monopiles and then if it gets a bit deeper approximately, I guess around 60-70 meters, they move over to jackets. And then if you go even deeper, like deeper than 100 meters, you might want to switch to a floating foundation.

So what we expect to see in the future: First Orsted is a big believer in monopiles, so if we can do something with monopiles, we'll do it with monopiles and we have pushed monopiles to greater depths than anybody expected. So our idea is that this will still be the standard operating procedure.

However, we also see floating coming to the market, Orsted has always been a bit of a follower when it comes to floating, but now we're aiming to take a leadership position in this as well in the near future. We've seen some test projects, all very small scale and it's still very much more expensive than monopoles, but it will come more and more in the future and if I look at our pipeline sort of after 2030, I think about 20% of our projects will be floating approximately. But if you look at the amount of MW, the vast majority will still be ground based foundations. Then jackets will also remain important for specific locations due to soil conditions, if it's lot of earthquakes, for instance, which we see in in APEC then we all use jackets, but standard is still monopiles.

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Karl Amandus Witt Brückner

For that concept to work is there enough geographical sites?

Steenbeek

It will also be possible in areas like Scotland, but Cadeler is a very strong believer that will do everything offshore with big vessels.

Karl Amandus Witt Brückner

Can you maybe elaborate a bit on your experiences with Cadeler, if you have had any and how Orsted is working with them?

We see Cadeler as quite positive at the moment, because they are investing heavily in newbuilds. They have 4 vessels on order at the moment and they got a couple of other things lined up. So that's very positive.

Cadeler has so far has been a vessel supplier. What I mean with vessel supplier is basically you chartered a vessel as developer and then we could use it however we wanted to usually for turbine installation because there are turbine suppliers like Siemens and Vestas that will also do the actual installation if needed. But what we're lacking at the moment is a good amount of T&I contractors who can do actual engineering and who will take on the risk and responsibility involved and also install the foundation. At the moment, Orsted is in talks with Cadeler to develop them from vessels provider to T&I contractor.

Karl Amandus Witt Brückner

So a big part of this of establishing a wind farm is also spreading the risk? and there you see a large potential in Cadeler to take on more of that operational risk in actually being part of the installation and not just in supplying the vessel.

Steenbeek

Exactly. Yeah. And Cadeler is growing very quickly at the moment and of course, there is a large demand for more T&I contractors and more installation vessels.

But it's not just about increasing in capacity, they also need to increase in capability. So being able to take on these responsibilities.

Karl Amandus Witt Brückner

What Cadeler is doing in terms of ordering vessels - is there anything risky about ordering these extremely expensive ships?

Steenbeek

Yes, and what we've seen so far with offshore wind is that it has been developing so quickly. When I started out a bit over 10 years ago, the turbines that were being installed were 3 to 3.5 MW. We're currently installing 12 MW and we're looking for our future projects at installing 15 to 20 MW turbines, so it is just exploding in size.

To build a vessel takes approximately 3 years. And you of cause need to design it first, get the financing in place, etc. So, at the moment when you design it you need to design it for a future and it is difficult to predict what the future holds and so far all the predictions have been underestimated. So basically, by the time the vessel hits the water, it is already too small and too old to handle the generation of turbines and foundations.

That's why there is also a bit of reluctance with financers and with contractors to invest in new vessels because they only have a very short life span. Old installation vessels are currently being used for O&M, operation and maintenance, work, which theirs is just a lot less money in.

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Philip Skat Nørrevig

What do you at Orsted feel about this change? Do you prefer like being able to go to a single contractor and signing a contract for both foundation and turbine installation or are you OK with this device that we're currently seeing?

Steenbeek

Traditionally, Orsted has always been involved with one contractor for each scope, so we hardly ever combined foundations and turbines. However, what we are currently seeing, as I said, with foundations, where are now very often being forced to source transport separately, and source secondary structure installation separately.

And that is an issue because we you get all these interfaces offshore and what if one thing doesn't work? What if you're transport scope is too late and you have your installation vessel waiting, then of course we have some liquidated damages from the transport company, but that's never going to compensate for any delay on a project as this will always cost the developer heavily.

Yeah. So that's why you would preferably have at least a whole scope - like foundation installation - preferably you have that with one contractor who has the main responsibility, and we don't need to be in the middle of all the time. But with the coordination that's just going to cost you to do so.

We've also seen other developers that have just one EPCI or balance of planned contractor that are responsible for even buying foundations, buying cables and then doing all installations.

Karl Amandus Witt Brückner

Does that also mean that you are taking a larger share of the risk and maybe also larger share of the return in this projects relative to the contractors?

Steenbeek

Yeah. If you mean by having all these separate contracts, yeah, there's more risk and why we have always been splitting up scopes is because we think we can manage it better than the contractor basically. And we have shown that in the past that to be the case as well where we were more competitive than developers that are awarding it all to a balance of plant contractor. But yeah, there's only so far you want to go with dividing up the scope, and at some point you would need to let's contractors take on the risk.

Philip Skat Nørrevig

So how do you mitigate some of these risks involved? Is it like purely contractual that you state the different requirements that you need or how do you go about managing these? Is there anything you can do sort of from the developer side to to hopefully mitigate some of these risks?

Steenbeek

As soon as the contract is signed and when, which we generally do three to two years in advance of installation. Then there's already a project team from our side already and from the contractor side. And then you start the whole engineering and the project preparation. So, you stay on the contractor really closely, really follow the schedule, the preparation schedule also on the supply side with production or foundation and cables turbines. We get monthly reports, you study them carefully, you make sure that any delay is picked up really quickly and then you can mitigate it and move things around.

Karl Amandus Witt Brückner

What do you see as the largest challenges for your department when you look just a few years ahead?

Steenbeek

That is really the supply chain, it's we have seen a massive shift in the market just in a few years. Looking back when I started in, in offshore wind over 10 years ago and just went in a few years time the cost of offshore wind was reduced by 65% percent. It's a really massive reduction.

The entire world saw that and decide as well that's a good business case for offshore wind. It's much cheaper than other forms of energy. That's good. And it's renewable as well. So, let's go for that. So that went in a few years that old governments have made plans for offshore wind. So mostly northern Europe, which was already quite active, but then we see this big acceleration, for instance, Dutch Government, English, the Danish Government, big acceleration in expectations for offshore wind. Also the US got fully on board with offshore wind, lot of projects being developed there at the moment. We've seen Taiwan as the first Asian country but also now see Korea, Japan, Vietnam, also China being very active. India is looking into it. Australia's looking into it. So the entire world is now developing wind farms which has caused, of course, a big demand of the supply chain.

So these are the things that we're operating with these installation vessels are global assets, so we're basically competing with all other areas of the world and there are very limited and it takes long time to develop these vessels. So that is the situation where now since about a year or maybe two years that we really struggling to get sufficient installation vessels for our projects. That also has an impact on the price of course the demand is much higher. So the prices have skyrocketed. It's like one and a half times as much we are seeing from contractors as what we were seeing 2-3 years ago. Plus, the contractors get to more or less pick and choose the projects they want to do, which is challenging because Orsted likes to go for the more, more difficult projects, and more difficult markets because there are more risks, and there is more money in that usually and we believe that we as the leading offshore wind company we can deal with these risks.

However, contractors might not be so eager to deal with these risks, and they will fix small, easy projects. And also, what we've seen is that contractors can now pick and choose to scope. So that's what we are seeing from some foundation installation contractors that they are willing to do the monopile installation, but they're not willing to do the secondary structure installation because that's smaller work but a lot of risk and a lot of complexity there, so that is what we are seeing, but also what our contractors are seeing. So, our tier 1 contractors, if they're dealing with our Tier 2 contractors, which then for instance hammer supplier or the transport providers, things like that. They there's also a huge demand for that at the moment, so also the prices they are getting from their subcontractors have also skyrocketed. So, they need to, of course charge us for that as well. So, it's the entire supply chain that every level is very strained at the moment and at the moment we just see a huge shortage of vessels and that's going to grow over the next couple of years. So the biggest challenge for us at the moment is to get more competent installation contractors through the market and more capable vessels to the market. So, that is our main focus and uh, currently the strategy that we're working on at the moment is really how do we secure capacity for the projects that we have. And that it's, yeah, we see that within our set, but we know the entire market is dealing with this.

Karl Amandus Witt Brückner

So maybe this trend of decreasing cost within offshore wind is may not continue the coming years?

Steenbeek

No, at the moment the work, there's always a bit of a delay with offshore wind. Of course it is different from country to country, but in general a developer wins or gets awarded the concession to build a wind farm or develop wind farm somewhere that happens usually a couple of years later, or then we would have to start sourcing all the different scopes. So, installation vessels, foundations, cables, everything which takes a few years and then it takes another few years till you get to installation. So, the moment we get to concession and then also the power purchase agreement is determined (i.e., how much we're getting for the energy) then a couple of years later we incurred the cost, those could be far higher than what we were thinking when we were awarded the concession. So due to that, some of the challenges we're in now and we see that our business cases are very strained because of this. And we see that with the other developers as well. So, the steep decline in cost of offshore wind has come to a halt and it's currently trending upwards a bit again.

Karl Amandus Witt Brückner

Can you touch a bit upon how you develop foundation and turbine installation firms in order to accommodate this new growth?

Steenbeek

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It is and we see that more and more that this is required to get new vessels through to the market, but it is a challenge. And that’s a big risk for us as well because if some of our projects get delayed then we have a very expensive installation vessel lying idle, not doing anything so. And that is what we are seeing Cadeler doing at the moment. They're talking to us, those other contractor developers about a long term commitment agreement. So basically they will sign contracts so they guaranteeing a specific vessel to a developer for a number of years so it's a good business case for Cadeler since they have guaranteed that their vessel is charted out. And the developer is at least certain that they can install their projects at that time, so that's what we're seeing more and more but it is also tricky again because it does take installation vessels off the market creating an even bigger shortage in the market.

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Karl Amandus Witt Brückner

Does that mean that there's a lot of projects that get started up and then you figure out that there is no way this is going to happen or what's the process?

Steenbeek

So far, we haven't had that.

We had to become a bit creative sometimes with the installation solutions, and we've seen it now on a couple of projects where there is just one contractor left to negotiate with and the contractor will know that as well because the market is so small. Everybody knows everything and that thing is not always the best for the developer. So, then you end up in a really difficult negotiation positions as the developer as the contractor knows you're are completely depending on installation vessels. So you're just going to have to eat whatever we are sending you. So it's a challenge that makes it a lot more expensive. But so far, we've always been able to secure a vessel, but it's not always at the time we want and under the conditions we want.

So in the future it is definitely possible that at some point you're going to stop projects because of lack of insulation vessels.

And what we see as well with the ever increasing size of turbines, it's very difficult to determine who is deciding which type of turbine the market is going for? Because you have the OEM's like Siemens, Vestas, and GE, they keep producing larger turbines because the developers keep asking for larger turbines, but they need to set up a whole new production facilities to make their new turbine. So there is a lot of costs for them. And if they only have a few years where they can sell a certain platform, it's not very profitable for them. So for them, there's an incentive not to increase too fast for developers, they always tend to go for the biggest turbine available because that gives the biggest and best business case. However, you do end up in a situation where it's impossible to install them because they're really no vessels at all that's capable of installing them. So, it's difficult for the supply chain to keep up with the ever growing sizes and of course with the bigger turbines come, the bigger foundations.

Karl Amandus Witt Brückner

That's quite interesting because you we always talk about this exponential growth within the offshore, but there's so many parties involved that needs to follow along and everyone is pushing for that, that the high growth but it doesn't really work in practice.

Steenbeek

No. And then the challenge is that the industry is developing so fast that it is just not profitable for the supply chain contractors to develop new technologies because they will be outdated by the time they get delivered. So it's the market that is developing faster than the supply chain can keep up with. There's both damaging for the developer and for the installation contractors.

Karl Amandus Witt Brückner

If you were to advise Cadeler or the T&I firms on which strategic initiatives they should really focus on for the next seven years, which handful of initiatives do you see as the most important ones?

Steenbeek

Yeah, it's difficult with Cadeler because Cadeler is already doing what we want them to do. As they are pretty much the only contractor both developing in capacity and capability. So that is and that's what we like to from other contractors as well. So being willing to take on more risk and responsibility and being able to do foundation installation themselves instead of just supplying vessels for turbine installation, that's one thing. And then developing new vessels capable of handling the next generation of foundations and turbines. Cadeler is building four vessels which is very good, and as a developer and I must say that they are the only contractor that is developing so many vessels at the same time. So that is very positive.

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Interview w. Simon Harder from Cadeler (Appendix 1: Cadeler)

Philip Skat Nørrevig

Kan du ikke fortælle lidt om dig selv og din rolle ude hos Cadeler.

Harder

Jo, Jeg er head of strategy business development, så man kan sige, jeg joinede i juni 21 faktisk kommet fra en helt anden industri i pharma. Men det som at jeg primært sidder med i mit team, det er vi har 3 streams.

Vi har sustainability stream, hvor vi har en sustainability manager, der sidder og sikre, at vi lever op til alle reglerne og krav, osv. Også kommer der jo også ESG rapporting som bliver en større og vigtigere del i fremtiden, hvor der vil komme omkostninger ved emissions og det vil indgå i kontrakter, som det kommre til at være et meget større krav, kan man sige. For eksempel, det her med ens når supply chain også skal decarboniseres, så han sidder blandt andet og arbejder med hvordan vi optimerer vores nuværende skibe, og hvordan vi sikrer vores nybyggede skibe kommer til at kunne arbejde så godt som muligt og have færre emissions. Jeg mener der er en 30-40% reduktion som de nye skibe får i forhold til de eksisterende, som allerede er begyndt at blive optimeret.

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Det er også sådan nogle ting, som for eksempel hvor skal vi lægge? hvad for et skal det være? og prøve at finde kontrakter på det. Men også hvad for nogle kontorer skal vi bruge andre steder? Da vi kommer til at have stor mangle på ingeniører hvilket er super vigtigt da det er noget vi bruger rigtig meget af, så det er et kæmpe problem, at vi mangler det, så hvordan kan vi tiltrække den arbejdskraft andre steder fra for eksempel? Ved at oprette kontorer andre steder, så vi kigger blandt andet på at oprette et kontor i Polen, hvor der er en masse gode ressourcer hente, og hvor vi også har projekter osv så hvordan gør vi det?

Og så er det sidste ben som er vores strategi, hvor man kan sige, at vi arbejder på vores overordnede del. Helt overordnet set, så vil vi op og være den førende T&I contractor i offshore vind. Det er vores overordnede mål, og så handler det om at finde ud af en masse ting såsom hvordan ser værdikæden ud? hvordan kan vi enable os selv bedst muligt? Vi er jo en børsnoteret virksomhed, hvilket vil sige, at vi ikke har uendelige penge, vi kan printe penge ved at lave private placements, men det skal man tænke over. Det har vi gjort 3 gange og hver af dem har givet et skib, men når du køber et skib så kommer der ikke nogen penge ind med det samme. Det er en omkostning i de første 3 år, indtil skibet kommer. Så hvordan gør du så og hvad for nogle midler kan du tage? Hvor vil vi gerne spille vi var i vinturbine installation og så har vi også installeret fundamenter, men det har været på en anden form for aftale hvor vi mere har lejet skibet ud, og så er har kunderne kunne komme ind og har lavet arbejdet. Hvor vi nu er gået ind i et større T&I scope – hvilket vil sige at du har hele scopet hvilket er et meget større område. Så det er en vertikal integration vi har lavet, så man kan sige, vi kigger på både de horisontale vertikale integrationer, vi kigger på købsmuligheder, nybyg muligheder alle sådan nogle forskellige ting. Hvordan skal vi reelt set komme videre herfra og opnå vores mål?

Så det er sådan lidt de 3 ting som vi sidder med i det team jeg arbejder

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Philip Skat Nørrevig

Den kan du sætte et par ord på Cadelers udvikling de sidste de sidste par år også i forhold til væksten vi har set inden for offshore vindmarked?

Harder

Det startede lidt, for lad os være ærlige og sige, at det startede faktisk da Mikkel han blev CEO, jeg mener det var tilbage i 2017 fordi Mikkel er en utrolig kommerciel og strategisk tænker, som forstår hvor vigtigt det er at skabe et netværk, skabe partnerskab, forstå sine kunder og have en tættere dialog - så fra at være måske en mere typisk shippingvirksomhed, som man jo også var i Swire, så er man gået over og har simpelthen sat meget mere fokus på den her relation med kunderne det er sådan kernen eller essensen af Mikkel, om man så må sige. Og det har de så har bygget op. Og i 2020 det jo så der hvor man laver sin egen IPO, hvor Swire bascially siger at de vil gerne fokusere på svare på deres fly, colaer og alt hvad de laver i over Asien også skal den her enhed ligesom have lov til at stå lidt for sig selv og arbejde og ikke være bundet af de samme restriktioner som man normalt kigger på. Og der vil jeg sige at fra den IPO og frem så er der lagt så meget vægt på det kommercielle, hvilket vil sige at altså Mikkel han er jo på whatsapp med kunderne, så hvis den øverste ledelse har et problem på et projekt jamen så kan de række direkte ud til ham. Det vil sige at der hele vejen igennem af alt enablement, men fordi der er den her gode relation så taler man direkte sammen. Så der ikke er nogen ting der går i hårdknude, fordi hvis der er noget der er ved at gå i hårdknude jamen så har man den her relation til hinanden. Og man kan sige en af de aller vigtigste ting at forstå med den her industri det er at de her entry barriers det faktisk ikke penge for hvis man har penge nok, så kan du sagtens gå ud og bygge et skib. Det kan godt være det koster de her 350-450 millioner euro hvilket er mange penge, men det er der mange der godt kan skaffe. Problematikken er at der ikke er særlig mange, der kan finde ud af at drive de her skibe. Og det betyder, at den allerstørste entry barrier er rent faktisk den tillid som det er du har når det er du er en incumbent i den her industri. Altså når du har arbejdet her i mange år og du ved hvad du laver jamen så har kunderne også en tillid til du rent faktisk kan finde ud af at sætte det op. Et perfekt eksempel på det det var de 2 nye virksomheder der kom ind – Eneti og OHT. Eneti kom ind og lavede et samarbejde med nogen der hedder Dominion i USA om at de skal hjælpe med at bygge deres skibe. Det er Jones act compliant skib til Dominon over i USA, der virker, og så vil de gerne bygge deres egen skibe selv til at bruge i Europa eller Asien. Og OHT gik ind og så ville gerne ind bygge et skib. Men de kunne simpelthen ikke få nogen kontrakter, fordi det var virkelig svært for dem, når de ikke havde en organisation, ikke vidste hvordan de reelt set skulle lave et tender, og det var der ikke rigtig nogen der havde tillid til de kunne. Så det endte med at Eneti købt nogen der hedder Seajacks som har arbejdet i industrien i mange år hvilket var et firma som mange havde tillid til. OHT blev nød til at slå sig sammen med nogen der hedder Subsea 7. Sådan så de ligesom havde noget af den her tillid osv bag sig.

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For O&M der laver du rigtig meget arbejde med OEM'er, fordi at de har de her serviceaftaler, så de skal vedligeholde nogle forskellige dele. Vi har fx lige set Siemens kom ud med en kæmpe justering fordi de har en serie fejl i deres direct drives – så der er nogle problemer de her turbiner - så de skal ud og have lavet en masse udskiftninger. Det har de indtil videre sat 500 millioner euro af til. Så det er meget dem man arbejder med og så som sagt ”konkurrenterne” om man så må sige det er altså dem, hvis de for eksempel lige står og mangler noget hjælp på et projekt eller whatever.

Karl Amandus Witt Brückner

Afhængigt af, om I fx arbejder med Ørsted, eller om I arbejder med de andre jeres konkurrenter, så ændrer projekterne sig vel også?

Harder

Det kan du sige, så man kan sige. Du har noget der hedder EPCI, T&I, og så har du charter – groft sagt.

EPCI det er hvor du - for eksempel lad os sige, at det er noget der sker på fundamenter - går du ud, og du sørger for, at du har et design til fundamenterne. Du sørger for, at du har en produktion af fundamenterne. Du sørger for, at alt bliver konstrueret. Det kommer til din havn. Og du sørger for, at alt bliver installeret, og du står for alt, så det er en total løsning.

Så er der T&I - transport and installation - det er det som vi er i. Vi gider ikke gå ud og designe monopiles eller bygge den fordi vi ikke gider tage den risiko. Det er voldsomt at skulle tage nogle af de her garantier, der har du virkelig brug for et balance sheet der kan noget, hvis det går galt i hvert fald.

Så T&I stedet for det er at vi står for, at vi modtager monopiles for eksempel og noget der hedder secondary steel eller secondary components nogle forskellige steder fra, og så får vi det alt sammen transporteret over til vores construction port, hvor vi står for alt logistikken, og vi står for det hele. Så vi tager det op på vores skib, sejler ud, og installerer det. Det er T&I conceptet lidt for simpelt.

Så har du charterkonceptet som er en løsning hvor man bare laver en kontrakt, hvor mange lejer sit skib ud. Sådan lidt forsimplet kan du sige det er en taxaordning, hvor det er at kunder lejer dit skib og du sender dit crew ud der kan sejle og alle de her ting, men specialisterne ombord er deres egen. Så det er sådan lidt de 3.

Vi har tidligere lavet meget taxaordning også, så det har været lidt blanding imellem det, og nu kører vi rigtig meget mod T&I.

Karl Amandus Witt Brückner

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Karl Amandus Witt Brückner

Hvis offshore vind industrien skal udvikle i særlige høj hastighed, så skal der også ske en eller anden rimelig ligelig risikospredning. Men vil det så ikke også sige, at hvis de forskellige led i værdikæden - for eksempel dem der står for T&I helst ikke vil bevæge sig ind på EPCI - ender det så ikke med at være udviklere der står med al risikoen, eller at sker der så en skævvridning af at risikoen?

Harder

Den vurderingssag, men du har ret. Og det er jo der stenen i skoen trykker i den her industri. Lige i øjeblikket er man i gang med at prøve at finde ud af hvad det er for nogle risici, man reelt set tager?

Og der kan man sige, vi er så lille en del af den samlede CAPEX. Vi er meget kritiske, hvis du ikke har et skib, så kan du ikke sætte dem op det. Det så simpelt, fordi der findes ikke særlig mange, og derfor så skal du have det, og det betyder jo også at vi har al magten, fordi hvis vi ikke gider at arbejde for nogen, så er det meget svært for dem at få sat noget op.

Så derfor tror jeg også det er er super vigtigt, at man er sit ansvar voksen, fordi vi kunne godt gå ud og trampe dem på halsen, når de ligger og har det svært og suge den sidste blodsdråbe ud af dem. Men så slår vi vores egen industri ihjel. Så noget af det, som vi kigger på, fordi vi prøver at reducere vores risiko meget også i vores Terms & Conditions men samtidig så handler det også om, at man skal have en forståelse for, at der skal være en form for symbiose, fordi hvis vi går ud og stiller fuldstændig horrible krav jamen så eksisterer den her industri ikke. Så det er lidt en sammenhæng af det hele, og jeg tror alle laver deres egne vurderinger, og jeg vil skyde på, at virksomheder som både Ørsted og OEM'erne osv historisk set har taget nogle risici at de ikke var særlig glade for når de nu sidder og kigger tilbage på deres liabilities nu. Og det er også derfor det er super vigtigt for os at vi tænker frem, fordi vi byder på projekter i 2027, 2028, 2029 og 2030 og så videre. Vi byder projekter op til langt ind i 2030 og sidder og kigger på framework agreements og sådan nogle ting altså langtidskontrakter. Så derfor er det super vigtigt at man forstår hvad det er for en risiko, og hvor for nogen risikoscenarier du sætter dig i - fordi der er ingen af os der ved hvad der reelt set ved hvad der sker om 7 år eller 10 år. Og det betyder, at der er mange risici, vi simpelthen ikke går ind og tager. Fordi at vi ikke kan kontrollere dem, så hvis vi ikke kan kvantificere hvor stor en risiko er, så kan vi ikke tage den, fordi så er det for stor en risiko for os. Og jeg tror at det er det som Ørsted og de andre er i gang med nu – de er i gang med at prøve at kvantificere hvor deres risiko reelt set ligger og så prøver de at dele ud i deres supply chain undervejs. Så er der måske nogle som der lider hårdt under det – dem de kan presse ret hårdt – og så er der dem der lider lidt mindre. Historisk set, så har skibe ikke været et problem, så det vil sige, at de har faktisk været rigtig hårde mod skibsejere. Og de har måske lavet den her med at træde folk på halsen, fordi at det kunne de og nu er nu er bordet vendt, og så er det bare vigtigt at vi ikke gør det samme, tror jeg. Så selvfølgelig får vi gode terms, og vores rater stiger og alle sådan nogle ting hvilket jo også er fair nok, men der skal stadig være noget reasonableness i kan man sige. Så for at svare på dit spørgsmål – så ja, jeg tror at der kommer til at være en uddeling af risikoen, men der er stadig nogen der kommer til at tage en større del af den risiko end andre. Og i og med at der er nogle kernedel, der er vigtige, så kan du også sætte nogle terms and conditions, og der vil det for eksempel være for os, at vi gider ikke EPCI, fordi at det er for stor en risiko, så den måde de selv æde.

Philip Skat Nørrevig

I forhold til jeres forretningsmodel. Vi snakkede om, at i tidligere havde lavet lidt det her charter, hvor i har chartret jeres skibe ud og nu fokuserer mere på T&I dele - kan du sætte ord på, hvad der skyldes det her skift og hvad jeres fokus kommer til at være fremadrettet?

Harder

Ja og jeg kan også sige at det er en ting, som der er mange der udfordrer når de ikke har 100% indsigt i det - så det er faktisk et rigtig godt spørgsmål.

Jeg vil sige en af de ting som der ligger i det det er at når du chartre noget, så gør du det på en day date, så hvis i ser på analytiker de elsker day rates fordi det er noget man har tilbage fra olie og gas. Så det er let at forholde sig til at hvis vi lejer et skib ud så koster det den her pris om dagen. Men i virkeligheden, når vi kører T&I koncepter, så er det noget helt andet. Det er lidt mere ligesom når du bygger et hus. Du går ikke ud og siger til et eller andet entreprenørfirma ”hvor meget skal i have om dagen for at bygge et hus” i går ud og siger ”hvad koster det at bygge det her hus?” Og det er lidt det samme, som vi gør. Vi sidder og forhandler om et komplet projekt, som er huset i det her tilfælde, og så går vi ud og siger, jamen det her er det det koster, og det er den her tid, det tager. Så er der rigtig mange, der stadig gerne vil tale det tilbage til day rates, men i virkeligheden er hele fordelen i det her det er, at vi er 100 meter mester i at lave de her projekter, fordi det er det vi har gjort og det er det vi er eksperter i. Så det vil sige, at vi kan gå ind og bygge det op fra bunden, så vi siger simpelthen det her er vores omkostningsbase det her det er vores risiko base og det her det er vores mark up. Og så er det det her, som vi går direkte hen til kunden og siger: vi har hele løsningen og det her er den samlede pris, og den er fordelt sådan her på de forskellige segmenter. De får selvfølgelig ikke detaljerne helt ned i detaljer, men de får de overordnede blokke. Så kan man sidde og tale lidt sammen om hvorfor er det her er så højt, og hvorfor dit og dat det og så samarbejder man på den måde, og så går man sådan set ind og kigger på det. Fordelen for os det er, at vi har 100% indsigt i projektet, fordi vi selv har lavet det, så vi styrer 100% selv, hvordan vi gerne vil drive det. Og det betyder, at vi selv kan optimere det. Så hvis vi gerne vil have et ekstra skib ind og hjælpe - jamen så kan vi gøre det, fordi det er vores eget projekt. Hvis vi ved, hvor vi har noget potentielt tid, og vi kan selv styre vores risiko, så et perfekt eksempel er for eksempel sådan noget som at sige, jamen vi har måske en potentiel supply risiko, hvis det er vi ikke kan sejle hurtigt nok. Så i stedet for at have et skib der chartret for en hel periode, jamen så kan det være at det kan betale sig for os at have et skib chartret i den her periode og et andet skib chartret her, så vi kører med 2 skibe i en periode. Og det er sådan nogle ting, som vi kan selv kan styre, hvis det er at vi står med hele projektet. Og det gør også, at vi har mulighed for at færdiggøre det hurtigere, og så er der en potentiel upside og du kan sige early completion bonus er også noget som man potentielt kan få med ind i det. Så vi har meget bedre kontrol med det, når vi laver et komplet T&I og for os, så gør det, at vores risiko daler markant i forhold til at vi risikerer at sende et skib ud, og så kan det ikke arbejde af den ene eller den anden årsag, og så får vi bøde. Hvis nu at vi har hele projektet og vores skib, lad os sige, at der er en eller anden wire der knækker, og vi bliver nødt til lige at gå ind og få en smed til at ordne noget. Det tager ikke nødvendigvis lang tid, men vi får ikke nogen bøder på det, så vi kan bare sætte farten op i den anden ende, fordi vi ved, hvor vi ligesom kan optimere, eller som sagt bruge nogle andre skibe til det. Så mere kontrol – der virkelig derisiker for os.

Philip Skat Nørrevig

Det har vel også gjort at alle jeres kompetencer internt har skulle udvikle sig?

Harder

Ja helt sikkert, og man kan sige.

Det er sådan at der er ret stor forskel på T&I på turbiner og T&I på fundamenter. Det er sådan at ved T&I på turbiner så er der er mange ting du stadig ikke står – du har ikke logistik, engineering, og sådan nogen ting - så du har ikke alt med 'sea fastening' og mange af de her ting. Når du skal over og tale i T&I på fundamenter så er det et helt andet bæst. Fordi du er ansvarlig for al transport, al engineering såsom 'sea fastening'. Hvilket er det her med at når du lægger noget op på skibet så skal det også helst stå fast, når du sejler, og det vil sige, at du for eksempel skal have nogle kæmpestore standere, der kan holde tårnene for eksempel eller nogle blade racks og sådan nogle ting. Alt det skal designes til det specifikke projekt, fordi der er mange af dem der lige har nogle små detaljer, der gør du ikke kan bruge det samme. Vi arbejder så på et design, så du kan bruge det til flere forskellige formater og en af vores fordele er at dimensionerne på alle skibene er lavet med de samme dimensioner forskelle eller afstands forskelle, hvilket vil sige, at den 'sea fastening' som vi har lavet på et skib, kan vi faktisk tage over på et andet skib og genbruge. Men alt det her det på et T&I scope på fundamentet der har du hele kæden fra at der er nogen, der har konstrueret de her produkter til at du tager det hele vejen over, du styrer havnen, du tager tingene ud, du installerer alt – det et kæmpe projekt, og derfor er vi i gang med at ansætte rigtig mange mennesker lige nu så det er det er fundamentalt vigtigt, og det gør jo også at de her sekundære work scopes - som man også får penge for – der er en kæmpe forskel. Hvis man kigger på det i grove terms så man kan sige det varierer. Det kan variere en del fra projekt til projekt, men bare for at give jer en lille smagssans for det, så kan man sige at på et WTG installations projekt, der er selve skibsværdien, den som man ligesom sælger skibet før er måske 75-80% af den samlede kontrakt. Det vil sige at de sidste 20-25% vil reelt set komme fra sea fastening, engineering og sådan nogle ting. På et fundament T&I scope derimod, der er det kun 25-30% som reelt set kommer fra skibet. Men skibet koster det samme fordi det samme skib men det udgør kun 25-30%, så hvis det skib lad os sige i det ene scenarie lå til 100 millioner på et WTG-installation og det så var 25 millioner på resten, så ville 100 millioner lige pludselig blive til 400 millioner for en kontrakt. Så hvor den ene ville være at have en kontraktværdi på 125 millioner, så vil den have på 400-450 millioner. Men forskellen på det er så, at marginerne er forskellige. Marginerne på skibene er jo relativt høje, altså fordi de jo er meget capex tunge og vi køber de her skibe, men det gør også, at vi tjener en del penge på dem og på mange af de her sekundære work streams der bruger du tredjeparter, så du har du hyrer nogen ind til at fragte, og du hyrer nogen ind til at stå for forskellige dele, og det har du ikke en særlig stor margin på, så der er forskel på den margin, man har.

Jeg vil gerne fortælle jer hvor marginen var, men det kan vi ikke, fordi den går vi ikke i markedet med, Men de sekundære scopes er der mindre marken på, og derfor er der på de forskellige marginer på de forskellige scopes. Så du kan tjene flere penge på et fundament T&I scope på men marginerne er dårligere, så du kan stadig få mere profit, men det er også en større risiko, hvor den anden er mere simpelt med et mindre team og så også mindre risiko

Karl Amandus Witt Brückner

Er det simpelthen fordi at fundamentet installation er så meget mere kompleks end turbine installation?

Harder

Det er simpelthen på grund af at du har så mange ekstra scopes - altså det her med at du måske lige pludselig har 2,3, eller 4 skibe som du skal have sea fastening på hvor der på en turbine installation der har du kun dit eget skib. Men i de andre, så skal du også have et secondary steel skib - typisk et construction support vessel eller et jack up - så skal du måske have nogen der kan sejle de her fundamenter frem og tilbage, så der skal du også have et eller 2 skibe der kan hente alt dit secondary steel fra de forskellige havne skal du også have nogle skibe alt det skal beregnes. Derudover så skal du have en hammer og sådan nogle ting som du kan bruge hvilket er er mega dyrt så det skal du ud og låne og det koster millioner. Med alle de her omkostninger ryger jo videre som sagt til kunden, som man går ligesom ud og siger jamen det her det er prisen for det, og det vi gør det er, at vi tager jo omkostningen, risikoen og en margin. Men vores margin er jo markant mindre på ting, vi ikke laver, hvor de høje på det vi selv laver, så det er det der sådan lidt er forskellen, hvor at du vil have mange flere folk, der sidder og arbejder på et projekt. Du vil have mange flere folk der arbejder på et fundament T&I projekt – der kan du have op til 10 ingeniører. Altså naval arkitekt, der sidder og beregner noget af gangen. Det er et stort team.

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Philip Skat Nørrevig

I forhold til jeres kunder hvad er deres største fokus, når de går ud og skal ud og finde en virksomhed T&I contractor?

Harder

Noget af det der er relevant i det her det er at forstå hvad tilliden er – fordi vores kunder prøver at deriske så meget som muligt. Vi er så lille en del af capex at derisken at det vigtigste for dem. Fordi som sagt hvis vi laver en fejl eller vi ikke er tilgængelige eller vi kommer for sent, eller vi vælger et andet projekt og aflyser dem - jamen så kan de ikke få sat møller op og det koster kassen fordi de får en bøde hver dag de der møller ikke er oppe. Det vil sige det er en dobbelt whammy for dem, når der er forsinkelser på projektet.

En ting der er vigtig at forstå i sådan noget her det er at når du har et skib ude at sejle og du installerer, så har de et helt construction spredt på én gang. Det vil sige, at lad os sige et skib måske ligger til 250.000 om dagen, så har de derudover en masse ingeniører, de har nogle havne som de lejer, de har sikkerhedsrådet, de har helikoptere, de har support vessels, de har alle mulige ting. Så hvis den koster 250.000 så koster hele deres day rate for projektet et sted mellem 1 og 1,3 millioner, så det vil sige, hvis man tænker på det her, så handler det også meget mere effektivitet, fordi hvis nu vi kan spare dem - og det her er et rent teknisk eksempel - men hvis nu, at du løfter et blad op og kan bruge din auxilary hook, så kan du måske gøre det 4 timer hurtigere end hvis du bruger din main hook. Hvis du kan spare 4 timer per blad du sætter – hver turbine har 3 blade - så 4 timer per plads os sige med 100 turbiner? Det er 400 timer svarende til 16-17 dage ca? Og til en day rate på 1,3 millioner så det lige pludselig rigtig mange penge de kan sparer.

Så hvis du tager et af vores nye skibe og sammenligner med et af vores konkurrenters nuværende skibe - så er vores nye skibe over 35% mere effektive. Det vil sige at det er virkelig mange dage du kan spare, og det betyder også, at når de sidder og kigger på deres samlede omkostning, så kigger de jo på det hele. Så hvis det tager meget længere tid at lave det, jamen så bliver det meget, meget dyrere, så det er ikke kun vores pris det er lige så meget hele deres construction spread som de kigger på.

Så jeg vil sige det er 2 ting: Den ene er virkelig det her med tillid, altså hvis man røvrender en kunde og du ikke bliver og hjælper når der er problemer, jamen så er det meget svært at få den kunde igen fordi så kan du finde på at gøre det igen så dem som der ligesom prøver at finde løsninger og sørger for at det her bliver gjort ordentligt, så de føler, at de kan stole på dig. Det er førsteprioriteten. Anden prioriteten det er effektivitet – altsp hvor meget koster det os reelt set?

Karl Amandus Witt Brückner

Hvis vi kigger lidt ind i fremtiden, hvor mange skibe skal i så have? Nu ved vi der er 4 på vej, og hvis vi kigger mod 2030 og 2035, er der så yderligere 4 på vej eller hvad?

Harder

Det må vi ikke guide på så det må jeg ikke udtale mig om, men man kan sige at vores mål er at være den foretrukne T&I contractor i verden. Det gør jo også, at vi som udgangspunkt skal vokse med markedet som minimum fordi vi er dem der har flest jack ups lige nu, så man kan sige, hvis markedet har brug for flere jack ups jamen, så bør vi jo også følge markedet og det der sker lige nu, som er vigtigt at forstå den her industri det er hvis vi kigger ind på 29% CAGR over de næste 10 år så ikke nok med at det stiger så meget så sker flere forskellige ting på en gang. Så der kommer meget større efterspørgsel, men turbinerne stiger også i størrelse, hvilket vil sige at mange af de eksisterende skibe ikke længere kan installere dem, så derfor får man en endnu større supply demand imbalance. Derudover så ser du at meget af den vækst der kommer, også kommer i andre regioner, og det er sådan at du kan ikke lige bruge 3 måneder på at sejle til Asien og 3 måneder på at sejle tilbage igen, bare fordi du skal lave et projekt. Det kan godt være du kan blive betalt for turen, men det slider på skibet og det er absolut ikke sustainable så det går vi ikke ind. Så hvis man sender skibe over og de skal arbejde på større basis, så vil du have nogle, der arbejder primært i Asien. Du vil have nogle, der arbejder i Sydamerika. Og du vil have nogle der arbejder i USA og nogle der arbejder i Europa. Det er det, der kommer til at ske, og det vil sige, at al den ineffektivitet, som der er i skibe, som der ikke kan rejse rundt på de forskellige regioner, alt den kapacitet der går over til O&M og al den kapacitet der går fra turbine installation til fundamenter, for eksempel, vores 2 F-class skibe vil primært arbejde i fundamenter.

Så vil der komme rigtig, rigtig meget tightness de forskellige steder. Så det er ikke kun det her med der kommer til at være meget mere, kompleksiteten og ineffektiviteten på grund af alle de her forskellige faktorer bliver også meget større.

Så jeg kan ikke sige, hvor mange skibe vi kommer til at bygge, men det er absolut fair at sige at vi forventer at vokse, og vi kigger både på organiske og inorganiske vækstmuligheder, ligesom vi kigger vertikalt og horisontalt i værdikæden. Det er ligesom vores overordnede, fordi det det skal du være klar til, hvis du gerne vil være den store på markedet.

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<u>Interview w. Vilius Vaisnoras from Copenhagen Offshore Partners (Appendix 1: COP)</u>

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Karl Amandus Witt Brückner

Can you put some words insights into how you do that balance between local content and foreign content?

Vaisnoras

Yes, absolutely. I think it's a very relevant question. Generally speaking, when entering new countries, it can be relatively difficult to find talent with experience in offshore wind. Even here in Denmark, it's quite challenging to find relevant people with a suitable background quickly. You usually have to scout quite a bit. When entering a new market where offshore wind is not yet developed, or even when the government is only thinking about it and planning for it, it can be quite challenging to find people with that experience. This issue is often driven by countries that set particular thresholds for local employment and opportunities for their citizens in the new industry. The best example that comes to mind when it comes to this is Taiwan. Their government did an excellent job of pushing the developers and companies that are developing offshore wind to find spots for local people, provide training opportunities, and invest in that area. They recognize that it is the future and that they would like to have their own capabilities. I think it's the right way to do it. Therefore, it is important to prioritize hiring locally, but from a capital point of view, it would be challenging to convince companies to do so without government intervention. If the government pushes for it and companies find ways to make it work, then it is possible.

Karl Amandus Witt Brückner

So you see it as a positive thing that local content is contractually obliged for the developers?

Vaisnoras

Yeah, absolutely. Of course, it shouldn't be something where they're setting up goals that are completely out of reach and impossible to meet. So I think if there is a discussion, if there is an opportunity, then of course any given company entering a new market and developing green energy for them should also at the same time trained locally. So by all means.

…

Will it be possible to get the necessary capability and capacity in the given country where we would like to develop a offshore or would you send to to try to find a foreign contractors even more?

Vaisnoras

You can have the best intentions of hiring only locally and trying to meet these targets, but sometimes it's just simply impossible, because in order to meet particular deadlines in order to meet deadlines, setup not only by the country, but also by the international bodies from that zero programs and so on. You do have to rely on foreign contracts. You do have to rely on expats. And you know, to basically deliver the project and then given sense. So of course it would be great if you could hire only locally. It would be great for everyone involved. But if that is realistic, it really depends on you know, a particular example that you have in mind in terms of the country and in terms of the capabilities, if you would choose generalization, I would say in in Europe. It is more probably realistic in in other parts of the world. I think it's probably it would take some time to sort of, yeah, change the mindset when it comes to this industry in particular.

…

Karl Amandus Witt Brückner

What were the main risks you witnessed in the past few years, and how do you see them changing in the future?

Vaisnoras

Over the past few years, like any other company, we have been significantly impacted by COVID-19. The pandemic led to a lot of uncertainty regarding project development, including government plans and regulations for green transition and offshore wind. Additionally, there was also a lot of uncertainty surrounding suppliers, their factories, and their capabilities to deliver the goods we have already ordered for existing projects. This is the most impactful thing that comes to mind when thinking about the past few years. We hope that this will not happen again anytime soon. Another risk is the current market. Governments are continuously pushing for a green transition, and there is a lot of ambition surrounding it. However, staying on the topic of vessels, there are not enough vessels in the market to deliver everything that has been promised. The same questions are being asked of all suppliers, not just vessel suppliers, but also turbine manufacturers, foundation suppliers, and cable suppliers. We are attempting to address this issue by focusing on the market as a whole instead of individual projects. Instead of ordering everything for one project, we are considering approaching a supplier and requesting a quotation for six different projects in this market. This method may make it easier for the supplier, but it also creates more risks for us. We need to figure out how to approach this and what to do if one card fails from our plan for multiple projects. It could have a domino effect on all the other projects as well. However, this is where the market is, and we must be adaptable to it.

…

And can you pinpoint any link in the value chain where you see potential problems in the coming years, such as installation vessels, cables, or turbines?

Vaisnoras

I think from my point of view, basically everything is interconnected. Starting, for example, with the foundations, we need tons of steel for them. In Europe, where most of the foundation suppliers are, they use a lot of steel from Russia, and because of the war happening, steel prices are going up, making it extremely expensive. This is affecting many project business cases. The same time, there are only three main turbine manufacturers, and with many projects happening around the world, it is questionable if their capacity can be delivered. So you have to be quite strategic in terms of landing these slots in their factories. Cables are the least concerning from my perspective, although there are some questions about whether they can get metals from their suppliers. Moving on to vessels, all shipping companies operating within offshore installation and construction installation have their books filled to the brim with new orders, but the question is when they are going to be delivered. I see some problems in the upcoming years across the board, and I think achieving some of the goals raised for 2030 is going to be hard to achieve. I don't want to be negative and say they won't be achieved, but let's see.

…

Karl Amandus Witt Brückner

Moving from a single project mindset to a market model with partnerships, what feedback are you getting from the industry?

Vaisnoras

It makes sense for them since it gives them the opportunity to be firm in their planning as well. For instance, if we are supplying a supplier with six or seven projects, they have the assurance that they will have six projects in their pipeline as well. Nowadays, especially with the upcoming European tenders for all projects until 2030, it is tough to approach suppliers and say that we are only interested in them supplying a particular project. They want to know more about our pipeline and plans in other markets, if any. Thus, mono-project is challenging to look at nowadays.

Karl Amandus Witt Brückner

So, do you see a general trend in moving into programs and multiple projects and consolidating the development sphere?

Vaisnoras

Yes, especially here in Europe, I believe that there are certain markets where it would be difficult to couple together. However, it's obvious that the trend is going in that direction.

…

Karl Amandus Witt Brückner

So, if I may paraphrase, partnerships are super important, and having a strong track record and expertise are the two essential components.

Vaisnoras

Absolutely, it's difficult to be a new entrant in the industry, even though offshore wind is quite new. Building trust takes years, and one way to do it is through partnerships. If it continues like this, everything should be okay in the short term of seven years.

…

Karl Amandus Witt Brückner

Can you make any generalizations in terms of risk appetite for developers?

Vaisnoras

I think CIP did an excellent job of opening eyes to different developers. Even though the market may not appear ready, you can still enter and succeed. CIP's job in Taiwan made a lot of developers shift their focus as well. It's just a matter of finding the market that fits your business model. Some developers have no interest in entering foreign markets without any information. For example, Vattenfall is a European developer that only wants to stick to Europe. It's an opportunity with so many projects happening around the world.

…

<u>Interview w. Olivier Candeel from Clarksons Platou (Appendix 1: Clarksons)</u>

…

Philip Skat Nørrevig

During your time in the industry how has this developed? You said that now a lot of these developers are starting to become EPC contractors themselves. How have you seen the developed in in the last couple of

Candeel

Let's go back seven years ago when there were only a few developers, such as Orsted and RWE, who were at the forefront of the market. Most developers at that time would bid on tenders for the procurement, construction, and installation (EPCI) of cables, turbines, or foundations. However, there was more supply than demand in the market, and therefore, many contractors were competing for jobs, particularly for the big EPCI contracts that could generate a lot of cash.

In the last 3-4 years, there has been a surge of new developers entering the market, including Oil & Gas developers. Today, anyone can become a developer, including banks, utility companies, or supermarkets. To save costs, many developers have adopted a multi-contracting approach, which provides transparency on all contracts. Meanwhile, tier one contractors who had previously taken on all the EPCI contracts have pulled back due to the high risks involved.

The shipping market has also turned, resulting in increased demand and supply, and contractors can now charge whatever they want for their vessels. As a result, contractors now prefer to handle only the installation, rather than taking on the entire turnkey solution.

Contractors have the freedom to set their prices for vessels, but they no longer take on the risk for engineering and procurement. For example, if a contractor is hired to do a T and I, they may only handle the installation, but still charge a higher price. Projects can take one to two years, and the cost of vessels can increase from $250,000 to $500,000 per day. This shift has been happening over the past five years, where inexperienced people want to handle everything themselves while experienced contractors are no longer willing to take on such risks. This trend is likely to continue and grow in the future.

Companies nowadays tend to hire individuals to form their development teams, as multi-contracting has become a popular way to save costs while maintaining transparency across all contracts. Tier one contractors, who used to handle all EPCs (engineering, procurement, construction) projects, have pushed back due to significant financial losses and the unwillingness to take on such risks.

These changes have caused a shift in the market, with inexperienced developers taking on more projects and experienced contractors pulling back. This trend is expected to continue, leading to significant growth in the industry.

Philip Skat Nørrevig

What is sort of the pros and cons of going with these two approaches so the multi contracting and the EPCI in your point of view?

Candeel

So basically, if you try to source a single contract for a project, you may end up paying a 30% markup to manage all the risks involved. Basically, when a developer gives their contractors instructions to build a wind farm, there are a lot of milestones that need to be covered. For example, the EPCI contractor needs to calculate backwards from the actual critical connection point and determine when to do the turbines, foundation, cables, fabrication, and engineering. It's a complex process with many interdependent parts. The thing is, if there's a loss of time or a missed deadline due to something going wrong, there's a snowball effect where it can impact the cables or turbines. As a developer, you manage all the subcontractors, which means there's a lot of liability that you can have if things are not on time. Even the subcontractors can claim money because of delays.

Nowadays, if you want to be competitive in the wind farm industry, you need to go low in price, which means taking a multi-contracting route where you manage all the contracts yourself and go directly to the source. But this can be challenging if you're inexperienced because you need to manage a lot of interfaces and back-to-back contracts, which requires a lot of people and budget. The repercussions of things going wrong can be huge in terms of millions, so it's important to be careful.

Back in Taiwan, when it was very competitive, the margins were maybe 15%, and that's where things went wrong. There was not enough money calculated in that. On the one hand, if your risk is covered, you would gladly pay 30% extra when you know you don't need to do anything, and someone else will cover it. But the problem is that because of inflation and all the data phrases that went so low, there is no wind farm anymore. As a developer, if you want to be competitive because so many people want to win concessions, then you need to go to the lowest price. It means there are a lot of milestones that need to be covered, and for the EPCI contractor, they need to calculate back from the critical connection to when they will build the turbines, foundation, and cables, and fabricate the foundations. They also need to engineer everything.

On one hand, having your risks covered by paying an extra 30% would be great, since you wouldn't have to worry about anything and someone else would take care of it. But the problem is that due to inflation and low data phrases, it's not possible to build a wind farm anymore. Developers now have to be competitive and bid the lowest price in order to win concessions, which makes it difficult to justify paying extra for risk coverage.

…

That's where we're at today. We have so much demand for offshore wind, but the supply stays the same. Everybody is fighting to be competitive, but we don't have the assets, companies, and people anymore to do it.

Philip Skat Nørrevig

So, going forward, what do you think multi contracting is still going to be the way to go moving forward?

Candeel

Yeah, I think so. Due to the cost on the one hand. But also due to, like I said, the tier one contractors will say “yeah we can do a EPCI won't really do an EPCI but at 40% margin” and nobody is gonna pay 40% margin. These are already billion-dollar projects, so adding another billion is a lot of money.

So, multi contracting will be the root going forward. And the market will just need to adapt there will be lessons learned of things that go wrong. There will be a shift of experienced people from the one project to the other project. The one who pays more. And it will probably stabilize at a couple of years where project might not happen because at one point all these projects have been won now, as we have all these new rounds with very cheap tariffs. You have all the inflation that happened, costs risen, and you don't have experienced people at one point. Projects will say, OK, we can't do this.

Karl Amandus Witt Brückner

Does that also mean that you see a future where there's simply just not enough turbines getting installed to meet the goals of 2030?

Candeel

Yeah, that will happen because these deadlines are ridiculous. And it is set by politicians who don't know the back story.

The challenge with deciding whether to go with multi-contract or single EPCI is that the cost is already too high. Developers think they can still go to the market for different packages, but there aren't enough cables or vessels available. When developers go to the market, contractors will say they're not interested and ask to be contacted directly.

This leads to financial investment decisions (FIDs) being delayed or over budget, and developers needing to ask for extensions on grid connections and add more sets. We're already seeing this happen in the US, where they set a target of 30 gigawatts by 2020. They are going to be happy if they reach just half.

So yeah, there's too much ambition globally without thinking of what is needed and then you also have a lack of investment of the actual governments in infrastructure which also doesn’t help.

Philip Skat Nørrevig

Zooming in a little on the specific T&I space how has the competitive landscape developed within the last couple of years.

Candeel

Well, so well, the business model was that they did some new builds, they all built like one big vessel for the next generation of foundations, but half of them were already too small because the foundation became too big. But there is still gonna be work for them. On the one hand, they are full now, so their vessels are all being contracted out. Then you have a couple of vessels from Heerema and Saipem who predominantly works in oil & gas who were made for the oil and gas and who were made for oil & gas. They had so much troubles, I think, working in the in the renewable space, working with tough developers and tough contractors, that they are now gonna go be back in the oil & gas space.

So, yeah, we are gonna have a very, very limited supply of vessels.

That's on the foundation space.

On the turbine space there are new buildings and it's easier. You just need a Jack up vessel and then your OEM - meaning a Vestas or GE - will do all the work. It's way easier, but as a foundation contractor you need a huge installation team, special tools, so yeah to start engineering these three years in advance.

…

Philip Skat Nørrevig

Since we see this, this lack of vessels in the market, how do you think the whole industry can push towards ordering new builds?

Candeel

To give contracts earlier and that's the problem. So, the at the moment it's difficult for the tier one contractors to immediately start a new build because all of that, I mean half of them is in the stock market, they have a lot of shareholders and they need to back up their investment decisions. So the investors might say "well you just build one or two new vessels - why do you need another one immediately? Let's wait a little bit. Let's up the prices. Let's don't go fast on this because we've seen that the newer generation type of vessel that are now in the market, they are already on the edge." So, there's a lot of hesitation. What's the next generation we need to go for, do we need to go for a bigger crane, do we need to go for a bigger deck, do we need to be more stable? So, there's a lot of questions there to immediately put 500 million, let's say into a new build.

…

Karl Amandus Witt Brückner

So, does that mean that if this industry is going to meet all the ambitions, then they have to follow a strategy like Orsted and really take on some risk and build these partnerships with the T&I firms and the other contractors?

Candeel

Yes, correct. The time of going to market is over. Build strategic partnerships, long-term ones if you have enough in the pipeline.

And again, it's because of all these new developments or developers, or a combination of joint ventures of different companies and have only contractors, people you know who suddenly need to act on behalf of the developer, they don't have that mindset. They have the mindset of I need to have this project here in 2028 or 29. That's my vision. And on the tier one contractors they don't they speak to so many new people who have the arrogance and they said no because eventually with the Orsted or RWE, who have already been in the market for 10 years, they pick up the phone to DEME and say, “hey do you want to do this project for me?”. DEME will say yes

…

…

Philip Skat Nørrevig

Just does that also mean that you think we're gonna go away from these zero-subsidy tenders towards the way it was back in the day? Because the price of the whole supply chain rising so much or?

Candeel

I would say yes or no with zero subsidy. The thing is that you don't have your connection in there. That means there's a big cost for your export cable. That's why in the UK you don't have that. In the UK, the CFD bits are really with plugging it in into the system. That's why you cannot go for 0 subsidy on in the UK.

You could in Holland and Germany because the connection is not. It's like 200m that is not I there and that's why. But I don't see us going back because there's always somebody who's gonna say we can do it – like BP and Shell who have a huge jar of money to throw at it because they want to be green and make shareholders happy. So, it's also not a fair competition if these guys get involved because they have their internal targets, BP has internal targets to say we need to be greener by 2030, so the moment they see that and there's so much competition on new concession rounds. So, if they say they wanna win it, they will just do it cheap and make a loss on it, because then the vision of BP is being followed and that helps the satisfy shareholders. Which helps the stock market price and that's the bigger picture. It's not as simple company vision. We need to supply. Yeah, profit loss revenue and cost. No for them. It's like we just need to have it and it's the, it's the bigger picture of BP becoming green.

…

Appendix 2: Interview guide

Introduction

- Who are we?
- Purpose of the interview
- Consent to record?

Please note: The guide presented below outlines a range of questions and themes intended for discussion with the interviewee. It does not encompass supplementary questions that may be asked to gain a deeper understanding. The precise structure outlined below was not necessarily strictly adhered to, as the interviews were conducted using a less formal, semi-structured approach. This guide served as a reference, allowing for the selection of questions as deemed necessary during the interviews.

Professional background and experience

- Could you tell us a bit about yourself and your experience in the offshore wind industry?
- What role does [insert company] play in the offshore wind industry?

European Offshore Wind Transport & Installation Industry Development (2018-2022)

- How would you describe the overall growth and development of the European offshore wind transport & installation industry between 2018 and 2022?
- What were the key drivers for this growth in the industry during this period?
- How has the regulatory environment influenced the development of the industry from 2018 to 2022?
- Can you identify any critical technological advancements or innovations that have shaped the industry during this timeframe?
- How has the competitive landscape evolved during these years, and what factors contributed to this evolution?
- What role have government incentives and subsidies played in the industry's development between 2018 and 2022?
- How has the industry responded to increasing demand for renewable energy during this period?

Project execution

- What different approaches can developers take to develop and execute offshore wind projects?
- What are the key challenges developers face in executing wind farm projects, and how can they mitigate them?
- What role does collaboration between stakeholders (developers, contractors, suppliers, and government authorities) play in the successful execution of offshore wind projects?
- How do developers assess and select contractors for EPC and T&I projects in the offshore wind industry?
- How do regulatory frameworks and permitting processes affect project execution timelines and overall project feasibility?
- How do project financing and risk management strategies influence the execution of offshore wind projects?

Competitive landscape and strategic actions that T&I firms can take?

- How does the competitive landscape look?
- What differentiates T&I firms?
- What are the main strategic actions that T&I firms can take to help the industry reach European targets?
- Are there any specific partnership or collaboration opportunities that T&I firms should explore?
- How can T&I firms adapt their operational processes to maximize efficiency?
- How can T&I firms address potential skill gaps within their workforce to ensure they are well-equipped to meet the challenges of the industry and achieve European targets?
- How can T&I firms manage risks and uncertainties in the offshore wind market while pursuing strategic actions to achieve European targets?
- How can T&I firms identify and seize opportunities in the global offshore wind market, considering the competition and different regional dynamics?
- How can T&I firms diversify their service offerings to capitalize on emerging opportunities within the offshore wind industry?

Projected development of the European Offshore Wind Transport & Installation Industry (2022-2030)

- How do you foresee the European offshore wind transport & installation industry developing from 2022 to 2030?
- How do you expect the role of supply chains to evolve in the offshore wind transport & installation industry between 2022 and 2030?

- What potential changes in regulations or policies might impact the industry's development in the coming years?
- Are there any emerging technologies or innovations that you believe will significantly influence the industry's growth during this period?
- What are the main challenges that the industry is expected to face during this period, and how can they be addressed?

Concluding remarks

Appendix 3: Evaluation and composite scores for T&I strategic actions

#	Strategic Action	Strategic Risk	Strategic Scope	2030 Targets Impact	Composite Score
1	Fleet expansion	2	3	3	2,75
2	Scaling current organization	2	3	2	2,25
3	Expanding delivery scopes	1	1	3	2
4	Strategic partnerships with developers	2	2	2	2
5	Horizontal collaboration	2	2	1	1,5
6	Collaboration with financiers	3	3	1	2

Criterion	Scoring
Strategic Risk	3: Low, 2: Medium, 1: High
Strategic Scope	3: Marginal , 2: Medium, 1: Radical
2030 Targets Impact	1: Low, 2: Medium, 3: High
Composite Score	25% * Strategic Risk + 25% * Strategic Scope + 50% * 2030 Target Impact

Appendix 4: Financial figures of peer groups present in the T&I industry

Peer Group	Profit margin			EBITDA margin			Assets	Leverage Ratio
	FY2022	*Full Period*	*'22-'21*	*FY2022*	*Full Period*	*'22-'21*	*'22-'21*	*'22-'21*
Cadeler A/S (OB:CADLR)	33%	-31%	23%	59%	-18%	52%	599.573	17%
Eneti Inc. (NYSE:NETI)	53%	-66%	34%	40%	25%	22%	810.889	13%
Fred. Olsen Windcarrier ASA		3%	14%		19%	45%	485.658	26%
Seaway 7 ASA (OB:SEAW7)	-7%	-11%	-6%	2%	3%	1%	1.382.050	10%
Average	26%	-26%	16%	33%	7%	30%	819.542	16%

T&I Peers	Profit margin			EBITDA margin			Assets	Leverage Ratio
	FY2022	*Full Period*	*'22-'21*	*FY2022*	*Full Period*	*'22-'21*	*'22-'21*	*'22-'21*
Cadeler A/S (OB:CADLR)	33%	-31%	23%	59%	-18%	52%	599.573	17%
Eneti Inc. (NYSE:NETI)	53%	-66%	34%	40%	25%	22%	810.889	13%
Fred. Olsen Windcarrier ASA	0	3%	14%		19%	45%	485.658	26%
Average	29%	-31%	23%	49%	9%	39%	632.040	19%

EPCI Peers	Profit margin			EBITDA margin			Assets	Leverage Ratio
	FY2022	*Full Period*	*'22-'21*	*FY2022*	*Full Period*	*'22-'21*	*'22-'21*	*'22-'21*
Boskalis International B.V.		-1%	-18%				1.018.029	
DEME Group NV (ENXTBR:DEME)	4%	4%	5%	4%	16%	17%	4.712.581	23%
Jan De Nul NV		3%	3%		5%	12%	2.376.393	
Saipem SpA (BIT:SPM)	-2%	-12%	-20%	4%	0%	-12%	13.187.628	29%
Van Oord NV		12%	-4%		10%	4%	3.005.279	
Seaway 7 ASA (OB:SEAW7)	-7%	-11%	-6%	2%	3%	1%	1.382.050	10%
Average	-2%	-1%	-7%	3%	7%	5%	4.280.327	21%

Diversified T&I	Profit margin			EBITDA margin			Assets	Leverage Ratio
	FY2022	*Full Period*	*'22-'21*	*FY2022*	*Full Period*	*'22-'21*	*'22-'21*	*'22-'21*
Dominion Energy, Inc. (NYSE:D)	6%	12%	15%	46%	46%	47%	101.916.500	43%
Maersk Supply Service A/S		-137%	4%		37%		751	
Shimizu Corporation (TSE:1803)	3%	5%	4%	4%	8%	6%	17.392.230	23%
Average	4%	-40%	8%	25%	30%	26%	39.769.827	33%

Source: Data extracted from Capital IQ

Appendix 5: T&I firm peer group T&I services historic track record

Cadeler T&I services historic track record

Offshore wind farm name	Onstream	Country	Total power MW	No. Of Turbines	Turbine size (MW)	Wind turbine manufacturer	EPC contractor	Wind turbine installer	WTI Vessel	No. of Turbines	Capacity installed (MW)	Foundation contractor	Foundation installer	Foundation	No. of Foundations
West of Duddon Sands	2014	UK	389	108	3,6	Siemens Gamesa							Boskalis/Cadeler	Wind Orca	78
Dan Tysk	2014	Germany	288	80	3,6	Siemens Gamesa		Cadeler	Wind Osprey	80	288		Van Oord		
Borkum Riffgrund 1	2015	Germany	312	78	3,6	Siemens Gamesa	DEME Offshore					DEME Offshore	Cadeler	Wind Orca	78
Gemini	2017	Holland	600	150	4	Siemens Gamesa	Van Oord	Van Oord/Cadeler	Wind Osprey	72	288		Van Oord/Cadeler	Wind Osprey	76
Sandbank	2017	Germany	288	72	4	Siemens Gamesa							Cadeler	Wind Orca	72
Galloper	2018	UK	353	56	6,3	Siemens Gamesa		Fred Olsen/Cadeler	Wind Orca	40	252		DEME Offshore		
Aberdeen (EOWDC)	2018	UK	92	11	8,4	MHI Vestas		Boskalis/Cadeler		11	92		Cadeler		
Rampion	2018	UK	400	116	3,45	MHI Vestas		Van Oord/Jan De Nul				Cadeler/Jan de Nul	Cadeler/Jan de Nul	Wind Orca	47
Beatrice	2019	UK	588	84	7	Siemens Gamesa		Cadeler	Wind Orca	84	588		Seaway 7		
Hohe See	2019	Germany	497	71	7	Siemens Gamesa		Fred Olsen	Wind Osprey			DEME Offshore	Cadeler		63
Triton Knoll	2021	UK	857	90	9,5	MHI Vestas		DEME Offshore/Cadeler	Wind Osprey	90	855		Seaway 7		
Hornsea Two	2022	UK	1.386	165	8,4	Siemens Gamesa		DEME Offshore	Wind Orca				DEME Offshore/Cadeler		114
Hollandse Kust 1-4	2023	Holland	1.540	140	9,5	Siemens Gamesa		Cadeler	Wind Osprey	140	1330		Seaway 7		
Seagreen 1	2023	UK	1.140	114	10	MHI Vestas		Cadeler	Wind Orca	114	1140	Seaway 7	Saipem		
Hollandse Kust Noord	2023	Holland	759	69	11	Siemens Gamesa		Van Oord/Cadeler		69	759		Van Oord		
Sofia	2026	UK	1.400	100	14	Siemens Gamesa		Cadeler	Cadeler	100	1400		Van Oord		
Borkum Riffgrund 3	2025	Germany	913	83	11	Siemens Gamesa		Cadeler/Seaway 7	Wind Osprey	36	396		Jan De Nul		
Gode Wind 3	2025	Germany	242	23	11	Siemens Gamesa		Cadeler/Seaway 7	Wind Osprey	12	132		Jan De Nul		
EnBW HeBW HE Dreiht	2025	Germany	900	64	15	Vestas		Cadeler	Cadeler O-class	64	960				
Moray West	2025	UK	860	60	14	Siemens Gamesa		Cadeler	Wind Orca	60	840				
East Anglia Three	2026	UK	1.400	95	15			Cadeler	O-class & X-class	95	1425		Seaway 7		
East Anglia Two	2026	UK	900	60	15			Cadeler	O-class & X-class	60	900				
East Anglia One	2027	UK	800	53	15			Cadeler	O-class & X-class	53	800				
Baltic Power	2026	Poland	1.200	80	15			Cadeler	O-class	76	1140				
Hornsea Three	2027	UK	2.852	190	15			Cadeler					Cadeler	F-class	192

Source: Data extracted from Jefferies (2022)

Seaway 7 T&I services historic track record

Offshore wind farm name	Onstream	Country	Total power MW	No. Of Turbines	Turbine size (MW)	Wind turbine manufacturer	Wind turbine installer	No. of Turbines	Capacity installed	Foundation contractor	Foundation installer	No. of Foundations
Arklow Bank	2004	Ireland	25	7	3,6	GE	Van Oord				Van Oord	
Greater Gabbard	2011	UK	504	140	3,6	Siemens Gamesa Brieux Gamesa	SeaJacks			Fluor	Seaway 7	140
Sheringham Shoal	2012	UK	317	88	3,6	Siemens Gamesa	SeaJacks				Seaway 7	66
Trianel Borkum	2012	Germany	200	40	5	Areva	DEME Offshore				Seaway 7	40
Riffgat 2013	2013	Germany	108	30	3,6	Siemens Gamesa	Fred Olsen Windcarrier				Seaway 7	30
Amrumbank West	2015	Germany	302	80	3,6	Siemens Gamesa	Van Oord			Van Oord	Jan De Nul	
Baltic II	2015	Germany	288	80	3,6	Siemens Gamesa	DEME Offshore				Seaway 7	
Humber Gateway	2015	UK	219	73	3	MHI Vestas				Van Oord	Jan De Nul	
Gwynt y Mor	2015	UK	576	160	3,6	Siemens Gamesa	DEME Offshore				Seaway 7	160
Dudgeon	2017	UK	402	67	6	Siemens Gamesa	DEME Offshore			Atkins	Seaway 7	67
Veja Mate	2017	Germany	400	67	6	Siemens Gamesa	Fred Olsen/Seajacks			Boskalis	Seajacks	
Nordsee One	2017	Germany	332	54	6,2	Senvion	Van Oord				DEME Offshore	
Beatrice 2018	2018	UK	588	84	7	Siemens Gamesa	Cadeler				Seaway 7	84
Hornsea ONE	2019	UK	1218	174	7	Siemens Gamesa	DEME/Fred Olsen				DEME/Boskalis	
Formosa 1	2019	Taiwan	128	22	6	Siemens Gamesa	Seajacks			Jan de Nul	Jan De Nul/Seaway 7	20
Trianel Borkum	2020	Germany	200	32	6,2	Senvion	Jan De Nul/Fred Olsen				Jan De Nul	32
Coastal Virginia	2020	USA	12	2	6	Siemens Gamesa	Jan De Nul/Fred Olsen					
Yunlin 2021	2021	Taiwan	640	80	8	Siemens Gamesa	Fred Olsen Windcarrier				Seaway 7	
Formosa 2	2021	Taiwan	376	47	8	Siemens Gamesa	Seajacks				Seaway 7	47
Triton Knoll	2022	UK	857	90	9,5	MHI	DEME Offshore				Seaway 7	90
Hornsea Two	2022	UK	1.386	165	8,4	Siemens Gamesa	DEME Offshore				DEME Offshore/Cadeler	
Kaskasi II	2022	Germany	342	38	9	Siemens Gamesa					Seaway 7	38
Hollandse Kust 1-4	2023	Holland	1.540	140	9,5	Siemens Gamesa	Cadeler				Seaway 7	140
Seagreen 1	2023	UK	1.140	114	10	MHI Vestas	Cadeler			Seaway 7	Saipem	
Dogger Bank A	2023	UK	1.200	95	13	GE	Jan de Nul				Seaway 7	95
Gode Wind 3	2023	Germany	253	23	11	Siemens Gamesa	Cadeler/Seaway 7	11	121		Jan De Nul	
Changfang & Xidao	2024	Taiwan	589	62	9,5	MHI	Fred Olsen Windcarrier				Boskalis	
Zhong Neng	2024	Taiwan	300	30	10	MHI	CSBC & DEME				CSBC & DEME	
Dogger Bank	2024	UK	1.200	95	13	GE	Jan De Nul				Seaway 7	95
Borkum Riffgrund	2024	Germany	913	83	11	Siemens Gamesa	Cadeler/Seaway 7	47	517		Jan De Nul	
Dogger Bank B	2025	UK	1.200	87	14	GE	Jan de Nul				Seaway 7	87
EnBW He Dreiht	2025	Germany	900	64	15	Vestas	Cadeler					
Seagreen 1A	2025	UK	500	36	14	Seaway 7					Seaway 7	95
Moray West	2025	UK	882	60	15	Siemens Gamesa	Cadeler					
East Anglia Three	2026	UK	1.400	95	15	Cadeler	Cadeler				Seaway 7	36

Source: Data extracted from Jefferies (2022)

Eneti T&I services historic track record

Offshore wind farm name	Onstream	Country	Total power MW	No. Of Turbines	Turbine size (MW)	Wind turbine installer	WTI vessel	No. of Turbines	Capacity installed (MW)	Foundation installer	Foundation vessel	No. of Foundations
Greater Gabbard	2011	UK	504	140	3,6	Seajacks	Leviathan	105	378	Seaway 7		
Walney 1 & 2	2012	UK	367	102	3,6	Seajacks	Kraken & Leviathan	97	349	DEME Offshore		
Sheringham Shoal	2012	UK	317	88	3,6	Seajacks	Leviathan	28	101	Seaway 7		
Meerwind	2015	Germany	288	80	3,6	Seajacks	Leviathan	80	288	Seajacks	Leviathan & Zaratan	80
Veja Mate	2017	Germany	400	67	6	Fred Olsen/Seajacks	Scylla	48	288	Seajacks	Scylla & Zaratan	67
Walney Extension	2018	UK	659	87	8,25	Seajacks	Scylla	87	718	Van Oord		
Deutsche Bucht	2019	Germany	252	31	8,4	Van Oord/Seajacks	Scylla			Van Oord/Seajacks	Scylla	31
Formosa 1	2019	Taiwan	128	22	6	Seajacks	Zaratan	20	120	Jan de Nul/Seaway 7		
Northwester 2	2020	Belgium	219	23	9,5	Jan De Nul/Seajacks	Scylla	4	38			
Yuedian Yangjiang Shapa	2021	China	302	47	6,45	Seajacks	Scylla	18	116			
Moray East	2022	UK	950	100	9,5	Fred	Olsen			DEME Offshore/Seajacks	Scylla	100
Greater Changhua 1 & 2	2022	Taiwan	896	112	8	Seajacks	Scylla	111	888	Heerema		
Akita Noshiro	2022	Japan	139	33	4,2	Seajacks	Zaratan	33	139	Seajacks	Zaratan	33
Formosa 2	2023	Taiwan	376	47	8	SeaJacks	Scylla	47	376	Seaway 7		
Saint-Brieuc	2023	France	496	62	8	Fred Olsen				Seajacks	Scylla	62
Yunlin	2024	Taiwan	640	80	8	Fred Olsen/Seajacks	Zaratan	35	280	Seaway 7		

Source: Data extracted from Jefferies (2022)

Fred Olsen Windcarrier T&I services historic track record

Offshore wind farm name	Onstream	Country	Total power MW	No. Of Turbines	Turbine size (MW)	Wind turbine manufacturer	EPC contractor	Wind turbine installer	No of turbines	Capacity installed (MW)
Belwind 1	2010	Belgium	171	56	3	MHI Vestas	Van Oord	Van Oord/Fred Olsen*	1	6
BARD Offshore 1	2013	Germany	400	80	5	BARD		WindLift/Fred Olsen	14	70
Riffgat	2013	Germany	113	30	3,6	Siemens Gamesa		Fred Olsen Windcarrier	30	108
Global Tech 1	2015	Germany	400	80	5	Areva		Fred Olsen/Seajacks	75	450
Butendiek	2015	Germany	288	80	3,6	Siemens Gamesa		Fred Olsen Windcarrier	80	288
Block Island	2016	USA	30	5	6	GE		Fred Olsen Windcarrier	5	30
Veja Mate	2017	Germany	400	67	6	Siemens Gamesa		Fred Olsen/Seajacks	19	114
Galloper	2018	UK	353	56	6,3	Siemens Gamesa		Fred Olsen/Cadeler	17	102
Wikinger	2018	Germany	350	70	5	Adwen		Fred Olsen Windcarrier	70	350
Hornsea ONE	2019	UK	1218	174	7	Siemens Gamesa		DEME/Fred Olsen	91	546
Hohe See	2019	Germany	497	71	7	Siemens Gamesa		Fred Olsen Windcarrier	71	497
Borkum Riffgrund 2	2019	Germany	450	56	8	MHI Vestas Vestas		Fred Olsen Windcarrier	56	448
Horns Revs 3	2019	Denmark	407	49	8,3	MHI Vestas Vestas		Fred Olsen Windcarrier	49	407
Merkur 2019	2019	Germany	396	66	6	GE	DEME Offshore	Fred Olsen Windcarrier	66	396
Albatros 2019	2019	Germany	112	16	7	Siemens Gamesa	DEME Offshore	Fred Olsen Windcarrier	16	112
Borkum II (Trianel)	2020	Germany	200	32	6,2	Senvion	Seimens	Fred Olsen Windcarrier	11	66
Moray East	2022	UK	950	100	9,5	MHI Vestas	Seaway Heavy Lift	Jan de Nul/Fred Olsen	100	950
Icebreaker 2022	2022	USA	21	6	3,45	MHI Vestas		Fred Olsen Windcarrier	6	21
Saint-Brieuc 2022	2022	France	496	62	8	Siemens Gamesa		Fred Olsen Windcarrier	62	496
Yunlin 2023	2023	Taiwan	640	80	8	Siemens Gamesa		Fred Olsen/Seajacks	45	270
Kaskasi II	2022	Germany	342	38	9	Siemens Gamesa		DEME Offshore		
Neart na Gaoithe	2023	UK	450	54	8	Siemens Gamesa		Fred Olsen Windcarrier	54	432
Baltic Eagle (Baltic sea)	2023	Germany	476	52	9,5	MHI Vestas		Fred Olsen Windcarrier	52	494
Changfang &	2024	Taiwan	589	62	9,5	MHI Vestas		Fred Olsen Windcarrier	62	589

Source: Data extracted from Jefferies (2022)

Appendix 6: Installation vessels global (ex. China) demand calculation

WTIV Demand scenario 2023-30, excluding China, 4C Offshore

		2023	2024	2025	2026	2027	2028	2029	2030
Turbines per trip	#	4	4	4	4	4	4	4	4
Installation days per turbine	#	3	3	3	3	3	3	3	3
Sailing time	Days	0,6	0,5	0,5	0,4	0,3	0,2	0,2	0,1
Total time per roundtrip	Days	12,6	12,5	12,5	12,4	12,3	12,2	12,2	12,1
Effective working days	#	300	300	300	300	300	300	300	300
Fleet Utilization	%	80%	80%	80%	80%	80%	80%	80%	80%
Active days per year	#	240	240	240	240	240	240	240	240
Total roundtrips per year	#	19,0	19,1	19,3	19,4	19,5	19,6	19,7	19,8
Turbines per trip	#	4	4	4	4	4	4	4	4
Turbines per year	#	76,1	76,6	77,0	77,5	77,9	78,4	78,9	79,3
Turbine size	MW	10,0	10,9	11,8	12,7	13,6	14,5	15,4	16,3
MW per vessel year	MW	761	834	909	984	1.060	1.137	1.214	1.293
Installed capacity	MW	4.800	11.200	13.700	15.800	20.700	25.100	27.200	31.200
Number of turbines	#	480	1.028	1.161	1.244	1.522	1.731	1.766	1.914
WTIV demand	#	**6,3**	**13,4**	**15,1**	**16,1**	**19,5**	**22,1**	**22,4**	**24,1**

FIV Demand scenario 2023-30, excluding China, 4C Offshore

		2023	2024	2025	2026	2027	2028	2029	2030
Foundations per trip	#	3	3	3	3	3	3	3	3
Installation days	#	3	3	3	3	3	3	3	3
Sailing time/Foundation	Days	1,1	1,0	0,9	0,8	0,6	0,5	0,4	0,3
Total time per roundtrip	Days	10,1	10,0	9,9	9,8	9,6	9,5	9,4	9,3
Effective working days	#	280	280	280	280	280	280	280	280
Fleet Utilization	%	75%	75%	75%	75%	75%	75%	75%	75%
Active days per year	#	210	210	210	210	210	210	210	210
Total roundtrips per year	#	20,9	21,1	21,3	21,5	21,8	22,0	22,2	22,5
Foundations per trip	#	3	3	3	3	3	3	3	3
Foundations per year	#	62,6	63,3	63,9	64,6	65,3	66,0	66,7	67,4
Foundation size (MW)	MW	10,9	11,8	12,7	13,6	14,5	15,4	16,3	17,2
MW per vessel year	MW	683	747	812	879	947	1016	1087	1160
Installed capacity	MW	4.800	11.200	13.700	15.800	20.700	25.100	27.200	31.200
Number of foundations	#	440	949	1.079	1.162	1.428	1.630	1.669	1.814
FIV demand	#	**7,0**	**15,0**	**16,9**	**18,0**	**21,9**	**24,7**	**25,0**	**26,9**

WTIV Demand scenario 2023-30, excluding China, GWEC

		2023	2024	2025	2026	2027	2028	2029	2030
Turbines per trip	#	4	4	4	4	4	4	4	4
Installation days per turbine	#	3	3	3	3	3	3	3	3
Sailing time	Days	0,6	0,5	0,5	0,4	0,3	0,2	0,2	0,1
Total time per roundtrip	Days	12,6	12,5	12,5	12,4	12,3	12,2	12,2	12,1
Effective working days	#	300	300	300	300	300	300	300	300
Fleet Utilization	%	80%	80%	80%	80%	80%	80%	80%	80%
Active days per year	#	240	240	240	240	240	240	240	240
Total roundtrips per year	#	19,0	19,1	19,3	19,4	19,5	19,6	19,7	19,8
Turbines per trip	#	4	4	4	4	4	4	4	4
Turbines per year	#	76,1	76,6	77,0	77,5	77,9	78,4	78,9	79,3
Turbine size	MW	10	10,9	11,8	12,7	13,6	14,5	15,4	16,3
MW per vessel year	MW	761	835	909	984	1060	1137	1214	1293
Installed capacity	MW	7.500	5.600	15.200	22.500	22.300	26.800	34.300	38.700
Number of turbines	#	750	514	1.288	1.772	1.640	1.848	2.227	2.374
WTIV demand	#	**9,9**	**6,7**	**16,7**	**22,9**	**21,0**	**23,6**	**28,2**	**29,9**

FIV Demand scenario 2023-30, excluding China, GWEC

		2023	2024	2025	2026	2027	2028	2029	2030
Foundations per trip	#	3	3	3	3	3	3	3	3
Installation days	#	3	3	3	3	3	3	3	3
Sailing time/Foundation	Days	1,1	1,0	0,9	0,8	0,6	0,5	0,4	0,3
Total time per roundtrip	Days	10,1	10,0	9,9	9,8	9,6	9,5	9,4	9,3
Effective working days	#	280	280	280	280	280	280	280	280
Fleet Utilization	%	75%	75%	75%	75%	75%	75%	75%	75%
Active days per year	#	210	210	210	210	210	210	210	210
Total roundtrips per year	#	20,9	21,1	21,3	21,5	21,8	22,0	22,2	22,5
Foundations per trip	#	3	3	3	3	3	3	3	3
Foundations per year	#	62,6	63,3	63,9	64,6	65,3	66,0	66,7	67,4
Foundation size (MW)	MW	10,9	11,8	12,7	13,6	14,5	15,4	16,3	17,2
MW per vessel year	MW	683	747	812	879	947	1016	1087	1160
Installed capacity	MW	7.500	5.600	15.200	22.500	22.300	26.800	34.300	38.700
Number of foundations	#	688	475	1.197	1.654	1.538	1.740	2.104	2.250
FIV demand	#	**11,0**	**7,5**	**18,7**	**25,6**	**23,6**	**26,4**	**31,6**	**33,4**

WTIV Demand scenario 2023-30, excluding China, Rystad Energy									
		2023	2024	2025	2026	2027	2028	2029	2030
Turbines per trip	#	4	4	4	4	4	4	4	4
Installation days per turbine	#	3	3	3	3	3	3	3	3
Sailing time	Days	0,4	0,4	0,4	0,4	0,8	0,5	0,7	0,8
Total time per roundtrip	Days	12	12	12	12	12,4	12,1	12,3	12,4
Effective working days	#	290	290	290	290	290	290	290	290
Fleet Utilization	%	80%	80%	80%	80%	80%	80%	80%	80%
Active days per year	#	232	232	232	232	232	232	232	232
Total roundtrips per year	#	19,3	19,3	19,3	19,3	18,7	19,2	18,9	18,7
Turbines per trip	#	4	4	4	4	4	4	4	4
Turbines per year	#	77,3	77,3	77,3	77,3	74,8	76,7	75,4	74,8
Turbine size	MW	7,9	7,9	10,3	11,2	11	11,6	12	11,9
MW per vessel year	MW	611	611	797	866	823	890	905	891
Installed capacity	MW	10.800	6.000	9.200	20.800	22.100	24.900	42.200	38.900
Number of turbines	#	1.367	759	893	1.857	2.009	2.147	3.517	3.269
WTIV demand	#	**17,7**	**9,8**	**11,6**	**24,0**	**26,8**	**28,0**	**46,6**	**43,7**

FIV Demand scenario 2023-30, excluding China, Rystad Energy									
		2023	2024	2025	2026	2027	2028	2029	2030
Foundations per trip	#	3	3	3	3	3	3	3	3
Installation days	#	3	3	3	3	3	3	3	3
Sailing time/Foundation	Days	1,1	1,0	0,9	0,8	0,6	0,5	0,4	0,3
Total time per roundtrip	Days	10,1	10,0	9,9	9,8	9,6	9,5	9,4	9,3
Effective working days	#	280	280	280	280	280	280	280	280
Fleet Utilization	%	75%	75%	75%	75%	75%	75%	75%	75%
Active days per year	#	210	210	210	210	210	210	210	210
Total roundtrips per year	#	20,9	21,1	21,3	21,5	21,8	22,0	22,2	22,5
Foundations per trip	#	3	3	3	3	3	3	3	3
Foundations per year	#	62,6	63,3	63,9	64,6	65,3	66,0	66,7	67,4
Foundation size (in MW)	MW	10,9	11,8	12,7	13,6	14,5	15,4	16,3	17,2
MW per vessel year	MW	683	747	812	879	947	1016	1087	1160
Installed capacity	MW	10.800	6.000	.200	20.800	22.100	24.900	42.200	38.900
Number of foundations	#	991	508	724	1.529	1.524	1.617	2.589	2.262
FIV demand	#	**15,8**	**8,0**	**11,3**	**23,7**	**23,3**	**24,5**	**38,8**	**33,5**

Source: Own creation based on expert inputs, 4C Offshore (2022), GWEC (2022), Rystad Energy (2022)

Appendix 7: Comprehensive list of government tenders from 2023 until 2026

Country	Tender name	Auction format	Technology	Year	Capacity (GW)
Netherlands	IJmuiden Ver IV	Central	Fixed	2023	1
Belgium	PEZ	Central	Fixed	2023	1
Portugal	Portugal Tender	Lease	Fixed	2023	7
United Kingdom	Celtic Sea	Lease	Floating	2023	4
United States	OR	Lease	Fixed	2023	3
Norway	Sørlige Nordsjø II	Lease	Fixed	2023	3
Denmark	Bornholm (1/3)	Central	Fixed	2023	1,3
Denmark	Bornholm (2/3)	Central	Fixed	2023	1,3
Denmark	Bornholm (3/3)	Central	Fixed	2023	1,3
Germany	Germany N-11.1	Central	Fixed	2023	2
Germany	Germany N-12.1	Central	Fixed	2023	2
Germany	Germany N-12.2	Central	Fixed	2023	2
Germany	Germany O-2.2	Central	Fixed	2023	1
Germany	Germany N-6.6	Central	Fixed	2023	0,6
Germany	Germany N-6.7	Central	Fixed	2023	0,3
Germany	Germany N-3.5	Central	Fixed	2023	0,4
Germany	Germany N-3.6	Central	Fixed	2023	0,5
Taiwan	Round Three Centralized Auction 2	Central	Fixed	2023	3
Japan	Round 2.2	Central	Optional	2023	0,9
Lithuania	Round 1	Central	Fixed	2023	0,7
France	Round 10	Central	Fixed	2023	1
Netherlands	IJmuiden Ver I	Central	Fixed	2023	1
Netherlands	IJmuiden Ver II	Central	Fixed	2023	1
Netherlands	IJmuiden Ver III	Central	Fixed	2023	1
Denmark	Hesselø	Central	Fixed	2024	1,2
Japan	Round 3	Central	Fixed	2024	1,5
Germany	Germany N-9.1	Central	Fixed	2024	2
Germany	Germany N-9.2	Central	Fixed	2024	2
Germany	Germany N-9.3	Central	Fixed	2024	1,5
Taiwan	Round Three Centralized Auction 3	Central	Optional	2024	3
Germany	Germany N-12.3	Central	Fixed	2024	1
Germany	Germany N-11.2	Central	Fixed	2024	1,5
Japan	Round 4	Central	Optional	2024	1,25
Norway	Utsira Nord	Lease	Floating	2024	1,5
Japan	Round 5	Central	Optional	2025	1,25
Germany	Germany N-10.2	Central	Fixed	2025	0,5
Germany	Germany N-10.1	Central	Fixed	2025	2
Netherlands	IJmuiden (Noord) Ver V	Central	Fixed	2025	1
Netherlands	IJmuiden (Noord) Ver VII	Central	Fixed	2025	1
Belgium	Princess Elisabeth 2	Central	Fixed	2025	1,4
Belgium	Princess Elisabeth 3	Central	Fixed	2025	1,4
Canada	Lease Auction Nova Scotia	Lease	Fixed	2025	5
Germany	2025 Auction	Central	Fixed	2025	5
France	Round 11 Mediterranean Extension	Central	Floating	2025	1
France	Round 12	Central	Fixed	2025	1
United Kingdom	CfD 7	Central	Fixed	2025	4
Japan	Round 5	Central	Fixed	2025	2
Lithuania	Round 2	Central	Fixed	2025	0,7
Netherlands	Nederwiek South I	Central	Fixed	2025	2
Norway	Sørlige Nordsjø II Site 2	Central	Fixed	2025	1,5
Poland	2nd Price Auction (2nd Wave)	Central	Fixed	2025	2,5
Germany	2026 Auction	Central	Fixed	2026	1,5
France	Round 13	Central	Floating	2026	0,5
France	Round 14	Central	Fixed	2026	1
United Kingdom	CfD 8	Central	Fixed	2026	4
Japan	Round 6	Central	Fixed	2026	2
Netherlands	Nederwiek Nord	Central	Fixed	2026	4,8
Netherlands	North of the Wadden Islands	Central	Fixed	2026	0,8

Auction	Average of Capacity (GW)
Central	1,56
Lease	3,92

Source: Own creation based on publicly available information

Appendix 8: Comprehensive list of identified vessels historically and expected employed in the T&I industry

No.	Name	Operator	Delivery	Market	Able to enter Baltic Sea	Lift [t]	Category FIV	Hook height [m]	Category WTIV
1	Bokalift 2	Boskalis	2021	EU	Yes	4000	3	125	2
2	Bokalift 1	Boskalis	2017	EU	Yes	2300	2	113	1
3	Asian Hercules III	Boskalis	2015	EU	Yes	1600	1	61	0
4	Taklift 4	Boskalis	1985	EU	Yes	1400	0	80	0
5	Fclass	Cadeler	2026	EU	Yes	3000	3	192	3
6	NG-20000X-G1	Cadeler	2024	EU	Yes	2600	2	192	3
7	NG-20000X-G2	Cadeler	2025	EU	Yes	2600	2	192	3
8	Upgraded Wind Orca	Cadeler	2024	EU	Yes	1600	1	180	3
9	Upgraded Wind Osprey	Cadeler	2025	EU	Yes	1600	1	180	3
10	Wind Orca	Cadeler	2012	EU	Yes	1200	0	117	1
11	Wind Osprey	Cadeler	2014	EU	Yes	1150	0	152	2
12	Green Jade	CDWE	2022	ASIA	Yes	4000	3	125	2
13	Orion	DEME Offshore	2022	EU	Yes	5000	3	135	2
14	INNOVATION	DEME Offshore	2015	EU	Yes	1500	1	141	1
15	SEA Installer	DEME Offshore	2012	EU	Yes	632	1	121	0
16	Upgraded Sea Challenger	DEME Offshore	2025	ASIA	Yes	1600	1	180	3
17	Upgraded SEA Installer	DEME Offshore	2023	EU	Yes	1600	1	180	3
18	Apollo	DEME Offshore	2018	EU	Yes	800	0	158	2
19	SEA Challenger	DEME Offshore	2014	EU	Yes	632	0	140	1
20	Charybdis	Dominion resources	2024	US	Yes	2200	2	174	3
21	conquest MB1	dutch offshore	2012	EU	Yes	1400	0	75	0
22	Eneti WTIV	Eneti Inc	2026	EU	Yes	2600	3	190	3
23	Eneti WTIV	Eneti Inc	2024	US	Yes	2600	3	190	3
24	Upgraded Bold Tern	Fred. Olsen	2022	EU	Yes	1600	1	174	3
25	Blue Tern (6)	Fred. Olsen	2012	EU	Yes	800	0	125	0
26	Brave Tern (6)	Fred. Olsen	2012	EU	Yes	640	0	138	1
27	tbd	Hafvram	2026	EU	Yes	-	3	-	3
28	tbd	Hafvram	2024	EU	Yes	-	3	-	3
29	Aegir	Heerema	2012	EU	Yes	5000	3	125	2
30	Balder	Heerema	1978	EU	No	2720	3	-	0
31	Sleipnir	Heerema	2019	EU	No	20000	3	185	0
32	Thialf	Heerema	1985	EU	Yes	14200	3	144	1
33	Les Alizes	Jan de Nul	2022	EU	Yes	5000	3	167	2
34	Voltaire	Jan de Nul	2022	EU	Yes	3000	3	187	3
35	Vole au Vent	Jan de Nul	2013	EU	Yes	1500	1	140	1
36	Maersk supply 1	Maersk	2026	US	Yes	3000	3	189	3
37	DLS4200	NPCC	2013	EU	Yes	3810	3	-	0
38	tbd	Obayashi	2023	ASIA	Yes	1250	1	-	0
39	Taillevent	Oceanrich	2017	ASIA	Yes	1000	0	-	0
40	BT220IU	OIM Wind	2026	EU	Yes	2600	2	165	3
41	Serooskerke/Walcheren	OOS	2020	EU	No	2200	2	82	0
42	tbd	Penta-Ocean	2022	ASIA	Yes	1600	1	140	1
43	CP-80017	Penta-Ocean	2019	ASIA	Yes	800	0	-	0
44	Saipem 7000	Saipem	1987	EU	No	14000	3	-	0
45	Saipem 3000	Saipem	1987	EU	Yes	2177	2	-	0
46	LTS 3000	Sapura	2007	EU	Yes	2722	3	-	0
47	Sapura 3500	Sapura	2014	EU	Yes	3500	3	-	0
48	Gulliver	Scaldis	2018	EU	Yes	2300	2	77	0
49	Rambiz	Scaldis	1976	EU	Yes	1750	1	77	0
50	Seajacks Scylla	Seajacks	2015	EU	Yes	1500	1	153	1
51	Seajacks Zaratan	Seajacks	2012	EU	Yes	600	0	119	0
52	Alfa Lift	Seaway 7	2022	EU	Yes	3000	3	108	0
53	Alfa Lift 2	Seaway 7	2025	EU	Yes	3000	3	108	0
54	Seaway Strashnov	Seaway 7	2011	EU	Yes	5000	3	100	0
55	JU Ventus	Seaway 7	2023	EU	Yes	2500	2	177	3
56	JU VIND 2	Seaway 7	2025	EU	Yes	2500	2	189	3
57	Seaway Yudin	Seaway 7	1985	EU	Yes	2500	2	79	0
58	Name tbd (4)	Shimizu	2022	ASIA	Yes	1250	1	179	3
59	Boreas	Van Oord	2024	EU	Yes	3000	3	190	3
60	Svanen	Van Oord	1990	EU	Yes	5705	3	72	0
61	Aeolus 2.0	Van Oord	2014	EU	Yes	1600	1	136,1	1
62	MPI adventure	Van Oord	2011	EU	Yes	1000	0	120	0

Source: Own creation based on publicly available information

Appendix 9: Financial figures from 2018-2022 on T&I industry firms

Cadeler A/S (OB:CADLR)	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	112.119	72.076	22.266	42.971	85.088
Total Assets	716.074	483.073	412.001	124.755	30.424
Total Debt	123.203	83.682	90.877	128.286	-
Net Income	37.443	8.813	-30.865	-26.604	1.087
EBITDA	66.280	32.296	-36.497	-15.186	3.028
EBIT	43.395	13.169	-40.995	-15.276	2.939
Total Current Assets	63.595	27.997	102.191	20.218	30.020
Inventories	587	500	382	293	968
Total Equity	577.715	369.903	294.878	-14.701	20.596
Total Current Liabilities	12.609	61.249	31.357	35.041	9.755

Cadeler A/S (OB:CADLR)	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	33%	12%	-139%	-62%	1%
EBITDA Ratio	59%	45%	-164%	-35%	4%
Asset base development	48%	17%	230%	310%	
Leverage Ratio	17%	17%	22%	103%	0%
Current Ratio	5,04	0,46	3,26	0,58	3,08
ROA	5%	2%	-7%	-21%	4%
ROE	6%	2%	-10%	181%	5%

Eneti Inc. (NYSE:NETI)	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	199.326	144.033	163.732	224.579	242.502
Total Assets	814.504	807.273	868.195	1.665.559	1.703.826
Total Debt	66.649	142.845	566.834	767.529	828.565
Net Income	105.702	20.227	-671.983	44.654	-12.698
EBITDA	78.796	5.575	14.139	70.061	99.917
EBIT	54.199	-4.615	-34.230	15.837	43.310
Total Current Assets	174.172	190.030	121.603	65.286	84.099
Inventories	5.795	5.846	10.614	6.371	3.595
Total Equity	715.314	620.344	272.598	874.967	860.804
Total Current Liabilities	45.011	131.163	87.016	123.833	152.614

Eneti Inc. (NYSE:NETI)	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	53%	14%	-410%	20%	-5%
EBITDA Ratio	40%	4%	9%	31%	41%
Asset base development	1%	-7%	-48%	-2%	
Leverage Ratio	8%	18%	65%	46%	49%
Current Ratio	3,87	1,45	1,40	0,53	0,55
ROA	13%	3%	-77%	3%	-1%
ROE	15%	3%	-247%	5%	-1%

Fred. Olsen Windcarrier ASA	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue		139.400	196.513	19.046	16.908
Total Assets		485.658	505.825	444.535	296.527
Total Debt		126.139	130.994		
Net Income		19.504	4.160	-433	-382
EBITDA		62.367	16.259	183	3.747
EBIT		29.083	-15.706	-2.576	2.860
Total Current Assets		82.593	84.928	103.293	74.273
Inventories		4.835	7.889		
Total Equity		291.397	295.330	188.768	114.445
Total Current Liabilities		100.221	62.201	144.387	67.097

Fred. Olsen Windcarrier ASA	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin		14%	2%	-2%	-2%
EBITDA Ratio		45%	8%	1%	22%
Asset base development		-4%	14%	50%	
Leverage Ratio		26%	26%		
Current Ratio		0,82	1,37	0,72	1,11
ROA		4%	1%	0%	0%
ROE		7%	1%	0%	0%

Seaway 7 ASA (OB:SEAW7)	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	1.119.000	1.260.000	631.400	61.128	56.484
Total Assets	1.376.100	1.388.000	767.000	219.547	192.220
Total Debt	138.500	127.600	43.800	26.811	
Net Income	-80.700	-62.500	-49.500	-7.629	-12.957
EBITDA	17.600	14.200	7.100	5.430	1.149
EBIT	-50.300	-38.900	-39.700	-6.035	-13.064
Total Current Assets	228.700	327.600	159.200	25.451	24.684
Inventories	7.700	5.900	1.000	2.421	4.640
Total Equity	987.300	864.300	578.100	169.226	176.854
Total Current Liabilities	292.700	467.600	181.600	48.896	15.366

Seaway 7 ASA (OB:SEAW7)	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	-7%	-5%	-8%	-12%	-23%
EBITDA Ratio	2%	1%	1%	9%	2%
Asset base development	-1%	81%	249%	14%	
Leverage Ratio	10%	9%	6%	12%	0%
Current Ratio	0,78	0,70	0,88	0,52	1,61
ROA	-6%	-5%	-6%	-3%	-7%
ROE	-8%	-7%	-9%	-5%	-7%

ZITON A/S	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	60.836	68.662	56.676	37.586	53.739
Total Assets	203.909	215.592	233.404	225.032	191.587
Total Debt	189.719	234.334	248.695	213.263	167.005
Net Income	-8.910	-18.163	-14.108	-17.408	-1.515
EBITDA	27.586	21.721	12.813	-1.577	34.237
EBIT	16.212	9.126	2.858	-3.934	24.898
Total Current Assets	16.142	8.151	3.509	5.543	15.924
Inventories	450	219	285	329	40
Total Equity	7.806	-25.299	-20.684	-5.911	10.192
Total Current Liabilities	13.533	132.546	60.948	18.438	8.333

ZITON A/S	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	-15%	-26%	-25%	-46%	-3%
EBITDA Ratio	45%	32%	23%	-4%	64%
Asset base development	-5%	-8%	4%	17%	
Leverage Ratio	93%	109%	107%	95%	87%
Current Ratio	1,19	0,06	0,06	0,30	1,91
ROA	-4%	-8%	-6%	-8%	-1%
ROE	-114%	72%	68%	295%	-15%

Boskalis International B.V.	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue		97.635	369.821	441.658	731.794
Total Assets		1.018.029	1.077.174	946.761	902.290
Total Debt					
Net Income		-17.963	-5.791	44.427	40.740
EBITDA					
EBIT		-7.394	369.821	50.040	49.911
Total Current Assets		871.401	898.856	812.083	793.231
Inventories		10.751	871	533	3.273
Total Equity		462.563	513.764	481.807	447.020
Total Current Liabilities		436.043	563.348	353.715	455.206

Boskalis International B.V.	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin		-18%	-2%	10%	6%
EBITDA Ratio					
Asset base development		-5%	14%	5%	
Leverage Ratio					
Current Ratio		2,00	1,60	2,30	1,74
ROA		-2%	-1%	5%	5%
ROE		-4%	-1%	9%	9%

DEME Group NV (ENXTBR:DEME)	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	2.796.778	2.969.494	2.507.213	2.935.457	3.124.573
Total Assets	4.819.684	4.605.478	4.795.051	4.426.865	4.374.539
Total Debt	1.114.432	1.052.894	1.375.342	1.340.304	975.144
Net Income	121.566	138.785	58.475	137.734	181.064
EBITDA	461.458	510.260	308.124	472.309	521.619
EBIT	156.301	191.659	11.705	141.539	218.522
Total Current Assets	1.646.349	1.541.410	1.503.206	1.360.577	1.393.367
Inventories	27.462	13.838	12.790	14.759	17.454
Total Equity	1.898.327	1.818.764	1.816.920	1.624.009	1.620.625
Total Current Liabilities	1.836.115	1.892.005	1.888.848	1.573.232	2.014.502

DEME Group NV	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	4%	5%	2%	5%	6%
EBITDA Ratio	16%	17%	12%	16%	17%
Asset base development	5%	-4%	8%	1%	
Leverage Ratio	23%	23%	29%	30%	22%
Current Ratio	0,90	0,81	0,80	0,86	0,69
ROA	3%	3%	1%	3%	4%
ROE	6%	8%	3%	8%	11%

Dominion Energy, Inc. (NYSE:D)	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	17.174.000	13.964.000	14.172.000	14.401.000	11.199.000
Total Assets	104.243.000	99.590.000	95.905.000	103.823.000	77.914.000
Total Debt	46.608.000	41.488.000	37.642.000	32.775.000	35.317.000
Net Income	994.000	3.314.000	-550.000	1.376.000	2.549.000
EBITDA	7.886.000	6.605.000	6.392.000	6.333.000	5.408.000
EBIT	4.773.000	3.837.000	3.556.000	3.356.000	3.128.000
Total Current Assets	9.850.000	7.269.000	6.886.000	6.096.000	5.161.000
Inventories	1.729.000	1.631.000	1.550.000	1.616.000	1.418.000
Total Equity	27.881.000	27.308.000	26.461.000	34.033.000	22.048.000
Total Current Liabilities	13.450.000	8.673.000	10.843.000	9.940.000	7.647.000

Dominion Energy, Inc. (NYSE:D)	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	6%	24%	-4%	10%	23%
EBITDA Ratio	46%	47%	45%	44%	48%
Asset base development	5%	4%	-8%	33%	
Leverage Ratio	45%	42%	39%	32%	45%
Current Ratio	0,73	0,84	0,64	0,61	0,67
ROA	1%	3%	-1%	1%	3%
ROE	4%	12%	-2%	4%	12%

Jan De Nul NV	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue		1.121.322	1.376.028	1.592.706	1.027.290
Total Assets		2.376.393	2.404.112	2.397.176	2.281.687
Total Debt		414	535		
Net Income		33.300	28.903	76	59.919
EBITDA		138.939	40.550	44.836	34.948
EBIT		94.785	-3.427	76.403	-1.431
Total Current Assets		1.881.155	1.763.619	1.812.135	1.860.398
Inventories		375.464	269.911	303.408	166.356
Total Equity		1.550.925	1.633.730	1.470.386	1.500.105
Total Current Liabilities		819.856	720.343	900.146	686.464

Jan De Nul NV	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin		3%	2%	0%	6%
EBITDA Ratio		12%	3%	3%	3%
Asset base development		-1%	0%	5%	
Leverage Ratio		0%	0%		
Current Ratio		2,29	2,45	2,01	2,71
ROA		1%	1%	0%	3%
ROE		2%	2%	0%	4%

Maersk Supply Service A/S	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue		1.732	1.767	133.816	109.203
Total Assets		751	674	867.920	979.552
Total Debt		-	-		
Net Income		74	50	-103.406	-522.958
EBITDA				2.058	78.363
EBIT		102	35	-43.920	-104.216
Total Current Assets		751	674	127.009	162.767
Inventories				7.229	4.374
Total Equity		617	543	449.962	-141.674
Total Current Liabilities		134	131	399.531	1.073.583

Maersk Supply Service A/S	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin		4%	3%	-77%	-479%
EBITDA Ratio				2%	72%
Asset base development		11%	-100%	-11%	
Leverage Ratio					
Current Ratio		5,60	5,15	0,32	0,15
ROA		10%	7%	-12%	-53%
ROE		12%	9%	-23%	369%

Saipem SpA (BIT:SPM)	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	10.521.400	7.721.184	8.448.235	10.186.912	10.080.715
Total Assets	13.248.905	13.126.351	13.776.147	14.598.810	13.369.590
Total Debt	3.241.424	4.475.151	4.227.523	4.156.660	3.378.750
Net Income	-220.183	-2.917.917	-1.275.399	109.717	-484.196
EBITDA	419.297	-2.164.486	304.863	1.090.455	996.734
EBIT	97.976	-2.519.320	-202.100	566.499	448.767
Total Current Assets	8.376.616	7.755.032	7.842.202	7.868.926	7.113.579
Inventories	225.500	293.415	342.508	340.029	346.920
Total Equity	2.229.347	399.181	3.606.116	4.629.110	4.621.021
Total Current Liabilities	7.389.120	7.783.464	5.997.554	5.839.973	5.072.132

Saipem SpA (BIT:SPM)	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	-2%	-38%	-15%	1%	-5%
EBITDA Ratio	4%	-28%	4%	11%	10%
Asset base development	1%	-5%	-6%	9%	
Leverage Ratio	24%	34%	31%	28%	25%
Current Ratio	1,13	1,00	1,31	1,35	1,40
ROA	-2%	-22%	-9%	1%	-4%
ROE	-10%	-731%	-35%	2%	-10%

Shimizu Corporation	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue	13.207.214	13.738.628	15.621.767	15.018.244	13.715.809
Total Assets	17.526.854	17.257.606	17.703.519	16.792.654	16.913.902
Total Debt	4.077.425	3.821.789	4.101.346	2.882.384	3.185.001
Net Income	423.728	729.411	911.739	902.956	768.524
EBITDA	582.086	1.102.346	1.357.039	1.290.139	1.207.557
EBIT	402.069	944.724	1.231.635	1.170.134	1.095.633
Total Current Assets	9.470.865	9.164.622	10.649.505	10.341.133	10.552.949
Inventories	454.280	1.283.230	1.348.850	1.607.418	1.614.594
Total Equity	7.206.960	7.427.237	6.843.832	6.635.150	6.179.831
Total Current Liabilities	6.984.823	6.463.964	8.099.784	7.561.303	7.668.076

Shimizu Corporation	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin	3%	5%	6%	6%	6%
EBITDA Ratio	4%	8%	9%	9%	9%
Asset base development	2%	-3%	5%	-1%	
Leverage Ratio	23%	22%	23%	17%	19%
Current Ratio	1,36	1,42	1,31	1,37	1,38
ROA	2%	4%	5%	5%	5%
ROE	6%	10%	13%	14%	12%

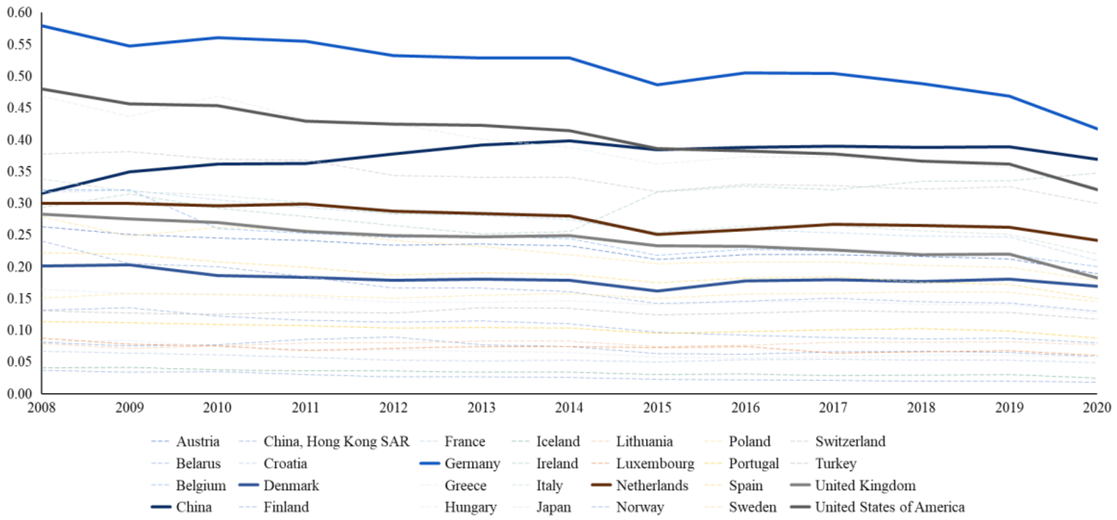
Van Oord NV	FY2022	FY2021	FY2020	FY2019	FY2018
Total Revenue		1.793.845	229.220	1.840.302	344.375
Total Assets		3.003.620	3.006.938	2.709.007	2.896.965
Total Debt					
Net Income		-73.844	37.728	51.367	108.763
EBITDA		72.153		283.891	
EBIT		-122.758	68.951	98.749	167.765
Total Current Assets		971.352	822.566	679.754	891.014
Inventories		63.886	45.976	38.635	45.421
Total Equity		1.040.470	1.207.779	1.091.034	1.089.662
Total Current Liabilities		1.218.398	1.095.414	799.797	1.189.342

Van Oord NV	FY2022	FY2021	FY2020	FY2019	FY2018
Profit Margin		-4%	16%	3%	32%
EBITDA Ratio		4%		15%	
Asset base development		0%	11%	-6%	
Leverage Ratio					
Current Ratio		0,80	0,75	0,85	0,75
ROA		-2%	1%	2%	4%
ROE		-7%	3%	5%	10%

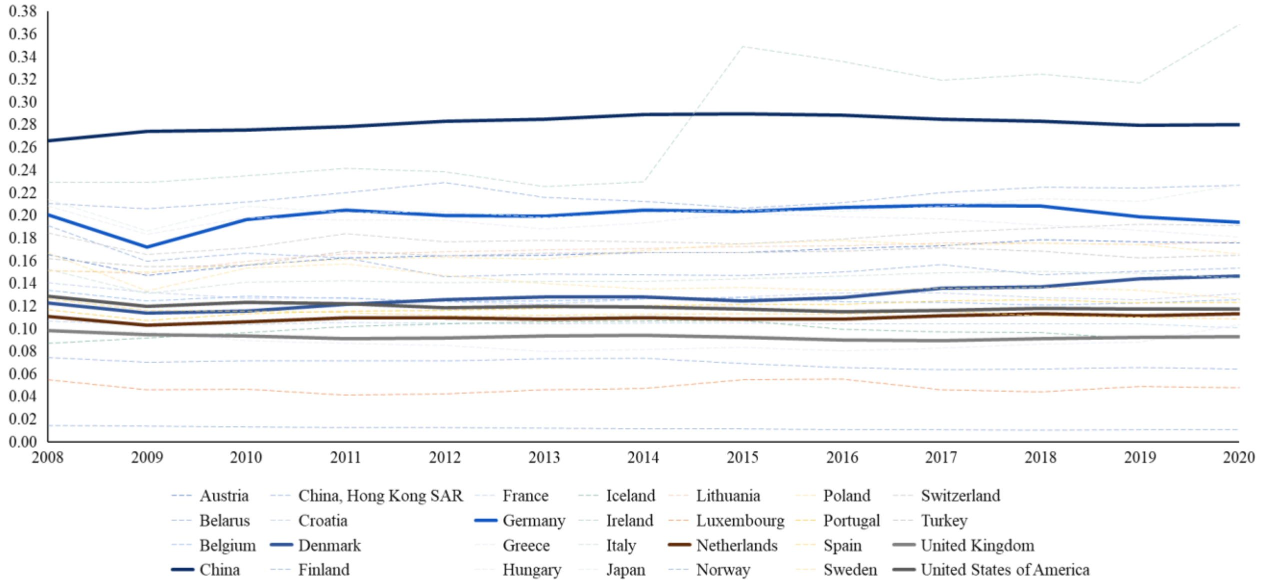
Source: Data extracted from Capital IQ

Appendix 10: Related and Support Industries – Data on industrial competitive nations

CIP Scores (Competitive Industrial Performance Index), 2008 – 2020



Manufacturing value added share in total GDP, 2008 – 2020



Source: Own creation based on data from UNIDO (2023)

Appendix 11: Financial ratios – Developers and Turbines Manufactures

	EBITDA				
Developers	*2022*	*2021*	*2020*	*2019*	*2018*
EDP - Energias de Portugal, S.A.	16%	16%	22%	18%	18%
Enel SpA	12%	17%	24%	20%	20%
Iberdrola, S.A.	23%	28%	28%	26%	25%
Ørsted A/S	15%	20%	30%	26%	18%
RWE Aktiengesellschaft	-1%	11%	30%	-5%	8%
Vattenfall AB	12%	30%	29%	25%	22%
Average	13%	20%	27%	18%	19%
Turbine Manufactures	*2022*	*2021*	*2020*	*2019*	*2018*
Siemens Gamesa Renewable Energy, S.A.	-1%	3%	1%	10%	10%
Vestas Wind Systems A/S (CPSE:VWS)	-5%	6%	7%	11%	12%
Average	-3%	5%	4%	10%	11%

	Return on Assets				
Developers	*2022*	*2021*	*2020*	*2019*	*2018*
EDP - Energias de Portugal, S.A.	2%	2%	3%	2%	2%
Enel SpA	1%	2%	2%	2%	4%
Iberdrola, S.A.	3%	3%	3%	3%	3%
Ørsted A/S	5%	4%	7%	4%	11%
RWE Aktiengesellschaft	2%	1%	2%	14%	1%
Vattenfall AB	0%	6%	1%	3%	3%
Average	2%	3%	3%	5%	4%
Turbine Manufactures	*2022*	*2021*	*2020*	*2019*	*2018*
Siemens Gamesa Renewable Energy, S.A.	-6%	-4%	-5%	1%	0%
Vestas Wind Systems A/S (CPSE:VWS)	-8%	1%	4%	5%	6%
Average	-7%	-2%	-1%	3%	3%

Source: Financial data extracted from Capital IQ (USD)