NORWEGIAN OPPORTUNITIES IN OFFSHORE WIND

9 SEPTEMBER 2016

intpow
Norwegian Renewable Energy Partners

EKSPORTKREDITT
Export Credit Norway

GREATER STAVANGER

Table of contents

Introduction

Eight to ten years ago, as the emerging offshore wind sector started its transformation from a few interspersed projects to a full-fledged industry capable of delivering clean electricity from large-scale projects, Norwegian business leaders and politicians saw new opportunities for Norway's well-positioned offshore oil and gas and maritime suppliers.

To review the Norwegian suppliers' market positioning and to point to future growth prospects, Export Credit Norway, INTPOW and Greater Stavanger have commissioned the international wind experts MAKE Consulting.

The report shows that, so far, Norwegian suppliers have only taken a relatively modest slice of the overall offshore wind market, accounting for an estimated 5 percent or less of deliveries to offshore wind projects since 2010.

But in some offshore wind sub-segments the Norwegian presence is considerably higher than this average number indicates. Within cable supply and installation, marine operations and supply of O&M and installation vessels and services Norwegian suppliers have demonstrated competitiveness. Some lower-tier suppliers have also achieved success in the offshore wind market.

MAKE expects the industry to grow by between 15 and 20 percent annually over the next few years. The quest to cut costs across the value chain offers fresh opportunities for Norwegian suppliers and INTPOW, Export Credit and Greater Stavanger expect the current slump in the oil and gas industry to spur more Norwegian suppliers with offshore or maritime expertise to enter the offshore wind industry.

INTPOW, Export Credit and Greater Stavanger

MAKE

This report has been produced by Make Consulting for INTPOW, Export Credit Norway and Greater Stavanger.

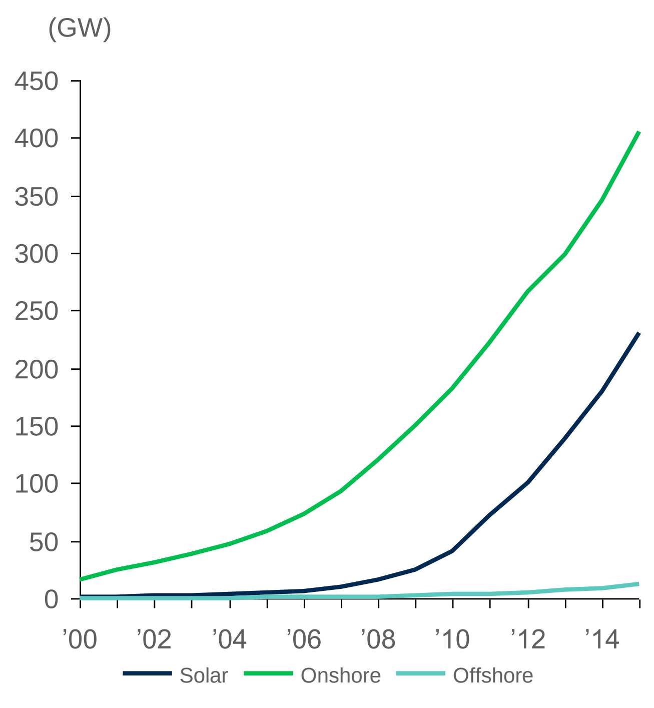
1 Global offshore wind industry overview

1.1 Offshore wind development

Offshore wind's path to 12 GW

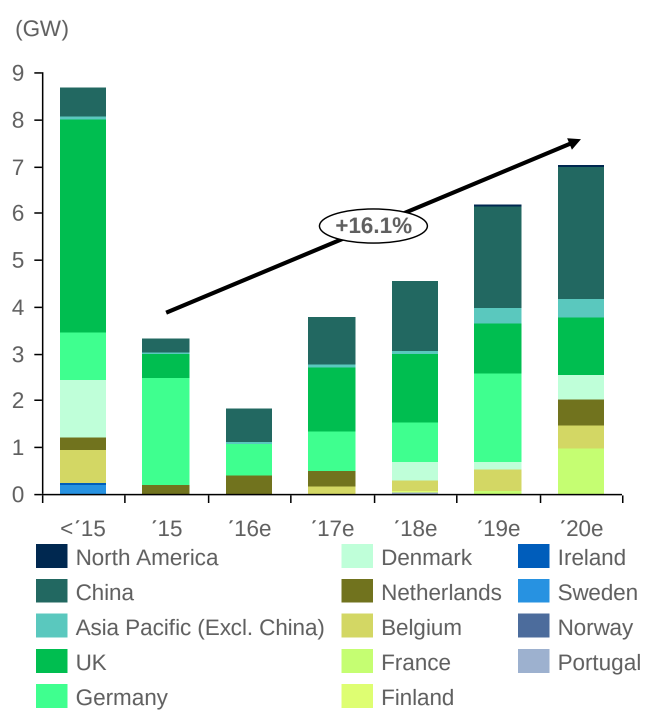
The first offshore wind farm, Vindeby, was connected to the grid in 1991. However, only 84 MW were installed globally by 2000. By 2000, offshore wind constituted only 0.5% of the total solar, onshore- and offshore wind portfolio, with Denmark and Sweden being the largest players and the Netherlands starting to test offshore wind. In the first half of the decade to follow, Denmark continued to be market leader while Sweden's role started to fade. Meanwhile, the UK entered the market. The UK's entry proved to play an important role for the years to come. By the latter half of the decade, the UK connected more than twice the amount of Denmark, which, nevertheless, continued to have a solid position in the offshore wind market. Generally, the second half of the decade was characterised by significant growth. Total grid-connected capacity increased from less than 700 MW in 2000 to almost 3GW in 2010, with Germany and Belgium entering the market and the Netherlands continuing to be present. The growth continued into the first half of the next decade, with China also moving into offshore wind. A staggering 8 GW was grid-connected in Europe by 2015. The UK and Germany constituted more than 90% of this growth, thereby gaining the leading position in offshore wind as of today. In summary, offshore wind's capacity increased significantly over the last 10 years and the industry is quickly moving up the learning curve. Nevertheless, as illustrated in Figure 1, offshore wind is still lagging behind solar and onshore wind and accounts for only 2% of the accumulated solar, onshore- and offshore wind portfolio.

Figure 1. Historical developments in solar (PV), onshore and offshore globally, 2000 to 2015



Note: Based on grid-connected capacity.
Source: MAKE, BP

Figure 2. Offshore market forecast, globally, 2015 to 2020e



Note: Based on grid-connected capacity.
Source: MAKE

Offshore wind is on track to realize 35 GW by 2020

As illustrated in Figure 2, MAKE expects the growth to continue with a CAGR of 16% through 2020. In line with this projection, almost 3GW of projects received final investment decision in H1-2016 and almost 4GW worth of projects are currently under construction. As also demonstrated in Figure 2, Germany and the UK will continue to strengthen their leading position, but France, the Netherlands, and especially China will also play an important role as we approach 2020.

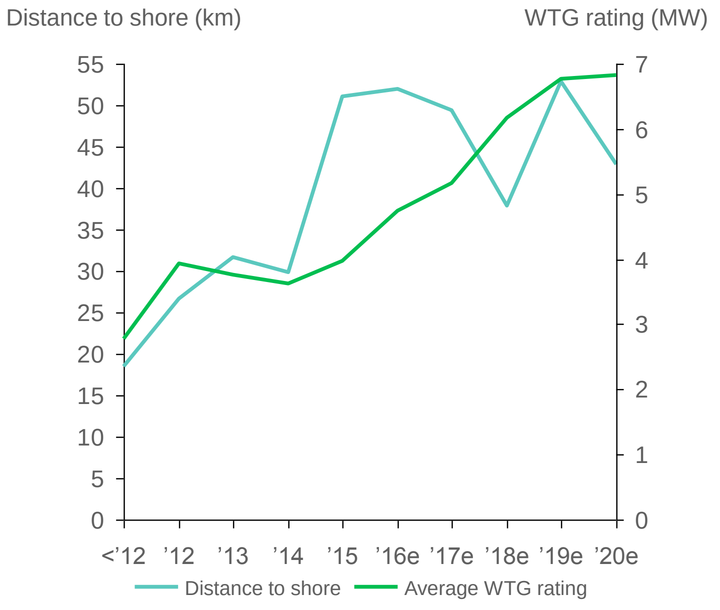
1.2 Supply chain developments

Since the establishment of Vindeby in 1991, the technology and locations of offshore wind have changed significantly and will continue to do so in the future as the industry continues to climb the learning curve.

Increase in distance to shore

As can be seen in Figure 3, the distance from shore has increased significantly since 2011. However, as is also evident, this situation is highly volatile. This volatility is driven by the relative share of German projects situated in the North Sea as they utilize HVDC substations, which allow developers to connect projects to the grid that are more than 100 kilometres offshore. Despite the volatility, we still see an increasing trend in distance to shore. This trend challenges cable suppliers, installation companies and operations and maintenance service providers.

Figure 3. Developments in distance to shore and turbine ratings in Europe, 2011 to 2020



Note: Based on grid-connected capacity.
Source: MAKE

Turbine rating set to accelerate in the latter half of 2010s

Towards 2020, MAKE expects a significant increase in turbine rating. This is largely driven by the introduction of MHI Vestas' V164-8.0 and Siemens' SWT-7.0-154 in the latter half of 2010s. However, as indicated by the decrease in growth in 2020, this trend is expected to subside at the start of the 2020s as no new turbine platforms beyond 8 MW are expected to be introduced before around 2023. Thus, the increase in rating will be driven by the scaling of existing turbine platforms, which can already be seen with MHI Vestas' recent upgrade of its V164-8.0 to 8.3 MW on Walney Extension 1 and Siemens' stated intentions of optimizing the SWT-7.0-154 platform to 8 MW. Besides the direct impact on turbine suppliers, this rise in sizes also increases the demands for foundation suppliers and turbine installation vessels.

The limits to project capacity continue to be pushed

From Figure 4, it is possible to see that project capacity is increased continually. The largest project in the current pipeline is Hornsea Project 1, which received final investment decision in Q1-2016. The project has a capacity of 1.2 GW. Due to its large size, the project developer, Dong Energy, has split supply contracts, an undertaking that requires a high degree of coordination. DONG Energy is going to apply both monopile foundations for the low water depths and suction bucket jacket foundations for the turbines placed in higher water depths. Furthermore, the export cable contract has also been split between two companies.

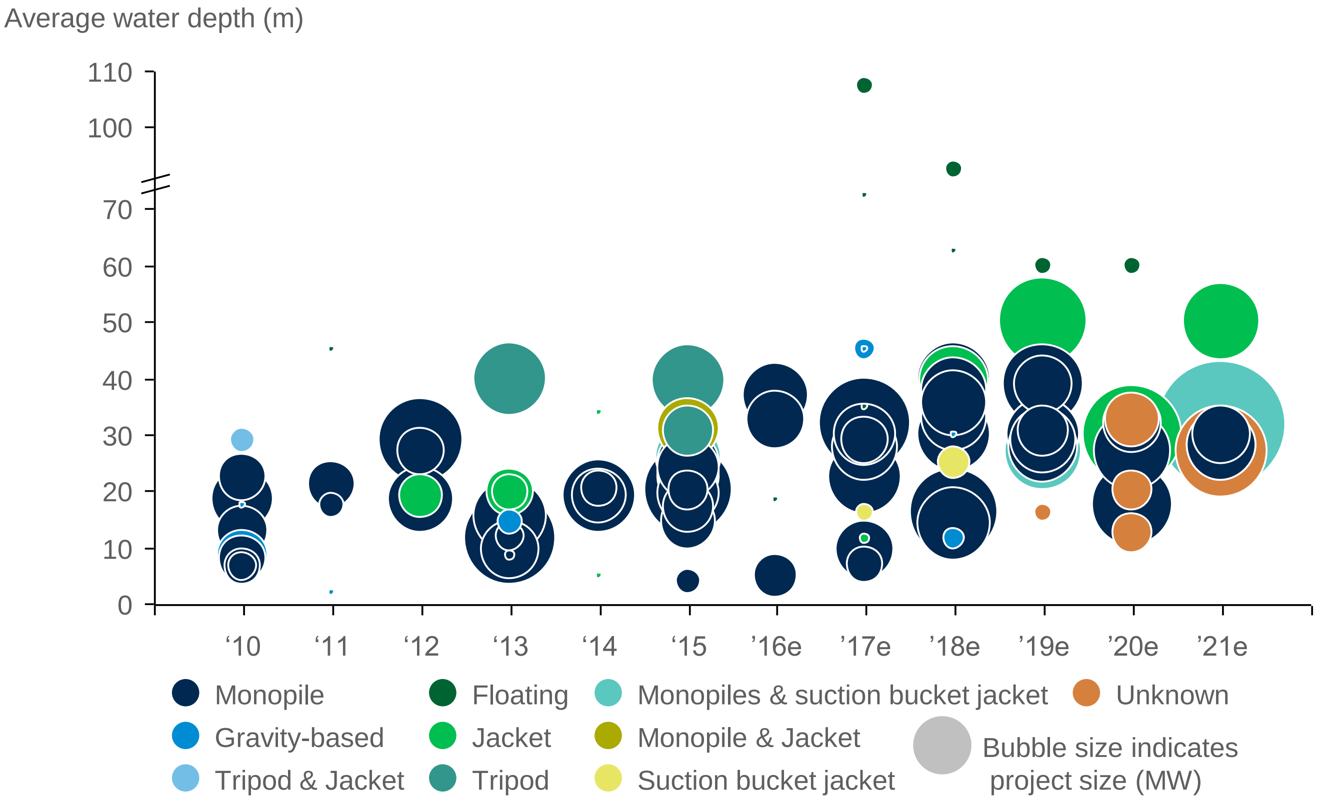
Future of floating wind

Floating wind comes in three forms: spar-buoy, tension leg platform (TLP) and semi-submersible. Floating wind has since 2009 demonstrated its technological viability by successfully installing seven demonstration projects in Norway, Portugal and Japan in water depths up to 120 meters, which has allowed the projects to achieve strong capacity factors. In the coming years, we will continue to see demonstration projects with two currently under construction in Japan and projects under development in the UK, France and Germany. Already in 2017, the first floating multi-turbine demonstration project will be connected to the UK grid, and France will connect 100 MW floating projects before 2020. These projects will seek to prove that floating wind is not only technically viable, but also economically feasible, which will influence the future of offshore wind.

Water depth set to double from 2010 to 2020e

The water depths of offshore wind farms have increased significantly and will continue to do so towards 2020. Water depth and soil conditions are the most decisive factors when choosing which type of foundation to apply. Monopile foundations have been dominant so far due to their low cost and relatively simple structure. The offshore wind industry will continue to stretch the application of monopiles beyond water depths of 40 meters in the future. However, due to large water depths, new types of foundations will also be more widespread towards 2020, as DONG Energy starts to apply suction bucket jackets in combination with monopiles and regular jackets start to play a larger role in the UK. The next likely commercial gravity-based foundation project in the pipeline is the French Fécamp project, which is expected to be fully grid-connected in 2023. Nevertheless, gravity-based foundations are expected to play a minor role compared to monopiles and jackets. Meanwhile, MAKE expects the developers to seize their application of tripod foundations. Furthermore, floating foundations will also start to play a role towards 2030.

Figure 4. Developments in project size, water depth and foundation technology in Europe, 2010 to 2021e



Note: Based on grid-connected capacity.
Source: MAKE

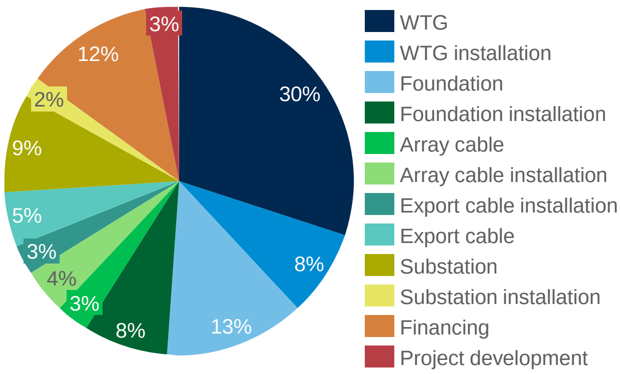
MAKE expects these developments to continue in the future. The next major technological development will be the transition from 33kV inter array cables to 66kV, which is already planned for the Danish Nearshore test site, Nissum Bredning, as well as the Dutch offshore tenders.

1.3 Costs and investments in offshore wind

Major offshore wind components

Figure 5 illustrates the main components of an offshore wind farm and how much of the total project costs these components constitute. However, as illustrated in the previous chapter, the area characteristics and applied technology vary significantly from project to project, meaning that the relative share of each component will vary accordingly. An increase in distance to shore will, for example, have a larger impact on cable costs than foundation and turbine costs. Hence, the split presented in Figure 5 is merely indicative. Furthermore, the total costs per MW of 4.2 million euro per MW also vary considerably across sites. The UK project, Beatrice, and the Danish project, Horns Rev 3, illustrate this variation. Both of these projects achieved final investment decision in Q2-2016. However, the total costs of these projects vary by 2.8 million euro per MW, as Horns Rev 3's costs are estimated at 2.9 million euro per MW and Beatrice's total costs are estimated at 5.7 million euro per MW.

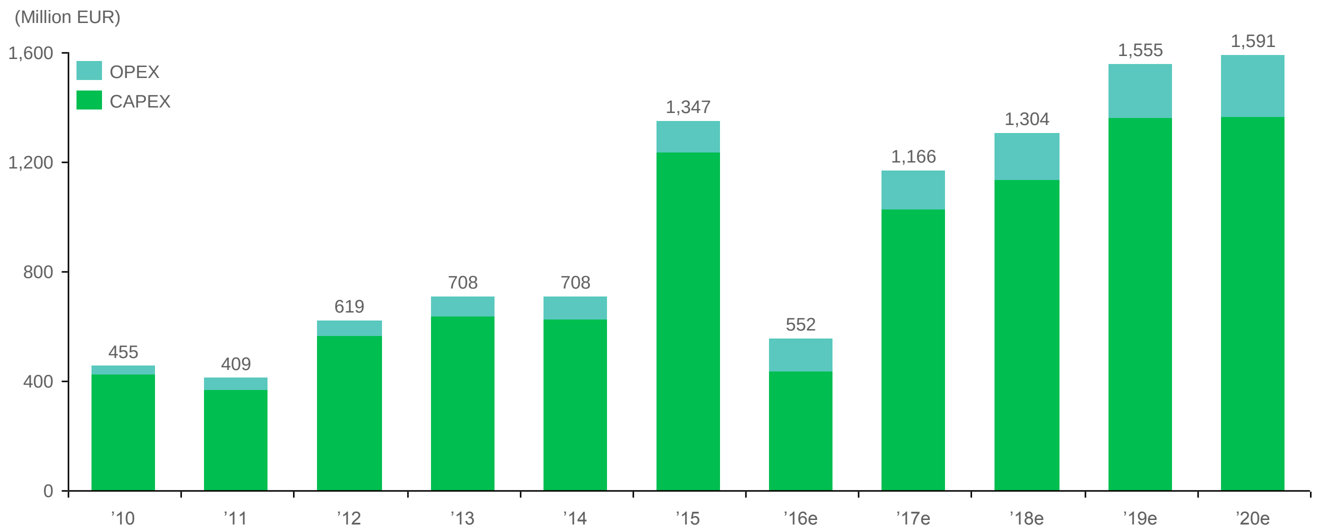
Figure 5. CAPEX split of offshore wind components



Source: MAKE

Increases in project size and complexity have led to increased CAPEX levels since the early 2000s. In 2003, 72 turbines were installed for the Nysted project in Denmark in water depths ranging between 6 and 9 meters and located 11km from shore. And in 2004, the 60MW Scroby Sands project was inaugurated and included 30 turbines with ratings of 2MW. The turbines were installed in water depths of up to 8 meters and only a couple of kilometres offshore. The associated CAPEX levels were around 2 million EUR per MW. Since then, in an attempt to take advantage of stronger winds further offshore, projects have moved further from shore and into deeper waters. This has resulted in enhanced CAPEX levels, driven partly by larger foundations and more complex logistics and transmission solutions. In the coming years, CAPEX per MW is expected to fall. Despite the trend toward increased CAPEX, it is important to emphasize that total lifecycle costs have dropped in recent years. This is due to increased output from larger turbines.

Figure 6. CAPEX investments in new projects and OPEX in Europe, 2010 to 2020e



Note: CAPEX calculated based on annual grid connection and OPEX is calculated based on accumulated grid connected projects.
Source: MAKE

Investments are set to peak in 2016, as project developers are striving to reach construction milestones in order to utilize their CfD support. Meanwhile, German developers aim to qualify for current support schemes before tender systems are implemented for projects to be commissioned in 2021.

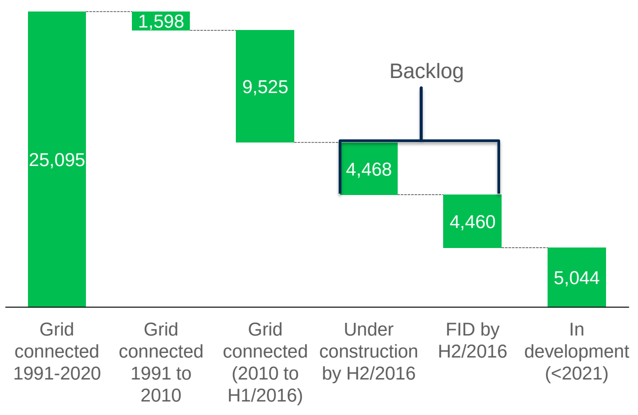
2 Overview of Norwegian companies

2.1 Market shares of major value chain segments

Between 2010 and the end of the first half of 2016, 47 offshore wind projects with a total capacity of 9.5 GW were fully grid-connected in Europe. Furthermore, almost 9 GW are currently under construction or have secured final investment decision and will in this report be referred to as backlog. Within the backlog, many contracts have already been awarded to suppliers. Therefore, the backlog is an important tool to understand both the current situation of Norwegian companies as well as short- to medium term opportunities.

Accordingly, the following sections will illustrate the market share of the major offshore wind segments identified in section 1 both in relation to track record and backlog.

Figure 7. Offshore wind connected to the grid, 1991 to 2020



Based on grid-connected capacity.
Source: MAKE

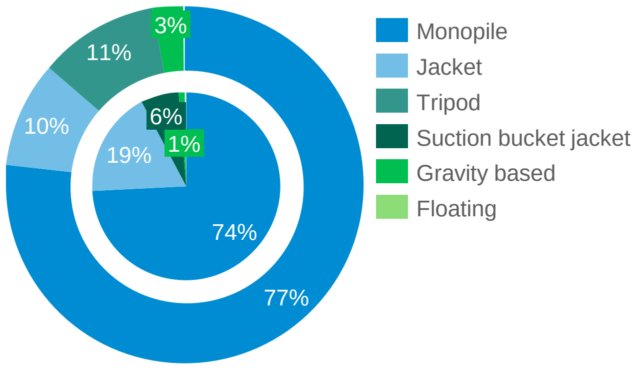
Turbines

The offshore original equipment manufacturer market is characterised by few players, with Siemens being the most dominant. All of these original equipment manufacturers (Adwen, Senvion, Bard, MHI Vestas and Siemens), have or had manufacturing facilities in Germany, Denmark and/or UK but no facilities in Norway. Furthermore, no major subcomponents (i.e., controls, converters, rings, shafts, pitch and yaw bearing, main bearing, tower, generator, gearboxes, blades, or nacelle assembly), have been produced in Norway in the past six years except Global Castings, which had production capacity for castings. However, this production facility was shut down in 2014.

In relation to lower tier suppliers, the Norwegian facilities of ABB, 3B, Dokka Fasteners and Øglænd System are worth mentioning as they supply medium-voltage switch gears for turbines, glass fibre for blades, specialized bolts and screws for turbine manufacturers and cable ladders, respectively.

In sum, Norwegian companies has no experience in turbine supply per se, but has had some sub deliveries to international turbine supply as mentioned.

Figure 8. Foundation types



Note: Track record for projects fully grid connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Foundations

Kvaerner Verdal has supplied components to jacket and tripod foundations, which constitute 10% and 11%, respectively, of the total foundations supplied between 2010 and the first half of 2016. Within the tripod segment, Kvaerner Verdal only had 3% of the total supply, which is shown in Figure 9. Moreover, as there are no tripod foundations in the backlog, the tripod segment is not attractive.

Norway's position in the floating wind segment

Norway has been active in the development of floating wind foundations from the very beginning of the industry due to Norway's deep waters. In fact, Statoil's Hywind I, which was connected to the Norwegian grid in 2009, was the first floating turbine to be installed offshore. Hywind I has performed beyond expectations and Statoil is currently working on Hywind II, which is expected to be grid-connected to the UK grid in 2017. This will make it the first multi-unit floating project. Thus, Statoil has entered the nascent floating foundation industry.

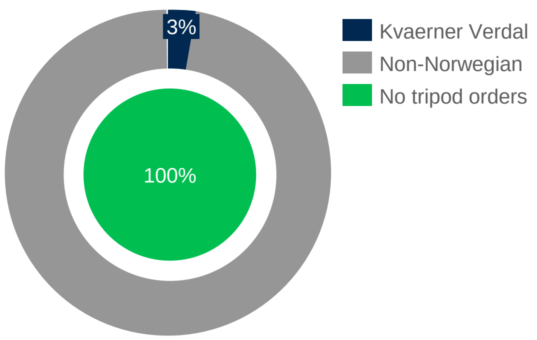
The floating foundation industry is fragmented, and new concepts are constantly being introduced by new suppliers while others fail to take their concepts further. The Norwegian company, Sway is an example of this. Sway managed to install a scaled version of their floating foundation concept in 2012, but has since had difficulties in taking their concept further.

In terms of track record, Kvaerner Verdal is well positioned in the jacket foundation market for offshore wind. Contrary to the tripod market, the jacket segment is expected to grow in the coming years. Moreover, the fact that the jacket contracts are split between multiple suppliers for single projects, suggests that there is room for new entrants in this segment. However, Norwegian companies have no backlog within the jacket segment and Kvaerner Verdal's decision to not actively pursue contracts within the offshore wind segment also limits Norwegian companies' prospects going forward within this segment.

In regards to foundation design, the Norwegian company OWEC Tower has designed the jacket foundations for two commercial projects and two demonstration projects which constitutes almost 500 MW. However, since 2013, OWEC Tower has failed to secure orders in the offshore wind industry.

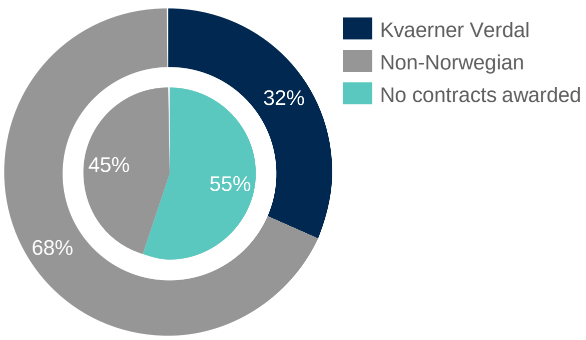
In summary, Norwegian companies have historically been well positioned in the jacket foundation segment both in relation to supply and design. Nevertheless, as jackets only constitute 10% of the total foundation market, Norwegian companies only have a total market share in the foundation segment of 3% and no current backlog.

Figure 9. Tripod supply



Note: Track record for projects fully grid connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Figure 10. Jacket supply



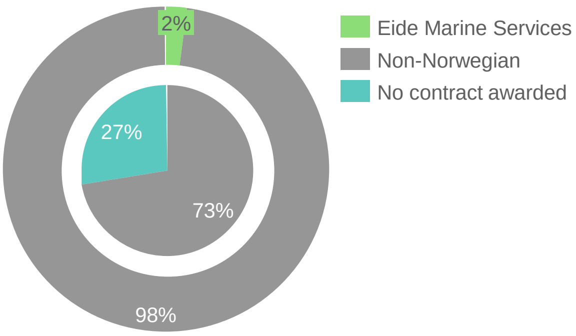
Note: Track record for projects fully grid connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Turbine and foundation installation

From Figure 11 we see that Eide Marine Services is the only company who has been installing foundations. All of these deliveries were gravity-based foundations. As illustrated in Figure 8, there are currently no gravity-based foundations in the backlog and hence, the outlook for Eide Marine Services in the foundation installation segment is rather bleak which is mirrored in the lack of backlog

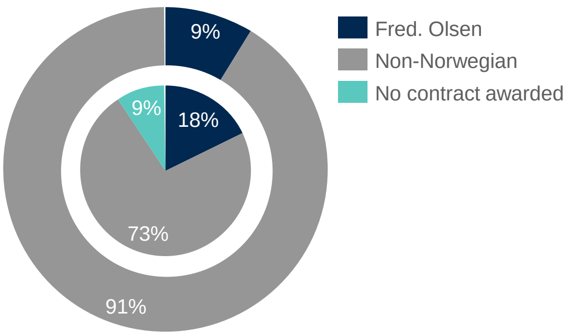
In contrast, Norwegian companies are in a more favourable position in the turbine installation segment as Fred. Olsen Windcarrier (Fred. Olsen) had a share of the turbine installation market of 9% between 2010 and the first half of 2016 with their two jack-up vessels Brave Tern and Bold Tern. Fred. Olsen's positive situation is set to improve as they currently have a 18% market share of 18 percent of the total backlog.

Figure 11. Foundation installation



Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Figure 12. Turbine installation



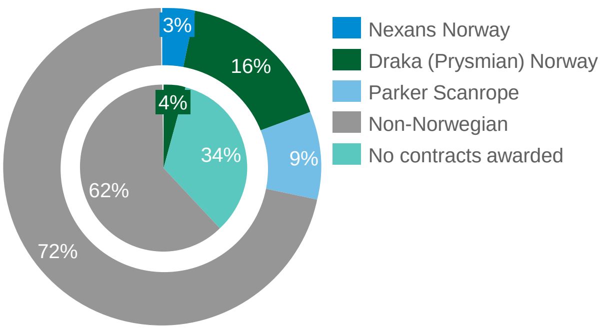
Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Cable supply

The Norwegian subsidiaries of Nexans, Parker Scanrope and Draka (Prysmian) manufactured almost one third of all the inter-array cables for offshore wind farms from 2010 to first half of 2016. However, Norwegian inter-array cable manufacturers have only managed to secure a more modest 4% of the orders with installation to 2020.

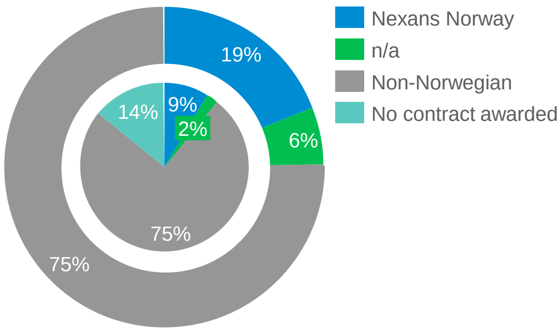
Nexans is the only export cable manufacturer with facilities in Norway that has both a track record and a secured backlog. The company manufactured one fifth of the export cables for offshore wind from 2010 to the first half of 2016 and has a 9% share of the market backlog.

Figure 13. Inter-array cables supply



Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Figure 14. Export cables supply



Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

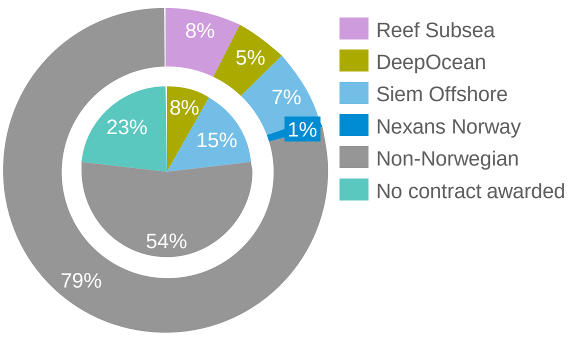
Cable installation

Historically, Norwegian companies have held a good position in the inter-array cable installation market. Despite Reef Subsea going bankrupt, the Norwegian companies are set to maintain this favourable position as DeepOcean and, especially, Siem Offshore are set to improve their position and thereby compensate for the loss in market share caused by Reef Subsea's exit.

Norwegian companies' presence in the export cable installation segment has been limited historically, but is said to improve through Siem Offshore's entry and DeepOcean's improved position which has given them a combined market share of 19% of the current backlog.

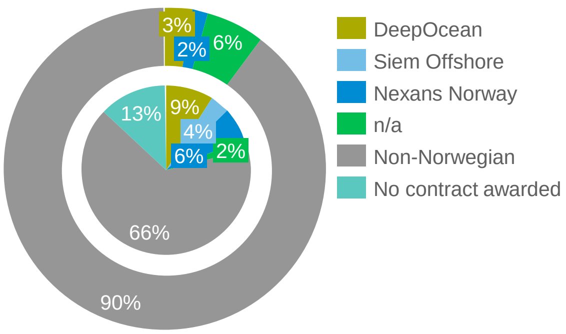
In addition, specialty cable protection supplier, Seaproof Solutions, has carved a position in that sub-segment of cable installation.

Figure 15. Inter-array cable installers



Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity. Source: MAKE

Figure 16. Export cable installers



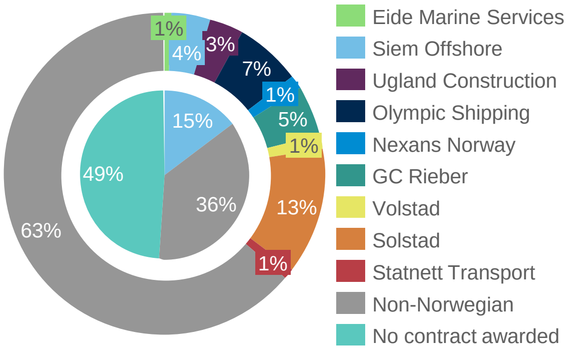
Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity. Source: MAKE

Cable vessel suppliers

Historically, Norwegian cable vessel suppliers have had a strong position as illustrated in figure 17. Nine Norwegian companies supplied cable vessels to inter array cable installers between 2010 and the first half of 2016, which constituted 37% of the market. So far, Siem Offshore is the only Norwegian supplier who has managed to secure a backlog. Siem Offshore's backlog gives Norwegian companies a 15% market share of the total backlog, which is a significant drop from the historical market share of 37%.

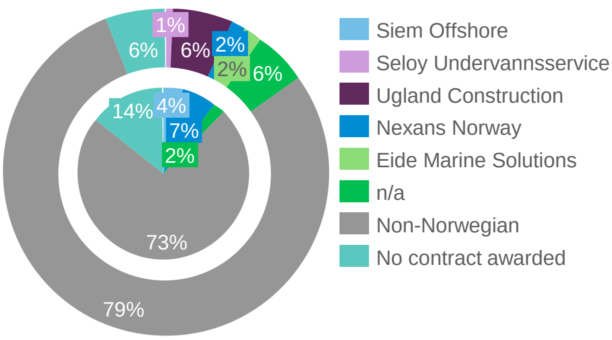
The development of the export cable vessel supply segment is more stable, albeit at a significantly lower starting point as Norwegian suppliers had a market share of 11% in the period 2010 and the first half of H1/2016.

Figure 17. Inter array cable vessel suppliers



Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity. Source: MAKE

Figure 18. Export cable vessel suppliers

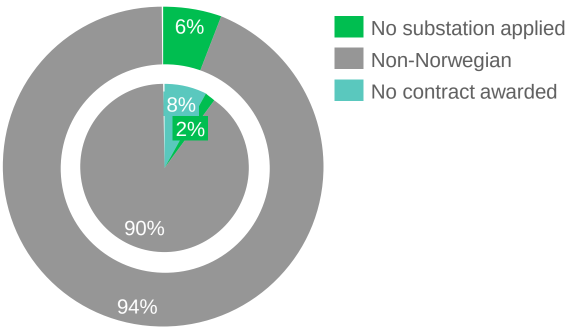


Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity. Source: MAKE

Substation supply

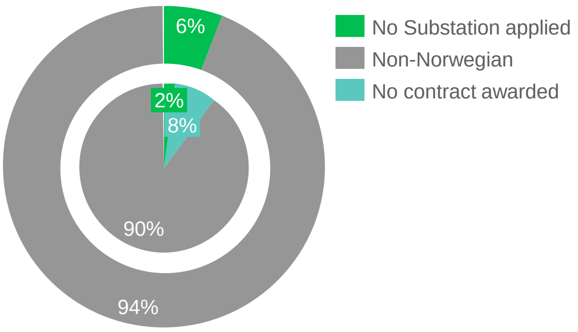
Norwegian companies have neither a track record nor a backlog in HVAC substation topside and foundation supply. However, Norwegian Aibel has been active in the HVDC substation segment. The company was contracted to construct the HVDC substation, Dolwin Beta. Aibel subcontracted the actual construction to Drydocks World in Dubai, but provided the auxiliary systems themselves in Norway. Aibel is the only Norwegian company pursuing contracts in the substation segment, but is without a secured backlog for the next years.

Figure 19. HVAC substation topside supply



Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Figure 20. HVAC substation foundation supply

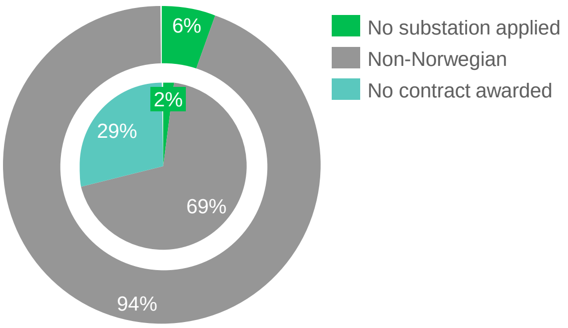


Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Substation installation

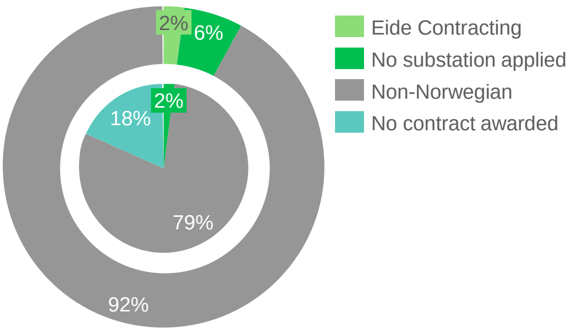
Eide Marine Services installed almost 500MW of gravity-based foundations for substations. However, as with the turbine foundations, gravity-based foundations for substations have failed to compete with monopiles and jackets. Norwegian companies have not engaged in topside installation yet.

Figure 21. Substation topside installation



Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

Figure 22. Substation foundation installation



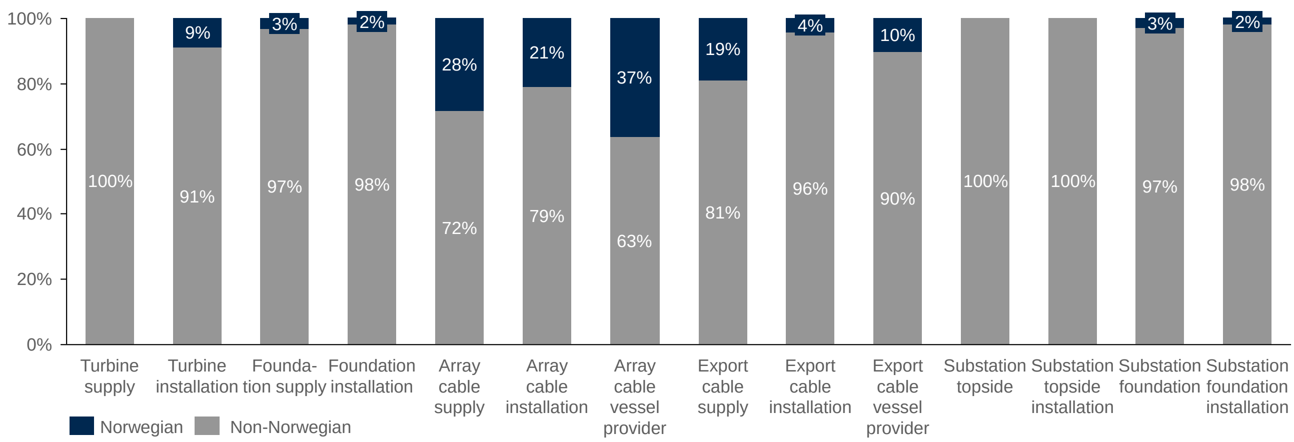
Note: Track record for projects fully grid-connected 2010-H1/2016 (outer circle) and backlog H2/2016-2020 (inner circle). Based on grid-connected capacity.
Source: MAKE

2.2 Norwegian market share of major segments

The conclusions in section 2.1 are summarized in Figures 24 and 25 in order to provide an overview of the current situation of Norwegian companies in the major offshore wind segments.

From figures 24 and 25, we see that Norwegian companies are well established within the cable segments and turbine installation segments. Moreover, Norwegian companies are also active in the operations and maintenance segments, especially in terms of vessel supply. Lastly, Norwegian shipyards are building vessels for the cable and operations and maintenance segments. Contrarily, Norwegian companies are currently less established in the foundation and substation segments as well as turbine supply.

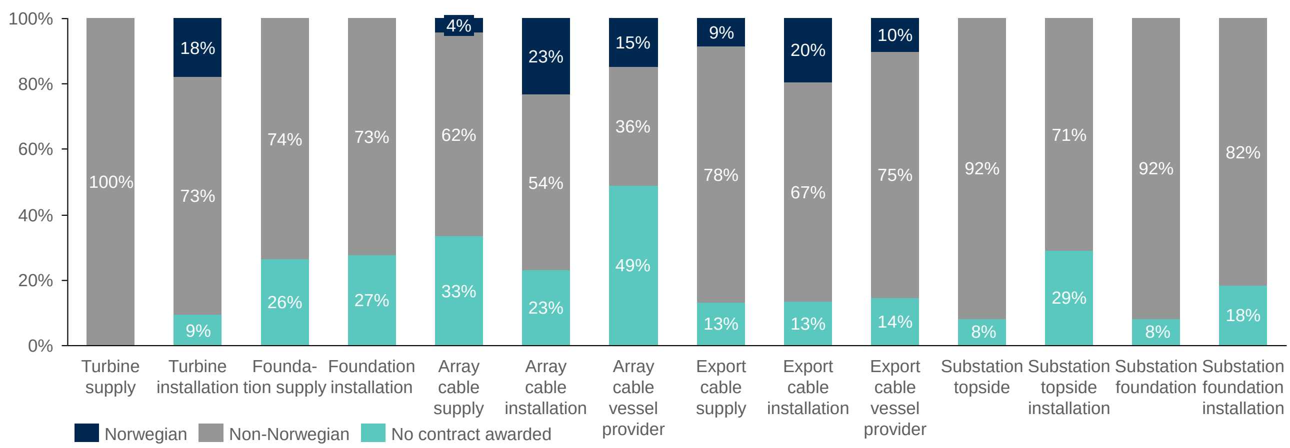
Figure 23. Norwegian market share by track record, 2010 to H1/2016



Note: Based on projects fully grid-connected by 2010-H1/2016.
Source: MAKE

Within the backlogs, there are still contracts that are yet to be awarded as illustrated in figure 24. This is most prominent in the array cable- and foundation segments. Besides the projects in the backlog, there are still 5 GW contracts that needs to reach FID and be fully grid connected before 2020 that is also yet to be awarded. The following chapter will address the future opportunities in these segments for Norwegian companies.

Figure 24. Norwegian market share on backlog, H2/2016 to 2020



Note: Based on projects under construction or with final investment decision by H2/2016-2020. Based on grid-connected capacity.
Source: MAKE

3 Opportunities for Norwegian companies

Pressure to bring down cost

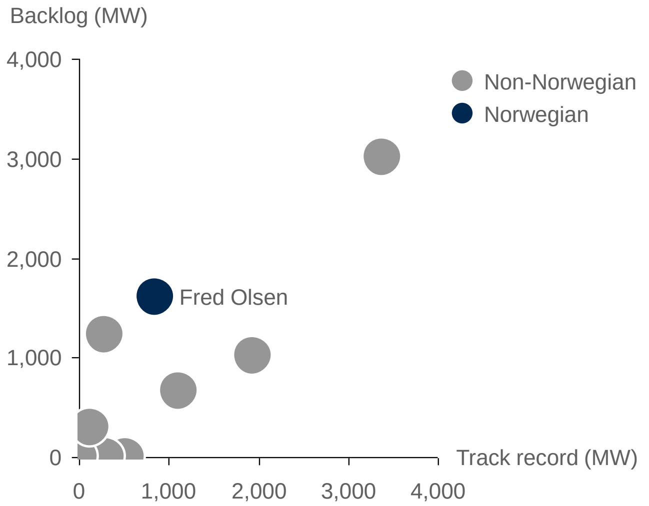
There is major pressure to bring down the costs of offshore wind, which reverberates through the entire supply chain. This pressure comes from governments, competing renewable energy sources and the offshore wind industry itself. DONG Energy's recently accepted bid of 72.7 EUR/MWh for the Dutch Borssele tender illustrates the potential for cost reduction going forward. The following assessment of opportunities for Norwegian companies will focus on Norwegian companies' opportunities within the defined major segments, based on current offerings.

Turbine installation

Fred. Olsen is currently the most successful Norwegian supplier in the offshore wind segment. Fred. Olsen is positioned well in the turbine installation segment, with a solid track record as well as a strong backlog as illustrated in figure 26. Furthermore, with the upgrades of Brave Tern in the start of 2016, this vessel will have the highest hook height in the market as illustrated in figure 27. Fred. Olsen's second vessel, Bold Tern, is also set to undergo the same upgrades. The strength of Fred. Olsen's vessels coupled with their backlog implicates that Fred. Olsen will continue to be competitive in the future and seize the opportunities in the growing offshore wind market.

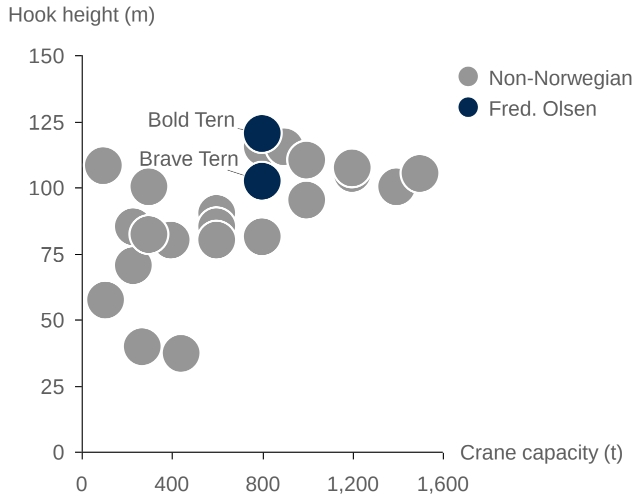
Fleet expansion is currently not a large concern for incumbent companies. This reality, combined with high turbine vessel requirements, suggest that the turbine installation segment offers limited opportunities for new Norwegian companies. Thus, the turbine installation segment holds great potential for Fred. Olsen, but rather limited opportunities for new players.

Figure 25. Turbine installation market position



Note: Based on turbine installation companies with track record and/or backlog. Based on grid-connected capacity.
Source: MAKE

Figure 26. Turbine installation capabilities



Note: Based on turbine installation vessels with track record and/or backlog. Based on grid-connected capacity.
Source: MAKE

Foundations

Currently, no Norwegian company has a foundation backlog for a commercial project. Nevertheless, untill 2020, there might be opportunities for Norwegian suppliers of jackets as this market is growing and requires comparatively less manufacturing investments compared to monopiles

In the longer term, more innovative Norwegian foundation concepts could start to play a role. In this context, Seatower's crane-free gravity-based foundations and Universal Foundation's mono-bucket concept offers the greatest opportunities among Norwegian companies. Seatower's gravity based floating structure was applied for a met mast in France and Universal Foundation's concept was tested in a Carbon Trust programme in 2014 and is chosen for the Lake Erie project developed by Fred. Olsen in the US.

Floating wind technology is expected to gain traction in the latter half of the 2020s. Until then the only multi-turbine floating projects in the pipeline are the Statoil's Hywind II and the four projects with a total of 100MW in France. However, as local content is a significant criterion for the French projects, it is unlikely that Norwegian companies will play a part in these tenders. Moreover, the floating wind industry is still fragmented due to its early stage of development. This implicates that new concepts will emerge and challenge Hywind, especially from Japan and France, but also from Norway where Dr.Techn. Olav Olsen have developed a floating foundation concept in a collaboration with Aibel. Nevertheless, Hywind will continue to be one of the most tested floating technologies into the early 2020s. The advantageous position of Hywind could also benefit Norwegian sub-suppliers. As an example, Statoil has awarded the Norwegian arm of Technip a contract at Hywind, which includes transportation of substructures for the floating wind farm, preparation for installation of top sections and generators.

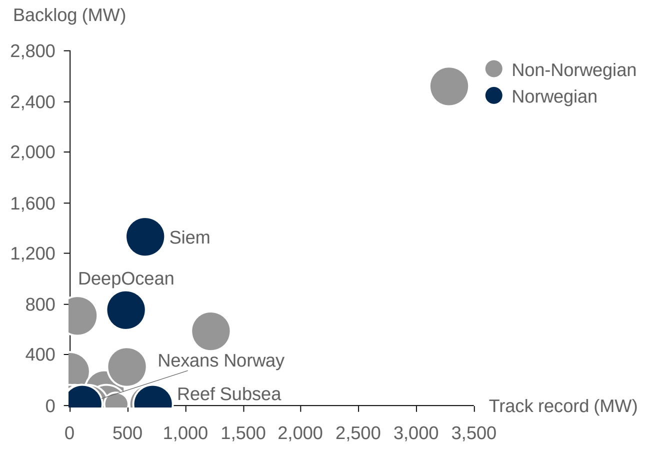
Cable installation

Based on Figures 28 and 29, we see that both the inter array and export cable installation segments are characterised by a clear market leader and many small players. Even with the bankruptcy of Reef Subsea, Norwegian companies are still well positioned in the medium term through DeepOcean and Siem Offshore as illustrated in figures 15 and 16. This year Siem Offshore added the purpose-built cable lay vessel, Siem Aimery, to its fleet. Siem Aimery is a valuable asset, which can already be seen in the backlog. The vessel will continue to be competitive in the cable installation segment beyond 2020. Unlike Siem Offshore, DeepOcean utilizes long-term charters of Maersk Supply Services to operate the purpose-built cable lay vessel, Maersk Connector. Through Maersk Connector, DeepOcean will be able to increase its market share in the cable installation segment.

Siem Offshore has a stronger backlog than DeepOcean in the inter array cable installation segment, but DeepOcean has a stronger backlog in the export cable installation segment. MAKE expects this pattern to continue in the future, as Maersk Connector, through its ability to go nearshore and its 7,000t turntable, is more suitable for export cable installation. Moreover, Siem Offshore and DeepOcean's acquisition of purpose-built vessels are in accordance with the overall cable installation transition from multipurpose vessels towards purpose-built vessels as illustrated in Figure 30.

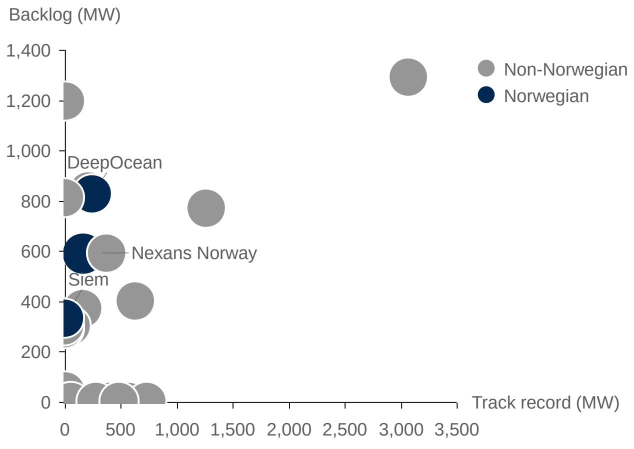
Thus, MAKE believe there is good chance of improving the role of Norwegian companies both in the export and inter array cable installation segments, largely driven by the capabilities of Siem Offshore and DeepOcean and their new vessels.

Figure 27. Inter array cable installers



Note: Based on inter array cable installation companies with track record and/or backlog. Based on grid-connected capacity.
Source: MAKE

Figure 28. Export cable installers



Note: Based on export cable installation companies with track record and/or backlog. Based on grid-connected capacity.
Source: MAKE

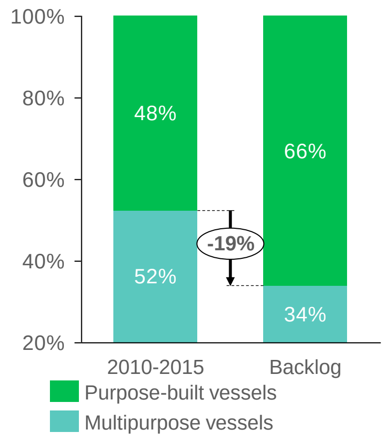
Cable vessel suppliers

The trend towards purpose-built vessels is disadvantageous for Norwegian vessel suppliers as 92% of the Norwegian vessels with a track record, and/or with a backlog, are multipurpose vessels. The negative trend is evident in Figures 31 and 32, as they illustrate that seven Norwegian vessel suppliers with a track record have failed to secure future orders. This is echoed in the overall market shares of Norwegian companies as there is an overall decrease in the inter array cable vessel supply segment of 22% between track record and backlog. However, Norwegian companies' market share in the export cable segment is unchanged despite Ugland Construction, Seloy Undervansservice and Eide Marine Solutions failing to secure a backlog because Siem Offshore has entered the market and Nexans Norway has increased their market share.

The cable vessel supply segment has the lowest proportion of awarded contracts which by itself implies many opportunities. However as VBMS is the installer of almost half of these it is unlikely that a Norwegian company will win these as VBMS has a close relationship with Stemat Marine Services.

Another important factor in the cable vessel supply segment is that the Norwegian shipping companies are currently restructuring their balance sheets due to the low price on oil. So far, this has affected Solstad, but other Norwegian shipping companies could also be affected by this either through consolidation or bankruptcy. Such consolidation adds further uncertainty to the future of the Norwegian vessel owners and their role in the offshore wind industry.

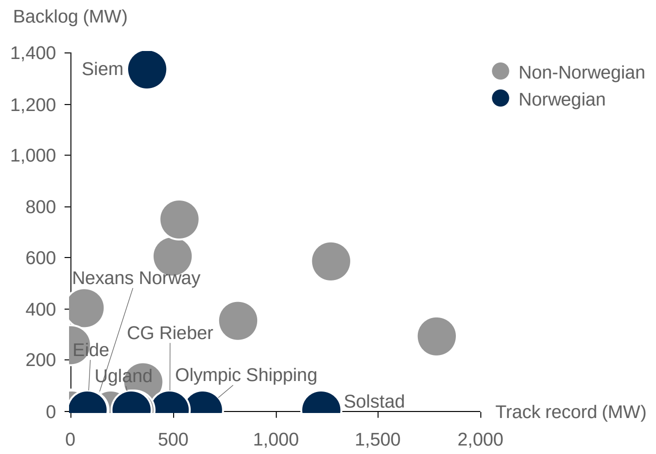
Figure 29. Cable vessel supply mix



Note: Backlog consists of firm orders and orders under construction for both inter array and export cable vessels in the period 2016-2020.
Source: MAKE

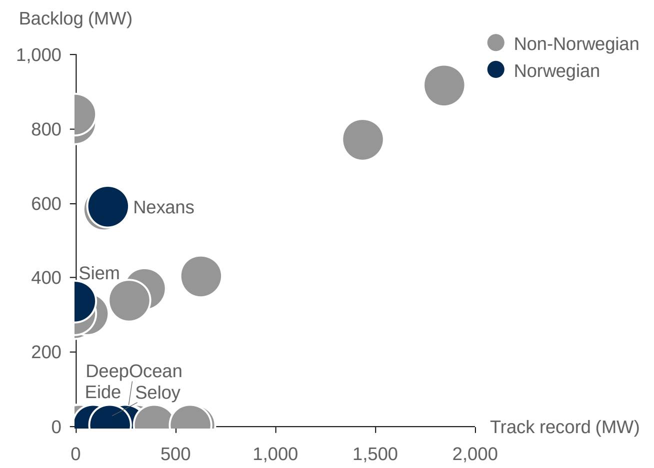
In sum, despite an overall a negative trend in terms of market share for Norwegian companies in the cable vessel supply segment, opportunities still exist within the cable vessel supply segments. However, MAKE expect fewer Norwegian cable vessel supply companies to be active within this segment.

Figure 30. Array cable vessel suppliers



Note: Based on array cable vessel providers with a track record and/or backlog. Based on grid-connected capacity.
Source: MAKE

Figure 31. Export cable vessel suppliers



Note: Based on export vessel providers with a track record and/or backlog. Based on grid-connected capacity.
Source: MAKE

Cable supply

Norwegian cable manufacturers have experienced an overall drop of market share in both the inter-array and export cables segments going forward, as illustrated in figures 13 and 14. This is however also affected by the exit of Parker Scanrope from the inter-array cable segment. Parker Scanrope had a 9% share of the market.

A longer term issue for Norwegian inter-array cable manufacturers is the technological transition from 33kV to 66kV cables as Norwegian inter-array cable manufacturers are currently not producing 66kV. The first 66kV cables are expected to be installed already in 2017 and the transition is expected in the years to come, albeit in a moderate pace which means that the vast majority of projects in the years until 2020 will continue to apply the 33kV cables. Thus, beyond 2020 this transition could be a threat if the Norwegian cable factories do not acquire the necessary capabilities to produce 66 kV cables. Nexans will produce its 66kV cables for the Blyth demonstration project in Hannover, Germany.

As Nexans is the only Norwegian company active in the export cable segment, the decrease in market shares is naturally linked to Nexans Norway. The company has not been active in the export cable market in the past couple of years. However, by securing an order for the Beatrice project in the UK, which has a total capacity of almost 600 MW, Nexans Norway manifested itself as a significant player in the export cable segment.

Substation engineering

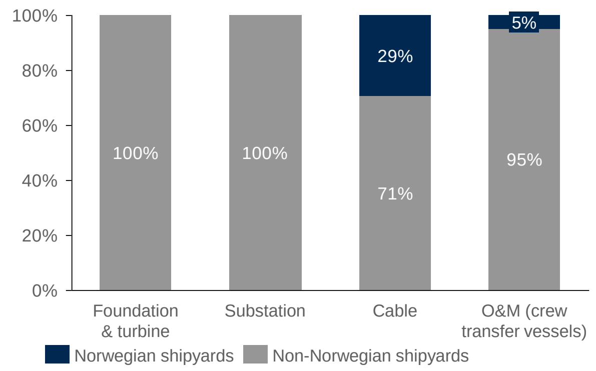
Even though Norwegian companies have only been directly involved in substation supply to a limited degree, there could still be options within this segment going forward. Norwegian companies have extensive experience in designing substations for the oil and gas industry. This experience can be leveraged within the offshore wind industry as well. As an example, the Norwegian company Head Energy specializes in providing engineering and consultancy services for the oil and gas industry as well as for the offshore wind industry. Head Energy has recently entered into a 5-year framework agreement with the leading offshore wind developer, DONG Energy, to provide personnel within substation engineering and electrical systems engineering. Consequently, one third of Head Energy's total revenues in 2015 came from the offshore wind segment.

Shipyards

Through Norway's strong position within the oil and gas industry, Norway has acquired maritime competencies and a strong fleet. In the offshore wind industry, Norwegian shipyards have been able to leverage these capabilities to the operations and maintenance, and cable vessel segments as illustrated in figure 33.

Almost 90% of the cable vessels built in Norwegian shipyards are multipurpose vessels. As the name suggest, multipurpose vessels can perform multiple tasks within both the offshore wind and oil and gas industries. Multipurpose vessels can easily equip portable turntables, which allows them to install cables for offshore wind farms. This is however a challenge because there is a growing preference for purpose-built vessels as illustrated in figure 30.

Figure 32. Installation vessel builders



Note: Based on total number of vessels in each segment with a track record and/or backlog.
Source: MAKE, Export Credit Norway

Norwegian shipyards have also manufactured vessels for operations and maintenance purposes in offshore wind. Approximately 5% of the crew transfer vessels servicing offshore wind have been manufactured at Norwegian shipyards. Furthermore, the Norwegian shipyards Fjellstrand, Ulstein and Havyard have manufactured service operations vessels for the offshore wind operations and maintenance segment. Moreover, Fjellstrand and Umoe have manufactured SWATHs and WaveCrafts, respectively.

Norwegian companies have potential for delivering sub supplies to the operations and maintenance segment in the coming years. Uptime International has delivered active heave compensated gangways for operations and maintenance vessels with the purpose to ensure safe transfer of personnel to wind farms even in extreme weather conditions and is now a leading supplier of gangways for the offshore wind segment. Recently, the Norwegian subsidiary of MacGregor have also entered the markets for motion compensated gangways as well as cranes for the offshore wind vessels.

Operations and maintenance

Norwegian companies are well positioned in the manufacturing and supply of vessels for the growing operations and maintenance market.

From a base in Denmark, Fred. Olsen offers crew transfer vessels for the operations and maintenance service providers and owns a majority of Global Wind Service, which, in turn, executes contracts for both onshore and offshore wind. Moreover, Umoe Wind and Odfjell also provide vessels for offshore wind operations and maintenance service providers. There is a growing demand for larger and faster crew transfer and service operations vessels in the coming years due to offshore windfarms moving further away from shore. Norwegian companies are already working on meeting these demands and MAKE expects Norwegian vessel owners to play a significant role in the years to come, particularly in the SOV market.

Norwegian companies are less active in providing operations and maintenance services than providing vessels. However, with Norsea Group's acquisition of Danbor, and recently, Øer, in Denmark, the company is now strongly positioned in the segment for provision of manpower for offshore operations and maintenance service as well as the installation markets. Nevertheless, MAKE expects that Norwegian companies will continue to be strong in relation to provision of vessels for operations and maintenance as opposed to performing the operations and maintenance services.

4 Summary

The limits of offshore wind have been pushed since the first offshore wind turbine was erected in 1992 and the industry will continue to do so in the years to come. Consequently, the area characteristics of offshore wind turbines have changed and so has the supply chain. This has led to opportunities for new players to enter the market, new technologies and processes to be developed and old technologies to be replaced. Some Norwegian suppliers have succeeded in exploiting these market dynamics, while others have been negatively impacted. Norwegian companies have proved to be competent in the turbine installation, operations and maintenance, shipyards and cable segments, but have so far failed to significantly establish themselves in the turbine supply as well as the foundation and substation segments. Figures 34-36 provide an overview of Norwegian companies' current market position and opportunities in offshore wind.

Norwegian companies have not supplied, nor sub-supplied turbines. However, historically, Norwegian lower tiered sub-suppliers to turbine suppliers have successfully found niches. Export Credit Norway estimates that Norwegian turbine sub-suppliers' export supplied roughly 65 million euro in 2015 to the offshore- and onshore wind industry. Norwegian companies are expected to continue to be present in these lower tiered turbine supply segments going forward.

Fred. Olsen's strong position in the turbine installation market is expected to improve in the coming years due to the company's recent and ongoing upgrades of its two sister vessels Bold Tern and Brave Tern. This trend is expected to continue in the coming years. However, Norwegian companies' limited activity in turbine- and substation foundation installation is expected to deteriorate further as demand for gravity-based foundations is decreasing.

The turbine jacket foundation market has not yet matured and the market is set to almost double over the coming four years. Thus, the jacket foundation for turbines offer opportunities for Norwegian construction yards. In addition to the jacket designer, Owec Tower, so far, only Kvaerner Verdal has successfully entered this market. As Kvaerner Verdal is no longer active in the turbine jacket market, it will require new Norwegian companies to enter this market or Kvaerner Verdal to re-enter the segment in order for Norwegian companies to play a significant role in this segment before 2020.

Norwegian shipyards have historically been strongest within the cable vessel market. However, due to changes in preferences, this position is expected to deteriorate. However, in recent years Norwegian shipyards have developed and built innovative vessels for the O&M segment. These vessels are meeting requirements for longer operations, increased distance to shore and harsh weather conditions.

Figure 33. Market position and opportunities of major segments (1/3)

	Turbine supply	Tier 3 and below turbine supply	Turbine installation	Foundation supply	Foundation installation	Shipyard
Current market position	○	◔	◑	◔	◔	◑
Opportunities	○	◔	◕	◔	○	◑

Note: Based on export sales related to track record and backlog
Source: MAKE

Both the Norwegian export and inter-array cable manufacturers are losing market shares. Nevertheless, with Nexans Norway's and Prysmian (Draka) Norway's recent activity, the cable supply segments are expected to continue to benefit Norway towards 2020.

Many Norwegian companies have been active in the cable installation and cable vessel supply segments. Their success have partly been driven by their ability to adapt their multipurpose vessels to these segments. However, the Norwegian cable vessel owners' strong positions in both the export- and inter array cable segments are expected to be challenged due to restructuring of balance sheets and demand for more efficient purpose-built vessels. In contrast, Norwegian companies' position in the export cable installation segment is set to improve due to DeepOcean and Siem Offshore's strengthened fleets. Despite the bankruptcy of Reef Subsea, the strong position of Norwegian companies in the inter array cable installation segment is expected to be maintained through DeepOcean and Siem Offshore.

Figure 34. Market position and opportunities of major segments (2/3)

	Array cable supply	Array cable installation	Array cable vessel provider	Export cable supply	Export cable installation	Export cable vessel provider
Current market position	◕	◑	●	◑	◔	◑
Opportunities	◔	◑	◑	◔	◑	◔

Note: Based on export sales related to track record and backlog
Source: MAKE

No Norwegian companies perform substation topside installation, as there is no Norwegian vessels able to carry the heavy weights. While Norwegian companies have not manufactured HVAC substation- topsides or foundations, Aibel has been manufacturing HVDC substation. With their background in offshore O&G, Norwegian companies are expected to be capable of offering engineering and consulting services related to the substation segment in the future.

Within the operations and maintenance segment, Norwegian companies look particularly strong when it comes to providing vessels for operations and maintenance service providers. The operations and maintenance vessel providers offer both small crew transfer vessels and larger and stronger vessels and the latter are expected to be applied to a larger extent in the future as wind farms move further away from shore. Thus, the operations and maintenance segments offer great opportunities for Norwegian vessel owners.

Figure 35. Market position and opportunities of major segments (3/3)

	Substation topside	Substation topside installation	Substation foundation	Substation foundation installation	Operations and maintenance service	Operations and maintenance vessels
Current market position	○	○	○	◔	○	◑
Opportunities	○	○	○	○	◔	◕

Note: Based on export sales related to track record and backlog
Source: MAKE

In conclusion, Export Credit Norway estimates that Norwegian company's total international sales to the offshore wind industry was 400-480 million euros in 2015, excluding DNV GL, with Siem Offshore and Fred. Olsen constituting roughly half of the total sales. The success of Siem Offshore and Fred. Olsen proves that large capital investments are required to be competitive in the offshore wind industry as the pressure to lower costs and competition is only increasing. However, as the offshore wind industry continues to grow and push its limits, new opportunities could continue to emerge for Norwegian suppliers in the future.

5 Appendix

Figure 36. Norwegian companies in offshore wind

Norwegian suppliers for major offshore segments		Norwegian sub-suppliers
Turbine original equipment manufac-turers	**Export cable suppliers**	Seaproof Solutions
n/a	Nexans (in Norway)	Christian Michelsen Research
Turbine Installers	Prysmian (in Norway)	Dr.techn. Olav Olsen
Fred. Olsen Windcarrier	**Export cable vessel installers**	Øglænd System Gruppen
Foundation suppliers	DeepOcean	3B
Kvaerner Verdal	Siem Offshore	Dokka Fasteners
Foundation installers	**Export cable vessel owners**	Global Castings
Eide Contracting	Siem Offshore	Havila Shipping
Inter array cable suppliers	Seloy Undervannsservice	Head Energy
Nexans (in Norway)	Ugland Construction	Uptime International
Prysmian (in Norway)	Eide Marine Solutions	SINTEF Energi
Inter array cable installers	**Substation topside supplier**	AAK Energy Services
Reef Subsea (bankrupt)	n/a	StormGeo
DeepOcean	**Substation topside installation**	Automasjon & Data
Siem Offshore	n/a	TP shipping
Inter array cable vessel owners	**Substation foundation supplier**	Wirescan
Siem Offshore	Kvaerner Verdal	MacGregor
Olympic Shipping	**Substation foundation installation**	Einar Øgrey Farsund
GC Rieber	Eide Contracting	Reach Subsea
Volstad	**Operations and maintenance**	Technip
Solstad	Fred. Olsen Wind Carrier	Subsea 7
Statnett Transport	Odfjell Wind	Ernst-B. Johansen
Ugland Construction	Umoe Wind	Kongsberg Digital
Eide Marine Services		Baze Technology

Source: MAKE

List of figures

This report has been produced by Make Consulting for INTPOW, Export Credit Norway and Greater Stavanger.

INTPOW
Norwegian Renewable
Energy Partners

Hoffsveien 23
P.O. Box 631, Skøyen
0214 Oslo, Norway
Phone: +47 21 01 12 90
mail@intpow.com
www.intpow.com
@intpow