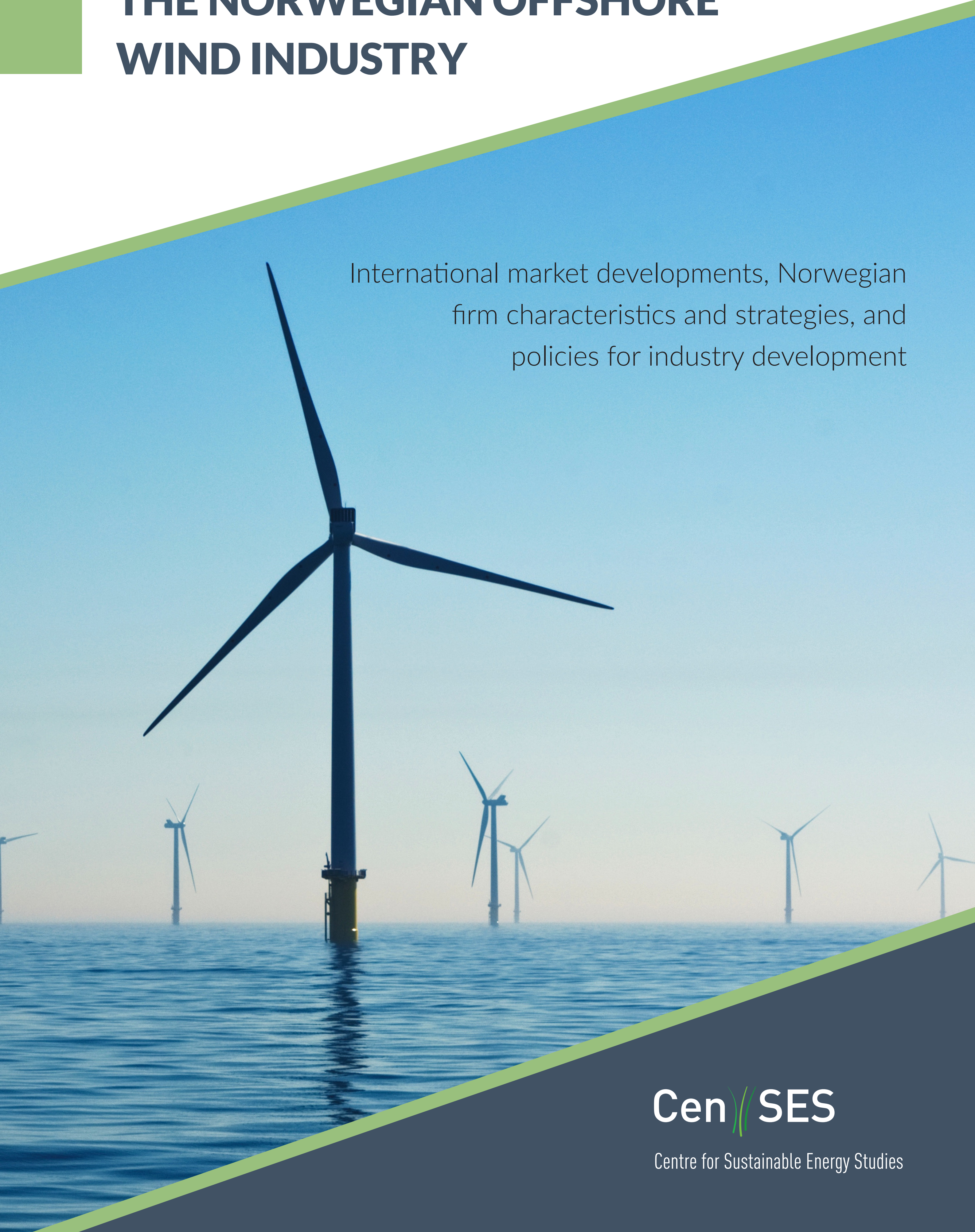
CONDITIONS FOR GROWTH IN THE NORWEGIAN OFFSHORE WIND INDUSTRY

International market developments, Norwegian firm characteristics and strategies, and policies for industry development



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International market developments, Norwegian firm characteristics and strategies, and policies for industry development

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Foreword

This report presents results from two ongoing research projects that are funded by the Norwegian Research Council and that study related topics concerning the development of a Norwegian offshore wind supply industry.

The project Conditions for Growth in Renewable Energy Industries (RENEWGROWTH) focuses on the industrial and political conditions for fostering growth of a Norwegian offshore wind industry supplying international markets. The project Internationalization of Norwegian Offshore Wind Capabilities (InNOWiC) focuses on the characteristics of international markets and production networks for offshore wind and the potential for the Norwegian firms` participation in these markets and networks.

The motivation for this joint report is to combine the insights gained from these projects about Norwegian conditions for developing an offshore wind industry with the insights on the international offshore wind markets and the value chains that Norwegian firms are aiming to enter.

The collaboration and interaction between the project groups in this report was facilitated by previous collaborations in the Centre for Sustainable Energy Studies (CenSES).

The report is authored by an interdisciplinary group of researchers with backgrounds from innovation studies, economic geography, international marketing, and strategic management. The authors have studied the Norwegian offshore wind industry for more than a decade.

This report is based on a recent survey and interview data covering firms and other stakeholders related to the offshore wind industry and is supported with secondary data sources. We would like to thank all respondents and informants for participating.

We are grateful to the Norwegian Research Council for funding the research presented in this report.

Oslo, 15.04.2019

Contents

Executive summary

Motivation

This report analyses the conditions for developing a Norwegian offshore wind industry. To date, large-scale offshore wind projects have not been deployed in Norway, but large international markets provide opportunities. It is commonly assumed that Norway's resource base—capabilities, knowledge and technology—from the petroleum and maritime sectors provides opportunities for diversification into international offshore wind markets.

Data and method

The report is based on a mixed-methods research design, including the following: a survey of 97 companies engaged in offshore wind; in-depth interviews and case studies of offshore wind firms, including interviews with top management; and secondary data (firm documents, reports and media).

Ease of diversification and international market access should not be overestimated

Technological relatedness is a key condition for entry into the offshore wind market. In part, this is based on the potential to deliver concepts to offshore wind similar to those used in other industries, particularly the petro-maritime industries. Norwegian firms involved in the offshore wind industry report relatively high degrees of *technological relatedness*. *Market relatedness*, such as customer relations, sales processes, contract design and regulations, is reported to be lower than technological relatedness and represents an entry barrier for diversifying firms. The entry to offshore wind is considered risky mainly due to market-related reasons. We observe persistent challenges for Norwegian firms to invest in capabilities needed to compete in international offshore wind markets.

Diversification from oil and gas – an opportunity and a challenge

The majority of Norwegian companies involved in offshore wind have diversified from the petro-maritime industries. However, many of these diversified firms have had a limited engagement in offshore wind. A majority of the firms report less than 5 percent of their total turnover from offshore wind. Additionally, firms have during periods with increased activity in Norwegian oil and gas industry reduced their levels of engagement in the offshore wind industry. This represents a challenge for developing a Norwegian offshore wind industry, as dedication and commitment over time is important for building up new industries.

Diversification to offshore wind requires directionality

As an example of diversification from petro-maritime sectors our study of offshore wind reveals several challenges linked to gaining market access and firms' dedication to diversification. This suggests that the authorities need to set a direction if the potential to develop a Norwegian offshore wind industry is to be exploited. This can be done in two complementary ways. First, stronger policies need to be established that support market access and incentivise diversification. We find that approximately half of the firms are not satisfied or only somewhat satisfied with the existing policies. Firms express satisfaction with policies focused on technology development but identify the following policy areas that could be strengthened: support for marketing activities, domestic market creation policies that support technology verification, piloting and demonstration, and access to capital. Second, if firms that primarily deliver to the oil and gas industry are to dedicate substantial resources to offshore wind over the longer term, the authorities may need to create incentives for diversification that sufficiently compensate for the pull towards oil and gas.

1 Introduction

This report explores the conditions for developing a Norwegian offshore wind industry. In contrast to other leading offshore wind countries, Norway has no domestic market. Norway does however have relevant industrial resources and knowledge, particularly from the petroleum and maritime sectors, which can be used to develop an offshore wind industry that targets international markets.

Several previous studies have been conducted on the Norwegian offshore wind industry. The estimates on turnover and market shares have varied in these studies. According to estimates made by Export Credit Norway, the annual turnover from offshore wind activity (including foreign subsidiaries) has increased from approximately 4.5 billion NOK in 2015 to approximately 5.4 billion NOK in 2017. Export Credit Norway estimated the Norwegian firms' share of the global offshore wind market at 3%-5%. Organizations representing the industry have stated ambitions of reaching a 10% global market share by 2030.[1]

Our point of departure is that the development of a Norwegian offshore wind industry, particularly via the transfer of resources and capabilities from established sectors such as the offshore oil and gas sector and the maritime sector, can contribute to addressing the need for the diversification of the Norwegian economy and building up export-oriented, clean-tech industries. Given this potential, this report explores the opportunities and challenges (conditions) for further development of the Norwegian offshore wind industry in relation to international market access. We focus on the following four main topics:

- The prospects for market entry depend on the characteristics of international offshore wind markets in terms of technological development, market outlooks, value chain development and regulatory environments. The report provides an overview of key offshore wind trends.

- The Norwegian firms' entry into international markets not only depends on the Norwegian firms' technologies but also on their capabilities and strategies. The report discusses how the assets and strategies of Norwegian firms fit with the characteristics of international offshore wind markets.

- The Norwegian offshore wind industry is tightly connected to the oil and gas industry, particularly through many diversifying firms. The report discusses opportunities, challenges and implications of this connection to oil and gas for the development and growth in offshore wind.

- Public policy can play an important role in fostering industrial development. The report discusses how Norwegian public policy can support the Norwegian firms' entry into international offshore wind markets.

The report is structured as follows: Chapter 2 describes the data and methods used. Chapter 3 describes the characteristics of technology and international markets and the regulative regimes for offshore wind. Chapter 4 describes the Norwegian offshore wind industry in terms of firm, industry and supply chain characteristics. Chapter 5 focuses on the strategies, drivers and challenges for entry of Norwegian firms to the international offshore wind market. Chapter 6 discusses Norwegian policies to support offshore wind. Chapter 7 provides concluding reflections on how the conditions for developing a Norwegian offshore wind industry could be strengthened.

2 Methods

This report is based on both quantitative survey data and qualitative in-depth data from interviews, as well as secondary data (reports, websites, media, etc.).

An online survey targeting all known Norwegian companies in the offshore wind industry was executed from April 2018–May 2018. Since we were targeting an industry with a limited number of actors, we put great effort into obtaining a high response rate. A total

1 Norsk Industri, Norges Rederiforbund, NORWEA (2017). Havvind - Et nytt norsk industrieventyr.

of 163 companies were identified by using a range of sources. We received 97 usable responses, which represents a 60% response rate. We consider this high enough to argue that it is a representative sample of the current Norwegian offshore wind industry. In chapter 4, based mainly on this survey data, the industry is described.

The information in chapter 3 is based on interviews with a range of Norwegian firms operating in or attempting to access international markets. In addition, chapter three draws on key informant interviews in the offshore wind industry in Norway, Denmark, Belgium, France and the UK. Additionally, the chapter is based on various secondary data sources, including market and industry reports, policy and government documents, and an offshore wind market database (4C Offshore).

In addition to comprising the information from the survey, chapter 5 is also based on two sets of multi-case studies on Norwegian firms in the offshore wind industry. The case selection was performed with the intention of providing a broad range of case companies to encompass the range of challenges related to entry into the international offshore wind industry.

Chapter 6 is based on interviews with actors in the offshore wind industry and on information obtained from the use of the survey. We used the survey to identify a variety of firms in terms of size, main business areas and age. In addition to firms, we interviewed non-firm actors, such as relevant industry associations and support organizations.

3 International market, technology and regulative status[2]

- Offshore wind is a rapidly growing industry, with most growth to date occurring in Northern Europe.
- Emerging markets include the US, China, and Taiwan.
- Offshore wind farms are becoming larger and are being developed further from shore.
- Regulatory conditions and policies vary between countries.
- Floating offshore wind constitutes an emerging market segment.

International markets for offshore wind comprise the opportunity space for Norwegian firms. This chapter discusses the technological, value chain and regulative characteristics of this opportunity space.

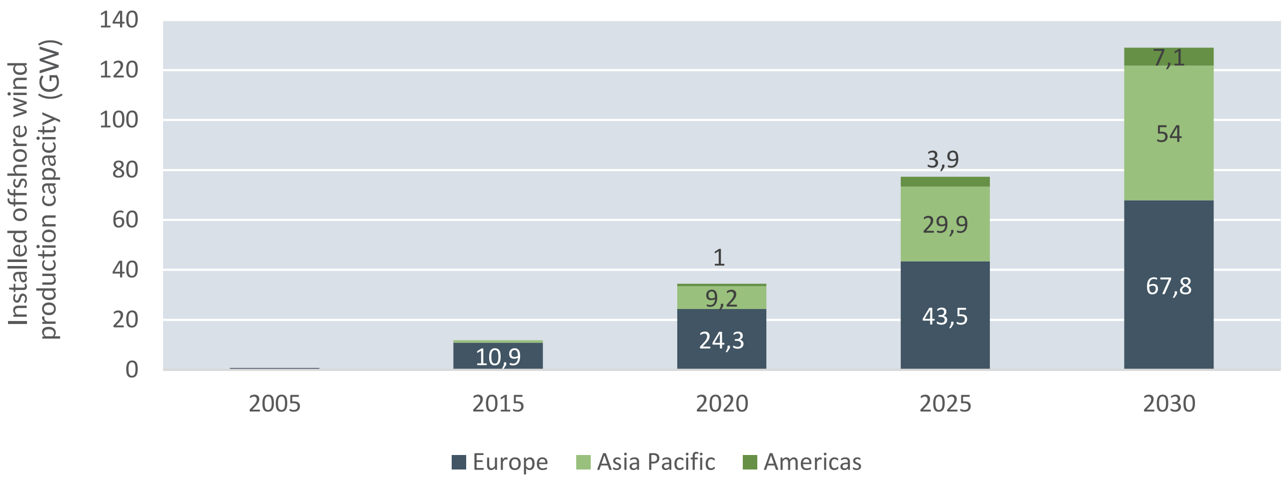

Figure 1 Market outlook for global installed offshore wind production capacity (GW). Source: Bloomberg New Energy Finance 2018

2 Parts of this chapter are based on Afewerki (Forthcoming)

Europe—especially United Kingdom, Germany, Denmark, Belgium and the Netherlands—constitute the main market in the rapidly developing offshore wind industry. By the end of 2018, the total cumulative offshore wind capacity in Europe reached 18,499 MW. This production capacity was spread out on 105 offshore wind farms in 11 different European countries, predominantly in the North Sea and the Baltic Sea.[3] Over the next decade, experiencing strong growth especially in the Asia Pacific region and in North America, the offshore wind market is expected to grow and become global (as illustrated in Figure 1).

3.1 Project and technology developments

Up until 2007 (the take-off year for offshore wind), almost all offshore wind farms were installed in shallow waters, typically in maximum water depths of 20 metres (m) at near-shore sites, i.e., in waters with a maximum distance of 30 kilometres (km) offshore. During the last decade of offshore wind farm developments, increasingly, many projects have been developed farther from shore in deep waters that provide better wind resources. At present, bottom-fixed offshore wind farms are being installed in water depths of up to 45 m and as far as 80 km offshore. This has been enabled by developments in wind turbine technologies, foundations, installation methods, access to transmission networks, operation and system integration and vessels. Measured in production capacity, projects have also increased in size: from an average of 79.6 MW in 2007 to an average of 561 MW for offshore wind farms under construction in 2018.[4] This move towards utility-scale projects diminishes the opportunities for new developers to enter the market. However, developments in new resource regions and smaller-scale projects (e.g., in floating offshore wind) provide potential windows of opportunity for 'latecomer' offshore wind developers and suppliers.

The 1.2 GW Horn Sea One project in the UK (currently under construction) is to date the largest offshore wind farm to have reached the Final Investment Decision (FID) stage. Recently, an *asset-clustering approach*, i.e., combining projects located near one another, has become a new trend, as it enables developers to achieve economies of scale. This entails approaching the build-up process as a pipeline of activity (production line approach) as opposed to a project-by-project

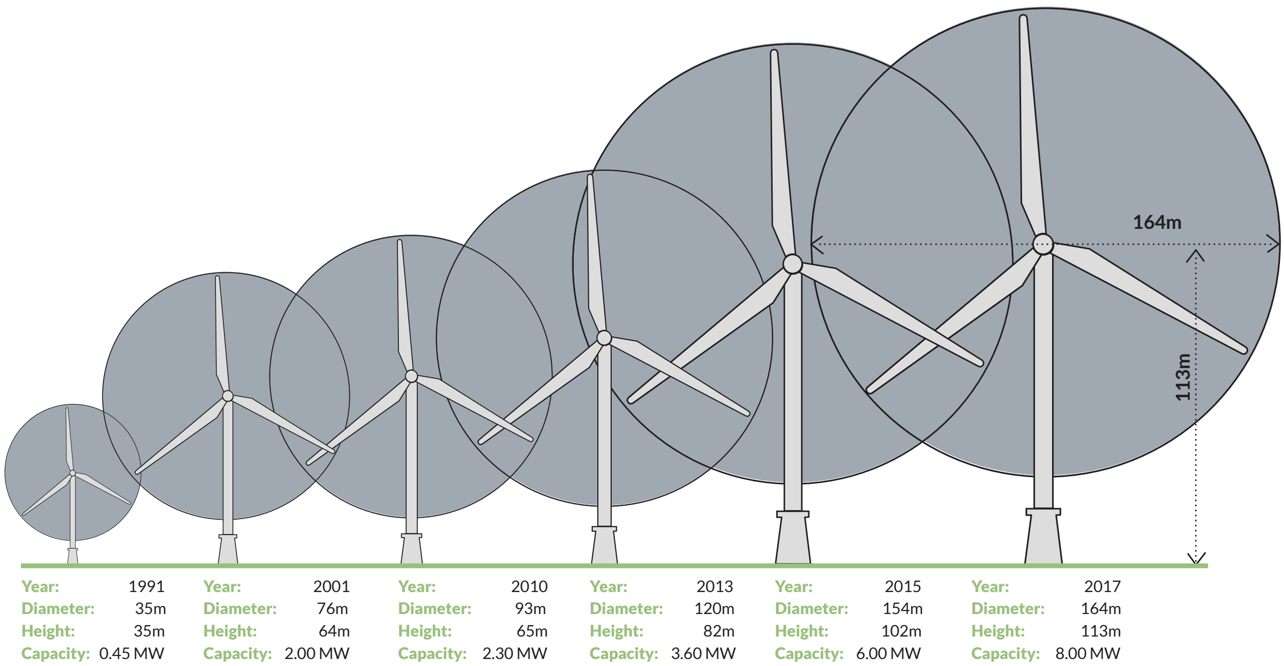

Figure 2 Evolution in the size of offshore wind turbines.[5]

3 WindEurope (2019)
4 ibid
5 Ørsted (2016)

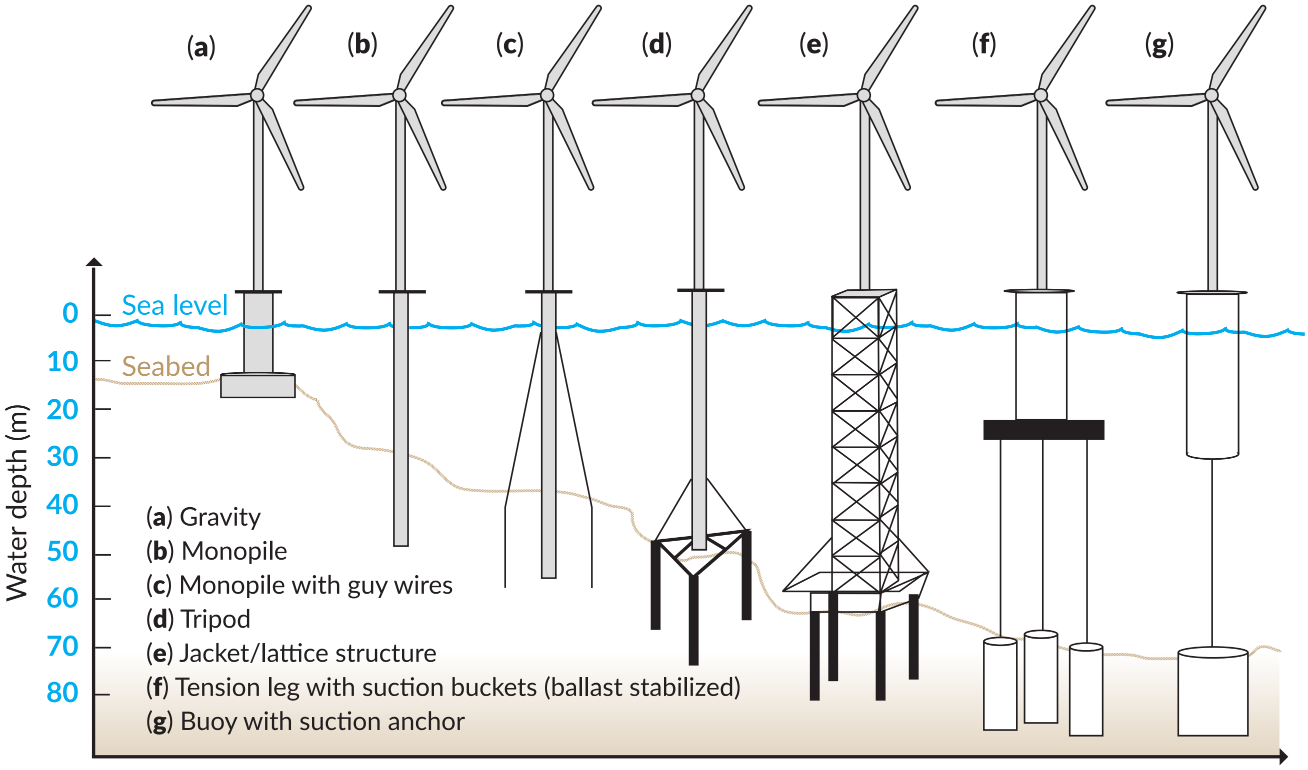

Figure 3 Illustration of bottom-fixed offshore wind foundation types.[6]

approach that has been typical in this industry. This may be a crucial step towards lowering the levelized cost of energy (LCOE) from offshore wind power since economies of scale enable synergies that can translate into lower logistics costs, fewer technician hours, fewer facilities needed and lower inventory levels.

The development of utility-scale offshore wind farm projects has further been enabled by the increase in the rated power of turbines, which in turn has contributed greatly to the rapid decline of costs per megawatt hour (MWh). From 2002 to 2017, the rated power of offshore wind turbines used in commercial projects tripled from 2 MW to 6 MW (see Figure 2). In 2016, Ørsted installed the first 8 MW MHI Vestas turbine at the Burbo Bank Extension wind farm (UK).[7] In 2018, General Electrics (GE) announced its next-generation design, the 12 MW Haliade-X, which has a rotor diameter of 220 m and is expected to come into commercial operation in 2021.[8]

However, deployments farther from shore mean higher costs for the transmission infrastructure, installation and operation activities, as well as greater electrical transmission losses. Hence, high voltage direct current (HVDC) transmission systems are starting to become more cost-effective than the traditional high voltage alternating current (HVAC) systems. This has led to reduced lifetime transmission losses and the creation of higher revenue, which outweighs the additional infrastructure costs to give a net lifetime cost benefit for the developers.

Offshore wind developers have used a range of foundations to support turbines. The choice of foundation type depends on various factors, e.g., water depth, seabed conditions, turbine loading, rotor and nacelle mass and rotor speed. The choice of the foundation's design is further contingent upon the developer's experience and supply chain capability in both manufacturing and installations. So far, the most commonly used foundations have been bottom-fixed, i.e., fixed to the seabed through piles, suction or gravity (see Figure 3). By far, the most used foundation structure to date is the monopile, whereas jackets (or other steel space-frame structures) and *gravity base foundations*

6 O'Kelly and Arshad (2016)
7 Ørsted (2016)
8 GE (Undated)

have typically been used on sites with either deeper water depths and/or seabed conditions that are not fit for monopiles. For shallow waters, compared to other foundation types, monopiles have proved very cost effective and have gradually been developed for use also in deeper waters and for larger turbines.

Existing bottom-fixed foundation designs are not commercially viable in sites with water depths of over 45 m. This is mainly due to both the cost of the serial manufacturing of such large structures and the availability of vessels capable of carrying and installing the units. This limits access to sites further offshore and/or in deeper waters with higher wind resources and potentially large markets. A vast majority of the global potential offshore wind market, including Japan and the west coast of the US, have limited shallow water areas. Floating foundation concepts, which are buoyant structures maintained in position by mooring systems, have been developed to address this market gap. The main advantage of floating wind is that wind speeds further offshore tend to be higher than that on land or in shallow waters. Small increases in wind speed mean large increases in energy production. Floating foundations could therefore be game changers in opening up new markets and could potentially also make installation easier and cheaper by reducing the amount of offshore activity and by avoiding the use of heavy-lift vessels. In addition, floating offshore wind is believed to provide the potential for rapid cost reduction, as well as increased standardization and mass-production. It is estimated that Europe, USA and Japan have a combined 6959 GW floating wind power potential.

Currently, four floating technologies are under development: *spar buoys*, *semi-submersibles*, *barge*, *and tension-leg platforms* (See Figure 4). The first three are loosely moored to the seabed, allowing for easier installation, while the tension leg platform is more firmly connected to the seabed.

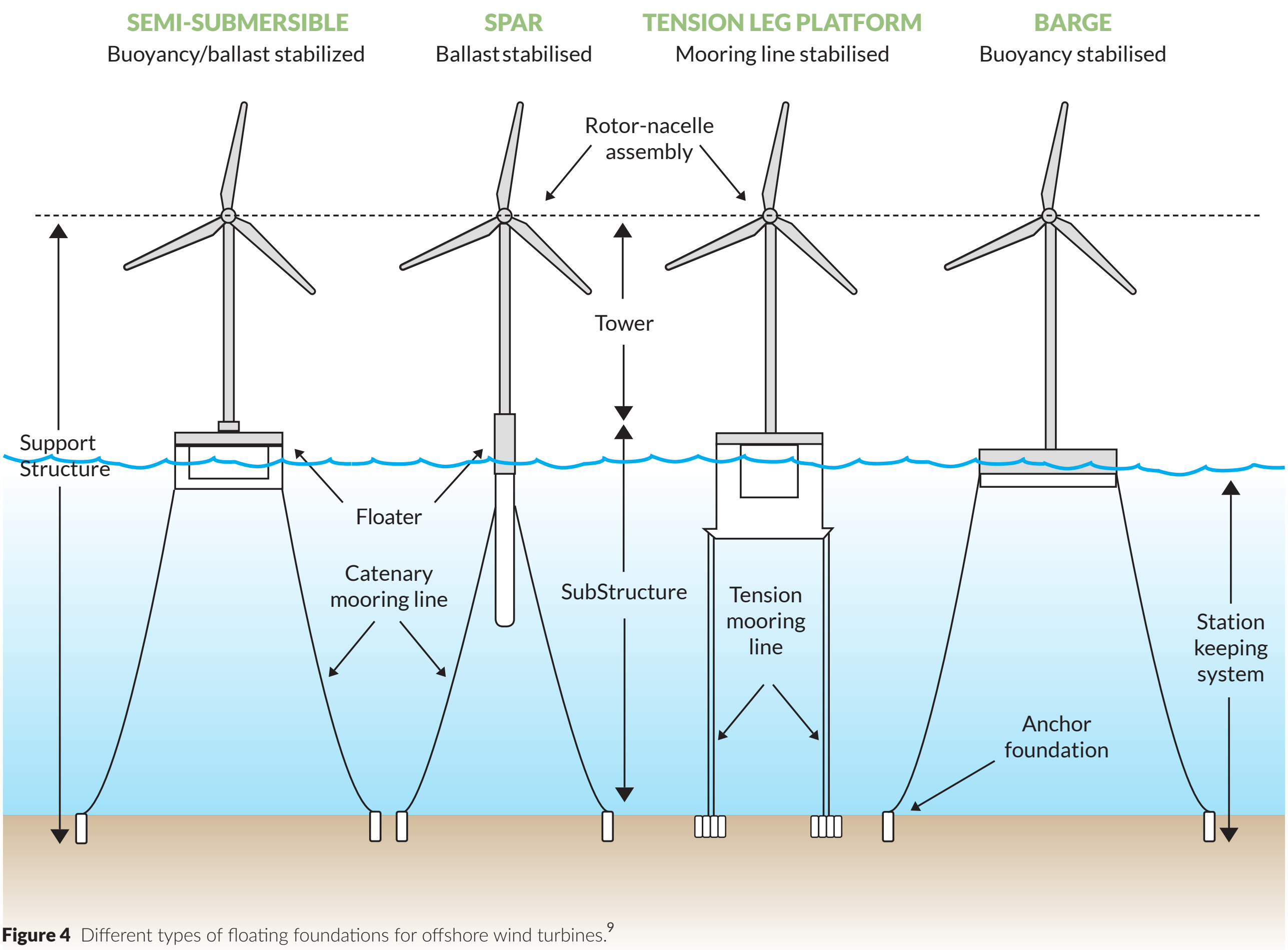

Figure 4 Different types of floating foundations for offshore wind turbines.[9]

9 DNV-GL (2018)

The first pre-commercial floating wind turbines were commissioned off the coast of Norway in 2009, the coast of Portugal in 2011, and the coast of Japan between 2011 and 2015. More specifically, the demonstration projects include Equinor's spar buoy Hywind (2.3 MW), Principle Power's semi-submersible WindFloat (2 MW) and the Marubeni-led consortium's semi-submersible Fukushima Shimpuu (7 MW). No tension-leg platform has yet been deployed for a wind turbine. Towards the end of 2017, the first full-scale floating pilot park, Hywind Pilot Park, was commissioned in Scotland.

Logistics are crucial in the offshore wind power industry, which has large quantities of massive structures that need to be moved from land to offshore sites. In Europe, industrial activities related to offshore wind power, i.e., the fabrication of turbines, towers, foundations, cables and so on, have largely been developed in and in proximity to key ports (e.g., Esbjerg in Denmark, Cuxhaven in Germany, and the Humber region in the UK) by the North Sea.

3.2 Support schemes

Various state-specific support regimes have been key to the development and expansion of offshore wind markets. These have been pivotal in facilitating private sector investments into offshore wind power production. Support arrangements (i.e., subsidies or other forms of incentives provided by governments to support market development) for offshore wind power production vary from jurisdiction to jurisdiction (i.e., national markets), but there are essentially three types of arrangements: feed-in tariffs, green certificates and contracts for difference (CfD). With feed-in-tariffs, the developer is paid a fixed price for the power generated. Green certificates provide the developer with a certain number of certificates for the power generated to supplement the revenue from its commercial power purchase agreement (PPA). With a CfD scheme, the developer receives a fixed, pre-agreed price (strike price) for the electricity generated for a duration of 15-20 years. Based on the contract, developers can sell electricity to the market above the strike price. However, if the market price is below the agreed strike price, then developers are entitled to receive (top-up) payments at the level of the strike price.[10] For the purposes of the CfD, the PPA is deemed to be the relevant market price and is referred to as the benchmark of the "reference price". For the developers, feed-in tariffs and CfDs ensure a long-term stable revenue stream, which greatly reduces financial risks. In the case of CfDs, the stability of the revenue streams is dependent on the ability of the developer to also secure a long-term PPA. Norway has a technology neutral green certificate scheme that on its own has proved insufficient to support domestic offshore wind market deployment.

Recently, 'subsidy-free' offshore wind farms have been announced in countries such as the Netherlands and Germany. However, in these cases, considerable shares of risk are taken on by the government in certain aspects, for instance, in the pre-development and planning phases. Additionally, in 'subsidy-free' projects, the capital and operational costs for grid connection are covered by the government, whereas in other markets, grid connection expenditure is internalized in project financing. Other factors that contribute to the low LCOE on 'subsidy-free' projects are the already established infrastructure, shallow water depths and the proximity to shore. In summary, these are special conditions that only apply to particular projects and contexts.

3.3 Financing

Large offshore wind projects are typically developed through a standalone company that is owned by the project investors and financed through either sponsor equity or debt. The sponsor equity entails financing by the equity investor, i.e., the owner of the project and/or the developer. Debt on the other hand refers to a contractually arranged loan that must be repaid by the borrower. Debt is usually raised through the issuance of bonds either at the corporate or project level. Wind power developments may involve two types of debt financing: construction debt, which is raised for the purpose of financing new assets, and

10 Low-Carbon-Contracts-Company (undated)

refinancing debt, which is raised for the purpose of financing construction debt at a longer maturity and/or lower interest rate. Often the sources of financing are the following: a firm's own balance sheet, external private investors, and funding from commercial banks and public capital markets, which in recent years, has become prominent for raising both debt and equity. The rapid rise in the offshore wind market has been underpinned by an increasing interest in the sector from financial institutions. The low-interest-rate financing conditions, cost improvements and the trust gained in the technology have all contributed to this effect. The primary lenders in the sector include a variety of bank and non-bank institutions, such as export credit agencies (ECAs), multilateral development banks (MDBs) and other international financial institutions (IFIs).[11]

Institutional and strategic investors are increasingly acquiring offshore wind assets. These financial actors are attracted by the long-term, steady and predictable returns. This 'farm-down' or 'asset rotation' model involves developers selling stakes in green power assets to institutional investors seeking long-term and stable yields. This unique risk-sharing model allows investors to only share the risks they are comfortable with. Based on the approach, developers typically divest 50% of their offshore wind farm stakes to industrial and institutional partners such as pension funds. Ørsted has pioneered this financing model that has been vital to the fast growth of the company and its dominant position in the sector. This financial approach is an important enabler of scale, as it allows a developer to reinvest capital in subsequent projects and to maintain a high-paced build-out of projects. For developers, this further provides significant portfolio value realization with less capital and reduced risk and has resulted in significant up-front value realization.[12]

In summary, the factors previously mentioned in combination with lower costs of capital and increased competition in the industry have contributed to significant cost reductions in offshore wind power. For instance, from 2010-2016, the global weighted average LCOE of offshore wind decreased from USD 0.17 to USD 0.14/kWh, despite the increase in total installed costs by 8% during this period (mainly 2012-2013).[13] In 2019, this is estimated to be approximately 0.09 USD/kWh and is expected to be approximately 0.07 USD/kWh 2020.[14]

3.4 Offshore wind value chains and production networks

The offshore wind power industry is organized around two main value chains: a manufacturing chain that focuses on the wind turbine and a deployment and services chain.[15] With a value chain approach, the offshore wind market is seen as one comprised by a *n* number of farms, which in turn have two distinct value chains. On each offshore wind farm, each value chain then has a '*lead firm*'. For example, on the Hywind pilot project in Scotland, Equinor (as developer/owner/operator) and Siemens are the lead firms of the deployment and services chain and the manufacturing chain, respectively. Both value chains are highly international in nature, implying that the various products and services that go into the making of an offshore wind farm are sourced from different countries and locations. We also see the development of buyer-supplier relationships, e.g., one in which a developer or large contractor will source certain key components or services from a limited number of suppliers.

The manufacturing chain is led by the large turbine OEMs[16], notably (for offshore wind), MHI Vestas and Siemens Gamesa. In 2018, these two companies had a combined 93% global market share in total installed production capacity. Wind turbines are complex-product systems made up of a high number of different components (software, power electronics, etc.). The insights into the supplier networks for the manufacturing chain are however highly limited, and there are few Norwegian firms involved in this value chain.

By contrast, the deployment and services chain is led by wind farm developers and/or operators, including

11 WindEurope (2018)
12 Afewerki (2019)
13 IRENA (2018b)
14 RenewableEnergyWorld (2019)
15 Lema et al. (2011)
16 OEM stands for original equipment manufacturer.

large energy companies (e.g., Ørsted, Vattenfall, Equinor) and many consortiums of smaller firms that join forces with other entities, e.g., financial actors. There is a tendency for less experienced owners/developers to develop offshore wind farm projects with a "single-contract" or through EPCI[17] contracting strategies, whereas more experienced owners/developers (typically the large utilities and energy companies) with larger in-house capabilities opt for multi-contracting strategies.[18] An example of an EPCI strategy is to parcel out all contracts for cables (array and export) to the same supplier that subsequently is also responsible for installation. In practical terms, this means for example that a provider of foundation installation service could have the developer as customer on a multi-contracting project, whereas the customer on an EPCI project would be a large contractor in charge of a larger 'package' of components and services. From a supplier perspective, understanding these differences in lead firm or large contractor procurement strategies is important in order to access markets.

From a Norwegian industrial perspective, the emerging floating offshore wind markets appear to offer even more potential than that offered by bottom-fixed wind markets because the technological, operational and logistical requirements have many similarities with those for oil and gas solutions in which Norway has comparative advantages.

3.5 Regulatory issues

The development of the offshore wind industry has evolved alongside changes in regulatory frameworks. In offshore wind, as is typical of emerging industries, framework conditions were not well developed and in place in early stages, leading to large uncertainties and risks related to both markets and technology. Regulatory systems and policies, which can vary greatly among countries, are important because they define the "rules of the game" and reflect the power relations between states and firms. Although some scholars have argued that the role of states has weakened in recent decades, offshore wind is an industry in which states are key actors not only in terms of planning and regulations but also in creating markets and setting key terms for market access.

3.5.1 Diverging industrial development trajectories

A cross-national analysis of the growth and the organization of the offshore wind sector reveals contrasting national trajectories, which are in part due to different starting points in terms of the countries` industrial bases. We illustrate this by using Germany and the UK as examples.

Germany has recently become the world's second largest offshore wind market. As typical for coordinated market economies, in collaboration with private stakeholders, the German government early on supported domestic industry and market developments by long term planning, the establishment of regulative and supportive bodies and market incentives. Prior to strong domestic market growth, Germany had success in facilitating industrial and infrastructural (e.g., ports) developments. This strategy proved successful regarding, among other outcomes, the development of wind turbine production capabilities. Germany`s industrial and infrastructural bases relied on relevant pre-existing assets across the offshore wind value chain.

By contrast, the liberal market economy of the UK has experienced a striking market growth in the offshore wind industry and now constitutes the world's largest market. The UK policy strategy was market-led from the start and was coupled with an industrial strategy of attracting foreign industrial investments, especially those related to turbine manufacturing. This strategy was partly a result of more limited domestic industrial and technological assets compared to those of Germany. Some industrial diversification based on technologies and infrastructures from oil, gas and maritime-related activities has taken place. More recently, the industrial policy in the UK has shifted towards a

17 EPCI refers to engineering, procurement, construction and installation.
18 BVG-Associates (2019)

more endogenous development strategy aimed at developing the domestic suppliers of components and services and thereby the use of local content requirements.[19]

3.5.2 Converging institutional frameworks

While industrial trajectories have evolved differently, the institutional and regulative frameworks across leading offshore wind countries have converged and become more similar in recent years. Denmark's legislative system for offshore wind is considered to be comprehensive[20] and transparent, as a singular Government body—the Danish Energy Agency (DEA)—is responsible for all required licenses and consenting activities related to leasing for offshore wind sites. This 'one-stop-shop' procedure is also recognized as ideal among neighbouring countries.[21]

Current German offshore wind development is based on a centralized approach (introduced in 2017) that is quite comprehensive. The Offshore Wind Act comprises an Area Development Plan and support scheme in line with Contracts for Difference (CfD), which are awarded by the federal government agency Bundesnetzagentur, which is the German regulatory office for electricity, gas, telecommunications, post and railway markets. The consent is awarded based on preliminary investigations conducted by the Federal Maritime and Hydrographic Agency (BSH) and on the investigations undertaken by the developer.[22] The offshore connection to the grid infrastructure is the responsibility of Tennet TSO (North Sea) and 50 Hz (Baltic Sea).[23] This arrangement contrasts with the British system where the developers themselves are responsible for the offshore grid connection for offshore wind farms.

Similar to Denmark and Germany, the UK employs a centralized planning regime. The Crown Estate and Crown Estate Scotland are responsible for the leasing of sites for offshore wind projects in the UK and Scotland, respectively. Favourable areas for projects are predefined by the Crown Estate. The Planning Inspectorate is responsible for the assessment of the offshore wind projects of more than 100 MW in England, while the final decision on approval is made by the Secretary of State for Business Energy and Industrial Strategy. In Scotland these similar roles are played by Marine Scotland and the Minister for Business, Innovation and Energy, respectively. Contracts for Difference (CfD) are the main price support mechanisms.[24]

3.5.3 Standards

Standards, constituting an important part of regulatory regimes, ensure safety and enable cost efficiency. Standardization processes differ between countries. While the authorities in Germany and Denmark use standards for certification, the UK approving authorities do not require such certification. Germany focuses mostly on national standards regarding technical regulation and certification, whereas Denmark has few national standards. In the UK, standards mainly relate to HSE[25] and foundations. In addition, standards vary in their origin. While Danish and German standards were initially influenced by the onshore wind sector, the UK standards were shaped to a certain extent by experiences from offshore oil and gas.

When the offshore wind sector emerged, there were few sector-specific standards. The current general tendency is towards a harmonisation across markets and a rise of international standards for offshore wind.[26]

Overall, the developments and changes in the regulatory and planning regimes aim to simplify the existing practices through centralization and to contribute to further commercialization and cost reduction, reflecting the maturation of the sector. Although the pace of change varies between countries, the common trends are centralization and the establishment of institutions facilitating price competition by the use of auctions.

19 The (UK) domestic content of total offshore wind costs in the British sector grew from 43% in 2015 to 48% in 2017. See RenewableUK (2017)
20 IRENA (2018a)
21 BVG-Associates (2018)
22 BVG-Associates (2018); BVG-Associates (2017)
23 MacKinnon et al. (2018)
24 Ibid
25 HSE refers to health, safety and the environment.
26 IRENA (2018a)

3.5.4 Implications for Norwegian firms entering foreign markets

Regulations and standards may have positive or negative implications for Norwegian firms entering or trying to enter foreign offshore wind markets. Our findings are ambiguous in these regards, not the least of which is because standards have different meanings for firms depending on their 'home' industrial sector and their position in the offshore wind value chain. Depending on which industrial sector they come from, suppliers have to relate to different standards. Installation contractors, shipbuilders and shipping firms typically need to comply with standards stemming from oil and gas and maritime sectors, whereas foundation or cable manufacturers need to comply with offshore wind-specific standards.

Energy companies involved in offshore wind (as developers/operators/owners) influence public standards, as they participate in working groups of standardization and certification bodies. Offshore wind developers furthermore set standards for suppliers. Ørsted in particular has been engaged in efforts to develop their supply chain by developing standards for processes and products. In doing so, Ørsted has consciously abandoned its former oil and gas approach to standards and has instead approached offshore wind with a key aim of exploiting the potential of economies of scale. In general, regulations and standardization have developed over time, mirroring the maturing of the sector. In the emerging phases of the offshore wind industry, many Norwegian suppliers struggled to comply with standards that were unclear, inconsistent or changing. In some cases, this implied high transaction costs, and bad experiences even led certain companies to withdraw from the offshore wind market altogether. These struggles are discussed more in chapter 5. However, as standards have developed and become more stable, firms seem to have found the requirements more transparent and predictable and thus easier to deal with. The tendency of harmonizing standards across countries also helps the Norwegian firms in these regards.

4 The Norwegian offshore wind supply industry

- The majority of firms have less than 50 full-time equivalents (FTEs).
- Only 14 firms have more than 500 FTEs.
- Most of the firms have diversified from other industries, mainly petroleum and maritime.
- The majority of firms have less than 5 per cent of their total turnover from offshore wind.
- Firms report larger technological similarities than market similarities between offshore wind and their core business areas.

In this chapter, based on our own survey data as described in chapter 2, we present a description of the Norwegian offshore wind supply industry. In this survey, we focused on the known population of all Norwegian firms that target the offshore wind industry with products or services. The responding firms comprise a diverse set of firms. They differ in core businesses, sizes, revenues, and the types of products and/or services that they provide.

4.1 Basic description of data and industry

Of the 97 firms in our sample, when surveyed in 2018, a total of 68 firms (70 per cent) had commercial sales to the offshore wind industry, while the remaining firms had ambitions to deliver to the offshore wind industry.

Most firms (51) were established before the year 2000, 25 firms were established between 2000 to 2009, and the remaining 21 firms were established between 2010 to 2017. Hence, there are quite a few relatively new Norwegian companies that are targeting offshore wind. Only 2 companies had their first sale in offshore wind before the year 2000, while 25 had their first offshore wind sale in 2000-2009 and the other 46 firms, between 2010-2017.

As seen in Figure 5, the firms deliver a wide range of products and services to offshore wind. A large share of the firms own or build ships (vessels and ship design). There are also many firms engaged in various maritime operations (e.g., logistics and installation and operations and maintenance). A total of 17 firms deliver various consultancy services, which include a wide variety of services, such as weather forecasting, certification, and market analyses. A final point is

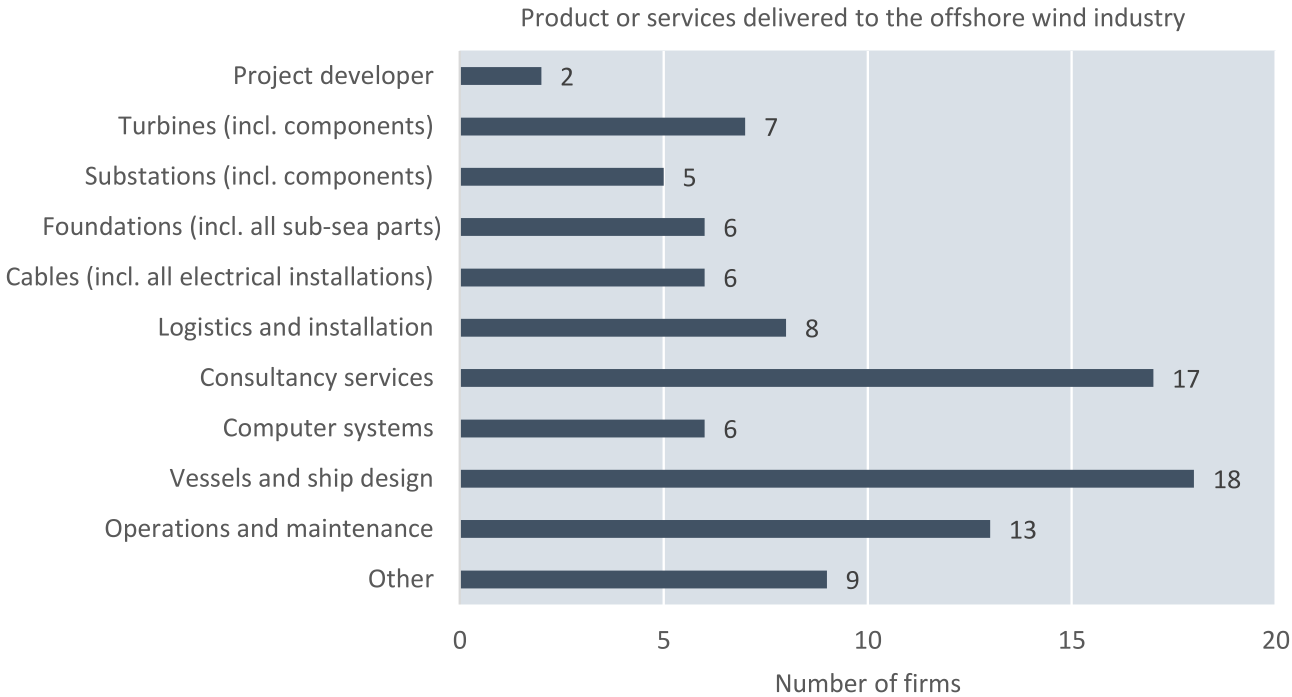

Figure 5 Distribution of firms depending on the products or services delivered to offshore wind. Many of the firms deliver several types of services or products and were asked to single out the most important product or service delivered to offshore wind. “Other” includes companies that identified with multiple product or service categories and firms that fell outside of the listed categories.

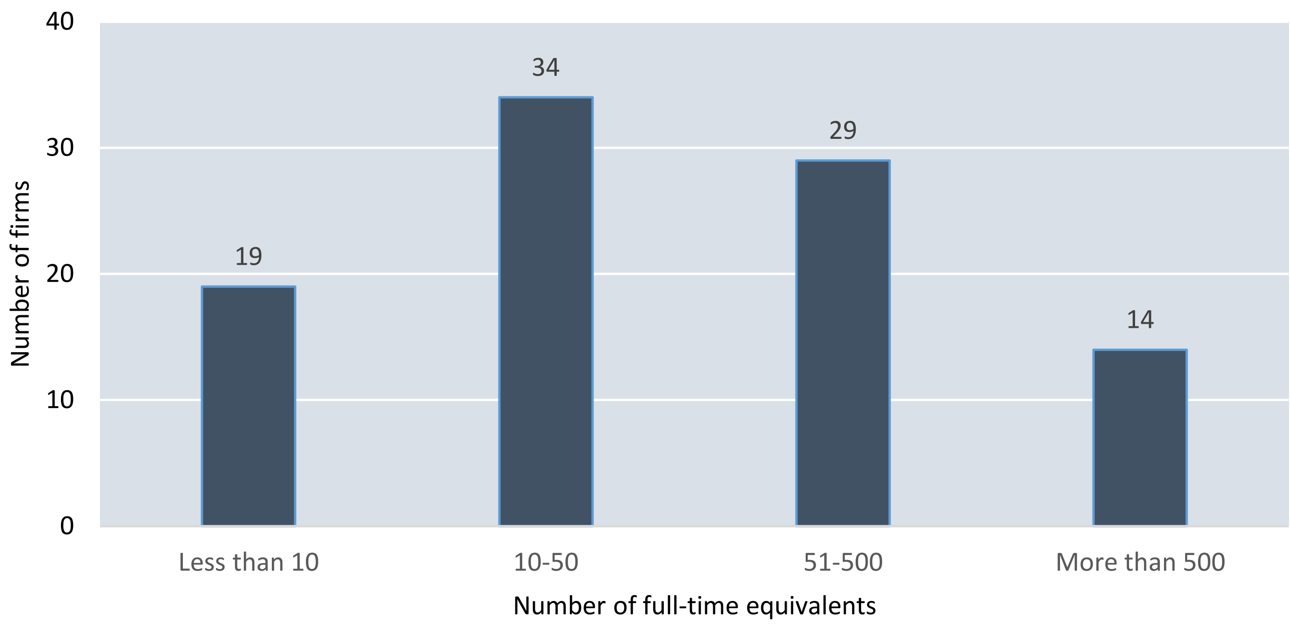

Figure 6 Distribution of firms depending on firm size (number of full-time equivalents) as reported by the survey respondents.

that many of the firms operate in multiple parts of the supply chain.

In terms of number of employees, Figure 6 shows that more than half of the firms have less than 50 full-time equivalents (FTEs) and that only 14 firms have more than 500 FTEs.[27]

4.2 Degree of diversification

Most of the firms have diversified from other industries. The sample includes only 13 companies with offshore wind as their core business. The remaining 84 firms have diversified from other industries, mostly from oil and gas and maritime, as shown in Figure 7.

The survey data not only shows that most of the firms diversified from other industries but also that most of these diversified firms' engagement in offshore wind is limited. As shown in Figure 8, a total of 50 of the 94 firms that reported data on the share of their total revenue from offshore wind have less than 5 per cent of their total turnover from offshore

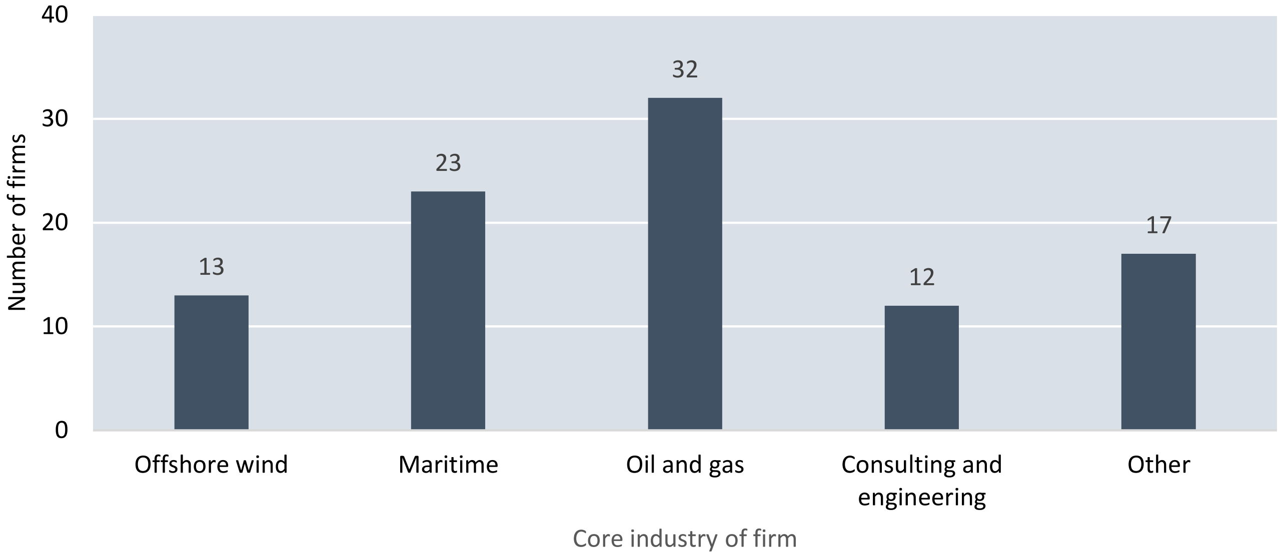

Figure 7 Primary industry of the surveyed firms, as reported by respondents. Other includes onshore wind, industry, and the power sector.

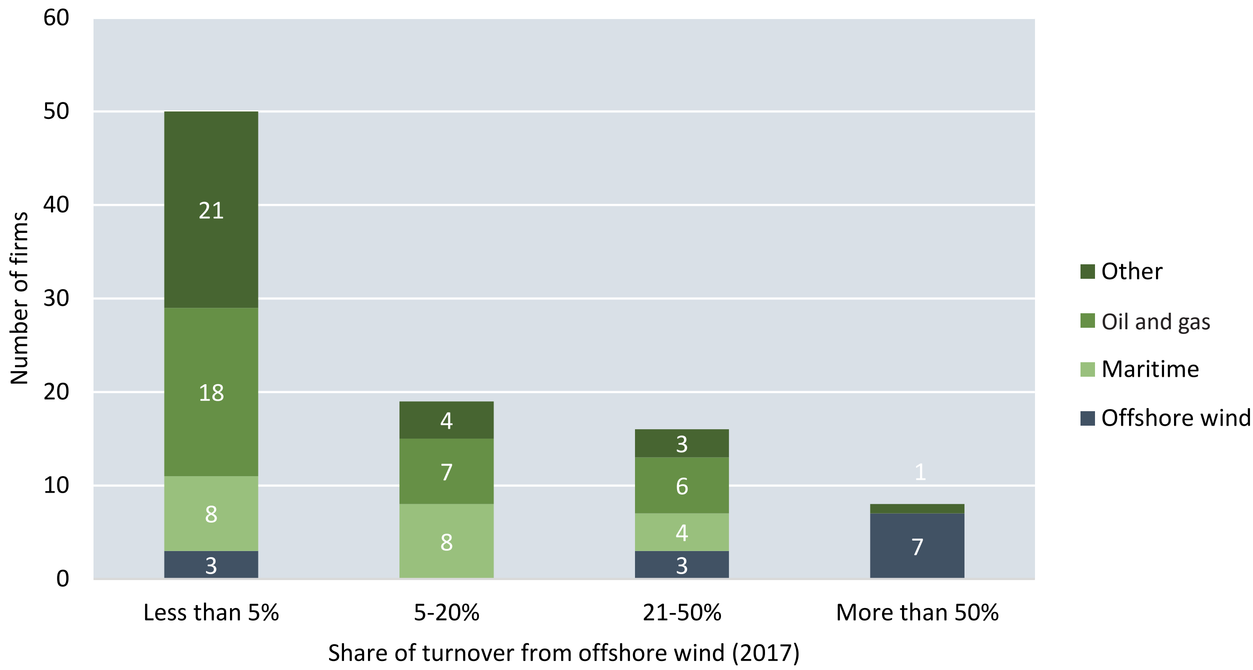

Figure 8 Turnover from offshore wind as a share of total turnover, as reported by survey respondents. Legend shows the core industry of respondents.

27 FTE refers to work that is performed by one full time employee or several part-time employees and that is equivalent to one employee working for a full year.

According to **Equinor**, Norwegian suppliers won between 30 and 40 per cent of the contracts for the Hywind Scotland Pilot Park. This is substantially more than the 3-5 per cent market share that Norwegian firms have in the global offshore wind market and might suggest that it could be easier for Norwegian suppliers to win contracts for Equinor than it would be for them to win other developers' contracts, and especially contracts for floating offshore wind projects.

Interviews suggest that for some firms, obtaining contracts is easier with Equinor than it is with other developers. Many of the firms interviewed indicated that they have been able to exploit relations with Equinor from oil and gas to secure offshore wind contracts. Thus, particularly for firms that have had existing relations with Equinor, Equinor can open doors to the international market. Moreover, with potential projects in Norway, Equinor can help develop a Norwegian supply chain. Finally, representing actions that have been instrumental in putting offshore wind on the policy agenda in Norway, Equinor's investments in offshore wind have sent a signal to the authorities and public agencies.

However, not all firms view Equinor's role in the same way. Some firms, particularly companies that do not come from oil and gas and therefore lack established relations with Equinor, assert that Equinor has a limited concern for Norwegian suppliers per se. Moreover, the fact that there is only one large Norwegian offshore wind actor (Equinor) can leave the rest of the Norwegian industry vulnerable. Having more than one Norwegian developer—and also a larger number of supplier companies—would potentially create a more dynamic market and provide suppliers with more opportunities.

One reason for the presence of Norwegian suppliers in the Hywind Scotland Pilot is that Equinor wanted to bring their existing highly competent and trusted suppliers along in the project. In addition, the particular requirements and possibilities for the floating wind technology have also been helpful for enhancing the use of Norwegian content. The floating turbines were assembled under favourable physical and infrastructural conditions at a Norwegian harbour in proximity to Norwegian suppliers and successively transported to the Scottish wind farm site. There are reasons to believe that the Hywind Tampen project, which is currently being developed by Equinor for electrifying oil and gas installations in the Norwegian sector, can offer opportunities for Norwegian suppliers. At the same time, Hywind Tampen is only one project with 11 turbines mounted on a particular foundation solution, implying that the project cannot be expected to provide opportunities for a broad range of domestic suppliers.

Box 1 Equinor's engagement in offshore wind

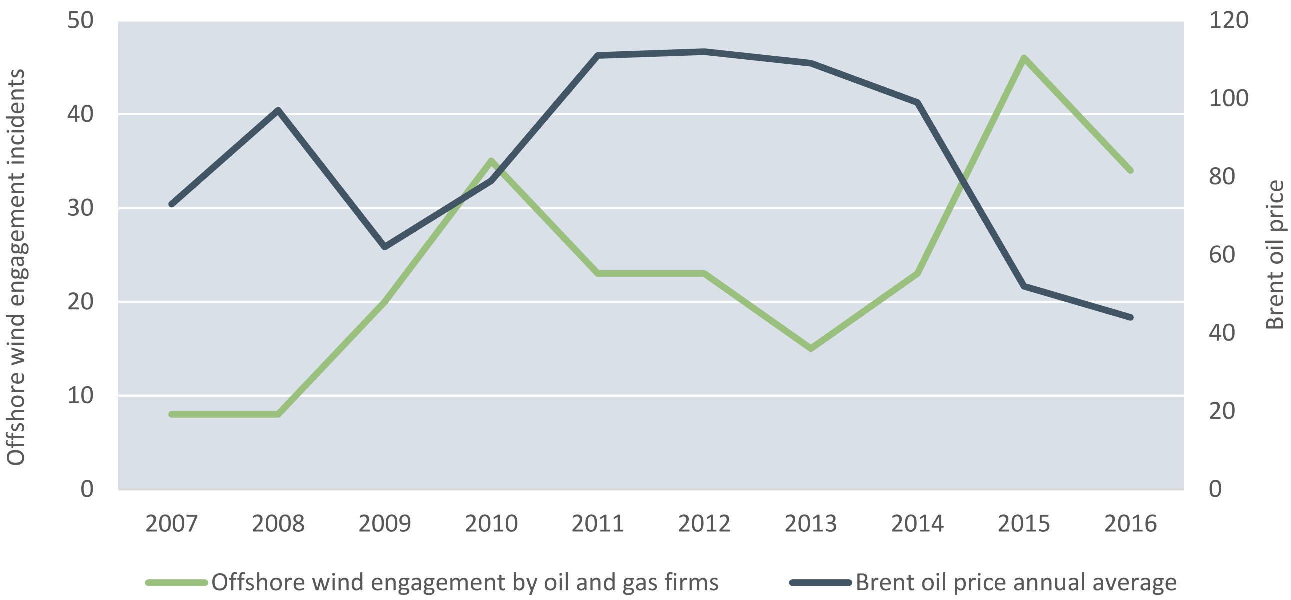

Figure 9 Offshore wind engagement includes the following incidents: public statement of interest in offshore wind, investments in offshore wind, and offshore wind contracts. The figure is based on Mäkitie et al. (2019).

wind. Another 19 firms have between 5 and 20 per cent of total turnover from offshore wind.

The largest Norwegian investor in offshore wind is Equinor. Equinor has so far invested primarily in projects in the UK (having operational projects in Sheringham Shoal, Dudgeon, and Hywind Pilot). In addition, Equinor has invested in one German offshore wind farm (Arkona) and is exploring market opportunities in other parts of the world. Equinor has so far only invested in a single, floating turbine in Norway (Hywind Demo), but it is currently developing a potential larger project on the Norwegian Continental Shelf (Hywind Tampen). In addition to representing a large, Norwegian activity in the international market for offshore wind, Equinor can also contribute in the development of a Norwegian supply industry. Box 1 explores this aspect of Equinor further.

4.3 A challenge posed by the relationship between oil and gas and offshore wind?

Figures 7 and 8 show that many of the Norwegian firms engaged in offshore wind have their core activity in the petro-maritime industry. Most of these diversified petro-maritime firms have a very small share of their activity in offshore wind. Despite the opportunities for diversification that competences and knowledge from maritime operations offer, this close relationship with oil and gas poses a challenge for growth in the larger Norwegian offshore wind industry. Previous studies of Norwegian offshore wind have shown how fluctuations in the activity levels on the Norwegian continental shelf have influenced the firms' engagement in offshore wind.[28]

Figure 9 shows the engagement of Norwegian oil and gas firms in offshore wind between 2007 and 2016. The figure also shows the average annual oil price over the same period. The figure illustrates how there was a greater offshore wind commitment when the price of oil was low and, perhaps more importantly, that there was a lower engagement in offshore wind when the oil price was high.

4.4 Relatedness between core industry and offshore wind for diversified firms

Firms tend to diversify into related industries, which are understood as industries that are similar in the demands for products and services and thus also in the underlying capabilities such as knowledge and

28 For a recent study, see Mäkitie et al. (2019).

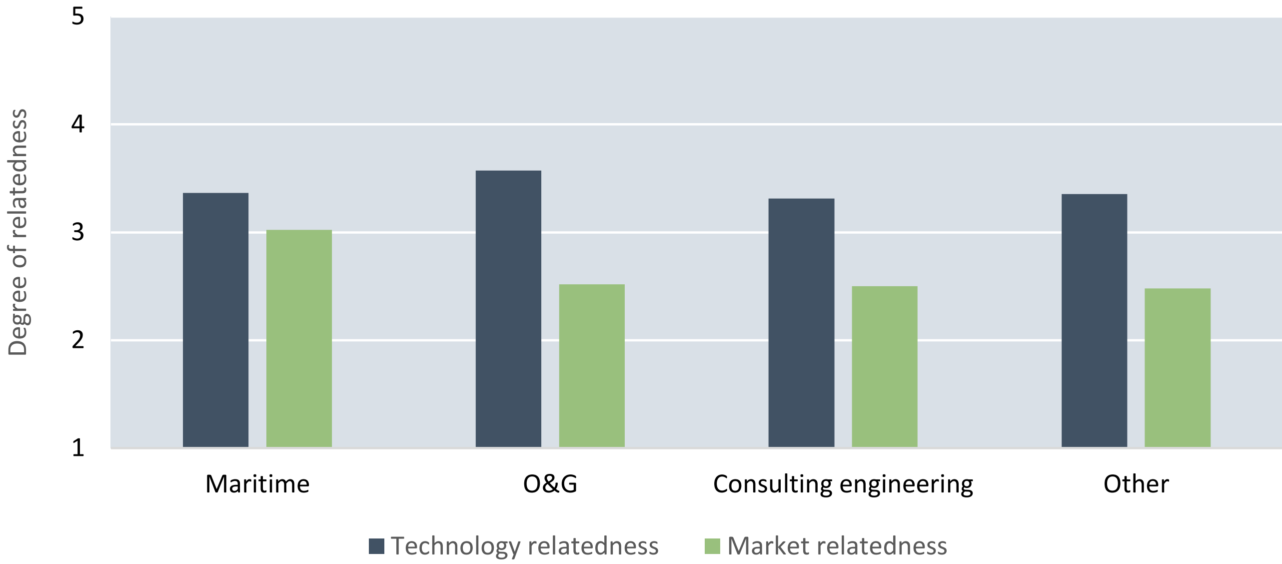

Figure 10 Survey responses to questions about technology and market relatedness. A value of 5 equals a high degree of relatedness, and a value of 1 equals a low degree of relatedness.

manufacturing resources. The nature of the relatedness between a firm's core industry and a new industry can affect the type and significance of challenges firms face when entering a new industry. Given the large presence of diversified companies in the Norwegian offshore wind industry, we wanted to know more about how firms assess the relatedness between their core business and offshore wind. In the survey, firms responded to several questions about similarities/differences between sectors, and these questions were grouped under two headings: *technology and competences* and *markets and relations*. We refer to these as technology relatedness and market relatedness, respectively. The former refers to the relatedness between the core industry and offshore wind in terms of technology, competence needs, products, design, and production processes. The latter refers to brand recognition, the sales and bidding processes, contract design, and whether customer relationships are similar for offshore wind and the core business area.

As seen in Figure 10, firms reported higher levels of technological relatedness than of market relatedness. Moreover, the difference between technology and market relatedness is particularly high for oil and gas firms. Chapters 6 and 7 discuss in more detail the implications of this for firm diversification and policy support.

5 Firm strategy and capacity building

- The main challenge for entry to offshore wind is market-related rather than technology-related.
- Firms consider market risk as higher than other risk factors.
- Due to industry immaturity, the perceived market risk delays the large firms' entry into offshore wind.

This chapter discusses three main issues concerning the entry of Norwegian firms into the international offshore wind industry: (1) related diversification, (2) new market characteristics and strategic behaviour and (3) risk assessments and entry strategies.

5.1 Related diversification – technological vs. market relatedness

One popular statement has been revealing in the discussion on the potential future of the Norwegian offshore wind industry. The statement comes in a variety of forms, but this one reflects the gist of the assertion:

"The Norwegian industry is world class in two areas—renewable energy and complex offshore projects. Offshore wind is an industry where these capabilities combine and where we really should be internationally competitive."

This statement goes to the core of the diversification literature over the past decades and is built on the assumption that Norway should have a comparable advantage in the building of an offshore wind industry.

The relatively slow growth in the offshore wind sector in Norway led us to investigate the role of related diversification in the growth of the offshore wind industry: our aim was to gain a better understanding of why technological and market relatedness might not have transferred directly into more Norwegian firms to successfully enter or to diversify more extensively towards offshore wind.

Chapter 4 (Figure 10) shows differences in the degree of technological and market relatedness between offshore wind and the diversifying firms` core business areas. In this chapter, we draw on qualitative case studies of Norwegian companies that have diversified from the petroleum or maritime sector to offshore wind. We explore how and what type of relatedness was important when the firms diversified into the offshore wind industry. It is important to note that the year of entry differs between the case firms. The earliest case firm to enter did so in 2001, while the latest was in 2016. This means that the firms diversified into the offshore wind industry at very different industry stages. For example, in 2001, the offshore wind industry was present only in a few countries and was dominated by test projects where turbines had modest capacity and each wind farm had relatively few turbines. In 2016, however, the industry was in a strong growth phase and had a much more specialized supply chain, dedicated manufacturing facilities and installation vessels but was still not yet a fully mature industry.[29]

The findings from our case studies support the notion that strategic diversification and relatedness indeed facilitated the entry into offshore wind. However, technological relatedness and market relatedness play different roles in the diversification process.

In terms of technological relatedness, the technological bridge from the original sectors to offshore wind seems to be easier to cross than the market relatedness bridge. When entering offshore wind, the case companies predominantly relied on existing internal technological capabilities and staff to develop and deliver offshore wind contracts. This was true for all the companies except one. The exception recruited heavily externally and built up a new division to serve the offshore wind market. However, this firm targeted the installation and maintenance segment, a labour-intensive function that required many new hands. All the other firms relied predominantly on existing capacity and internal competence to develop offers for the offshore wind market.

> *"We value the importance of waiting; it's saved us millions of kroner. Having established premise providers is crucial, and entry in 2015 was early enough."*
> **Large maritime firm**

Technological capabilities aside, in the early years of the offshore wind industry, the industry had certain market characteristics that represented significant challenges for entering firms. These characteristics were the direct consequences of the market's immaturity, and the challenges they represented were mostly expressed by the diversifying firms.

Firms that diversified from mature industries such as energy or maritime had become accustomed to structured and transaction cost efficient markets. In these markets, most actors and technological capabilities are well known, contracts, market offerings and technologies are standardized, and monitoring schemes and access to low cost capital are readily available. None of these factors were present in the offshore

29 Dedecca et al. (2016).

> *"The market was even more immature than we expected, and the clients uncertain of what they wanted. Specifications and standards weren't ready."*
>
> **Large maritime firm**

wind sector at the time the early firms entered. This immaturity had two major consequences. The first was purely economic, as the transaction costs were high. The second was strategic, as new market capabilities had to be developed. Consequently, the market experience and market resources developed in the petroleum and maritime industries proved of little value when seeking to overcome these challenges in offshore wind. For example, a company's customer could operate in both oil and gas and offshore wind but typically not with the same people or the same branches, thus making established customer knowledge and networks of little value.

Our case material provides several examples of how these market-related challenges materialized. One factor, which is frequently mentioned and generally associated with emerging industries, is the high cost of capital. Up until recent years, the high costs of capital drove transaction costs to unreasonably high levels in the offshore wind industry, and several of our case companies pointed to the lack of reasonably priced capital as the main reason why they had not moved into the industry earlier and more extensively. The capital situation in offshore wind has definitively improved over the past few years, but the price of capital was one of the major reasons why established actors chose to wait on entering the industry and why the industry as a whole had a fairly slow start.

Another factor that was frequently mentioned was the consequences of market immaturity on market offerings. Due to little experiential market knowledge, market offerings, specifications, solutions and even business models were changed frequently in the early years. To stay competitive and win contracts, actors needed to be flexible in their market offerings. Surely, this requirement was driving costs, but it was also something that firms were not accustomed to doing in their operations in mature markets, such as energy and maritime, where designs of offerings and contracts have found their dominant form.

Hence, in the earliest stages of the offshore wind industry development, firms faced considerable challenges associated with the lack of an established industrial regime that efficiently could reduce transaction costs and business risk. Our study shows how a set of diversifying firms have been able to mitigate these challenges by changing value-creating processes and business models to accommodate them to new customers in the offshore wind industry. In summary, these factors contribute to understanding the main finding that the major challenge associated with entry into the offshore wind industry is more of a market problem than a technological one. In recent years, the mainstream 'bottom-fixed' offshore wind market has matured significantly, and most of the challenges mentioned above have less relevance. In immature emerging markets outside Europe and in the market for floating installations, it is likely that we will see similar challenges today.

5.2 New market characteristics and strategic behaviour

To further explore the challenges linked to the market dimension, we wanted to determine whether new industry characteristics influenced market entry behaviour. If so, in what way do characteristics of emerging industries affect the industry entry strategy of established and new firms.

> *"Offshore wind projects carry great risk, which imply that one has to focus on risk assessment in every step."*
>
> **Offshore wind start-up**

The general problem of entry into new industries has long been recognized in the field of entrepreneurial marketing, and we know quite a lot about the general characteristics of emerging markets from previous studies.[30]

> *"It's hard to stick out as a small firm in the offshore wind industry, especially with the rapid growth of the offshore wind farms."*
>
> **Offshore wind start-up**

- **High levels of uncertainty and risk.** Due to the lack of experiential market knowledge, market factors are often 'truly uncertain'. This means that it is difficult to extract risk profiles of the industry because the likeliness of events occurring and their eventual consequences are truly unknown. This also makes the industry unattractive for incumbents from other industries and to industry actors, such as institutional investors and banks, which use probabilities as their main tool.

- **Complexity and turbulence.** In the early phases of industry development—also referred to as the 'era of ferment'—there are a variety of technical solutions, market offerings and entrepreneurial actors. Most of these are selected out of the market as dominant designs in market offerings, business models and contract types emerge when the industry becomes cost efficient.

- **High transaction costs.** Due to the two factors mentioned above— high levels of uncertainty/risk and complexity/turbulence—new industries are generally transaction cost inefficient, which reduces their competitiveness compared to that of established related industries.

- **Disadvantages of scale and immature/untested products and services.** As new markets generally deal with new solutions on a limited scale,

Ulstein Group is a family owned group of companies offering a wide range of maritime solutions. Ulstein is considered one of the most innovative Norwegian maritime companies. In line with this, Ulstein has built up its own analysis unit (relatively unique in the maritime sector), which is key for their internal knowledge development and 'fact-based decision-making'. With most of its activities within oil and gas, Ulstein was vulnerable to industry cycles and therefore wanted to diversify into other maritime segments.

In 2009, the company started to assess the possibilities of entering the offshore wind industry. However, Ulstein observed an immature industry that was very different from their other market segments, consisted of a "*few professional companies*" and had a different focus on safety and efficient solutions than that in other segments. Ulstein chose to monitor the offshore wind sector from the sideline but eventually decided to enter the offshore wind sector in 2014/15.

At this time, Ulstein saw that the maintenance market had grown and was a large enough market to target with specific maintenance vessels, i.e., service operation vessels (SOVs). This proved to be a successful approach, and Ulstein's second SOV, the Windea Leibniz, placed second in the Norwegian "Ship of the Year" contest in 2017. The company emphasizes that although there were similarities between offshore wind and oil and gas, it makes no sense for them to take existing and expensive oil and gas solutions and offer them to the offshore wind industry; it is rather preferable to create new solutions made specifically for the offshore wind and based on the companies' own capabilities.

Box 2 Ulstein Group's engagement in offshore wind

30 See Forbes and Kirsch (2011); Klepper and Graddy (1990); Christensen and Raynor (2013); Möller and Svahn (2009)

the liabilities of small scale reduce their general competitiveness compared to that of related industries.

We also know quite a lot about the characteristics of emerging international industries, i.e., industries such as offshore wind that are international from the outset.[31]

- **Born Global industries.** Many new industries—such as offshore wind—emerge without domestic maturation. All actors meet international competition from the first contract.

- **Innovation and entrepreneurially driven.** There is fierce competition from both new and established players and floating collaborations where actors might collaborate on one contract and compete on another.

- **Information gaps.** Market work is hampered by market information gaps and the lack of established arenas for market information and knowledge exchange.

In this study, we found evidence that all of the factors listed above were present in the offshore wind industry. Specifically, the case firms emphasized that uncertainties related to unstandardized processes and contract structures and the political risk related to (the potential removal of) subsidies were challenging. These uncertainties were enhanced by industry characteristics such as complexity and turbulence (as illustrated above). Moreover, we found that several of these factors were decisive factors for strategic decision-making associated with market entry.

One of the major factors was how to deal with the relatively high levels of uncertainty and risk (explored more in the following section).

We found a variety of strategies that the firms used to deal with risk and uncertainty. One of the most common was simply postponing industry entry until risk levels became acceptable. Another strategy was to limit offshore wind investments to internal resources and exposing the firm to market risk slowly and incrementally.

Market information gaps also contributed to the perceived risk of market entry. Here, we also observed a range of different strategies to deal with the lack of market information. Some companies invested heavily in market research to close information gaps, and start-ups especially found this necessary. The downside of such a strategy is evidently that it contributes to increasing transaction costs.

The established actors tried to avoid increased transaction costs by following two main strategies. To compensate for lack of market information, they used existing business relations and experiences from either the petroleum or maritime sector to exploit informal arenas and business relationships. The other strategy was to compensate for incompleteness and variations in contracts through flexible partner arrangements. In the early years especially, actors showed high levels of flexibility in the use of a variety of partnerships and collaborative business models to meet ever-changing contract requirements.

In summary, our cases show that the emerging offshore wind industry indeed fits the new international industry characteristics that are known to us from previous research. Moreover, we found that these characteristics shaped the firm entry strategies. More specifically, these strategies entail the following:

- *Careful management of the timing of market entry*

- *Extensive use of informal arenas and existing business relationships to close information gaps and reduce transaction costs*

- *Flexibility in partnerships and collaborative business models to meet ever-changing contract requirements in an immature industry where dominant designs in market offerings, business models and contract types are not decisively selected*

5.3 Risk assessments of target markets and entry strategies

Given the risks and uncertainties observed in our case studies, we used survey data to identify the firms' most important markets, how they evaluated risk in these markets, what entry strategies they used, and

31 See Løvdal and Aspelund (2011); Bjørgum (2016); Aspelund et al. (2018)

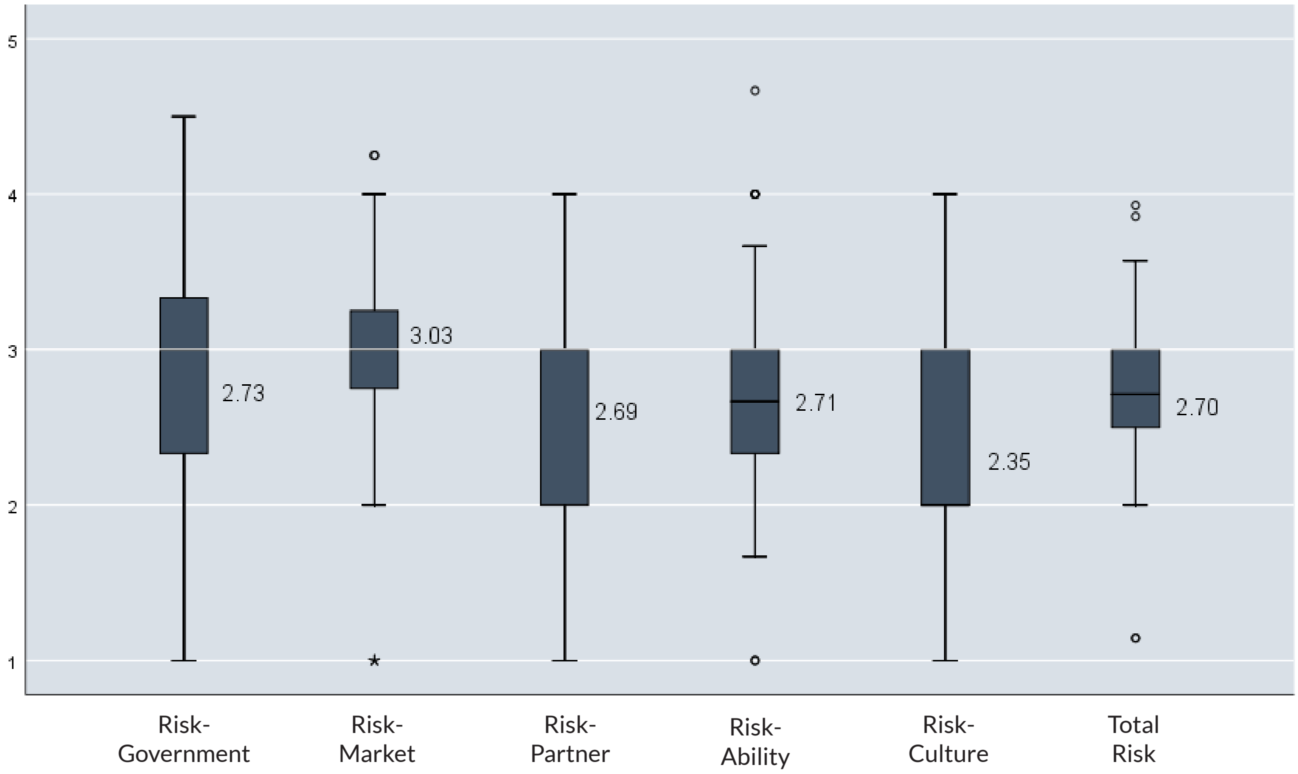

Figure 11 Total risk assessments of target markets

whether entry strategies were related to these risks. Figure 11 shows how firms assessed the various risks associated with their target markets.

First, as seen in Figure 11, companies generally considered market risk to be highest. This type of risk is associated with variations in demand, the introduction of new technologies, increasing supplies of substitutes, and aggressive price competition. This finding is consistent with the discussion in section 5.1. concerning market-related difficulties. We also see that government risk varies widely, which is likely due in part to the different risks associated with various national offshore wind policies; the same could be claimed about cultural risk. In our case studies, the firms emphasized subsidies as being a risk factor. Case companies consistently saw subsidies as a nuisance because subsidies exposed the firms to political risk. This left the impression that making the industry subsidy-free was a goal in itself to reduce the actors' exposure to political risk. Finally, although the risk related to the firms' own ability to deliver according to specifications and customer expectations and the risk related to the partners/suppliers abilities to deliver have similar mean scores, the range of partner/supplier risk naturally varies more widely.

Target markets and entry strategies represent other interesting aspects seen in the data. As shown in Table 1, Germany and the UK were the two most frequently identified target markets, and direct sales was the most common entry mode used. Many companies that reported Germany as their most important market had also succeeded in gaining contracts in this market (19 out of 20). This was clearly the most successful target market in terms of contracts, and direct sales was the most frequently used entry strategy (17 out of 20).

Finally, when looking at the relationships between risk assessments and entry strategies in Table 2, we obtain a better idea of the types of offshore wind market entry strategies firms used according to the firms' risk assessments. To be clear, we assume that entry strategies are determined by risk assessment and not the other way around. This means that if a firm evaluates a particular risk in a market to be high, then it will be more likely to use a specific entry strategy to mitigate that perceived risk. Total risk (the average of all risks

Target market	Number of companies	Most used entry strategy	Number of firms that have achieved sales contracts
Germany	20	Direct sales (17)	19
UK	20	Direct sales (18)	13
Norway	18	Direct sales (13)	10
Denmark	9	Direct sales (7)	6
EU (e.g., France and Netherlands)	7	JV (4)	4
Asia (e.g., Taiwan, China)	2	Direct sales (1), Agents (1), JV (1)	0
USA	2	Agents (2) and JV (2)	2
Sweden	2	Direct sales (2) and JV (2)	2
Combination (multiple countries listed)	17	Direct sales (8)	8

Table 1 Target market, entry strategy, and sales

	Direct sales	Sales via agents	JV with Norwegian partner	JV with international partner	Acquisition	Subsidiary
Risk – government	-.18	.09	.19	.32**	.03	.17
Risk – market	.03	-.15	.14	.04	-.09	.07
Risk – partner	.08	-.01	.11	.19	.11	.04
Risk – ability	-.11	.05	.22*	.22*	.04	.06
Risk – culture	-.04	-.01	.29**	.17	.05	.23*
Total risk	-.09	-.01	.27*	.27*	.03	.16

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 Risk assessments and entry strategies

combined) and ability risk (the risk stemming from a firm's own abilities) were significantly associated with joint ventures (JV). To reduce ability risk and total risk, firms were more likely to enter into offshore wind markets by using JVs, either with Norwegian partners or other international firms. Interestingly, cultural risk was most highly associated with JVs with Norwegian partners, while government risk was most highly associated with JVs with international partners. Thus, we assume that firms seek Norwegian JV partners when cultural risk is perceived to be high and that they seek international JV partners when governmental risk is perceived to be high. It is possible that sought-after JV partners already have existing knowledge and relationships in the target market, but we do not have enough information to confidently conclude this.

6 Policy

- Current policy frameworks are insufficient and do not address the needs of some firms.
- R&D is important but is not enough.
- Policy should support marketing and sales activities.
- Access to capital and the lack of a home market to enable technology verification is a challenge.

Public policy is important for the growth of new industries. Today, there are a variety of policy instruments that support Norwegian offshore wind. The intention with this chapter is not to present these instruments or to evaluate the current policy mix for offshore wind. Rather, the chapter presents findings on Norwegian firms' views on the importance of different policy instruments. The chapter also presents areas where Norwegian firms identify policy needs.

6.1 Policy needs

Figure 12 shows that approximately half the respondents are not satisfied or only somewhat satisfied with the existing Norwegian policy instruments in connection with their offshore wind efforts. Approximately a quarter (26%) were not satisfied at all.

In the following, we explore the variety among firms in terms of policy needs and the most critical areas where firms experience weaknesses and strengths in the current policy environment.

Figure 13 shows the variety in types of policies that firms see as most important for their own success in the offshore wind market. The results in this figure are based on an open question in which firms were asked to list the *most* important change in public policies that would support the firm's efforts in offshore wind.

Below, we explore three of these areas of policy that if addressed can help Norwegian firms succeed in the offshore wind market: (1) R&D support and supplementary mechanisms, (2) market creation policies and pilots

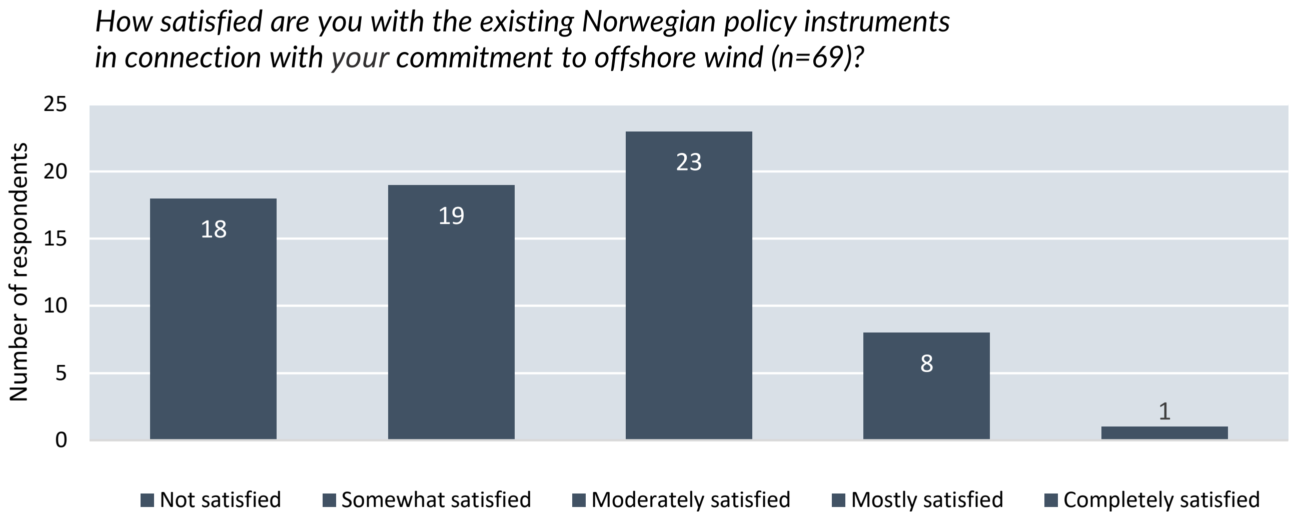

Figure 12 Satisfaction with existing Norwegian policy instruments, as reported by survey respondents.

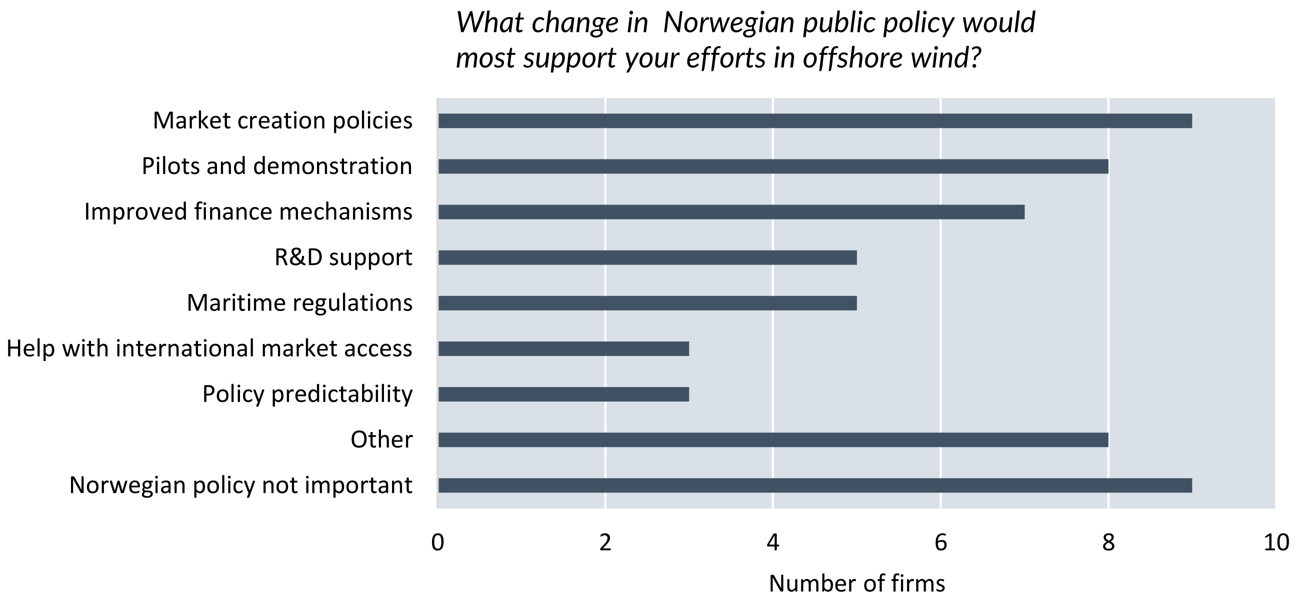

Figure 13 Survey responses to open question about which policy change would most support efforts in offshore wind. Categorized in nine groups. N=57.

and demonstration and (3) capital access and investments.

6.2 R&D support is important but is not enough

In Figure 13 only 5 firms (9%) point to improved R&D support as the most important change in the policy environment to support their offshore wind efforts. Considering that the Norwegian authorities in their efforts to support a Norwegian offshore wind industry have prioritized public R&D programmes, this is not surprising. Policy instruments that are particularly important include Innovation Norway's Environmental Technology Enterprises Financing Scheme (Miljøteknologiordningen), Enova, SkatteFUNN administered by the Norwegian Research Council (RCN), as well as research and development projects funded by RCN. The importance of R&D support is also highlighted in Figure 14.

However, for many firms, public R&D support is not sufficient to obtain access to international markets. As Figure 7 in chapter 4 shows, most of the Norwegian offshore wind firms are suppliers to the oil and gas industry. Chapter 5 discussed how these firms have technological capabilities that are transferable to the offshore wind industry but that the process

In Norway, we are extremely lucky because we have a support system through the Research Council, Innovation Norway, Enova, that is really good. We have been utilizing all of these three agencies and they are brilliant - something that we really should value in Norway. I think they are extremely important.

Large technology firm

of acquiring contracts and getting sales can be quite different and challenging due to weaker market relatedness.

Publicly funded organizations such as Export Credit Norway/GIEK and NORWEP have been established to support market access, and for some offshore wind firms, these organizations are important. However, efforts to deal with market access can be resource demanding. Several of the interviewed companies point to the importance of establishing specialized sales teams and setting up local offices

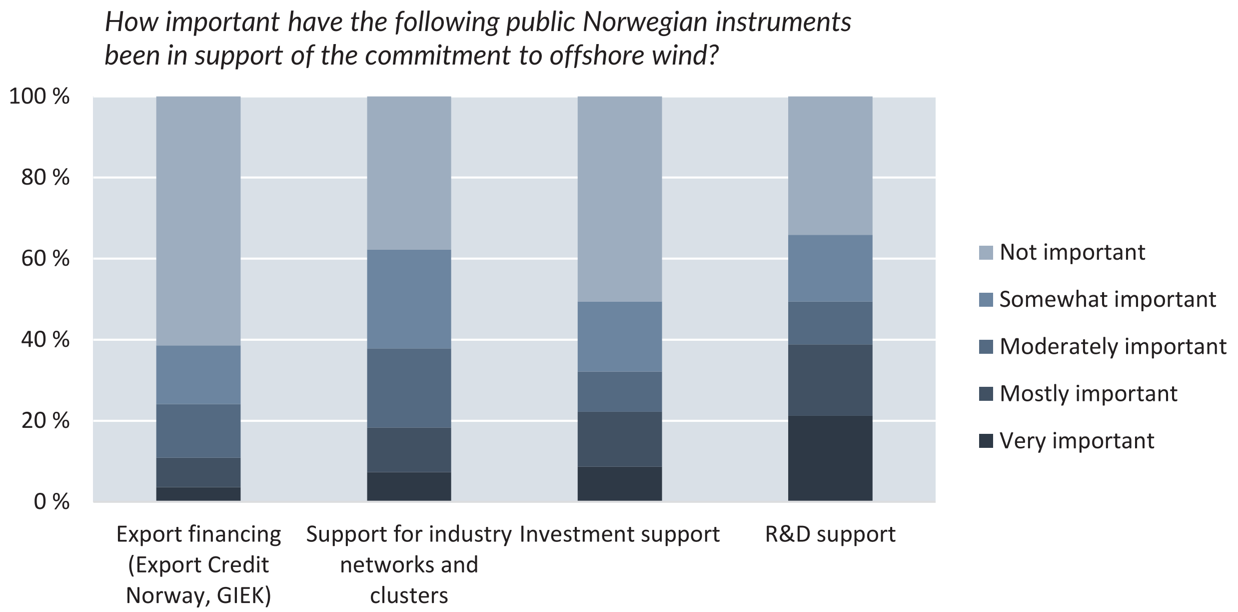

Figure 14 Importance of selected types of policies

or hiring local sales representatives in the offshore wind markets they see relevant. For some firms, the costs relating to marketing and sales can be comparable with those incurred from technology development.

The lower degree of similarity in market conditions and the resource demands linked to marketing should be seen in relation to how companies experience policy support for offshore wind.

A key finding from the interviews is that while companies report a general satisfaction with policies concerned with technology development, they report challenges and a lack of support for marketing products and services. This lack may provide barriers for market entry, even in instances where technologies could be easily transferred from oil and gas to offshore wind. To successfully reorient the business towards offshore wind from industries such as oil and gas can require large investments in marketing and sales processes. The allocation of these resources often needs to be sustained over a longer period before the firms are able to capitalise on those investments. For small- and medium-sized firms, this can be challenging. Interviews thus indicate that public support for marketing could be useful since the process of marketing may be cumbersome and resource demanding.

A rationale for providing support to offshore wind in Norway's Energi21 strategy is to enable firms to become competitive in international markets. Considering this target, our findings indicate that increased support for market access could potentially boost the effects of existing policy support for research and technology development. Overall these findings lend support to the innovation studies'

> *"We have a great policy scheme up until it's almost commercialised, but I need to cope with the costs that I have incurred during the development phase when I'm starting to market and in sales. The marketing and the sales costs are one to one with the development costs. All the support is going up to this point, and after this you're on your own."*
>
> **Large technology firm**

perspectives that assert that industrial development should not only be seen as a technology development process alone but also should include important non-technical factors, such as establishing customer relations, creating legitimacy for novel technical concepts and gaining market access.

6.3 A home market for offshore wind

Out of the 57 firms responding to the question regarding policies that could help them (Figure 10), a total of 8 firms suggested that various forms of policies related to piloting and demonstrating technology, products, or services, represent the most important tool that Norwegian policy-makers should introduce. In addition, a total of 9 firms called for market creation policies. The lack of a home market that could allow for qualification of technology creates an additional barrier for some firms that need to provide references for their products or services.[32]

Despite having been on and off the public agenda for many years, the need to demonstrate and qualify technology remains critical for several firms. Most firms do not have the resources to do this themselves. Thus, firms who need to demonstrate new and capital-intensive products or firms who have not established a foothold in the existing international markets could benefit from the establishment of Norwegian pilot and demonstration projects. The group of firms that emphasize the need for a home market for demonstration includes many firms with core activity in the oil and gas industry and both large and small firms. The main benefits from having access to a domestic market for piloting and demonstration include the following:

- Demonstrate competence and capabilities
- Gain references from real-world projects
- Gain valuable experience
- Help develop a local supply chain

"A domestic market within offshore wind in Norway would of course enable suppliers and contractors to gain valuable experience that we can utilize and use when we go international."

Large technology firm

A home market for offshore wind has been on and off the public agenda for many years. In particular, during the first wave of interest between 2008 and 2011, there were a number of calls for publicly funded bottom-fixed projects. However, these initiatives, which could have helped firms to also obtain a foothold in the international market, were not successful due to a combination of lack of political commitment and a boom in the oil and gas industry between 2011 and 2014 (see also section 4.3).

While the focus a few years back was on attracting government support for a full-scale commercial bottom-fixed wind farm, the focus now seems to have turned towards demonstration of new technology related particularly to floating turbines. The reason for this is in part that the market for bottom-fixed has matured substantially in recent years. There remains, however, a question of who can and should finance a large-scale wind farm for the demonstration of new technology in Norway. We return to this point in section 7.3.

6.4 Access to capital

Figure 10 shows improved finance mechanisms as an area where companies would like to see more support.

An issue mentioned in interviews was the challenge

32 The lack of support for pilots and demonstration and the importance of having this support has been discussed in several previous reports on the Norwegian offshore wind industry (e.g. Hansen & Steen, 2011; Normann & Hanson, 2015). Also see Normann and Hanson (2018) for a discussion of the role of home markets

in terms of securing access to capital, particularly for capital-intensive ventures, such as new built vessels or larger structures. In terms of taking on these financial burdens, several firms point to challenges due to small firm size and lack of financial muscle. Interviews also show that companies may struggle with getting public support for financing because they lack private investments and links to commercial partners that are able to provide additional investments to fulfil the criteria for public funding.

However, some companies highlight the importance of having (foreign) owners who are willing to invest and provide equity to finance venturing into offshore wind, as illustrated in box 3. This type of company internal financing can also be important as a means to make early phase investments into new business areas, such as offshore wind. For example, this

> *"...the oil and gas industry was booming in 2012-2014, so it was from a capacity point of view a bit challenging to move away from the core business and over to full speed ahead on renewable business."*
>
> **Large technology firm**

Dokka Fasteners is a company with approximately 150 employees and whose core business is to manufacture bolts for the wind and the oil and gas market. In 2018, 13 000 tons of bolts were produced in Dokka, which is a small village just over 2 hours outside Oslo. Approximately a quarter of those bolts are used on offshore wind parks.

Dokka Fasteners has successfully captured a part of the market for offshore bolts. Technological upgrading by investing in robots and automated production has been an important enabler for Dokka to establish itself within this market niche. The significant investments in new manufacturing technology were enabled by Dokka's German mother company Würth, which provided the financial means. Dokka Fasteners is currently investing in a new innovation project on smart bolts. The project can potentially help their customers reduce their operations and maintenance costs significantly, which in turn will help the company in strengthening its market position. The project involves investments in new technology and has been funded by Innovation Norway and Würth. However, the most important aspect of the Innovation Norway funding is that it sends a signal to the owner that the Norwegian authorities are willing to invest in the company. Thus, Norwegian policy support has been an important enabler of international funding, which has been vital for the innovation project.

Just as support from Innovation Norway has been important for securing commitment from the owners, the long-term funding from Würth provided the resources required to properly engage with the Norwegian policy support system. The management has been clear that without the resources made available by the owner, Dokka Fasteners would not likely have been able to investigate various public support opportunities and secure funding from Innovation Norway. This puts Dokka Fasteners in a fortunate position. However, it also points at a possible problem for many small to medium-sized enterprises that do not have the resources to search for support mechanisms in Norway.

Box 3 Dokka Fasteners' engagement in offshore wind assistance can be in the form of human resources dedicated to new technology development. For those firms without funding from owners, interviews show that capital strains can be a significant barrier, particularly for new technology development. In these situations, customers may be hesitant to pay in advance, which means that the supplier needs to take the financial risk. This can be particularly challenging if the company is not successful in securing public financing or risk loans.

Figure 7 in chapter 4 shows that most actors in the offshore wind industry have their main business activity in industries other than offshore wind. Interviews show a variation in whether this provides benefits or challenges for diversifying companies in regard to financing and investments in offshore wind activity:

- Companies that are able to use existing infrastructures or technical solutions report less need for high capital investments for offshore wind entry.
- For some firms, revenues from oil and gas can provide necessary capital to invest in offshore wind, but revenue generation can be challenging during downturns in oil and gas.
- For other firms, upturns in oil and gas prices can reduce the incentives to invest in offshore wind.

"We have not had the capacity to look at new building projects at this stage because of the downturn in the offshore industry and the resulting crises for all typical offshore owners."

Large technology firm

7 Discussion and conclusions

- The non-technological features of international offshore wind markets can provide barriers to entry.
- Strong petroleum incentives can challenge the diversification and build-up of the offshore wind industry.
- Clearer political priority and direction could help strengthen Norwegian offshore wind.

The objective of this report has been to discuss opportunities and challenges for achieving more growth and internationalization in the Norwegian offshore wind industry. To explore this, we have investigated how the characteristics and strategies of Norwegian firms are aligned with international offshore wind markets. Moreover, we have looked at how policy can support an internationally oriented Norwegian offshore wind supply industry.

Based on an industry survey and interviews, we show that the majority of Norwegian companies in offshore wind are diversifiers. These companies report that entry into offshore wind is enabled by technological relatedness. In spite of the opportunities to transfer resources from core business areas to offshore wind, we observe several challenges with further diversification to offshore wind.

7.1 Non-technological barriers to market access

The offshore wind market has specific characteristics that can be dissimilar to those markets from which firms have previous experience. Contract designs, sales processes, and customer relations are examples of such differences. Thus, whereas most firms that diversify into offshore wind may only need to make minor changes in terms of technology, they often need to make more substantial changes and investments in terms of sales and marketing capabilities. Challenges linked to new market characteristics are also mirrored in the fact that firms assess market risks as higher than other risks, such as technology. Market risks and uncertainties can in turn stall firm entry to offshore wind. Market characteristics and the capabilities and resources needed to enter international offshore wind markets can represent barriers for Norwegian suppliers.

We also observe that these challenges have important implications for policy. Current policy support is geared towards research and technology development. Whereas firms report satisfaction with these instruments, some firms also express the need for other types of support mechanisms. Support for marketing and sales activities—i.e., taking technologies to the market—is seen to be insufficient under current framework conditions.

7.2 Diversifying from oil and gas

A large share of Norwegian firms that are active in the offshore wind industry have diversified from oil and gas. More than half of the surveyed firms report having less than 5 per cent of their total turnover from offshore wind. We believe this represents a challenge for building up a Norwegian supply chain for offshore wind.

The development of Norway's offshore industry has in many ways been influenced by market cycles in oil and gas. A fluctuating oil price and reduced investment levels in Norwegian oil and gas has been a major motivation for diversification to offshore wind. However, periods with increased activity in Norwegian oil and gas industry have reduced the levels of engagement in offshore wind. A long-term optimistic outlook for Norwegian oil and gas can therefore hinder the build-up of a large group of dedicated offshore wind firms in Norway.[33] New industries often start in relatively small niches, and these require dedicated actors for a significant period. If we look at the Norwegian offshore wind industry, we doubt that such conditions are in place. This raises the question of whether as a collective offshore wind industry, Norwegian firms are sufficiently organized beyond a number of individual firms that have varying degrees of activity in offshore wind. While this is an industrial challenge, it is also a political issue.

The firms' dedication is intrinsically linked to the dynamics of the sectors that firms are diversifying from. If the "*main policy aim is to provide a framework for the profitable production of oil and gas in the long term*"[34], firms may not have sufficiently strong incentives to make the necessary investments required to fully commit to a new industry such as offshore wind. The level of dedication by diversifying firms relies on the long-term expectations for both their existing business and the prospects for new industrial opportunities.[35]

If diversification and a stronger commitment to offshore wind is an objective, then a sector targeted industrial policy and sufficient support for new niches through incentives and resources for sustained diversification is important.

7.3 Setting a direction to support the growth of the Norwegian offshore wind industry

Governments play important roles in setting the direction for economic activity.[36] The challenges linked to market access and diversification suggest that the authorities need to set a direction if the potential to develop a Norwegian offshore wind industry is to be exploited.

Floating offshore wind represents a second opportunity wave. The experience with the first wave of bottom-fixed offshore wind offers important lessons. First, there has been a lack of strong direction setting, long-term political signals and intent from Norwegian authorities on whether the development of an internationally competitive offshore wind industry is something that Norway should prioritize. Second, Norwegian firms had no home market to experiment

33 See Mäkitie et al. (2019); Normann (2015); Steen and Hansen (2018) for further elaboration on this argument.
34 The quote is from a speech given by Prime Minister Erna Solberg at the Equinor Autumn Conference, 20 November 2018.
35 Steen and Weaver (2017)
36 Fagerberg (2018); Mazzucato (2015)

and gain market experience from. Third, some firms assessed international markets as risk-filled and took a wait and see approach, while the international market grew, matured and consolidated.

We argue that stronger direction setting can be achieved through two complementary approaches.

First, intermittent statements about the potential for diversification from oil and gas to offshore wind need to be followed up by policies that support market access and incentives for diversification. We have identified some areas where stronger support and incentive mechanisms could be important. These include **support for marketing activities** (since many firms report relatively high technological relatedness but lower market relatedness), **domestic market creation policies that support technology verification, piloting and demonstration** (since firms report challenges with verifying and proving the relevance of concepts for international markets) and strengthening support for the **access to capital** (since many firms are small- and medium-sized enterprises with insufficient internal resources). Any implementation of policy measures should, however, be seen in relation to the potential synergies that could be achieved in combination with other policy instruments.

Second, the cyclical nature of the oil and gas industry has weakened the long-term commitment to diversification in some firms. This lack of diversification has been amplified by the political signals that the authorities will ensure the continued long-term profitability in the oil and gas industry. Thus, if firms that primarily deliver to the oil and gas industry are to dedicate substantial resources to offshore wind over the longer term, the authorities may need to create incentives for diversification that sufficiently compensate for or reduce the pull towards oil and gas.

"If you want to develop the industry built on concepts to be exported out in the world, then authorities need to put in place incentive mechanisms. That could be in multiple facets really: it could be feed-in tariffs, it could be tax exemptions, it could be direct public grants, whatever is in there. But I think authorities need to understand that they need to liaise with the developers in order for projects to materialize."

Large oil and gas supplier

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