Winds of *opportunity*

Offshore wind industry growth through
synergies and collaboration across Scandinavia

Capgemini invent

in collaboration with

energy CLUSTER DENMARK | energy valley

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About this report

Harnessing the power of renewable energy, Scandinavian countries place a major focus on offshore wind development. This focus entails two ambitions: developing the domestic market and expanding the export industry. In our 2022 report "Creating Offshore Winners: How Norway can become a global leader in offshore wind", provides an in-depth look on how to successfully develop the Norwegian market. In this report, we will investigate the latter in a Scandinavian context - how to build an industry across Scandinavia capable of supplying global markets.

The report is the result of a study carried out by Capgemini Invent in collaboration with the industry clusters Energy Valley and Energy Cluster Denmark. The study is based on 29 interviews with industry stakeholders across Scandinavia and extensive research into reports and publications. The challenges and recommendations presented in this report should not be seen as the direct opinions of the stakeholders interviewed.

Capgemini Invent would like to thank the following organizations for their participation in interviews and for sharing their insights

KONGSTEIN · TechnipFMC · Innovasjon Norge · Ørsted · equinor
AkerSolutions · Norwegian Offshore Wind · Statnett · SEAGUST · vårgrønn
SIEMENS Gamesa RENEWABLE ENERGY · DNV · WIND CATCHING · seaway 7 · THOMMESSEN
ESBJERG HAVN · Norwegian Energy Partners · SHORELINE · Hafslund · imenco SMART SOLUTIONS
ABB · SEB · KONGSBERG · Eksfin NO EXPORT FINANCE NORWAY · SINTEF · BUSINESS SWEDEN

The study was conducted between June and August 2024, and capability assessments and recommendations are based on the status at the time of writing.

Executive summary

The offshore wind industry in Scandinavia is well-positioned for substantial growth, driven by the region's commitment to renewable energy and the unique strengths of each country. This report, based on a study by Capgemini Invent in collaboration with Energy Valley and Energy Cluster Denmark, provides an in-depth analysis of the offshore wind industry within each country, aiming to identify how the region can excel as a supplier to the global offshore wind market.

To support this analysis, the Scandinavian countries were assessed across four areas crucial for industry development: 1) Regulations and policies, 2) Industrial capacity and innovation, 3) Workforce and competence, and 4) Financial and market conditions.

Findings underscore the fact that Denmark, Norway, and Sweden excel in different aspects of offshore wind development. Denmark has taken a leading position with a strong domestic market and export initiatives, leveraging its project allocation framework and turbine manufacturing capabilities. Norway, with its maritime history, excels in offshore installations and innovative floating wind projects, but is dependent on successful re-skilling and recruitment to maintain this edge. Sweden, with a solid industrial base and a large project pipeline, sets a production standard and has strong export potential, particularly in grid solutions and electric components. Following, the region has the collective potential to serve as a one-stop-shop.

To leverage these strengths and to accelerate the growth of the Scandinavian off-shore wind industry, four main levers must be utilized:

Specialize

Enhance regional competitiveness by building on existing industry capabilities and expertise.

Sustainable

Prioritize sustainable practices in all parts of the value chain to ensure long-term industry viability.

Scale

Embrace standardization, mass production techniques, and digital technologies to achieve economies of scale and improve efficiency

Synchronize

Alignment across the Scandinavian market provides streamlined frameworks for industry growth.

By focusing on these levers, Scandinavian countries are well positioned to develop an industry capable of serving global markets.

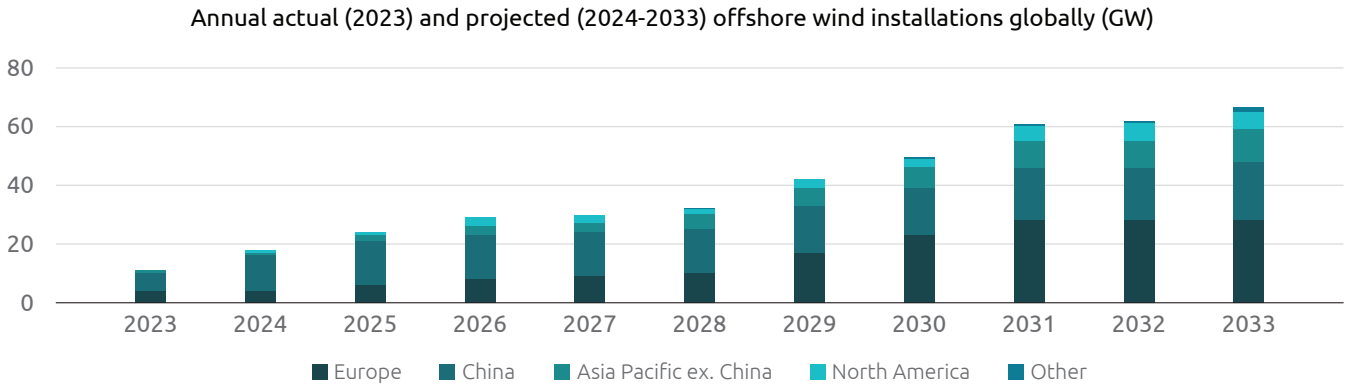
Introduction

In 2023, energy-related CO2 emissions reached a new record high of 37.4 billion tons (Gt) [1]. Without the increased deployment of renewable energy sources, this rise in emission would have been even greater. As global electricity demand is predicted to double throughout 2050, the production must continue to decouple from CO2 emissions to mitigate climate change. To achieve this, renewable energy sources such as wind must maintain the accelerated deployment seen in recent years.

Offshore wind is especially interesting in this regard due to its high capacity-factor*, averaging around 50%. Combining this with the fact that current global installed capacity of 75 GW (2023) [2] accounts for a miniscule fraction of the total technical offshore wind potential of 420 000 TWh reveals great potential for increased deployment [3].

Figure 1:

Predicted annual development in offshore wind installations globally from 2023-2033 [2]



Today, China leads in global installations, but as visualized in figure 1, other regions are expected grow more rapidly, with Europe expected to dominate from 2029 [2]. Denmark has since its first offshore wind farm 1991, been at the forefront of offshore wind development. Norway and Sweden have later committed to developing offshore energy, and today all three countries have set ambitious targets, as illustrated in figure 2. However, future installations outside of Scandinavia are significantly larger, with Europe being led by the UK who is predicted to account for 32% of installed offshore wind capacity across Europe in 2028 [4]. This development urges the Scandinavian players to look beyond domestic markets for expansion.

As a region with open economies, comparable political systems and close geographical proximity, the hypothesis is that cohesively investigating Denmark as an industry pioneer, Norway as a leading offshore nation, and Sweden as a stronghold for industrial production, could yield insights into how these countries may collaborate, learn, and leverage synergies for common success in the offshore wind market.

Figure 2:

Scandinavian production targets [28] [11] [29]

Allocate a minimum of
9 GW by 2030

Allocate areas with
30 GW potential by 2040

Allocate areas of
27-34 GW* potential

** Given a capacity factor 40-50%*

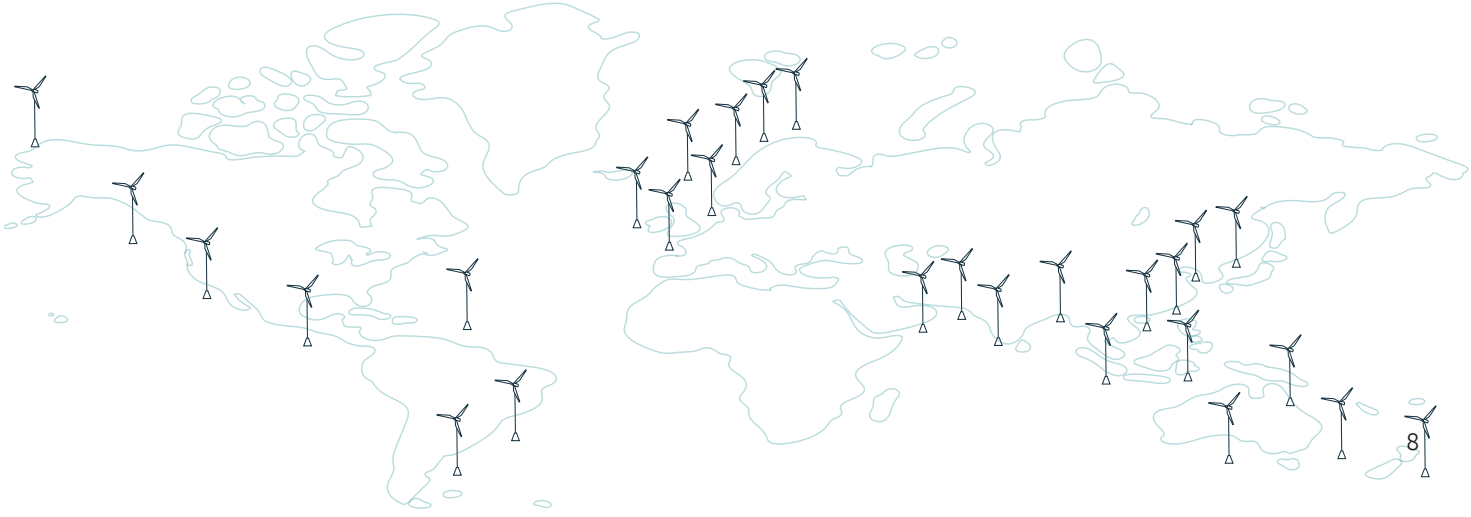
**The capacity factor is the average power generated by wind divided by its peak capacity. For reference other energy sources have the following capacity factores: Onshore wind – 30-48%, Solar panels – 10-25%, Nuclear – 92% [30] [31]*

The role of domestic offshore wind development

While a global focus is essential for building a significant offshore wind industry, the development of the home market plays a crucial role in industry growth. However, it's importance and whether it is a prerequisite or merely beneficial is debated. Below, the two contrasting viewpoints are described:

The home market is a prerequisite	The home market is beneficial
Ability to succeed with global export depends on buildup and security of domestic projects	*Contributing to general market growth, however not a necessity to enable global export*
Need for experience and market validation – operating within the home market allows companies to gain the necessary industry experience to compete in other markets	**Home markets are small –** waiting for the home market to evolve is a bottleneck and prohibit companies from partaking in the global offshore wind "race"
Industry familiarity and lower risk – domestic market conditions are more familiar, reducing risk associated with unforeseen challenges	**Companies are successful abroad –** current situation shows that companies are not dependent on domestic success
Credibility and reputation – a solid track record domestically enhance a company's credibility and reputation internationally	**Different criteria globally –** global markets might value different capabilities, which companies must accommodate from the start
Closed markets globally – several offshore wind markets have local content requirements hindering entry for foreign suppliers	**Possibility to target niche market -** going global enables targeting niche markets

The validity of each argument differs among companies, but an indisputable fact is that companies across Scandinavian countries have significant offshore wind revenues despite the varying size of their home markets, implicating that domestic market development is not a prerequisite. However, industry players emphasize its accelerating effect, and even though some companies have succeeded globally without domestic markets at this stage, this does not mean other companies will achieve the same feat going forward. Throughout the report, we thus consider the home market as a key accelerator for industry growth.



Country Capability Assessment

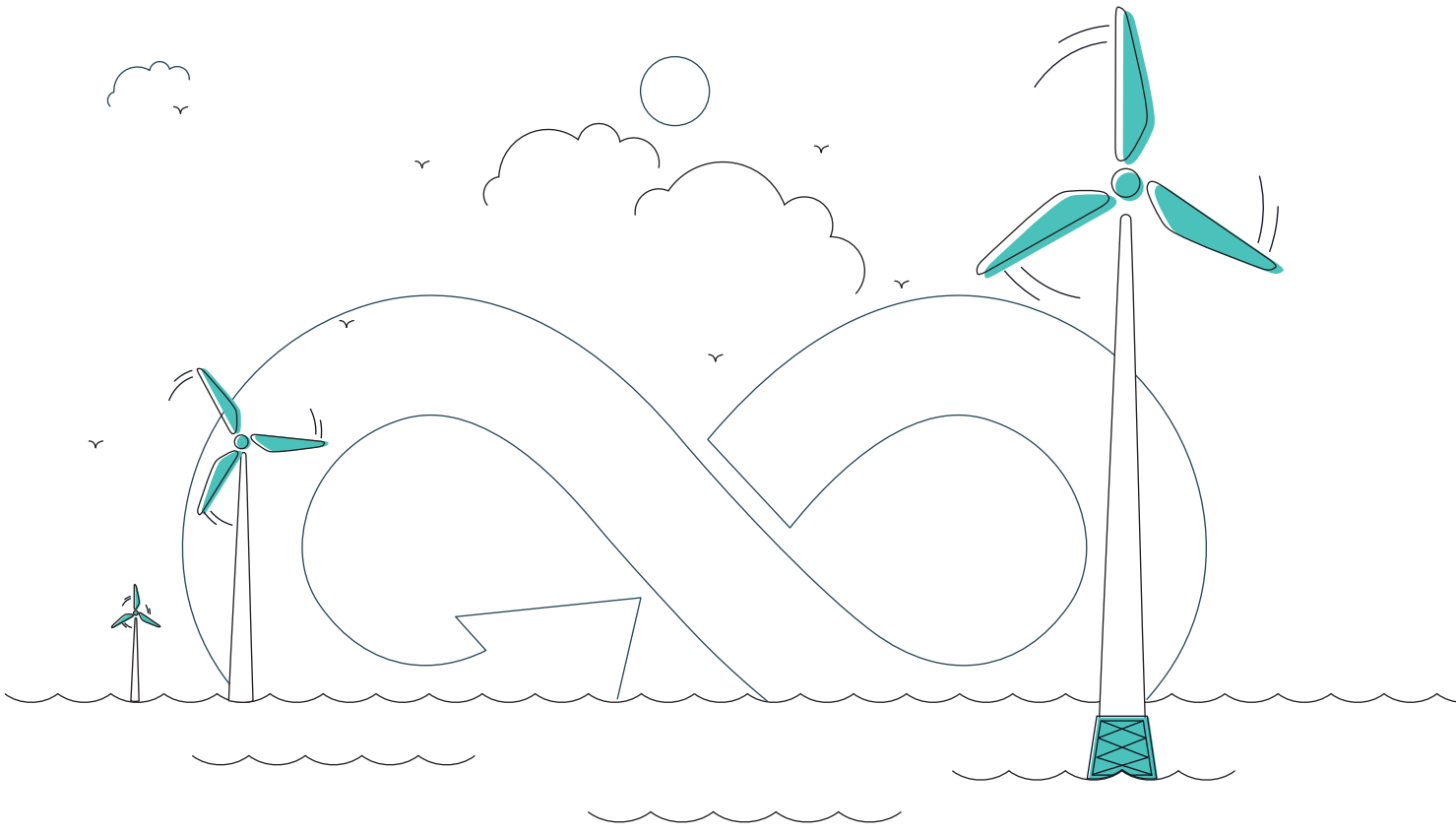
To identify the distinct strengths of each Scandinavian country, a capability assessment was conducted across four areas crucial for national advancement

Regulations and policies
as supportive and predictable regulatory frameworks are prerequisites for attractive business environments and industry growth

Workforce and competence
as the labor force must have skills and knowledge aligned with market developments, as well as sufficient capacity

Industrial capacity and innovation
as the ability to produce efficiently and economically, as well as innovate, drives industry development

Financial and market conditions
as sufficient financial capabilities and favorable market conditions are prerequisites for industry viability



Regulations & Policy

Stable political and regulatory environments reduce financial risk and facilitate interaction across value chains and borders. The strength of a country's offshore wind-specific governmental targets, export strategies and support frameworks are therefore an important indicator of its growth potential.

Targets, initiatives and export strategies indicate a high political priority throughout Scandinavia

Norway is the only Scandinavian country with an explicit export target, to cover 10% of the global market. However, both Denmark and Sweden have set goals for domestic capacity which would also support an industrial growth capable of export. Moreover, all three countries have selected target export markets. While Norway and Denmark's targets offshore wind specifically, the Swedish strategy entails a broader focus on green industrialization and digitalization [5].

All three countries have strategic export initiatives in place. Norway's current export strategy involves positioning domestic supply companies and regional developers into the value chain of larger consolidated players, specifically through the "Offshore Wind Entry Program" from Innovation Norway [6]. Sweden has identified "High Potential Opportunities" on a higher political level, where selected markets are analyzed to identify business opportunities abroad [7]. The Danish Export Agency bundles complementary firms throughout the value chain, in *Strategic Business Alliances*, to promote an end-to-end offering within offshore wind, enabling sufficient economies of scale to win international contracts [8]. In addition, send-outs from the Foreign Ministry share experiences on domestic regulations and frameworks abroad, while also identifying potential distributors and customers for Danish companies [8].

Coordination and support frameworks vary with Denmark applying a highly efficient solution

In general, research indicate a positive correlation between companies receiving export financing support and an increase in export volume. Specifically, SMB's receiving such support were found to a revenue increase of 8-9%, and 3-4% higher employment. Therefore, a well-functioning financial export support system would be positive for export [7].

All Scandinavian countries have financial institutions who offer both A-rated guarantees and loans to international developers, provided they choose domestic suppliers for their project [9]. To exemplify the scale of this support, the Export and Investment Fund of Denmark (EIFO) and Export Financing Norway (Eksfin) have an accumulated financing amount for projects of €11 BN and €3.3 BN respectively. Compared to the European Investment Bank, who until 2024 has funded a total of €10.3 BN, and newly initiated a €5 BN offshore wind support program, Scandinavia is found to have large financial support capacity [10].

Figure 3:

Overview of governmental entities in the Scandinavian region [11] [5] [12]

Financing	• Provide capital and financial A-rated guarantees • Facilitate funding of cross-border initiatives	Innovasjon Norge, Eksfin	EIFO	Business Sweden, SEK
Marketing	• Grow global sales and international branding • Establish market connections in target markets	Innovasjon Norge, Royal Norwegian Ministry of Foreign Affairs	energy Cluster Denmark, State of Green	Business Sweden
Regulation	• Coordinate allocation process • Control permit applications and grid integration for new projects	Olje- og Energidepartementet, Statnett, NVE	ENERGINET, Danish Energy Agency	Swedish Energy Agency, Svenska Kraftnät

The majority of the offshore wind industry in Norway and Denmark participate in non-competing parts of the value chain. Therefore, Eksfin and EIFO can collaborate on international projects to stimulate increased export of early-phase technological projects. Such cross-border initiatives stimulate collaboration and is valuable to both countries and integral for standardization and scaling. Public entities such as Norwegian Enova facilitate joint projects between research institutes and industry players by allocating grants to validate new technology. Despite these initiatives, research has identified lack of funding for pilot projects to become ready for market, a potential bottleneck for scaling new technology.

Although financial incentives and export support are found to be accessible throughout Scandinavia, Denmark emerges as a leading example with a closely coordinated and consolidated structure.

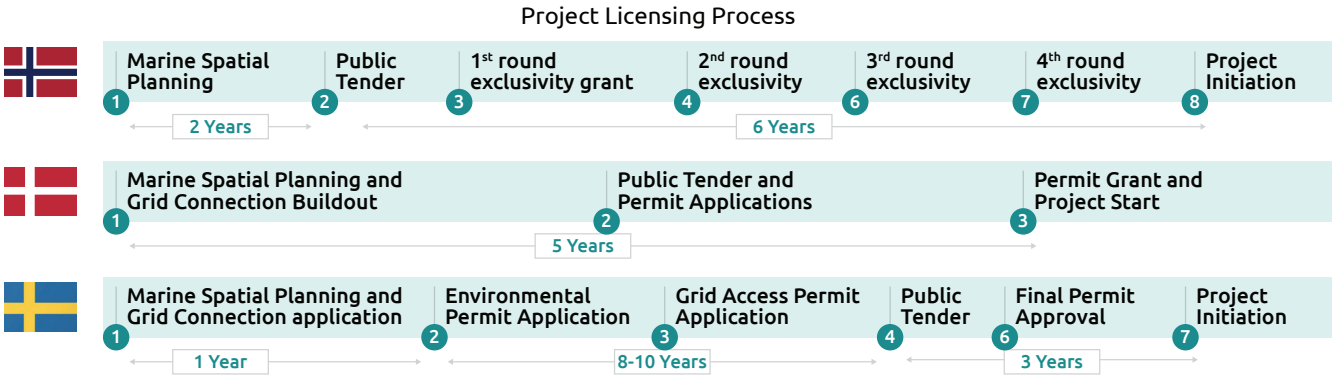
Ørsted purchase Aibel products with guarantees from Eksfin

In 2024, Eksfin provided a loan of EUR 525 million to Danish Ørsted for the purchase of two converter platforms from Norwegian supplier Aibel. The platforms will be used in its offshore wind project Hornsea 3, located on the east coast of England. Ørsted is planning major developments in all key markets for Norwegian offshore wind exporters, including Europe, the USA, and Asia, illustrating how Eksfin enables profitable export and collaboration opportunities.

Despite broad political focus, regulatory risk varies between countries

Development of the home market will, as discussed earlier, have an accelerating effect on industry growth and followingly on export ventures. As the project allocation framework is a key determinant for domestic growth, lengthy process signals a potential bottleneck.

Figure 4:
Project Licensing Process in the Scandinavian region [11] [5] [12]



The Norwegian framework lacks consistency and predictability on concession criteria, allocation timelines and production requirements – resulting in an 8-year commissioning timeline. Sweden's 8-10-year timeline is a result of a similar complex permit application process, subject to comprehensive environmental and municipal approvals. Denmark has a merchant market approach, centrally managed by the Danish Energy Agency. Parallel processing of permits speeds up the overall process, resulting in a quicker, predictable commissioning timeline of 5 years. However, the speed of the allocation process must not be the sole focus, and ensuring sufficient time for environmental assessments should not be neglected.

Industrial Capacity & Innovation

To deliver projects for both national and international markets, major industrial capacity is required. Although already significant, the Scandinavian industry is not yet fully mature, leaving room and need for growth to reach global and national ambitions.

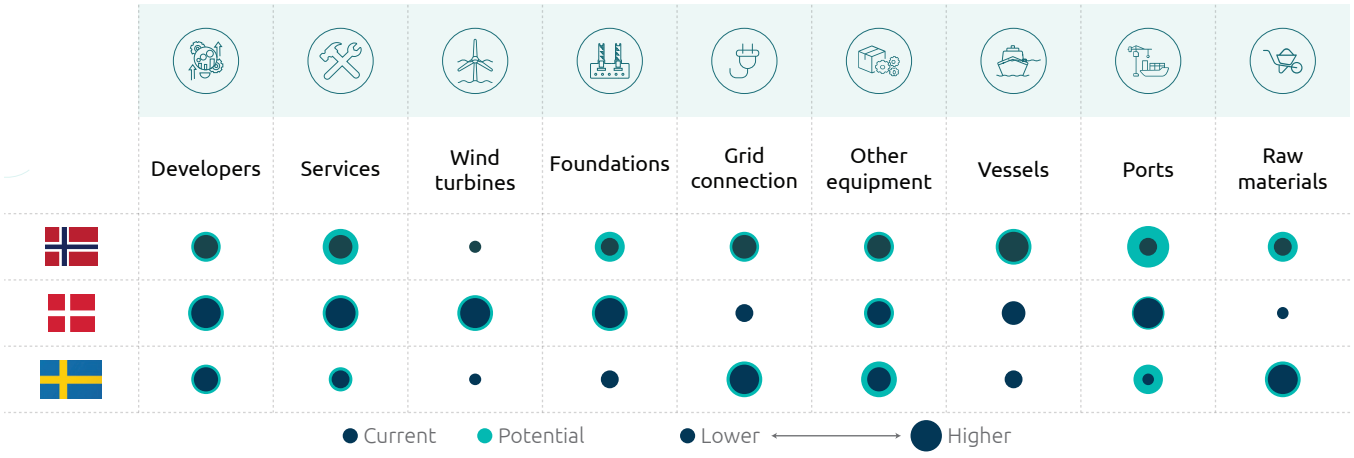
Denmark covers the entire value chain whereas Norway and Sweden are more specialized

Denmark has grown a major industry of world-leading companies offering equipment and services to the industry. Alongside the growth of Ørsted into the world's largest offshore wind developer, major companies such as Vestas and their ecosystem of smaller suppliers have grown into global players. Furthermore, in addition to being particularly strong within turbines, Denmark is also, as one of few countries, considered able to supply most of the equipment and services needed for an offshore wind farm.

Sweden and Norway both have less mature domestic markets, with combined offshore wind capacity totaling to 11% of Denmark's. However, they are both major suppliers within segments of the value chain. Sweden has a traditional strong industrial base and has been highly successful in large export deals to the global market, exemplified by Hitachi Energy. Some of Norway´s legacy O&G suppliers have been successful in pivoting, such as Imenco who has found a market for existing products developed for oil & gas in the offshore wind industry.

Figure 5:

Qualitative assessment of current and potential industrial capabilities of the offshore value chain across Scandinavia



Hitachi Energy Export Deal

Sweden's biggest-ever export deal was realized in 2023 when Hitachi Energy together with Petrofac secured a 13 billion offshore wind deal with Dutch-German grid operator TenneT [33]. Hitachi will manufacture the majority of converter stations and related equipment in Ludvika, Sweden. The deal fueled the recently announced expansion in Ludvika, with a $330 million investment and 2000 additional employees by 2027 [34].

Scandinavian industry has a substantial global footprint and high potential for growth within both fixed and floating offshore wind

Scandinavian offshore industry is significant. As an example, the Norwegian offshore wind industry had estimated revenues of 34.4 billion NOK in 2022, with 78% of revenues being exports or international revenues [13]. Industry actors support the notion that Norway are within reach of 10% market share globally, but also points out that the revenue is somewhat concentrated among a few major players, such as Nexans, Aibel and Seaway7.

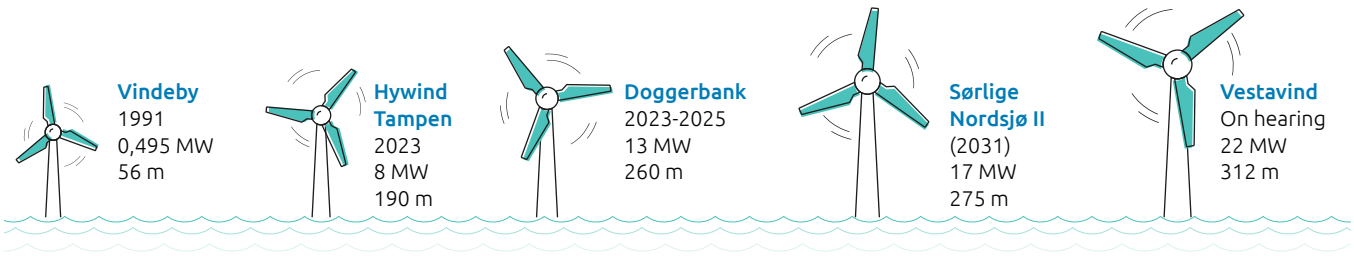
The projected global market growth in the coming years highlights potential for local industry growth. However, industry actors mention that the Norwegian ambition is highly dependent on the growth of the floating wind segment, as the traditional oil & gas suppliers in Norway are mostly proficient within submersible structures and other subsea equipment. The bottom-fixed segment of the industry will also grow significantly, but estimated to benefit mostly incumbents, which could provide the case for continued growth for Danish suppliers. The Swedish expertise of grid solutions has the benefit of being necessary across floating and fixed. This is further supported by the need for grid investments as de-localized and variable energy production increase. However, across all segments the industry must expect tough competition globally, particularly from major Chinese companies that seek opportunities abroad as their domestic market growth slows down.

Continuous innovation within offshore wind, manifested by ever-larger turbines, is necessary, but challenge standardization and scaling

A continuous, and necessary, challenge for the industry is the drive towards lower cost and higher efficiency through innovation. Since the first offshore turbine installed in 1991 the most visible innovation is the turbine size, a development that continues. This necessitates adaptation across several parts of the value chain to accommodate larger turbines and introduce uncertainty on what is needed in the marketplace in the long-term.

Figure 6:

Overview of historic and potential offshore wind turbine size development



Danish companies have been leading the offshore wind innovations, using the number of patents as a proxy for innovation. From 2002 to 2022, Denmark registered the second highest number of patents [14], being the leading country relative to its size. Norway is also a considerable patent developer with the 9th highest number of patents. This is assumed to be a result of our leading position within floating wind, exemplified by the METCentre. Sweden is not considered a patent leader in relation to offshore wind, but has the second highest technological advantage within systems supporting electrical power generation, transmission or distribution only behind Korea [15], a testament to their strong grid industry.

Marine Energy Test Centre (METCentre)

The METCentre is a world leading test center for floating offshore wind technologies located on the South-West coast of Norway. Since 2009 the center has offered infrastructure and services to test technologies in varying depth and testing conditions in collaboration with industry, academia, and policymakers.

Workforce & Competence

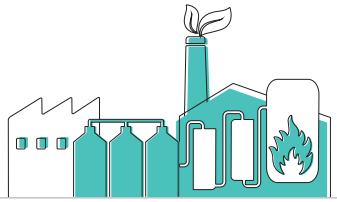
As an industry grows, a key lever for sustainable growth is to successfully utilize its existing workers, whilst simultaneously recruit and educate sufficient future labor. Therefore, to facilitate this growth, the respective countries must carefully assess its current workforce and make necessary adjustments to meet expected demand.

Each country should capitalize on their unique domestic capability

The Scandinavian countries all share a global reputation for expertise within sustainability, HSSE and overall quality delivery, and provide unique competencies within different parts of the value chain.

Denmark is a pioneer in the wind industry and has successfully leveraged knowledge and experience from onshore wind industry to its offshore ventures. This enables them to offer high competence and skilled labor across the entire value chain, especially within turbine technology and production.

Norway lacks knowledge within turbine technology, but benefits from its history as a strong maritime nation. Industry players highlight that Norway has competitive advantages linked to O&G subsea installation and maintenance, offshore operations, planning and engineering. Moreover, 40% of the value chain for Norwegian offshore oil and gas is considered highly transferable to the floating segment, further indicating a competitive advantage within floating wind technologies [16].



Sweden shows industrial experience and competence within efficient production lines, grid and electrical components, and access to raw materials, whilst lacking in expertise within turbine technology and construction services.

Future labor demand shortages are expected despite a highly competent Scandinavian workforce

When considering future labor demand, the main uncertainties are total market size and captured market share. Industry players highlight that the current rapid market development indicates significant shortages of relevant labor. Furthermore, a transition in industry demand is expected from engineering to installation competence as the industry matures. This shift is underscored by the relative increase in demand for skilled workers, as shown in figure 8 [17]. To tackle this, the Scandinavian countries may consider three possible solutions: Increase import of foreign labor, provide more relevant education and re-skill existing workforce.

Figure 7:

Expected Employment Needs In Norway's Offshore Wind Industy (2035)

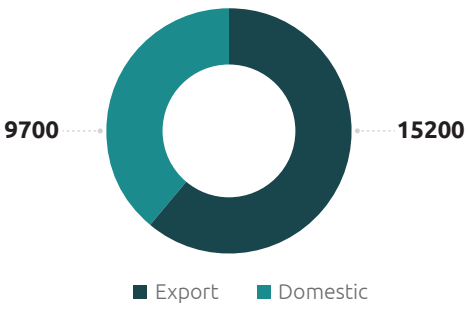
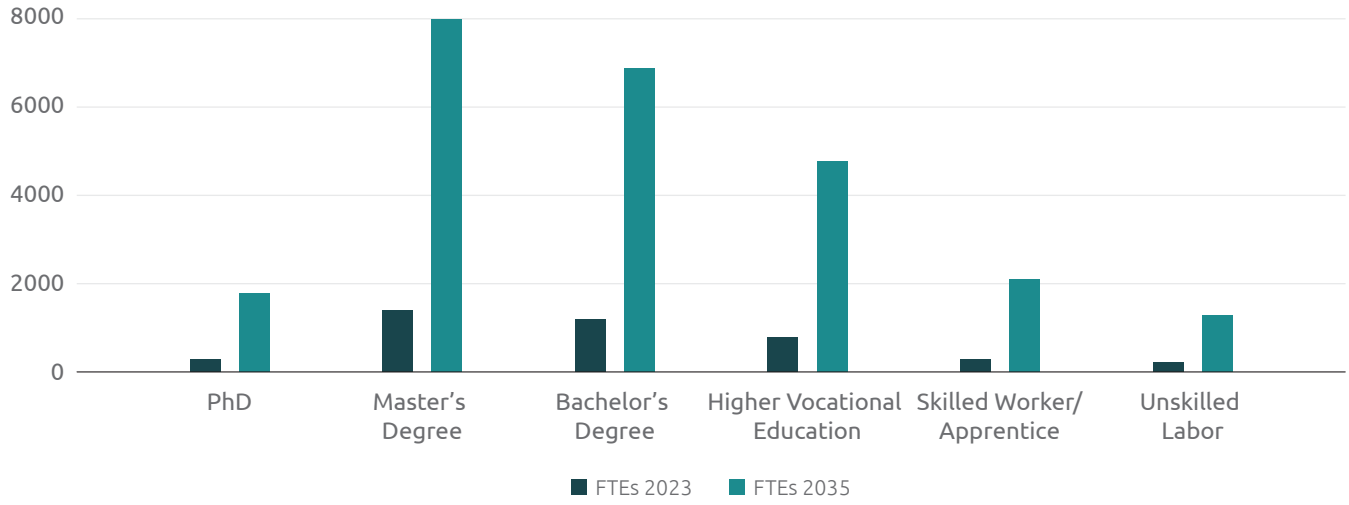


Figure 8:
Expected demand for employees by education level for the offshore wind industry [32]



Workforce transition is challenged by competing industries, despite high industry attractiveness

The main factors impacting industry attractiveness, according to industry players, are salary, market stability, sustainability, and the rate of innovation. While the first two present challenges, the latter duo contribute positively to recruitment. Scandinavian suppliers experience strong competition from various sectors regarding salary, especially from the oil & gas and life sciences & healthcare sector, in Norway and Denmark respectively. In Denmark, the situation is even more complex due to a more advanced and less marginalized onshore wind industry. Furthermore, market stability, influenced by fluctuations from political initiatives, technological breakthroughs, and external conditions, creates a cyclical demand and unpredictable recruitment environment. Despite these challenges, industry players emphasize that the sector is generally perceived as attractive to talent. This attractiveness is driven by a noticeable interest in sustainability and a desire to engage in renewables, as well as the high rate of innovation. These factors make the industry appealing for talent seeking to contribute in a rapidly growing and changing field.

Low industry margins call for labor cost optimization to maintain competitiveness

The offshore wind industry is characterized as a low margin sector, making optimization of labor cost a high priority. It is therefore important for the Scandinavian countries to gain a comprehensive understanding of its workforce to optimize its recruitment strategy. Norwegian labor demand high salaries, which questions its export viability. However, their highly educated workers are more cost-efficient relative to their European counterparts [18] [19]. To leverage this, the region could benefit from promoting relevant education and upskilling.

To optimize its workforce, the Scandinavian countries may rely on subcontractors and outsourcing to other countries for parts of the value chain. For example, due to global shortage in certain parts of the value chain, such as wind turbine maintenance, Denmark, who specialize in this domain, could benefit from both increasing domestic capacity as well as labor export. However, as Chinese turbine manufacturers enters the European market – offering components at 50% lower prices and cheaper labor – such export is challenged.

Financial and Market Conditions

Offshore wind markets are highly complex, leaving them subject to a variety of factors such as financial risk, legal complexity, and changes in the macroeconomic environment.

Financing of offshore wind is capital intensive with long lead times, and is thus sensitive to the high number of risks associated with development

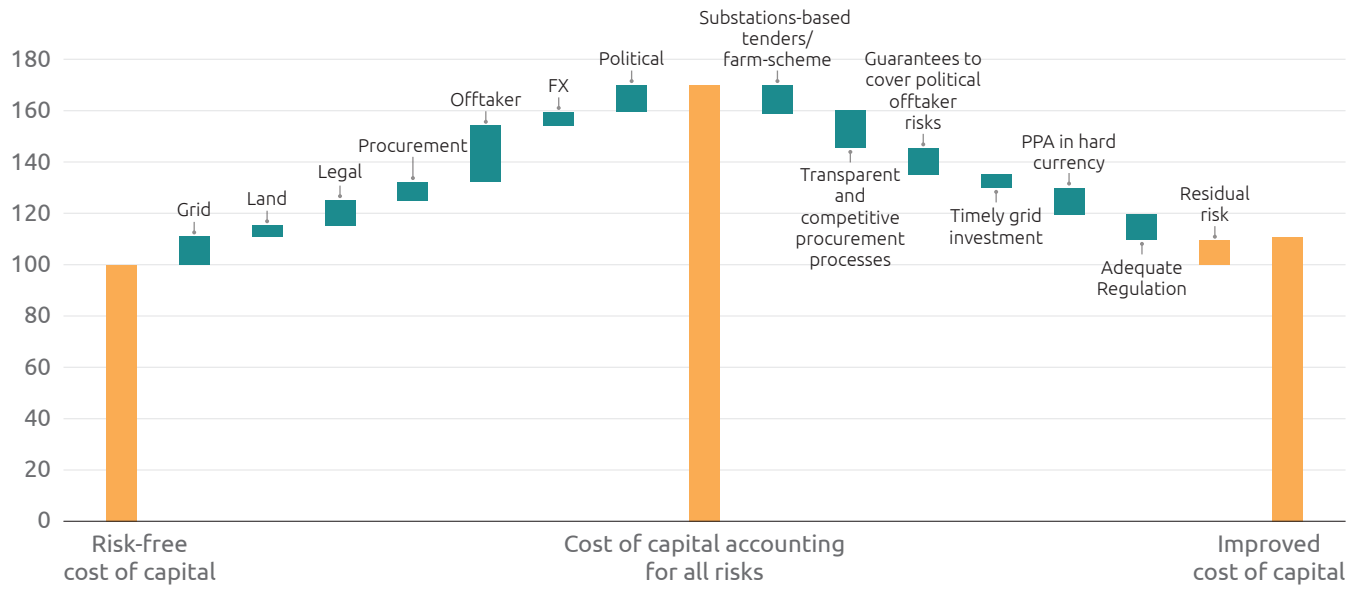
Offshore wind farms require major up-front investment and raising this capital is complicated due to a high number of risks associated with development. Figure 9 introduces the various risks impacting financing cost for offshore wind projects, and a key focus to accelerate development is the minimization of these risks. A success story of risk reduction is the use of contracts for difference (CfDs) and purchase power agreements (PPAs) to ensure predictable cash flows. The use of these contracts, combined with a lower technical risk over the last decade, contributed to a reduction of risk-premium for projects by 58-74% between 2011-2019 [20].

On the other hand, financing costs have increased between 2022-23, with a weighted average cost of capital (WACC) of 6.9%, up from 6.5%. Higher cost of capital, combined with strained supply chains and high inflation have haltered industry development. However, interest rates are forecasted to decrease in the long run, which will likely lead to reduced financing costs [21] and higher project realization.

Financial risk and large CAPEX lead to projects being funded by several financiers, so that banks do not bear the risk and investments alone. As an example, the Dogger Bank Wind Farm has 25-30 corporate banks across the world providing capital. The projects are generally too large for local and regional institutions to finance in terms of solidity requirements and risk appetite. Thus, there are just a few banks across the Scandinavian economies able to partake in the financing of major offshore wind farms. This indicates that Scandinavian developers and financiers must have a global scope from day one.

Figure 9:

Illustrative impact on the cost of capital of operational and development risks and their associated mitigants [2]



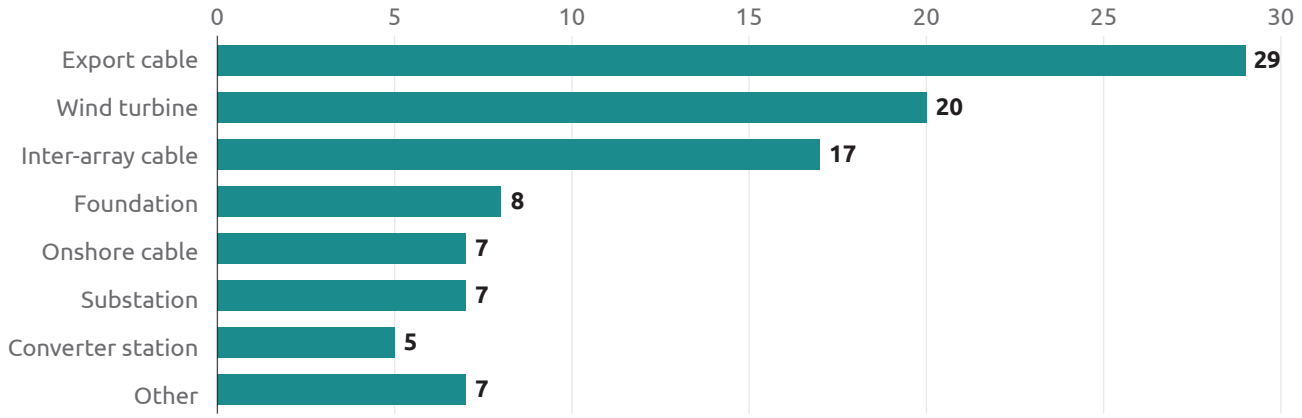
Risk management and liability requirements pose challenges for developers undertaking large-scale projects and for suppliers pivoting from other markets

The legal aspect of offshore wind markets is complex and highly relevant for market development, collaboration, and the responsibility of suppliers. There are many involved parties and in many cases no single entity is willing to take on the full project risk, as no party is responsible more than 30-40% of CAPEX. Thus, the developers seek to transfer risk to each involved party, requiring clear definition of interfaces between the deliverables of varying parties. Smaller industry players point to differing standards for liability when supplying equipment to offshore wind versus oil & gas installations, and companies throughout the value chain must therefore focus on understanding the differing market legalities and accompanying risk and liabilities.

As seen in figure 10, the top cause of claims for offshore wind farm is the export cable [22]. This implies that a strategy where the TSO takes larger responsibility of the development of the offshore grid lowers the risk for developers. This can again lead to more competition in the tenders for the projects. An example is TenneT, the German-Dutch grid operator, who is responsible for the offshore grid in preparation for expected development of German and Dutch offshore wind farms. This is beneficial for project attractiveness, proven by record-high participation as well as lower bid-prices in its latest auction rounds.

Figure 10:

Top causes of claims in offshore wind farms according to Allianz Commercial claims data across Germany and Central and Eastern Europe [22]



Macroeconomic uncertainty and competing industries complicate the offshore wind adoption and the necessity of pivoting legacy industries

Norway and Sweden were both net electricity exporters in 2023 [23], but with ambitions to grow energy-intensive industries such as battery manufacturing and hydrogen production, this situation may change. Denmark was not an exporter of electricity in 2023 despite its extensive offshore wind capacity. Increased offshore wind development is considered the solution for Sweden and Norway to keep their status as exporters, but certain challenges must be addressed to make this happen.

Norwegian oil & gas companies and suppliers face high short-term demand and despite the inevitable long-term slowdown, the industry switch is haltered. An illustrative example showing the resistance from investors to pivot is how the Equinor stock price jumped +5% after they announced the loss of Sørlige Nordsjø II to Ventyr. Industry in Denmark and Sweden does not face the same strain on industrial capacity but might still be reluctant to invest in a low margin industry with increased global competition. Together, low industry margins and inflation have resulted in underinvestment in manufacturing capacity, ending in likely supply chain bottlenecks post 2026.

Summary of country assessment and comparison

In summary, each of the Scandinavian countries demonstrate proficiency in distinct aspects of offshore wind development.

Denmark has exemplified best practices in expediting the growth of its domestic market and consolidating national export initiatives. A streamlined project allocation framework has accelerated its first-mover advantage – and with the Esbjerg port as the main entry to the North Sea, they have solidified their position as a key player in the industry. Furthermore, their strong competence within turbine manufacturing is in high demand worldwide, a key advantage as it is expected to be a future industry bottleneck. However, with global players such as China entering the European markets, the Danish industry could face challenges in maintaining their current position.

Norway has a clearly defined export objective but is considered less coordinated in the operations of its support organizations. With a strong maritime history, Norway possesses robust capabilities in the production of offshore installations. To leverage this competitive advantage, successful re-skilling and recruitment of future workforce is essential. Moreover, Norway shows large innovative capabilities, especially within Floating Offshore Wind projects at piloting stages, such as Equinor's Hywind Tampen and its electrification of offshore oil & gas installations.

Sweden, with its solid industrial base, sets a production standard for others to emulate. There is a large pipeline of projects, indicating that there is a strong demand for projects on the domestic stage. In addition to this, Sweden has a strong potential to succeed with its exports. With the increasing demand for grid solutions and electric components, they are well-positioned to leverage their expertise in these areas. Although their export framework is similar to their neighboring countries, Sweden prioritizes a wider scope, with a strong emphasis on green industrialization.

Key recommendations for Industry Growth

Our analysis of the Scandinavian countries' strengths within the offshore wind industry reveals substantial opportunities for growth. By capitalizing on these strengths and leveraging inherent synergies and opportunities for value-adding collaboration, the region can position itself as a comprehensive hub for offshore wind solutions. To expedite this development, four primary levers must be utilized.

Figure 11:
Key recommendations for industry growth

Specialize

The Scandinavian countries each have respective strengths within the offshore wind industry. By specializing these further, each country can grow into world-leading suppliers within their segments of the value chain. Furthermore, their complementary expertise provides an opportunity to foster synergies through R&D and educational programs.

Build upon Existing and Specialized Capabilities

Each country has capabilities within certain parts of the value chain that should be fostered. Norway can capitalize on its robust maritime industry, offshore engineering expertise, project management skillset, and marine logistics. The rich history in deep-sea operations and subsurface equipment serves as a unique advantage in the floating wind farm segment. Denmark, home to one of the world's largest wind turbine manufacturers, Vestas, should emphasize their focus on export of wind turbine technology. Despite being capable of serving each segment within the value chain, the rapid industry growth suggests that further specialization in this segment could be advantageous. This would allow Denmark to concentrate on increasing efficiency. Lastly, Sweden excels within grid solutions and has a strong industrial base driven by clean energy capable of manufacturing the components needed in the industry.

Develop Knowledge and Expertise

Norway, with its Marine Energy Test Centre, is at the forefront of floating offshore wind technologies. Denmark contributes significantly to R&D with extensive research conducted by its universities, in close collaboration with industry leaders. The establishment of R&D collaborations across Scandinavian universities and joint test centers could be a next step towards strengthening Scandinavian offshore wind expertise. An example of this is the Nordic Offshore Wind R&I, where Norway and Denmark collaborate to leverage their complementary scientific and infrastructure capabilities. The inclusion of Sweden in such a collaborative effort would further contribute to development of new technology.

Adapting Academic Offerings to Meet Industry Demand

Through specialization of workforce and education towards domestic key competencies, the Scandinavian countries may mitigate labor shortage whilst simultaneously strengthen their individual competitive edges. In addition to this, it is important to increase educational capacity and the number of re-skilled workers, as well as strengthening recruitment efforts. To support educational specialization, the Scandinavian countries could benefit from creating unified educational programs. This would enable students to share insights and expertise between countries. While Norway and Denmark already have such alliances with universities in the Netherlands and Germany through their European Wind Energy Master, additional programs including Sweden could provide students with knowledge on energy infrastructure, grid solutions and serial production.

Scale

To ensure continued cost reductions in the offshore wind industry, it is necessary to enable economies of scale through standardization, efficient production, and increased adoption of digital technologies.

Standardize Technology for Predictability

Innovation is generally a driver for efficiency and cost reductions, but in markets with complex and highly interlinked value chains, constant introduction of new products reduces predictability and hinder scaling of production volume and standardization. The offshore wind industry is vulnerable to that challenge, and knowing future demand could solve this. However, this often require regulations and standards to be implemented by market regulators, but ideally by industry clusters to ensure relevance.

An example could be to define turbine size for certain periods of time. This would enable OEMs and suppliers to plan production, as well as vessel operators and other parts of the value chain to better prioritize investments and asset development. In this regard, Scandinavia could look towards the Netherlands, where the Netherlands Wind Energy Association has proposed a limit on turbine height to 1000 feet until 2037. If such a standard is set across Scandinavia together with the Netherlands and other countries in the North Sea region, it would create a coherent and predictable market, benefiting local industry players [24].

Focus on High-volume Manufacturing

Norwegian companies could benefit from adopting best practices in serial and mass production learned from Sweden and Denmark. While Norwegian companies in the oil and gas sector are accustomed to one-off projects, the high number of identical components in an offshore wind farm necessitates a shift towards serial production. To achieve this, Norwegian companies should invest in advanced Industry 4.0 technologies such as automation, robotics, and data analytics. These technologies can streamline production processes, reduce waste, and improve quality control. Additionally, fostering partnerships with Swedish and Danish firms can facilitate knowledge transfer of best practices in mass production.

Leverage Digital Technologies for Improved Services

Digital technologies are pivotal in enabling scale and industry growth by providing new and value-adding services effectively. Including digital tools in services such as surveying, design, and operations & maintenance could reduce labor intensity while also increasing quality. Recent years have witnessed significant investment in industrial IoT and digitalization, where several companies have thrived by digitalizing the oil & gas industry.

Other than developing software-enabled services, an alternative route to scale and global reach, is developing the software itself. Several Norwegian start-ups have successfully developed such solutions, and companies such as Shoreline have been successful in growing globally without needing a home market. To accelerate digital innovation, stakeholders such as major industrial players and developers could support the start-up community by providing real-life use cases and access to confidential data.

Sustainability

Ensuring sustainability throughout the offshore wind value chain is essential to guarantee that the sector not only contributes to the global energy transition, but also operates in a way that protects the environment and drives economic and technological development.

Prepare for Expected Growth in Turbine Decommissioning

Along with industry growth, an increasing number of offshore wind farms will be decommissioned. This demand corresponds to the general lifetime of an offshore wind farm, in other words a 20–30-year lag. Because the offshore wind market is in it's early-stages, few companies have positioned themselves in offering services and products required to perform decommissioning, which should be seen as a market opportunity. An example of how this can be done is Siemens Gamensa and Stena's development of recyclable turbine blades. More information about this below.

Vestas and Stena Recycling partner on circular solution for turbine blades

While recycling practices exist for many turbine components, rotor blades, made of composite materials, pose a significant recycling challenge. However, the CETEC initiative with Danish turbine manufacturer Vestas, Swedish Stena Recycling and academic partners have developed a chemical process to recycle turbine blades already in operation. There is no need for blade redesign, and it will eliminate landfill disposals for the epoxy-based blades after decommissioning, whilst simultaneously enabling new blades to be produced with recycled materials.

Scandinavia as Leaders in Sustainable Offshore Wind Development

Embracing sustainability can enhance the Scandinavian countries competitive edge, distinguishing them from regions that prioritize cost-efficiency over environmental responsibility. This includes embedding sustainability throughout the entire supply and value chain, ensuring that every aspect, from sourcing of raw materials to the vessels used, adheres to sustainable practices. As for the first, responsible sourcing of raw materials poses an opportunity for long-term sustainability for Norway and Sweden especially. As for the latter, it is exemplified by Norway's experience with eco-friendly vessels that minimize emissions and Ørsted's current focus on modifying and building vessels that can run on clean fuels. Moreover, with a high share of renewable energy, Scandinavian industry is inherently more sustainable compared to production in more fossil-fuel-dependent nations.

Couple Offshore Wind with Complementing Technologies

Integrating offshore wind production with other technologies and industries, can result in synergies, further promoting sustainability, economic growth, and technological development. Relevant use cases involve Power-to-X, energy for Carbon Capture and Storage (CCS) processes, electrification of oil platforms, and energy to industry in geographical proximity. In addition to decarbonizing these processes, such coupling can result in more efficient energy utilization.

Furthermore, collaboration between larger actors and start-ups may prove as a cost-efficient way of driving innovation and facilitating testing of new technologies, accelerating the development of increasingly sustainable energy solutions.

Synchronize

To facilitate an attractive Scandinavian market, the industry needs an efficient, streamlined, and predictable framework. This can be achieved through synchronized efforts on regulatory structures, coordinated financial support schemes and strategic collaboration across the entire region.

Harmonize Regulatory Structures and Rationalize Public Resources

Industry players highlight bottlenecks in slow governmental processes and complex allocation frameworks in both Norway and Sweden. In Denmark, the DEA allows parallel permitting applications for both grid connection and handling of Environmental Impact assessments, in addition to ensuring that the state-TSO is building out sufficient grid capacity for new projects. This model has been shown to be integral to the industrial buildout in Denmark. Thus, a balanced approach, with parallel processing of permits, could be a key learning for Swedish and Norwegian regulators to speed up their domestic allocation processes. However, this must not come at the expense of thorough assessment of environmental impact and seabed analysis.

Aligning regulatory frameworks across Scandinavia could significantly reduce commissioning lead times. Should the format be adopted by other markets, the Scandinavian industry would extend their advantage through its experiences from previous projects. By aligning allocation frameworks, the growth of the Norwegian and Swedish home markets may increase, which would be beneficial for Scandinavia as a whole. Moreover, it alleviates the already strained public entities, freeing up relevant resources for alternative purposes such as innovation and R&D.

Coordinate Financial Support Schemes

Industry players state that a key measure to facilitate scaling and industrializing new technology is to provide a clear support framework throughout each stage of development. When each organization has individual criteria, application processes, frameworks, and funds – there is a risk of inefficiency and unpredictability. This could be addressed by coordinating or consolidating existing support entities into a single support offering, funding projects from R&D to market entry.

An example is the “Grønn Plattform” initiative in Norway, where the activities of export, research, and financing entities such as Innovasjon Norge, Siva, Eksfin and Forskningsrådet were coordinated to provide financial support for consortiums with projects from the stage of R&D all the way to market-ready solutions - with the end goal to increase Norwegian export.

Establish closer coordination between Scandinavian Offshore Wind Clusters

As each country further specializes within the value chain, there may be significant learnings to be shared and opportunities to collaborate between the Scandinavian industries. Where each country already has established domestic clusters and organizations which aims to strengthen domestic suppliers and industry, tighter coordination between these clusters could facilitate realisation of further synergies. Closer communication could strengthen development and alignment of regulatory frameworks, export schemes and matchmaking between suppliers and developers across countries. As global players such as China enter the European market strong clusters could be the way to mitigate this.

AirBus – A success story about cross-country collaboration

Airbus, a global leader in the aerospace industry, is a remarkable example of how cross-country collaboration can lead to market leadership. In 1967, ministers from France, Germany and Britain signed a declaration aimed at strengthening European co-operation in the field of aviation. The countries had realized that combining European efforts was the only way they would be able to compete with the dominant American aerospace industry. This partnership allowed the countries to pool resources, share expertise, and distribute financial risk. To this day, components are still manufactured across several European countries prior to assembly, enabling the various benefits from specialization of competence throughout the value chain.

The Airbus case further shows how strategic governmental intervention and market forces can be combined to accelerate industry development. The Airbus program was initiated by cross-country governmental collaboration, and in the first years the governments provided financial support for research and development. Over the years, their financial contribution was gradually reduced, and from 1989, Airbus projects were fully self-financed. [25] [26] [27].

Summary and conclusion

This study affirms that the Scandinavian countries are particularly well-positioned to excel in the growing offshore wind industry. Not only by expanding their domestic capacity, but rather especially by supplying global markets. The foundation for this is strong, with Denmark's pioneering industry leadership, Norway's offshore expertise, and Sweden's industrial capacity, offering a unique opportunity for cross-border collaboration and learning to develop a globally competitive industry.

To accelerate the growth of the Scandinavian offshore wind industry, four main levers must be utilized:

Specialize:

Build upon existing capabilities within the industry and develop an ecosystem that supports enhancement of relevant competence. This specialization will enhance the region's ability to advance and remain competitive on a global scale.

Sustainability:

Develop the industry based on sustainable practices throughout the value chain, from development to decommissioning. Embracing sustainability can enhance the Scandinavian countries competitive edge, distinguishing them from regions that prioritize cost-efficiency.

Scale:

Enable scaling of new and existing equipment and services through standardization, high-volume manufacturing and industrial digitalization. Scaling will enable the industry to supply the increasing demand in an efficient and cost-effective manner.

Synchronize:

Share learnings and practices across borders, and adopt best practices regarding regulatory frameworks and financial support schemes. Coupled with strategic collaboration, this will create a cohesive market that leverages the strengths of each country, while fostering a robust and unified industry.

By focusing on these levers, Scandinavian countries can not only meet their domestic offshore wind targets but also develop an industry capable of serving global markets. Collaborative efforts between Denmark, Norway, and Sweden will be crucial in achieving this vision, ensuring that the region remains at the forefront of offshore wind development and innovation.

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Bibliography

[1] International Energy Agency (IEA), *"CO2 Emissions in 2023 - A new record high, but is there light at the end of the tunnel?,"* 01 03 2024. [Online]. Available: https://www.iea.org/reports/co2-emissions-in-2023.

[2] Global Wind Energy Council, *"Global Offshore Wind Report 2024,"* 2024. [Online]. Available: https://gwec.net/global-wind-report-2024/.

[3] International Energy Agency, *"Offshore Wind Outlook 2019,"* 2019. [Online]. Available: https://www.iea.org/reports/offshore-wind-outlook-2019.

[4] F. Lucía , *"Capacity forecast of offshore wind in Europe 2028, by country,"* Statista, 2023. [Online]. Available: https://www.statista.com/statistics/708836/offshore-capacity-europe-forecast/.

[5] F. A. Government Offices of Sweden, *"Government.se,"* 2024. [Online]. Available: https://www.government.se/contentassets/cc8b5c6c15724583855273c16111662b/strategy-for-swedens-trade-investment-and-global-competitiveness.pdf.

[6] Innovasjon Norge, *"Offshore Wind Entry Programme,"* 2024. [Online]. Available: https://kompetansesenter.innovasjonnorge.no/kurs/offshore-wind-entry-programme.

[7] Menon Economics, *"Kan Norge tette eksportgapet"* 2020. [Online]. Available: https://www.menon.no/wp-content/uploads/2020-85-Kan-Norge-tette-eksportgapet.pdf.

[8] Norsk Industri, *"Samarbeidsforum for havvind"* 2024. [Online]. Available: https://www.norskindustri.no/dette-jobber-vi-med/energi-og-klima/norsk-industri-om-vindkraft/samarbeidsforum-for-havvind/internasjonalisering-og-eksport/?chapter=579808#part2.

[9] NTB Kommunikasjon, 2024. [Online]. Available: https://kommunikasjon.ntb.no/pressemelding/18058243/eksfin-stiller-seks-milliarder-kroner-i-lanefinansiering-til-orsted-aibel-skal-bygge-plattformer-til-britisk-havvindpark?publisherId=6029228&lang=no.

[10] European Investment Bank, 2024. [Online]. Available: https://www.eib.org/en/projects/loans/index.htm?q=offshore+wind&sortColumn=sector&sortDir=asc&pageNumber=0&itemPerPage=25&pageable=true&language=EN&defaultLanguage=EN&loanPartYearFrom=1959&loanPartYearTo=2024&orCountries.region=true&orCountries=true&secto.

[11] Danish Energy Agency, *"Offshore wind farms tendered towards 2030,"* ENS, 2024. [Online]. Available: https://ens.dk/en/our-responsibilities/offshore-wind-power/ongoing-offshore-wind-tenders/offshore-wind-farms-tendered.

[12] T. N. Government, *"Regjeringen.no,"* 2022. [Online]. Available: https://www.regjeringen.no/contentassets/78bfc87bb04044c0933002ad7dd6e0f1/erklaring-energiministere.pdf.

[13] Multiconsult, *"Kartlegging av de norskbaserte næringene for fornybar energi og hydrogen i 2022"*, 2023.

[14] *"Offshore wind energy: Patent insight report,"* European Patent Office (EPO) and International Renewable Energy Agency (IRENA) , 2023.

[15] International Energy Agency, *"A Global Review of Patent Data for Smart Grid Technologies,"* 2024.

[16] B. Aslesen, *"Flytende Havvind,"* 2022. [Online]. Available: https://www.menon.no/flytende-havvind/.

[17] Havvind.no, *"Kompetanse,"* 2024. [Online]. Available: https://havvind.no/tema/kompetanse.

[18] Utdanning.no, *"Ingeniør,"* 2023. [Online]. Available: https://utdanning.no/yrker/beskrivelse/ingenior.

[19] ALP Consulting, *"Top 10 Highest Paying Countries for Engineers,"* 2023. [Online]. Available: https://alp.consulting/top-10-highest-paying-countries-for-engineers/.

[20] WindEurope, *"Financing and investment trends: The European wind industry in 2019"*, 2021. [Online]. Available: https://windeurope.org/wp-content/uploads/files/about-wind/reports/Financing-and-Investment-Trends-2019.pdf.

[21] T. U. F. Reserve, *"Schwab,"* 2024. [Online]. Available: https://www.schwab.com/learn/story/fomc-meeting.

[22] Allianz, *"A turning point for offshore wind - Global opportunities and risk trends,"* 2023. [Online]. Available: https://www.allianz.com/content/dam/onemarketing/azcom/Allianz_com/press/document/Allianz-Commercial_A-turning-point-for-offshore-wind.pdf.

[23] Enerdata, "*Electricity balance of trade*", 2024. [Online]. Available: https://yearbook.enerdata.net/electricity/electricity-balance-trade.html. [Accessed 08 08 2024].

[24] NedZero, *"News,"* 2023. [Online]. Available: https://www.nedzero.nl/en/news/the-north-seas-standard-enable-growth-with-wind-turbine-standardization#0.

[25] S. I. W. Amir R. Amir, *"Britannica Money,"* 2024. [Online]. Available: https://www.britannica.com/money/Airbus-Industrie.

[26] Airbus, *"Newsroom,"* 2018. [Online]. Available: https://www.airbus.com/en/newsroom/stories/2018-05-focus-on-how-an-aircraft-is-built.

[27] Airbus, *"Airbus.com,"* 2024. [Online]. Available: https://www.airbus.com/en/our-history.

[28] Regjeringen, *"Havvind"*, 2022. [Online]. Available: https://www.regjeringen.no/no/tema/naringsliv/gront-industriloft/havvind/id2920295/.

[29] Hav och Vatten myndigheten, "*Planer för vindkraft till havs ute på ett sista samråd"* 2024. [Online]. Available: https://www.havochvatten.se/arkiv/aktuellt/2024-05-16-planer-for-vindkraft-till-havs-ute-pa-ett-sista-samrad.html.

[30] WindEurope, *"The EU built a record 17 GW of new wind energy in 2023 – wind now 19% of electricity production"*, 2024. [Online]. Available: https://windeurope.org/newsroom/press-releases/the-eu-built-a-record-17-gw-of-new-wind-energy-in-2023-wind-now-19-percent-of-electricity-production/.

[31] Institute for Global Sustainability, *"What are capacity factors and why are they important?"*, Boston University, 2024. [Online]. Available: https://visualizingenergy.org/what-are-capacity-factors-and-why-are-they-important/.

[32] Menon Economics, *"Kompetansebehov i norsk havvindnæring frem mot 2035"*, 2023. [Online]. Available: https://www.menon.no/gigawatt-krever-megaloft-kompetansebehov-i-den-norske-havvindnaeringen-frem-mot-2035/.

[33] Business Sweden, *"Sweden´s offshore wind supply chain"*, 2023. [Online]. Available: https://marketing.business-sweden.se/acton/media/28818/the-swedish-value-chain-within-offshore-wind----opportunities-for-green-jobs-and-exports.

[34] Hitachi Energy, *"Press Release"*, 2024. [Online]. Available: https://www.hitachienergy.com/news-and-events/press-releases/2024/06/hitachi-energy-to-invest-330-million-3-7-billion-sek-in-sweden-and-hire-additional-2-000-employees-by-2027-to-accelerate-the-clean-energy-transition.

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