Baltic InteGrid

Integrated Baltic Offshore
Wind Electricity Grid Development

Qualified overview paper

Market and supply chain analysis and overview of SME investment opportunities for offshore wind transmission assets in the Baltic Sea Region

October 2018

Interreg
Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Qualified overview paper

Market and supply chain analysis and overview of SME investment opportunities for offshore wind transmission assets in the Baltic Sea Region

Reviewed by Pierre Ståhl (Energikontor Sydost)

By Elizabeth Côté (IKEM) and Kate Miller (IKEM)

Based on inputs from Jan Brauer (Deutsche WindGuard GmbH), Nils Heine (INWL), Michael Holton (IKEM), Anika Nicolaas Ponder (IKEM), Gert Proba (Gesellschaft für Wirtschafts- und Technologieförderung Rostock mbH), Julia Sandén (IKEM), Anna-Kathrin Wallasch (Deutsche WindGuard) and BVG Associates.

Published by: Baltic InteGrid

www.baltic-integrid.eu

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

Contents

List of figures

List of tables

List of abbreviations

BIG	Baltic InteGrid project
BSR	Baltic Sea Region
CCV	Catenary continuous vulcanisation
EEW	Erndtebrücker Eisenwerk
GW	Gigawatt
HVAC	High-voltage alternating current
HVDC	High-voltage direct current
MW	Megawatt
NSW	Norddeutsche Seekabelwerke GmbH
OMS	Operation, maintenance, and service
OWE	Offshore wind energy
OWF	Offshore wind farm
SMEs	Small and medium-sized enterprises
PLB	Post-lay burial
ROV	Remotely operated vehicles
SLB	Simultaneous lay and burial
TSO	Transmission system operators
VCV	Vertical continuous vulcanisation

Summary

Offshore wind capacity in the Baltic Sea Region (BSR) could reach 9.5 GW by 2030.[1] The objective of the Baltic InteGrid (BIG) project is to conduct interdisciplinary research that will promote efficient offshore wind deployment in the region. BIG research explores the framework conditions, opportunities, and barriers relevant to the development of a regional meshed grid. This qualified overview paper summarises four previous BIG reports that cover the market and supply chain for offshore transmission in Europe and the BSR; potential Baltic hubs for offshore grid development; and business opportunities for local small and medium-sized enterprises (SMEs).

Chapter 1 presents findings from the market analysis of the offshore transmission industry. Information on the future component demand and market characteristics, including competitive landscapes, bottlenecks, price and technological trends, and barriers to entry for new manufacturers is provided. The analysis indicates that the high-voltage alternating-current (HVAC) subsea cable market is mature. European suppliers are well established, and no major bottlenecks are anticipated. Future demand is expected to be met by existing suppliers, with an increasing trend towards turnkey solutions. The high-voltage direct-current (HVDC) market is growing due to an increased demand for long-distance transmission. Established manufacturers are expected to meet the demand. Prices are projected to decrease significantly by 2030. OWE converter demand in Europe is driven by the deployment of HVDC technologies. The market is concentrated in the German part of the North Sea and dominated by a limited number of suppliers. The competitive landscape for OWE power transformers is characterised by a few well-established suppliers. This market is expected to grow, and further moderate technological innovations are anticipated; however, prices are projected to remain stable. Tap-changer supply represents a potential bottleneck, as does the supply of copper windings. There is a high level of competition among suppliers of OWE substation foundations, with important players located in the BSR. Some experts forecast an increase in non-European suppliers. No major bottlenecks are anticipated, and foundation prices are expected to decrease. Condition-based maintenance is expected to be provided for AC technologies by the early 2020s and for other system components by 2030. The provision of third-party servicing is forecast to grow; large manufacturers are also expected to market new OMS products more frequently.

The findings of the supply chain analysis are summarised in chapter 2. Subsea cables can only be manufactured in specialised plants. Market entrants face high initial costs (e.g. for building new facilities, recruiting skilled workers, and developing specialised expertise). In addition, technologies in the supply chains for offshore converter, power transformer, and protection equipment are associated with high costs and risk levels that can generally be borne only by large companies. To withstand the harsh conditions in offshore

[1] According to the Baltic InteGrid high scenario.

environments, components must be durable and of high quality; these requirements present further barriers to market entry. Manufacturers of offshore substation foundations tend to be large and have direct access to water. Larger companies seeking to enter the market may benefit from creating subsidiaries and drawing on pre-existing expertise in the field. The OMS sector provides attractive business opportunities for local SMEs that wish to enter the industry.

Chapter 3 presents the results of an assessment of potential Baltic hubs for the manufacture, installation, and maintenance of offshore wind transmission grids; it also identifies port infrastructure requirements. The demand for export cable installation in the BSR is relatively small and likely to be met by existing providers. Some ports may reap benefits from nearby manufacturing facilities or offshore wind farms (OWFs) by providing vessel or storage services. Although the BSR has the capacity to produce substations, local demand for these is low. Supply is thus likely to come from outside the region. Adequate port infrastructure is available for the installation and maintenance of the electrical supply. Specialised substation electrical work could be performed by regional companies. The BIG assessment indicates that publicly owned ports are more likely to accept new industries that provide potential economic benefits to a wider municipal area. Privately owned ports, however, evaluate new activity primarily on financial merit. Barriers to investment include the relatively low demand and lack of certainty associated with the schedule and scope of transmission grid projects. Because OWE development in Germany is expected to exceed that of other countries in the BSR by 2030, German ports offer more opportunities than do those of other Member States.

Chapter 4 outlines conclusions from an assessment of potential business cases for SMEs seeking to enter the OWE transmission industry. An increasing demand was identified for crew and crew transfer vessel services — work that could be performed by local SMEs. On its own, however, the BSR offshore wind transmission market is unlikely to provide many business opportunities due to its limited size and the high level of competition in the industry. The competitive advantage for local SMEs is their proximity to the customer. SMEs looking to enter these highly specialised areas should attempt to recruit experienced individuals from competitors. Partnerships with existing offshore wind suppliers can bolster credibility. There are also opportunities for local SMEs to export goods and services to the wider European market. SMEs can standardise their supply, demonstrate their innovative capacity, and improve cost-efficiency by delivering multiple contracts.

Introduction

Offshore wind energy (OWE) is expected to play an important role in the future European energy mix. In 2017, offshore wind capacity in Europe totalled 15.8 gigawatts (GW), the vast majority of which was installed in the North Sea.[2] With 86 per cent of the total global OWE capacity in its waters, the European Union (EU) is the world leader in OWE deployment. WindEurope estimates that European wind capacity could reach 70 GW by 2030.[3,4] Conditions in the Baltic Sea Region (BSR) are conducive to OWE development. Relative to those of the North Sea, Baltic waters are shallow, with lower wave heights, less pronounced tides, and potential sites closer to shore. These features allow for lower costs of manufacturing, installation, and grid infrastructure.

The objective of the Baltic InteGrid (BIG) project is to conduct interdisciplinary research that will promote potential transnational infrastructure coordination and efficient offshore wind deployment in the BSR. BIG provides stakeholders with the most recent insights into framework conditions for the development of a regional meshed grid. Its research addresses all major fields relevant to OWE infrastructure development and examines the national contexts of each Member State to foster transboundary coordination in the BSR.

Work Package 3 addresses the fields of Policy and Regulation, Market and Supply Chain, Technology and Grid, Environment and Society, and Spatial Planning; it also evaluates the costs and benefits of offshore transmission assets. A high-level concept for the Baltic offshore grid is developed from these analyses. This qualified overview paper is the overarching output of the group of activity 3.2, which primarily analyses the market and supply chain for offshore wind transmission assets in the BSR. This analysis summarises findings from four specialised reports produced in the context of the BIG project. The four reports address the market and supply chain for offshore wind transmission assets, as well as potential Baltic hubs for offshore grid development, and business opportunities for local small and medium-sized enterprises (SMEs).

This analysis is divided into four parts, which provide the main findings of the studies in a market analysis overview (section 1); a summary of the findings of the supply chain analysis (section 2); a description of conclusions from the Baltic hub assessment (section 3); and suggested business cases for regional SMEs (section 4). A summary is also included to outline the main conclusions and recommendations that emerged from the research.

---

[2] WindEurope (2018): *Offshore Wind in Europe, Key trends and statistics 2017.*

[3] According to the central scenario (the high scenario forecasts a potential of 99 GW of installed capacity by 2030, whilst the low scenario estimates 49 GW for the same year).

[4] WindEurope (2017): *Local impact, global leadership, The impact of wind energy on jobs and the EU economy*, p. 17.

For further information on the methodologies used in the research process and for a thorough presentation of the results, please see the following BIG reports:

- *“Market analysis of the offshore wind energy transmission industry: overview for the Baltic Sea Region”;*
- *“Supply chain analysis of the offshore wind energy transmission industry: overview for the Baltic Sea Region”;*
- *“Assessment of Baltic hubs for offshore grid development: a summary report for the Baltic InteGrid project”;*
- *and “Baltic offshore grid SME business cases: a summary report for the Baltic InteGrid project”.*

1. Market Analysis Overview

This section provides stakeholders with the most recent information on market conditions for the development of a regional meshed grid. Relevant findings from the market analysis of the OWE transmission industry are outlined, with a particular focus on Europe and the Baltic Sea.[5] First, a general overview of the European offshore wind energy industry is provided. Component-specific market overviews are then presented for high-voltage alternating-current (HVAC) cables; high-voltage direct-current (HVDC) cables; converters; transformers; substation foundations; and dominant operation, maintenance, and service (OMS) activities.

1.1 Overview of offshore wind energy

In 2017, the total European offshore wind installed capacity reached 15.8 GW, produced by 4,149 grid-connected wind turbines across 11 countries. The cumulative share in the BSR was 12 per cent, with most of the capacity located in Denmark (880 megawatts (MW)) and Germany (693 MW). OWE development has also taken place in two other BSR Member States, Sweden and Finland. WindEurope expects the total European capacity to reach 25 GW by 2020.[6] **Fehler! Verweisquelle konnte nicht gefunden werden.** shows the projected installed capacity of OWFs in the BSR through 2030, according to the high and low scenarios developed in the BIG project.[7] In the high scenario, the total installed capacity in the BSR could reach 9.5 GW by 2030.

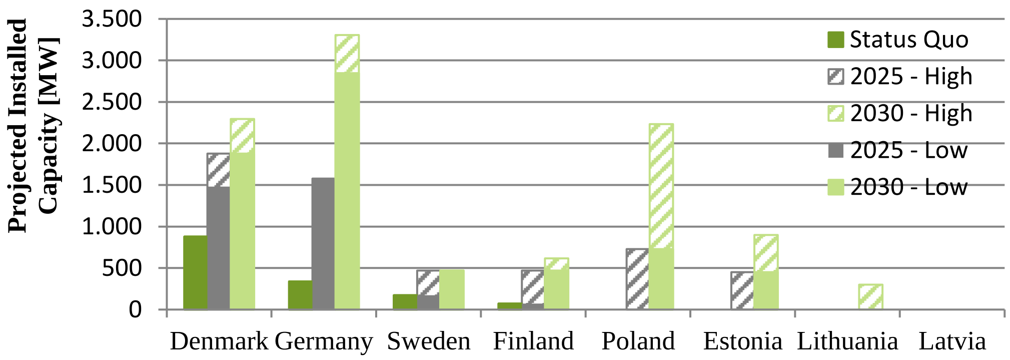

Figure 1. OWE development scenarios in the BSR through 2030. (Source: own figure)

[5] For more details on the BIG Market Analysis methods, findings, and sources, please consult "*Market analysis of the offshore wind energy transmission industry: overview for the Baltic Sea Region*".

[6] WindEurope (2018): *Offshore Wind in Europe: Key trends and statistics 2017.*

[7] WindEurope offshore wind capacity estimates for the Baltic Sea include wind farms located along the east coast of Denmark. In the present study, the boundaries of the BSR are based on maritime spatial planning and exclude wind farms located in the Kattegat area. The offshore wind status quo capacity presented in Figure 1 is lower than that reported by WindEurope due to the difference in definitions (i.e. 1.8 GW and 1.4 GW, respectively).

1.2 Summary of component-specific market analyses

The following market analyses for offshore wind transmission components are based on information compiled from the technology catalogue,[8] relevant literature, and semi-structured interviews. The subsections outline findings on market characteristics (e.g. competitive landscape, manufacturing bottlenecks, and price trends); estimate component-specific demand through 2030 on the basis of BIG project scenarios; highlight major technological developments; and identify the main barriers to market entry for new manufacturing entities.

1.2.1 HVAC subsea cables

The offshore wind HVAC subsea cable market is mature and dominated by three main actors: the Prysmian Group, Nexans, and the NKT Group GmbH. European companies have been the primary suppliers thus far, but new players are likely to enter the market as demand grows. Figure 2 shows the demand forecast in the Baltic Sea for the high and low scenarios. Barriers to market entry for new suppliers include the high capital intensity and high-level skills required, as well as a growing demand for turnkey solutions. Manufacturers have expanded their production capacity in response to the increasing demand, and continued expansion is expected to meet future demand increases in the short term. No major bottlenecks in the supply chain were found. However, rising demand may cause a shortage of installation ships. New cable manufacturing facilities are unlikely to be established in the BSR due to the relatively small size of the OWE market. SMEs may find business opportunities in the OMS segment. High electrical capacitance limits transmission beyond 80–100 km; technology currently under development should allow cables to support longer-distance transmission in the future.

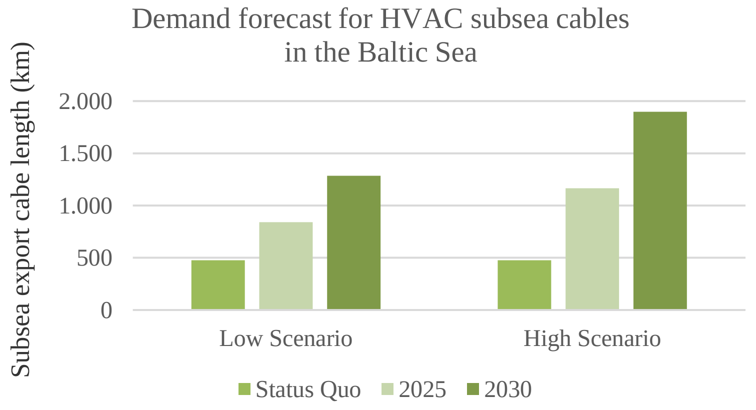

Figure 2. Cumulative demand forecast for HVAC subsea cables in the Baltic Sea. (Source: own figure)

[8] Kaushik Das and Nicolaos Antonios Cutululis, *Technology catalogue: components of wind power plants, AC collection systems, and HVDC systems*, DTU, prepared for the Baltic InteGrid project, Work Package 3

1.2.2 HVDC subsea cables

HVDC technology has emerged as another solution to mitigate the limitations of HVAC. The European market for HVDC cables is growing due to increased demand for long-distance transmission. Although the technology is mature, its use in the offshore wind industry is relatively new. Figure 3 shows the offshore wind HVDC subsea cable demand forecast in the Baltic Sea through 2030 based on the BIG development scenarios. Demand in the low scenario is larger than that in the high scenario. This can be explained by the fact that the low scenario presupposes a greater number of radial connections, whilst the high scenario assumes that a large cluster of OWFs will not be commissioned until 2035. Over the long term, industry use of HVDC technology is likely to increase. For now, however, demand forecasts are challenging due to the uncertainty and risks associated with the technology. Given the current production capacity, a too-rapid increase in demand may cause shortages; however, any gap is likely to be filled by well-established manufacturers. At present, the most important manufacturers are the Prysmian Group and Nexans. Prices for HVDC technologies are expected to decrease by 2030 as technology improves, system reliability increases, and cumulative experience grows.

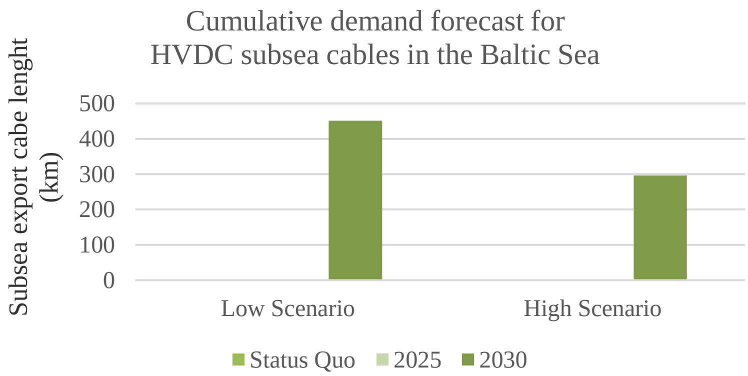

Figure 3. Cumulative demand forecast for HVDC subsea cables in the Baltic Sea. (Source: Own figure)

1.2.3 Offshore converters

OWE converter demand in Europe is mainly driven by the development of HVDC technology. The market is currently concentrated in the German part of the North Sea. As wind farms are built at greater distances from shore, demand is expected to grow while production and installation costs decline. In the BSR, only one converter station is expected to be installed by 2030 in both the high and low scenarios, as shown in Figure 4. Factors that may impede market growth include transmission congestion and instability, high initial costs, lack of investment in grid infrastructure, lengthy approval processes, and technological limitations. The same suppliers are involved in each European OWE project. Due to the track record requirement and small market size, it is unlikely that local SMEs will enter the supply chain for offshore wind converters. No major bottlenecks are foreseen. Recent technological developments have allowed for reductions in surface area and size, reducing installation and OMS costs.

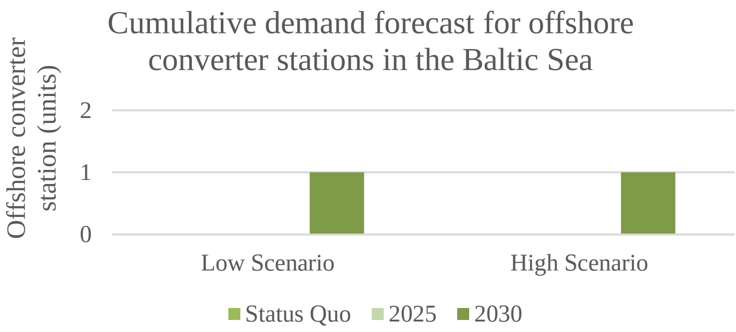

Figure 4. Cumulative demand forecast for offshore converter stations in the Baltic Sea. (Source: own figure)

1.2.4 Offshore power transformers

Offshore wind transformer efficiency, rating, weight, and dimensions have risen in recent years due to the increasing capacity of OWFs and changing requirements. Further moderate innovations are anticipated as the market continues to grow. Figure 5 shows the demand forecast for OWE transformers in the Baltic Sea in the high and low scenarios. The competitive landscape is characterised by only a few well-established suppliers. Track record requirements present additional barriers to market entry. Tap-changer supply, dominated by Maschinenfabrik Reinhausen GmbH, was found to be a potential bottleneck in the future European supply chain, as were copper windings. Prices of offshore power transformers are relatively stable. Further improvements in power density are expected, but capital expenditure is not projected to decrease.

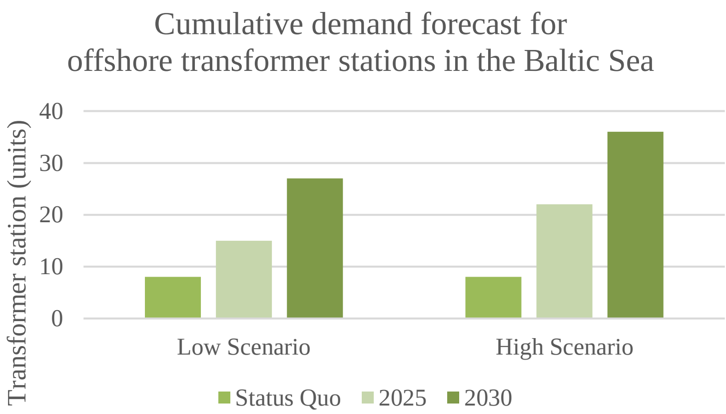

Figure 5. Cumulative demand forecast for offshore transformer stations in the Baltic Sea. (Source: own figure)

1.2.5 Offshore substation foundations

There is a high level of competition among OWE substation foundation suppliers. Thus far, most European manufacturers have been locally based, with significant players in the BSR. The market is mature but remains closed due to the capital intensity and 'know-how' requirements of the industry, which make market entry difficult. Nevertheless, sectors like engineering, installation, logistics, and subcomponent manufacturing are areas in which SMEs could become competitive. Some experts also anticipate an increase in non-European supply. Figure 6 shows the demand forecast in the Baltic Sea in the high and low scenarios. No major bottlenecks are foreseen, and prices are expected to decrease with technological improvements and commercial progress. The European market for substation foundations is dominated by jacket foundations. In the Baltic Sea, however, gravity-based designs have thus far been the most common design. Increasing demand for structures at greater water depths has contributed to the development of floating foundations, which could enable the installation of OWF at depths exceeding 100 m.

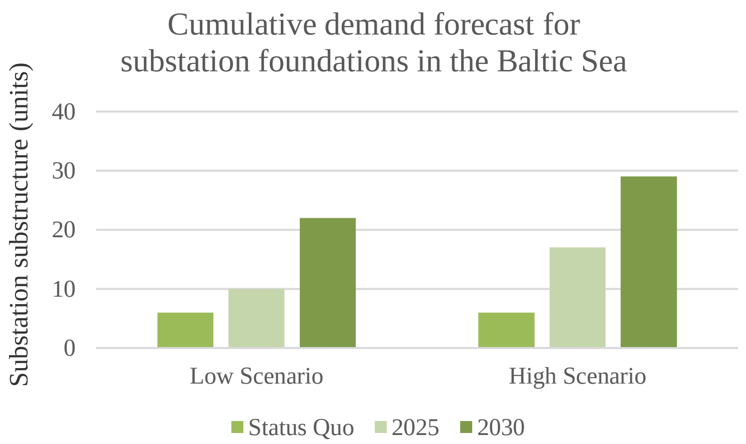

Figure 6. Cumulative demand forecast for substation foundations in the Baltic Sea. (Source: Own figure)

1.2.6 Operation, maintenance, and service

The OMS sector is relatively immature, and activities must constantly adapt to changing parameters. Condition monitoring, forecast improvements, and technological innovations have allowed OMS practices to become more proactive, which reduces costs and increases energy generation. Further cost reductions have been driven by improvements in personnel transfer vessels and access systems. Future savings are expected to result from further progress in weather forecasting; remote monitoring, inspections, and repairs; condition-based monitoring; offshore logistics; and a holistic approach to OMS strategy. Condition-based maintenance is expected to be used for HVAC technologies by the early 2020s and for other system components by 2030. Third-party service provision is also projected to increase. In addition, large manufacturing companies have shown a greater tendency to offer new OMS products, such as turnkey solutions. Still, there is space for new companies to compete, provided that their services reduce costs.

2. Supply Chain Analysis Overview

The supply chain analysis provides stakeholders with an overview of the current supply capacity for offshore transmission components. The main findings of the report are presented below.[9] First, insights on the activities, requirements, and timeline related to the construction of offshore wind transmission assets are provided. Second, findings are presented from the analysis of the supply chain for various components, including subsea export cables (i.e. HVAC and HVDC cables that connect the wind farm and grid), offshore converters, transformers, substation foundations, and protection equipment. OMS activities are also examined.

2.1 Offshore transmission construction activities and timeline overview

Transmission system operators (TSOs) are responsible for grid connections, whilst OWF operators bear responsibility for substation construction. HVAC or HVDC cables connect the transformer station to the converter station or onshore grid (Figure 7). Alternative current has thus far been the preferred technology because it is mature and relatively cost-efficient. However, the popularity of direct current appears to be increasing as OWFs are built farther from shore. Subsea cables can only be manufactured in highly specialised facilities because they are produced in very long lengths to reduce the number of joints. This requires specific production lines, such as vertical continuous vulcanisation (VCV) or catenary continuous vulcanisation (CCV) lines.

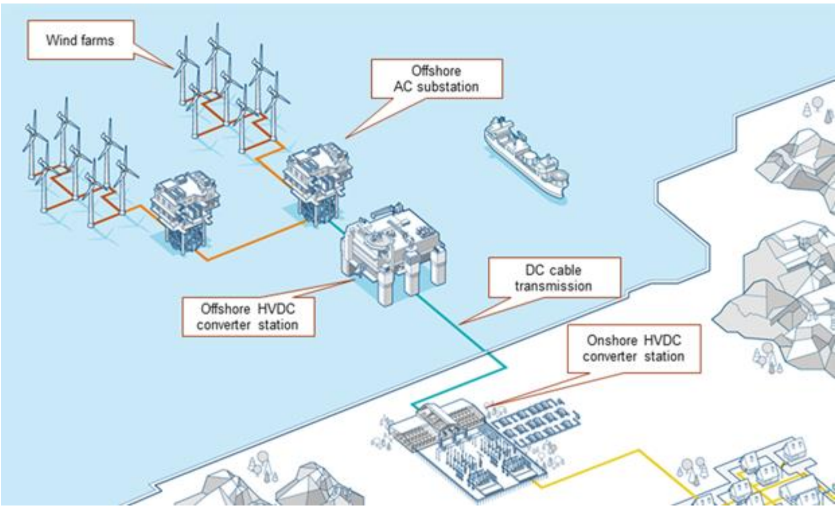

Figure 7. Example of direct current solutions for offshore wind connections.[10]

Cables can be laid by post-lay burial (PLB) or simultaneous lay and burial (SLB). In PLB, cables are laid on the ground, and remotely operated vehicles (ROVs) are used to bury them

[9] For more details on the BIG Supply Chain Analysis methods, findings, and sources, please consult "*Supply chain analysis of the offshore wind energy transmission industry: overview for the Baltic Sea Region*".

[10] ABB (2018): *DC Solutions for offshore wind connections*

using water jets. In SLB, jet sledges pull export cables over the seabed. The ground is trenched using a device at the front of the unit, and cables are lowered into the ditch from the back of the unit. In both techniques, vessels must carry a large number of cable reels. Vessels are also needed to transport foundation parts to the site. A crane is required for installation, as are drilling rigs, depending on the design. Offshore wind converters and transformers are also transported by vessel and are installed using the same process. The total duration of the construction process greatly depends on the converter and transformer installation. If offshore converters are not installed on time due to supply-chain delays, construction may be delayed significantly, as this postpones the installation of onshore converters and export cables until offshore transformer installation begins.

2.2 Summary of component-specific supply chain analyses

The supply chain for OWE transmission components was analysed based on desk research and semi-structured interviews with representatives from leading manufacturing companies. Company profiles and portfolios were drawn up with information on the location of current production sites, key economic figures, experience, competitive advantages, and current market shares. These measures facilitated the identification of potential bottlenecks, barriers to market entry, and opportunities for the integration of local SMEs into the OWE supply chain.

2.2.1 Subsea cables

Subsea cables must be durable and robust to withstand harsh underwater conditions. They are produced in long lengths to avoid large numbers of joints. Their production process differs greatly from that for onshore cables. Expertise and experience in onshore cable manufacturing are thus insufficient, as offshore cables have very specific requirements and present additional technological challenges. Only specialised manufacturing plants can perform the necessary production activities. In addition, production is cost-intensive. Manufacturing companies are thus typically large and well-established. New market entrants face high costs associated with the construction of new manufacturing facilities, the recruitment of skilled workers, the acquisition of specialised cable-laying vessels, and the development of specialised expertise. The manufacture of HVDC cables presents greater risks than does that of HVAC cables.

The demand for OWE export cables is expected to increase, and interviews with major European suppliers revealed that manufacturers are prepared to adjust their production capacity to prevent bottlenecks. However, some respondents emphasised that rising demand could cause a shortage of installation ships. SMEs are unlikely to enter the supply chain for subsea cables but may find opportunities to compete in the OMS segment. In 2017, all of the export cables on the European offshore wind market were produced by Prysmian Group, Norddeutsche Seekabelwerke GmbH (NSW), and NKT Group GmbH (including the former company ABB cables).

2.2.2 Offshore converters, power transformers, and protection equipment

Research and development for offshore wind converters, power transformers, and protection equipment is cost-intensive. Manufacturing requires specialised facilities and considerable know-how. The use of converters within the offshore wind industry is relatively new: only seven have been installed to date. The technology is associated with high costs and risks that can generally only be borne by large companies. Components must be designed to withstand harsh environmental conditions. Market players must not only overcome high cost pressures, but also provide durable and high-quality products. Major suppliers of offshore wind converters include ABB Ltd., Siemens AG, and General Electric Company. Offshore wind power transformer manufacturers include ABB Ltd, Siemens AG, General Electric Company, CG Power Systems, and Schneider Electric. ABB Ltd, Siemens AG, General Electric Company, CG Power Systems, Schneider Electric, and the Hyosung Corporation are some of the companies that produce OWF protection equipment.

2.2.3 Offshore substation foundations

Because the technology for offshore wind substation foundations is less complex, the barriers facing companies entering the market differ from those for the component markets described above. Nevertheless, new market entrants require facilities able to accommodate the manufacture of large and heavy components. Direct access to water facilitates transport. For SMEs, market entry in this segment is difficult due to the high capital intensity of the sector. Larger companies may succeed in entering the market by creating a subsidiary and drawing on pre-existing expertise in the field. An example of this is Steelwind Nordenham, an established steel producer and part of the Dillinger Group. Seven companies that supply offshore substation foundations are Sif Group B.V., Erndtebrücker Eisenwerk (EEW) Group, Steelwind Nordenham, Ambau GmbH, Bladt Industries, St3 Offshore, and GSG Towers.

2.2.4 Operation, maintenance, and service

OMS activities are the technical and administrative measures required to ensure the safe and effective functioning of components. These activities are of paramount importance, especially for offshore wind projects where equipment is exposed to extremely challenging environmental conditions. There is an increasing trend towards condition monitoring, because the technology monitors assets continuously to detect wear and corrosion in a timely manner. This technology may extend the service life of components and help avoid costly production losses. Service activities can include end-of-service-life solutions, in which manufacturers provide solutions for or assume control over the decommissioning process and product disassembly. Furthermore, manufacturing companies increasingly offer maintenance and service solutions. Subcontracting arrangements for OMS activities are also common in the industry and represent a promising business opportunity for local SMEs seeking to enter the OWE supply chain.

3. Assessment of Baltic Hubs for Offshore Grid Development

A BIG study was conducted to assess potential Baltic hubs for the manufacture, installation, and maintenance of components used in offshore wind transmission grid development.[11] The main findings of the assessment are presented below. Port infrastructure requirements are explained for key elements of an offshore transmission grid. The assessment also identifies Baltic port hubs that can contribute to the future development of the offshore grid in the BSR. Finally, the section summarises conclusions on the suitability of sites for supporting this. The findings presented below are not meant to advocate specific improvements to ports or realignment for any particular use of opportunity ports.

3.1 Approach

The study focuses on the OWE transmission supply chain and the port infrastructure required to deliver supply chain elements. The assessment first created an overview of the existing supply chain capability in the BSR. Secondly, to identify the opportunity ports, a list of 306 Baltic ports was compiled from an online database; ports were filtered by water depth and the ability to accommodate vessels used in the OWE transmission market. Opportunity ports were identified based on their proximity to current and future offshore wind transmission projects, accessibility, availability, and synergies with the existing supply chain. Many ports were found to be capable of accommodating crew vessels for substation servicing.

The study identified 14 opportunity ports for further assessment. The characteristics of each opportunity port are assessed against infrastructure requirements for export cables and substations at each supply chain stage: manufacture, installation, and maintenance. Assessments were conducted using publicly available information and, where necessary, supported by communication with the port authority.

3.2 Baltic hubs: existing Baltic capability

3.2.1 Export cables

Several market leaders in export cable supply operate facilities in the BSR due to high demand for subsea interconnector cables. Current port infrastructure was found to be adequate to meet cable supply demand in the BSR. Furthermore, several cable installation companies already operate in the BSR. Baltic demand for cable installation is relatively small and is expected be met by cable installers from both in and outside the BSR. The primary opportunities for Baltic hubs are expected to lie in short-term cable storage prior to installation and in the accommodation of vessels where current port infrastructure is

[11] For further details on the BIG assessment of Baltic hubs, please see “*Assessment of Baltic hubs for offshore grid development: a summary report for the Baltic InteGrid project*”.

adequate. Several cable suppliers and installers in the BSR also have the capacity provide cable service work packages. Opportunities for Baltic hubs are also likely to include the long-term storage of spare cables and the accommodation of vessels for cable survey and repair.

3.2.2 Substation structure

There are several large fabrication yards operating in the BSR that have supplied substation structure components. Baltic market demand for substation structures is small, and current port infrastructure is likely adequate to meet it. Demand for substation structure in the BSR could also be met by suppliers from outside the region. In addition, substation installation companies also operate in the BSR. Demand for substation installation is the same as that for substation manufacture, and the current port infrastructure was found to be likely adequate to meet the demand. As with manufacture, substation installation demand in the BSR could also be met by suppliers from outside the region. Infrastructure in the BSR will require certain infrastructure improvements to accommodate the large vessels used in major substation component replacement and repair; however, there is little demand for such activity. Crew vessels must have access to the substation for structural maintenance and service. There is moderate demand for this activity, and it does not require highly specialised ports. Some companies in the BSR have the capacity to provide maintenance services for substation structures.

3.2.3 Substation electrical

Owner-furnished equipment, primarily power electronics equipment, can be transported by truck, rail, barge, or ship from outside the BSR to the substation structure fabrication yard. The supply of this equipment does not require a highly specialised port or dedicated infrastructure as most general cargo vessels, if required, can use onboard cranes to self-load and unload. Electrical equipment may be imported and exported through Baltic ports, though only in small quantities. The current port infrastructure was found to be adequate for substation electrical supply. Crew vessels are required to access the substation for high-voltage electrical installation, but demand is low and highly specialised infrastructure is unnecessary. Some specialist substation electrical work packages can be performed by BSR companies. The port infrastructure required for the maintenance of substation electrical systems is the same as that required for the substation structure.

3.3 Baltic hubs: opportunity ports

The 14 opportunity ports identified for further assessment are listed in alphabetical order in Table 1, and Figure 8 shows the location of each in the BSR. Port assessments were based on the port authority area as a whole rather than on specific facilities or locations within it.

	Port	Country
1	Gdynia	Poland
2	Karlskrona	Sweden
3	Klaipėda	Lithuania
4	Koverhar	Finland
5	Liepāja	Latvia
6	Lübeck	Germany
7	Muuga	Estonia
8	Norrköping	Sweden
9	Rønne	Denmark
10	Rostock	Germany
11	Sassnitz-Mukran	Germany
12	Stralsund	Germany
13	Świnoujście	Poland
14	Wismar	Germany

Table 1. List of Baltic Sea opportunity ports included in the study.

Figure 8. Location of opportunity ports in the Baltic Sea Region. (Source: own figure)

3.4 Summary of main findings

The BSR is well-positioned to provide export cable manufacturing and installation, with a robust existing supply chain that includes port infrastructure at the point of supply. There are a large number of cable manufacturing facilities in the BSR as a result of regional demand for interconnectors. These manufacturing facilities have since provided a supply high-voltage export cables for offshore wind transmission; these cables are used in Baltic Sea projects and are exported for use in projects outside the region. The strength of this supply means that there is no clear demand for major new manufacturing or installation infrastructure in the BSR. Some ports are likely to benefit from nearby manufacturing facilities or OWFs, such as those providing vessel services or short-term cable storage.

Port infrastructure in the BSR is sufficient to meet the demand for substation structures and electrical supply and installation. The BSR has some capacity to produce substations, but the demand for these is low and the supply is likely to come from outside the region. There is not a strong demand for new supporting infrastructure for substation structures or for electrical manufacture and installation.

BSR hubs will have more opportunities in the OMS segment than in the manufacture and installation of offshore transmission components. The Baltic offshore grid is set to grow from 1.8 GW of current installed capacity to up to 9.5 GW in 2030, according to the high scenario of the Baltic InteGrid. There are many ports in the BSR capable of establishing themselves as hubs for the maintenance supply chains of offshore transmission assets. These operations do not require specialised port infrastructure; as a result, ports that have not yet gained experience in the OWE sector — such as the eastern Baltic ports — may have an opportunity to support transmission maintenance. Supply chains for offshore transmission maintenance are also more sensitive to distance from the installed transmission system. Manufacture and installation will more readily come from outside the BSR (such as the Baltic 2 export cable being manufactured by NSW General Cable in Nordenham), whilst maintenance is typically carried out from hubs near where the transmission system is installed.

BSR ports can take advantage of their expertise to improve transmission manufacture, installation, and maintenance. There are several major ports in the BSR that can offer an advantage through the project lifecycle from their experience in areas such as cargo handling and logistics, and through close or even co-location of supply chain for export cables and substation manufacture, installation, and maintenance. This offers the opportunity to build hubs around these facilities to further drive economies of scale and co-location.

The main barriers to developing the optimal port infrastructure in the BSR are competition from outside the region and the relatively low level of demand. There is also competition for space and quays from within the port areas themselves. Publicly owned ports are more likely to accept a new industry entering the port authority based on the economic benefit to a wider municipal area; privately owned ports will evaluate a potential change to the utilisation of port infrastructure purely on financial merit. There is also lack of certainty about the dates and total volumes of transmission grid that will be needed, which is a risk to ports considering investment in further infrastructure.

German ports are the most likely to develop into and remain hubs for the offshore transmission sector. The study identified more opportunity ports from Germany than any other Member States in the BSR. Current BSR transmission supply chains are predominantly located in Denmark and Germany. Although Denmark has the highest installed capacity in the BSR, Germany is anticipated to install a greater volume of capacity by 2030. German ports have the most infrastructure, due in part to the strength of the connection to central European industries. German ports and supply chains will likely continue to serve the offshore transmission sector in the BSR beyond projects installed in German waters. Ports in countries whose OWE sectors are in their infancy (such as Poland, Lithuania, Latvia, and Estonia) will have to compete against the experience and track record of German hubs when their projects are ready to be developed.

4. Business Cases for Small and Medium-sized Enterprises

The present chapter highlights the main findings of the assessment of various business cases for SME involvement in the OWE transmission supply chain.[12] The chapter first identifies the contractor-awarded work packages that could be delivered by a SME across the lifecycle of OWE transmission assets. It then describes the challenges to market entry for SMEs and provides recommendations for entering the OWE transmission supply chain.

4.1 Approach

The analysis assessed the OWE transmission market in three supply chain areas: export cables, substation structure, and substation electrical system. These areas were then examined at each stage of the product life cycle: development, manufacture, installation, and maintenance. From the primary OWE transmission contracts awarded by the main contractor, 37 potential subcontracted work packages that could be delivered by SMEs were identified. The largest contract on which a SME can bid is estimated to be approximately €10 million.[13] Each of the 37 work packages was then further assessed in terms of potential future demand growth, required investment size, synergies with other sectors, level of competition, complexity of interfacing, and relevance of proximity to customers. Challenges and opportunities for SMEs entering the OWE transmission market were identified from these assessments and from five case studies of BSR SMEs that have won subcontracted work packages.

4.2 SME work packages

Table 2 summarises the 37 work packages that the study found to be deliverable by SMEs. Some packages — such as diving services, crewing services, and crew transfer vessel services — are contracted across several supply chain elements or lifecycle stages.

	Export cables	**Substation structure**	**Substation electrical**
Development	Cable design	Structural design analysis	System design
	Cable ancillaries design	Logistics analysis	
	Cable route engineering	Sea-fastening design	
Manufacture	Factory jointing	Architectural steel	Busbars

[12] For further details on the BIG SMEs business cases, please see "*Baltic offshore grid SME business cases: a summary report for the Baltic InteGrid project*".

[13] BVG Associates professional estimation. The turnover of a company with 250 employees could be up to €25 million and a single contract of more than €10 million would probably be considered a significant risk by the buyer.

	Cable ancillary manufacture	Secondary steel	Heating, ventilation, and air conditioning
	Equipment servicing	Signage	Fire detection and suppression
	Transport and storage	Sea-fastening manufacture	Lighting
		Cable routes and trays	
		Cranes	
Installation	Cable protection	Port services	
	Route clearance and pre-lay grapnel run	Crewing services	
	Unexploded ordnance survey and removal	Crew transfer vessel services	
	Remotely operated vehicle services		
	Diving services		
	Cable termination and testing		
	Cable surveying		
	Trenching tools		
Maintenance	Repair jointing	Asset inspection services	Safety checks
	Fault monitoring		

Table 2. The 37 SME work packages considered in the study.

4.3 Conclusions

Demand will increase in work packages that can be delivered by an SME; however, this may not raise demand for SME services.

Offshore wind developments in the BSR will increase demand across most of the work packages identified in this study. Demand varies across supply chain elements and lifecycle stages. The greatest growth is likely to be in crew services and crew transfer vessel services that are required for the installation and maintenance of offshore transmission assets. Nearly all work packages will promote growth, at least to some degree; however, it is unlikely that an SME located in the BSR will be able to develop a business case for entering the offshore wind transmission market to serve this industry alone. Work packages with the lowest barriers to entry for SMEs tend to be ones with fewer growth opportunities.

Competition from rival businesses is the biggest challenge to SMEs entering the offshore wind transmission market.

Of the various factors studied in this assessment, competition in the market presented the greatest barrier to market entry for each work package. Many work packages require highly specialised skills or an established track record; neither is easy for SMEs to obtain. These packages are most likely to be kept in-house by the primary fabrication or installation contractors and may only become available to SMEs when the contractor has insufficient in-house capacity to fulfil multiple contracts at once. When subcontracting opportunities do arise, they are likely to be won by competitors, which may be large companies. SMEs seeking to enter these highly specialised areas may benefit from recruiting experienced individuals from competitors.

There are significant opportunities to transition from, or diversify into, similar markets.

Companies with experience in supplying similar industries (e.g. oil and gas, telecommunications, or interconnectors) are more likely to transition successfully into the OWE transmission market. In order to demonstrate a credible offshore-wind track record and compete with experienced suppliers, SMEs must emphasise their technical, commercial, and logistical experience in applications relevant to OWE. Gaining a detailed understanding of the technology, supply chain, and contracting approaches is essential to identifying key potential customers. For more specialised packages, partnerships with existing offshore wind suppliers can help establish credibility and are often an effective means of entering the sector. Similarly, an SME considering entry into the offshore wind market should consider that potential customers may also be in parallel sectors, due to the synergies with other markets identified in all work packages in this study.

There are advantages to SME provision of multiple work packages.

Many work packages can be contracted as single packages to reduce interfacing complexity and risk to the end client. It is advantageous to integrate some work packages, such as through the provision of both design and manufacturing services. SMEs in the BSR who have been successful in entering the offshore transmission sector tend to demonstrate competence in multiple areas.

There are opportunities for SMEs to serve markets outside of the BSR.

Although demand will increase significantly in the BSR by the end of 2030, offshore wind will also be installed in significant volumes in the North Sea and at moderate levels in the Atlantic and Mediterranean. Contracting within the existing market has shown that the offshore wind supply chain operates entirely in Europe. Many work packages have been delivered by suppliers who are not located near their subsuppliers or end clients. SMEs should build their capacity to export goods and services to the wider European market. After acquiring the requisite capacity and experience, SMEs may find opportunities to expand into emerging markets, such as North America and Asia, which will rely on European suppliers until their domestic supply chains are established.

SMEs may need a strong relationship with large supply chain contractors.

The scale and importance of offshore transmission assets means that a high level of trust is required in any SME that has been subcontracted to undertake most of the work packages in this study. Any SME that develops a relationship with a large contractor should seek to secure a framework agreement to enhance the likelihood of further opportunities. Some of the advantages of framework agreements include:

- a stronger working relationship between client and supplier;
- cost efficiencies of delivering multiple contracts;
- an increase in company confidence, allowing reinvestment into the company and expansion into other work packages and markets; and
- standardisation of supply.

Framework agreements often 'split' larger packages into smaller-scale projects that are more accessible to SMEs with little experience or risk capacity. SMEs in the BSR have been successful in securing framework agreements with major offshore wind contractors.

SMEs can exploit the advantage of their proximity to the customer.

Some successful Baltic SMEs have utilised their proximity to customers and/or projects to win contracts for OWE transmission work. In many cases, the initial work package is used as a platform to demonstrate the capacity of SMEs, which in turn enables the company to secure future work.

Investment may be required for both capital assets and skills.

Many SMEs have the equipment or infrastructure in place to become suppliers in the OWE transmission market without further significant investment. The capacity expansion required to win additional work packages may require further investment in capital assets; due to the high skill level necessary for many work packages, investment in skills development, such as training or certification, is also essential in some cases.

There are opportunities for SMEs to demonstrate their innovative capabilities.

The offshore wind industry faces the challenge of deploying more reliable technology at a larger scale whilst maintaining an emphasis on cost reduction. A strong and competent European supply chain has developed to support the offshore wind industry, and many companies are exploring innovative ways to reduce costs. SMEs that can demonstrate competence and offer innovative, cost-cutting solutions in work packages will be attractive to large clients.

Conclusion

Findings from the market and supply chain analyses of the offshore wind transmission industry indicate that the **HVAC subsea cable** market is mature and dominated by three main actors. New suppliers face formidable barriers to entry, such as high capital intensity, the need for high-level expertise, and the growing importance of delivering turnkey solutions. The potential increase in demand is expected to be met by existing manufacturers, and no major bottlenecks are foreseen; however, the availability of installation vessels could prove problematic as demand rises. The BSR is well positioned to provide export cable manufacturing and installation, and a large number of cable manufacturing facilities are already operating in the region. However, the study identified no clear demand for new infrastructure.

The European market for **HVDC technology** is growing due to increased demand for long-distance transmission. In the long term, the use of HVDC technology in the OWE industry is likely to increase, provided that prices are reduced to competitive levels. For now, uncertainty and risk associated with the technology make it difficult to forecast demand. **OWE converter** demand in Europe is driven by the deployment of HVDC technology, and the market is currently concentrated in the German part of the North Sea. The first OWE converter station in the BSR is expected to be installed by 2030.

OWE transformer efficiency, rating, weight, and dimensions have risen significantly due to increased OWF capacity and changing requirements. As the market grows, further moderate innovations are expected. The competitive landscape is characterised by the dominance of a few well-established suppliers. The supply of tap changers represents a potential bottleneck, as do copper windings. Further improvements in power density are expected, though without any significant reduction in capital expenditure. As for **OWE substation foundations**, there is a high level of competition among manufacturers. Thus far, most suppliers on the European market have been locally based, with significant players in the BSR. No major bottlenecks are anticipated. The **OMS** sector is relatively immature. Condition monitoring, forecast improvements, and technological innovations have allowed OMS practices to become more proactive, which reduces costs and increases energy generation. There is space in the OMS market for new companies to compete, provided that they offer cost reduction solutions.

Some **Baltic ports** are likely to benefit from the development of OWE in the region, notably through the provision of vessel services or short-term cable storage. Port infrastructure in the BSR is sufficient to meet the demand for substation structure and electrical supply and installation. The BSR has some ability to produce substations, but the regional demand for these is low and the supply is likely to come from outside the region. There are more opportunities for Baltic hubs in the OMS segment than in manufacturing or installation, which require specialist port infrastructure and are more sensitive to distance. The main barriers to developing the optimal port infrastructure in the BSR are competition from outside the region and the relatively low level of demand. The total offshore wind installed capacity could reach up to 9.5 GW in the region by 2030, with the largest growth anticipated in Germany. The study identifies more opportunity ports in Germany than in any other Member State in the region. German ports have the most developed infrastructure, due in part to the strength of the connection to central European industries.

Finally, the capital-intensity, high competition, and track record requirement associated with the offshore wind industry are barriers to market **entry for new manufacturers and SMEs**. Offshore wind developments in the BSR will provide an increase in demand across different work packages, with the greatest growth likely to be in crew services and crew transfer vessel services. It is unlikely, however, that local SMEs can create a business case for entering the BSR offshore wind transmission market based on serving this industry alone. Furthermore, work packages with the lowest barriers to entry for SMEs tend to have fewer growth opportunities. Competition from rival businesses is the biggest challenge to SMEs entering the offshore wind transmission market. An SME seeking to enter highly specialised areas should look to recruit experienced individuals from competitors. Companies that have experience supplying similar industries (such as oil and gas, telecommunications, or interconnectors) are more likely to be successful in transitioning to the OWE transmission market. Partnerships with existing offshore wind suppliers can help establish credibility and facilitate sector entry. The analysis shows that SMEs in the BSR who have successfully entered the offshore transmission sector tend to display competency in multiple work areas. SMEs that can demonstrate capability and offer innovative, cost-cutting solutions are most likely to overcome barriers to market entry.

References

Brauer, Jan; Heine, Nils; Proba, Gert and Sandén, Julia. *Supply chain analysis of the offshore wind energy transmission industry: overview for the Baltic Sea region*. Baltic Integrid, 2018

BVG Associates. *Assessment of Baltic hubs for offshore grid development: a summary report for the Baltic InteGrid project*. Baltic Integrid, 2018

BVG Associates. *Baltic offshore grid SME business cases: a summary report for the Baltic InteGrid project*. Baltic Integrid, 2018

Côté, Elizabeth; Holton, Michael; Nicolaas Ponder, Anika; Sandén, Julia and Wallasch, Anna-Kathrin. *Market analysis of the offshore wind energy transmission industry: overview for the Baltic Sea region*. Baltic Integrid, 2018

Das, Kaushik and Antonios Cutululis, Nicolaos. *Technology catalogue: components of wind power plants, AC collection systems and HVDC systems*. Baltic Integrid, 2017

"DC Solutions for offshore wind connections." ABB. 2018. https://new.abb.com/systems/offshore-wind-connections/main-2/dc-solutions (Accessed on 08 October 2018)

WindEurope (2017): Local impact, global leadership, The impact of wind energy on jobs and the EU economy, online. Available at https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Local-impact-global-leadership.pdf [Accessed 31 August 2018]

WindEurope (2018): Offshore Wind in Europe - Key trends and statistics 2017, Page 17-20, online. Available at https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2017.pdf [Accessed 16 February 2018].