JOB CREATION IN A NEW INDUSTRY

LEARNINGS FROM DENMARK'S OFFSHORE WIND JOURNEY

Danish Energy Agency

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Disclaimer

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Foreword

Creation of new green jobs is an integral part of a just transition to a more sustainable future. Denmark has been a prime example of this, as the growth of the offshore wind sector has led to a substantial increase in the number of employees working in the wind industry.

To understand how this was achieved, and to share learnings with other countries, this report examines the initiatives implemented by both the public and private sectors to support successful job creation in the Danish offshore wind sector.

The results of the analysis demonstrate that job creation from the offshore wind sector can be achieved without the need for large national interventions or explicit local content requirements. Instead, job creation has largely been driven by local and regional solutions, initiated by private sector businesses and local and regional stakeholders, to meet market opportunities and demands.

By sharing our practices with other countries, Denmark wish to promote the growth of the offshore wind sector globally and create new opportunities for job creation, economic growth, and prosperity around the world. As the General Director of the Danish Energy Agency, I am, therefore, pleased to present this report, which serves as an example of what is possible when the right conditions are in place.

I hope the report will be seen as an inspiration for other countries and serve as a useful tool in the green transition.

Kristoffer Böttzauw
Director General, Danish Energy Agency

For more information on the work carried out by the Centre for Global Cooperation please visit: https://ens.dk/en/our-responsibilities/global-cooperation

Executive summary

This analysis focuses on job creation in the offshore wind industry in Denmark. Whilst previous studies have focused on what created growth in the industry in the 2000s, little information has been available on drivers and public sector mechanisms and initiatives supporting job creation. This study seeks to rectify this. Job creation, and ultimately job retention, occurs when job demand, powered by sector growth, is matched with the right skills and competencies. In Denmark, job creation in the offshore wind industry is driven by an ability to meet the growing demand for skills at the local, national, and international level.

The present analysis shows that job creation in the 2000s is grounded in an interplay between four domains 1) the political and regulatory environment, 2) the economic and investment environment, 3) network and organisation, and 4) competencies and knowledge.

The political and regulatory environment played an important part in removing barriers, ensuring favourable conditions and minimising risks for companies. This provided a safe investment environment that enabled the industry to attract and retain investments crucial to its growth. Another important factor has been the ability to organise, develop, and direct local competencies, made possible through a strong network and organisation of stakeholders in the offshore wind ecosystem. This connectedness has enabled local suppliers to deliver their services to the offshore wind industry and to accommodate the increasing international demand, thereby securing job growth.

Meanwhile, the ability to maintain high levels of specialisation and competitiveness has been a key driver for job retention, and competencies and skills continue to play a key role in securing adequate skill supply. In the Danish case, existing competencies and skills from other industries helped ensure an influx of relevant labour to the offshore wind industry, especially in the initial stages. Later, wind power companies have ensured future offshore wind competencies by focusing on growth, upskilling and specialization. Because of this, the Danish offshore wind industry has been able to secure job creation without the need for local content requirements.

In conclusion, the results presented in this report show that job creation in the Danish offshore wind industry can be attributed to a multitude of factors. It is not only a result of national employment policies, but rather of local and regional initiatives developed by businesses and local stakeholders with the purpose of meeting market opportunities and demands.

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1. Introduction: Background and aim of the study

Since 2010, global offshore wind capacity has increased more than fourfold, and the industry has proven to undergo one of the largest expansions in deployment across different sources of electricity technology. Historically, growth in the offshore wind industry has primarily been fostered in European countries. Countries bordering to the North Sea have favourable conditions, as wind resources here are plenty and waters relatively shallow[1]. In Denmark, the first offshore wind farm was created in 1991[2]. Figures from the industry, estimates that 30 years later, Denmark employs close to 33,000 people in the offshore wind industry, equivalent to 2% of the private sector employment[3]. Region of Southern Denmark (2017) estimates that a revenue of 62 billion DKK was obtained in 2015, clearly indicating the successful creation of an offshore wind industry.

As the demand for a rapid transition to more sustainable energy grows, the offshore wind power capacity is set to increase significantly worldwide by 2040, with an estimated expansion of 13% per year[4]. This represents a significant potential to engage local competencies. In this process, development of efficient supply chains has been important to keep costs down when establishing offshore wind farms. However, this is also a complex and challenging task, estimated to call for multibillion-dollar investments across the different components that make up the supply chain[5]. The Danish offshore industry has been successful in both creating but also retaining jobs in the offshore wind industry and has managed to develop a supply chain that not only operates at national level but also internationally. In the following, the Danish offshore wind industry serves as a case example for understanding the key drivers as well as policy mechanisms and measures behind job creation and retainment in Denmark. This, as a lever for both successful industry growth and employment.

1.1. Purpose and methods

Against this backdrop, the objective of this analysis has been to explore the dynamics and key drivers behind the evolvement of Danish job creation in the offshore wind industry, from the early 2000s and onwards, focusing on job creation as well as job retention. The analysis aims at identifying key learnings and principles behind the Danish job creation success, with a primary focus on policy measures at national and local level, organisational and network efforts, competencies and knowledge base as well as the economic and investment environment.

The following key questions have been explored in the study: How was Denmark able to create jobs (and an industry) from offshore wind farms, when the sector was emerging and in its infancy? Were there any specific policies, initiatives, or strategies to support job creation, and were there any measures ensuring the right talent, skills, and labour were available? Did job creation just happen by chance without any real intervention? How has Denmark successfully created a sizeable industry from offshore wind farms without local requirements as regards to content?

Findings from the study presented in this report intends to outline defining drivers and barriers for the ability to create jobs in the Danish offshore industry. Countries with emerging offshore wind markets can hopefully feel inspired by the report and potentially adopt some of the measures and initiatives instigated by Denmark

[1] International Energy Agency 2019
[2] State of green. 2021
[3] QBIS, 2020
[4] IEA 2019
[5] QBIS 2020

to help secure the economic development and job creation benefits linked with developing an offshore wind market.

While the historical development of the offshore wind industry has been thoroughly described in literature and studies, the key drivers and policy measures for job creation have historically been scarcely addressed. Because of this, the analysis about key drivers for job creation in the Danish offshore wind industry is primarily based on deep-dive interviews and a supporting document analysis. The study has explored drivers at national level through 12 deep-dive interviews with key stakeholders involved in the historical development of the industry. Further, stakeholders from three Danish offshore wind farms, Anholt, Esbjerg, and Nysted, were interviewed with the aim to provide local and regional level reflections on effective drivers for job creation. Finally, studies and additional literature have contributed with background knowledge of the industry, the growth of the industry, and the demand for skilled labour within the industry.

The study is conducted by Ramboll Management Consulting in close cooperation with DEA from June to November 2022. See appendix 1 for an overview of stakeholder interviews.

1.2. Structure of the report

The report is structured as follows:

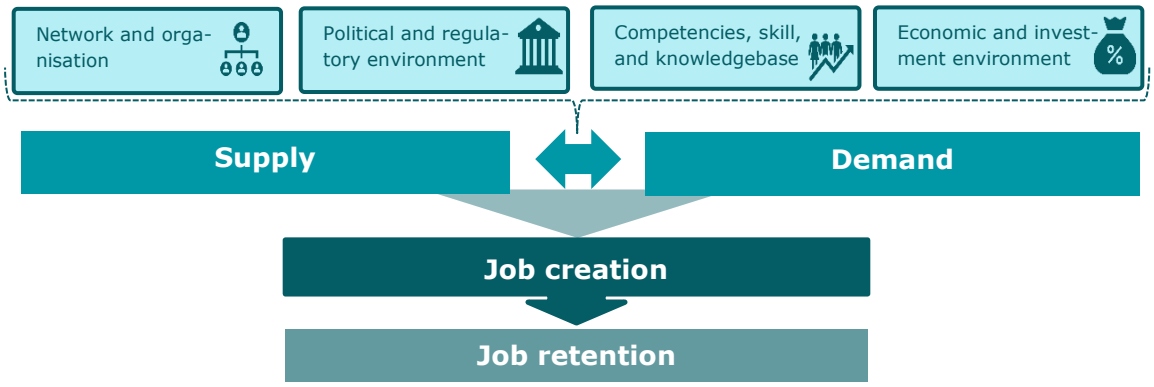
- Chapter 1 introduces the background and aim of the analysis, including the methodological and analytical framework approach applied.
- Chapters 2 sets the stage in terms of a brief introduction to the development of the offshore wind industry in Denmark and requirements as to skills and competencies arising from this.
- Chapter 3 to 6 presents the findings of the analysis divided into four main dimensions: political and regulatory environment, economic environment and investments, networks and organisation, and competencies and skills.
- Chapter 7 summarises conclusions and synthetises key findings.

1.3. Analytical framework

Overall, successful job creation is powered by an optimal match between demand and supply of skills relevant to meet the needs of the offshore industry:

- *Demand for skills* covers the nature of skills and job types needed to meet the growth and operational demands of the industry. The analysis focuses on demands closely linked to the offshore wind industry at national and local level (selected cases), whilst job creation in secondary industries (e.g., hotels, restaurants etc.) are not explored systematically. As demands for skills to a high extent are driven by the rapid growth of the industry, relevant factors from this development are included in the analysis when relevant.
- *Supply of skills* covers the ability to supply the necessary skills or competencies needed to meet the growth of the industry. As skills need to be supplied at local level, that is, for the actual offshore plants, the analysis combines general drivers from national level with learnings from different models and approaches applied in local cases.

Figure 1: Figurative illustration of the analytical framework applied



Job creation is explored in a dual perspective: Identification of drivers for immediate job creation are combined with drivers for job retention as this is a prerequisite for solid and continuous growth and benefit realisation.

Factors (drivers and barriers) for the above job creation are identified within four main dimensions as set out below:

- *The **political and regulatory environment*** focuses on national, regional, and local framework conditions influencing the industry and the development in the 2000s. Offshore wind industry is characterised by the development of critical infrastructure over a long time horizon, meaning that the political and legislative framework conditions play a major role in ensuring a stable development of the industry. Focus has been on identifying national, regional, and local policy initiatives that have affected the development of the industry and/or job creation in the industry.
- ***Network and organisation*** cover how different stakeholders in the value chain and the ecosystem work together. The offshore wind industry is characterised by large construction and operating costs, with long-range project planning and lifespans, requiring multiple elements of skill and capacity that need to

come together. Thus, for the industry to grow and enable job creation, network, organisation and collaboration in the industry are factors of great importance.

- *The **economic and investment environment*** focuses on the ability to attract financing in the industry and as such the ability to establish large projects such as Horns Rev and Nysted (former Rødsand) offshore wind farm. As initially explained, financial costs make up for a large part of establishing offshore wind farms, and the ability to attract these investments plays an important role for the development of the industry. Thus, this section focuses on measures launched in Denmark to ensure such investments and economic viability of the wind farms. Some of the content within this dimension borders on the political and regulatory environment, as political measures undertaken were instrumental in securing the investments made in the Danish industry. However, the perspective taken is the independent role and importance of the economic aspects related to offshore wind.
- ***Competencies and skills*** cover drivers and initiatives which have played a role in attracting and developing the right competencies and skills to ensure the right knowledgebase for creating jobs and growth in the industry. We have assessed whether the initiative to develop competencies has emerged from a governmental level and if so, from the national, regional and/or local level, or if the development was powered by companies, industry associations and the like, or a mix. The analysis differentiates between competencies and skills in accordance with the definitions included in the box below:

In the report competencies and skills are defined as follows:

- **Competencies**: The ability to do something successfully or efficiently due to knowledge, skills, learned behavior or attitudes. Usually takes time to acquire and not easily transferable between individuals or units.
- **Skills**: Learned or applied abilities to utilize one's knowledge effectively when executing tasks, projects, or performances. Skills are relatively agile and transferable as it can be done e.g., through training in a matter of days.

It has not been possible to distinguish clearly between the two concepts used by the interviewees. We therefore refer to the two concepts in conjunction throughout the report.

2. The Danish offshore wind industry

This chapter presents the historical background (Section 2.1) and the demand for skills in the offshore wind industry (Section 2.2).

2.1. Historical background

A precise start date for the political interest in wind power in Denmark is not easily established. However, during the oil crisis in the 1970s, the introduction of oil prices at quadrupled rates created great incentives for the Danish government to explore alternative energy sources apart from oil[6]. DEA was established in this context as well as the government's "Danish Energy Policy 1976"[7]. The motives at the time were almost purely economic as politicians sought to secure energy supply and a higher degree of self-sufficiency in general[8], but increased funding for research and development in wind energy was also granted by the government in 1976[9]. Environmental considerations did not seem to be a key driver before the 1980s, but in the wake of the Brundtland report from 1987 it grew to become a primary political driver for the development of wind energy onshore as well as offshore[10].

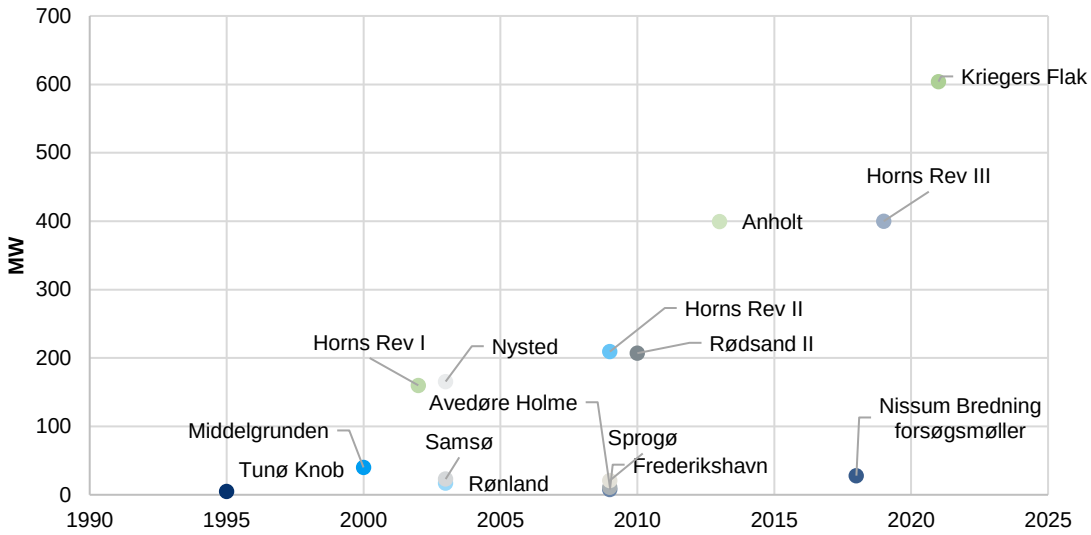
Some of the first steps to establish wind power were taken already in the 1970s and 1980s when the potential of wind power was investigated more thoroughly[11]: The establishment of a Test Station for Wind Turbines at Risø National Laboratory in 1978 is a prime example of this increased focus on research[12]. From 1979, the wind turbine industry was supported by a 30% installation subsidy of all project costs, but this subsidy was gradually reduced until it was finally removed completely in 1989[13]. In terms of offshore wind – the focus of this study – some key steps to establish this industry were taken in 1985 when the Danish Ministry of Energy along with what was then known as Union of Danish Power Plants (now called Danish Energy) agreed to build and install 100 MW of wind turbines before 1990. Of the 100 MW, 45 MW had to be in the Eastern part of Denmark. However, finding the exact locations on land proved to be difficult, and as a result the utility companies investigated the possibilities to place a wind farm offshore. The result in 1991 was an offshore wind farm of 4.95 MW placed near Vindeby on Lolland – the first offshore wind farm in the world[14].

Since then, the wind turbine market has continued to grow, which in turn made it even harder to find a place for them on land. Due to solid experience from the first offshore wind farms, it became increasingly more promising to build offshore wind farms in even larger scales. A paramount agreement was made in 1998, when Svend Auken, former Minister for Energy and Environment, required Elsam and Elkraft (at the time, two associations consisting of different state-owned utilities) to build and install five wind farms of about 150 MW each, and obtained approval of the establishment of additional coal power plants. Of these five wind farms, only "Horns Rev 1" and "Nysted 1" went into construction, while the remaining three were cancelled by the government elected in 2001. The conditions in the 1990's was characterized by a large political will and a stable regulatory environment, where concrete initiatives were undertaken to support investment security and efforts to support grid development. The period from 1996 and until 2004 was characterised by a

[6] Lemming, Andersen & Madsen 1999
[7] State of Green. 2021
[8] Petersen & Thorndahl 2014
[9] State of Green 2021
[10] Ibid.
[11] Petersen & Thorndahl 2014
[12] Petersen & Thorndahl 2014, Lemming, Andersen & Madsen 1999
[13] Lemming, Andersen & Madsen 1999
[14] Petersen & Thorndahl 2014

sufficiently stable political environment to secure a steady growth in the industry, e.g., by a fixed price on offshore wind farm electricity and R&D support for wind turbines[15]. Figure 2 illustrates a timeline of the establishment of the Danish windfarms, including the capacity of each windfarm.

Figure 2: Timeline of the establishment of Danish offshore windfarms, including capacity measured in megawatt.



Data source: https://ens.dk/ansvarsomraader/vindenergi/havvindmoeller-og-projekter-i-pipeline

As Denmark was one of the first countries to establish national wind farms, it was possible to benefit from this experience in the transition from the national to the international offshore wind market. Here, Danish wind companies and suppliers were able to successfully lead and integrate into the global supply chain of offshore wind[16]. In effect, this matured the Danish offshore wind industry to use its first mover advantage to retain development and competitiveness on the international market.

2.2. Demand for skills in the offshore wind industry

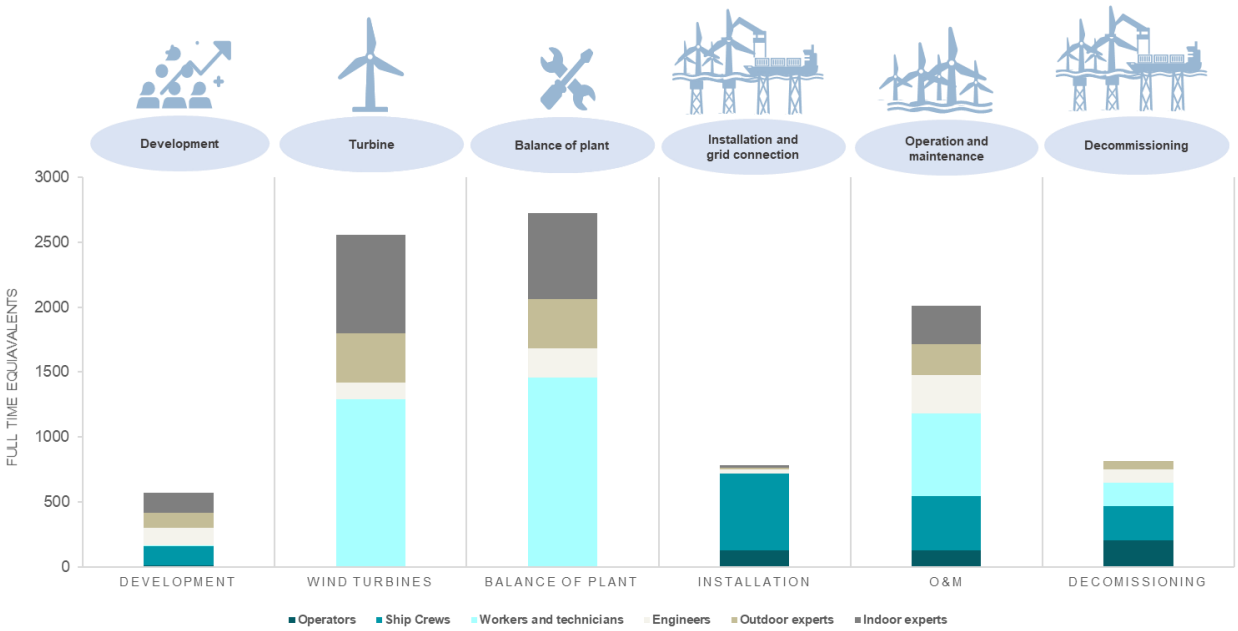
During the past 20 years, the development of offshore wind has gone through a rapid growth and technological development. The growth in the Danish offshore wind production has steadily increased from 2000-2021 and since the first offshore windfarms were established, the capacity of the installed turbines has increased significantly. Through the 2000s and 2010s, offshore wind technology developed dramatically, both reflected in turbine size, tip height, and maximum output. The number of offshore wind turbines is now higher than onshore wind turbines, and Denmark´s offshore wind capacity has increased from 5 MW installed capacity in 1995 to 2.300 MW in 2021[17]. In parallel, from 2010 and 2018 the turnover accruing from the Danish offshore wind industry is estimated to have increased from around 2.1 to 5.3 billion USD[18].

The nature of the technological development of offshore wind energy contrasts with the production of onshore wind energy on several parameters: For one, there are less obstacles regarding size, noise, light, and aesthetics regarding offshore wind compared to onshore wind, thus making public perceptions easier to manage. On the other hand, offshore wind plants are more challenging to build, operate, and maintain, thus

[15] Ibid.
[16] QBIS 2020
[17] Data source: https://ens.dk/service/statistik-data-noegletal-og-kort/data-oversigt-over-energisektoren
[18] QBIS 2020

require specialized knowledge and skills. For example, transport and installation of offshore foundations and substations require special vessels. In addition, when the turbines are up and running, maintenance is more difficult compared to onshore maintenance due to harsh conditions offshore, and maintenance is often performed using special equipment. The logistic challenges and need for special solutions make capital costs high, especially when compared to other forms of energy production. Figures from QBIS (2020) estimates that capital costs amount to between 55-75% of total expenses (CAPEX +OPEX). Capital costs are set to accrue within the development, production, and installation phase (25-42 months), whereas operating costs are assumed to accrue over a 25-year period.

Figure 3: Employment according to profession over the lifetime of an offshore wind farm.



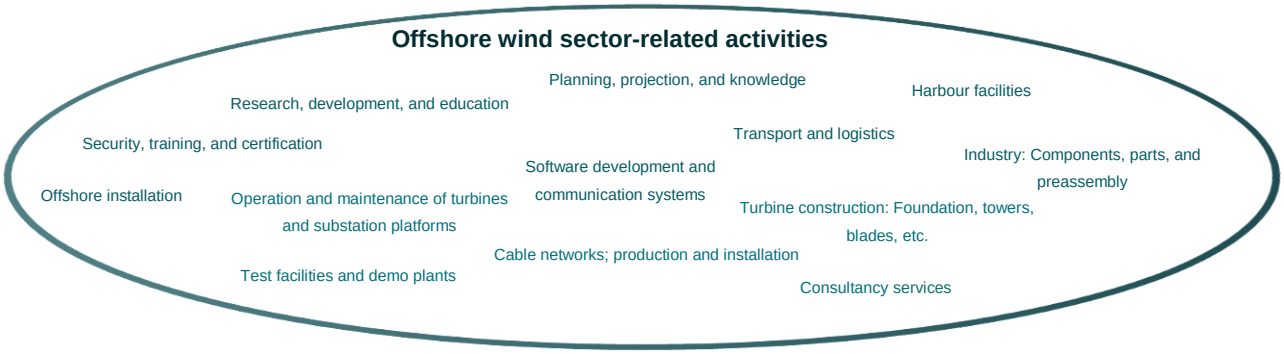
Note: Graph is made based on figures from QBIS (2020). Data source: from Statistics Denmark, Ørsted, Vattenfall, Siemens Games, Semco, BVG Associates (2016 and 2019) and IRENA (2018b).

The characteristics of offshore wind, briefly outlined above, hold implications for the skills required to support the development and thus for the type and capacity of jobs created: From development of a project to decommissioning there is a need for offshore-specialized workers and technicians, ship crews, operators, engineers, as well as experts with knowledge regarding everything from logistics, health and safety, environmental aspects to administrative tasks, regulation, financial aspects, etc. as illustrated in figure 3

The group with the most intensive labour input when considering the lifetime of offshore windfarms, are the industrial and civil workers and service technicians[19]. It is noteworthy that these specialized competencies did not reside within the Danish industry in the initial stages but were developed over time from the establishment of the first offshore wind farms and in particular through the 00s. This will be elaborated further in the analysis. Figure 4 illustrates some examples of common offshore industry-related activities and activities that are specific for the offshore wind industry[20].

[19] QBIS 2020 and IRENA 2018
[20] Langkilde et al. 2015

Figure 4: Examples of offshore-related activities and examples of offshore wind related activities.



3. Political and regulatory environment

Section 3 presents the main findings regarding the political and regulatory environment and how this affected supply and demand respectively with regard to jobs within the offshore wind industry. Firstly, the most important state level policies and initiatives for job creation and retention are addressed (section 3.1), followed by section 3.2 addressing the identified locally based policies and initiatives.

Key takeaways

The political and regulatory environment has been instrumental in securing framework conditions enabling development of – and growth – within the sector in Denmark. Ultimately, growth in the sector is expected to affect demand of the national job creation. However, it has not been possible to identify specific employment initiatives derived from political or regulatory frameworks.

Local policy initiatives have played a role, particularly in terms of investments in local infrastructure to support the development of the offshore wind sites. Again, this has formed an important basis for developing and anchoring sector development, but without reflecting concrete employment initiatives. Anholt has, however, served as an exemplary case where local authorities took measures to support local employment. This was done by participating in facilitating matchmaking between main suppliers and local SMEs and, in addition, by safeguarding buildings at the harbour for activities related to service, operation, and maintenance.

3.1. National policies and the political priorities

All interviewees have elaborated on national policies and political priorities, of which were considered as defining for the offshore wind industry's development in Denmark. However, national policies have primarily been drivers for growth in the industry, meaning that the primary effect has been to help establish a *demand* for jobs.

Since the 1970s and 1980s, focus has been on alternative energy sources in general, and since the beginning of the 1990s, on offshore wind in particular in Denmark. The Danish energy and environmental policies formulated around the turn of the millennium formed the basis for concrete initiatives supporting offshore wind growth, and eventually the establishment of Horns Rev I and Nysted. In addition, the relevant legislative framework was adequately adjusted to support this development. The aforementioned political agreement on a guaranteed price on electricity produced by offshore wind, coupled with an obligation for utility companies to connect the offshore windfarms to the electricity grid, significantly reduced the economic risks associated with establishing new offshore wind turbines[21].

However, no specific national policy initiatives targeting job growth existed in the offshore wind industry in the 1990s and 2000s. As described above, the policy initiatives were primarily directed towards ensuring favourable conditions for the offshore wind industry to grow, but the actual job creation and subsequent

[21] State of Green 2021

retention was driven by other factors internally in the wind turbine and utility companies, and furthermore by initiatives in the ecosystem surrounding these companies.

3.2. Local policy initiatives

National policies targeted the offshore wind industry primarily influenced the development and growth of the industry. Along the same line, local policy initiatives were aimed at anchoring the industry locally through for instance the development of local ports, and therefore primarily affected the demand of job creation.

Results from interviews reflect that municipalities have initiated local policy initiatives with the aim of ensuring and supporting vital investments in infrastructure and local planning to facilitate local anchoring of offshore wind. For example, in most cases it has been necessary to adjust local infrastructure to meet the requirements of offshore wind supporting the development of offshore wind anchored locally. To ship large wind turbines, access to and from the harbour has in several cases (such as Esbjerg) been tailored through expansions and/or adaptation of local infrastructure (e.g., roundabouts and crossroads) as well as harbour facilities.

Furthermore, the engagement of local authorities has played a role as the Danish industry matured. The

Case example: Anholt

The case of Anholt serves as a good example of how local authorities have focused on not only anchoring sector development locally but also supporting local employment prior to the establishment of Anholt Windfarm. The local municipality undertook initiatives in collaboration with e.g., DONG (former) and Djurs Windpower (former) to match local SMEs with main suppliers prior to the construction phase. Thus, cooperation between main suppliers and local SMEs was established prior to the project. This made a huge difference, especially for the local SMEs, as many had been struggling to fill their orderbooks prior to the construction phase of Anholt Windfarm. The Municipality of Norddjurs bought an old service building at the harbour with the intention to secure that operation and maintenance activities would be locally anchored. The municipality furthermore invested in Djurs Windpower to ensure that a local network was established.

Source: Content from interviews.

Port of Esbjerg is a good example of how focus on continuous infrastructural planning and adaptation of the harbour to meet the market demands from the industry has facilitated continued development and subsequently retention of jobs. As the industry grew, the local infrastructure and the harbour have been tailored to enable handling and shipping of turbines. Today, the harbour is able to manage preassembly and to ship preassembled elements. Also, at Port of Grenaa the municipality invested in harbour facilities, thus making the harbour attractive as an installation port.

However, as with national policy initiatives, no local policy initiatives directly aimed at job creation and retention existed. Rather, local policy initiatives focused on securing a local anchoring, thus ensuring demand and laying the foundation for job creation. The case of Anholt probably serves as the best example of how the Municipality of Norddjurs invested in creating advantageous conditions for local companies to engage in offshore wind, thereby countering the challenges of increased unemployment prevalent in the municipality at the time. The actual skill development of local companies was not supported by the municipality, but

Norddjurs succeeded in engaging the local companies, subsequently making them able to tap resources from labour available derived from the establishment of Anholt Windfarm.

4. Economic and investment environment

Section 4 includes main findings from interviews related to the economic and investment environment aspects. Firstly, subsection 4.1 describes main points of how investments were drawn in to offshore wind, especially in the early 00s. Subsection 4.2 outlines how a focus on cost reductions has been stated working as a lever for competitiveness in the Danish offshore industry. The analysis indicates that the ability to secure a favourable economic and investment environment played a vital role in terms of developing the offshore wind industry in Denmark. Especially, the initial growth of the industry.

Key takeaways

The ability to secure sufficient and favourable economic conditions for the offshore wind projects, thus consolidating investments, has repeatedly been stated among the respondents included in this analysis as having been central in the Danish offshore wind case. The results from interviews suggest that a safe investment environment in the initial stages of the sector's emergence, first and foremost was created through the regulatory framework conditions stipulated as fixed prices on offshore wind farm electricity. Later, the Danish Pension Funds played a role in terms of financing offshore wind farms.

The ability to reduce costs has been important in keeping the Danish offshore industry competitive. The high costs of energy production associated with offshore wind is a central characteristic and addressing this has been stated to play a role in terms of creating an economically viable sector. This has been done in part by focusing on introducing and applying improved technology, industrialisation, and standardisation of processes, thereby streamlining processes and the costs associated with the offshore wind projects. However, equally important has been the ability of the Danish wind power producers to use their first mover advantage to target international markets and involve their suppliers in projects abroad. A prevalent *open-book* approach has supported knowledge, competencies, and skill related to cost-out, among other things, to be shared within the ecosystem. Eventually, this supported the maintenance of a competitive Danish offshore wind sector.

4.1. The investment environment

Offshore wind power is characterised by large investment costs per MW[22]. In this regard, the offshore wind industry differs remarkably from the onshore wind industry, meaning that – as the industry emerged in Denmark – the necessary investments were on a much larger scale.

In the early 00s, investments in offshore wind in Denmark were ascribed to the large Danish utility companies: DONG, Elsam, E2, among others. With an immature industry, large up-front investments and largely unknown risk levels external investors were difficult to attract. However, and notably, the guaranteed fixed price on electricity ensured the ability to finance the first projects in Denmark. Whilst the offshore wind industry was still in its infancy, the 12 years of a guaranteed fixed price on electricity was a key element that made the companies see a favourable business case for investing in the industry. This initiative also lowered

[22] Andersen et al. 2014

the risk associated with investments in offshore wind, thus increasing the ability to attract investors, which again strengthened the demand.

As the industry matured, the Danish Pension Funds became very defining in relation to financing offshore windfarms. Some of the major well-driven pension funds were able to invest after the first offshore windfarms had been up and running a few years. At this point, risk associated with construction was no longer an issue, and results from the first Danish projects suggested the investments to be safe. Together with Danish investment funds, this ensured the ability to secure funding for the continued establishment of offshore windfarms as the industry matured. Thus, with time, the demand for jobs became even stronger.

4.2. Cost reduction as a lever for competitiveness

The ability to reduce costs has been important in keeping the Danish offshore wind industry competitive and arguably to affect the ability to ensure ongoing job creation and retention. However, the Danish wind power producers also benefited from being first movers and from being able to involve their suppliers abroad. In some cases, for instance in Esbjerg, local suppliers have also been able to collaborate with international wind power companies[23]. This has provided the Danish offshore wind industry a competitive advantage and has also created jobs. For instance, the Danish suppliers' labour input to offshore wind farms in other EU countries than Denmark was assessed to around 3,133 direct FTEs per GW, based on a 35% Danish market share of the EU offshore wind farms[24].

Interviewees have pointed to the fact that as the Danish offshore industry matured, focus on reducing the costs associated with construction, operation, and maintenance intensified. As an example, cluster organisations and consultancies within the sector were mapping costs associated with different parts of the value chain. The focus was on how new technology, industrialisation, and optimisation would lead to cost reductions. This allowed for a process of standardisation of multiple operations. Interviewees pointed to the fact that this has kept the Danish industry at the forefront of competition. Moreover, the knowledge base and skills as to how to build and operate windfarms cost-effectively was developed within the Danish offshore wind industry and workforce and thus resided with it. It is stated by interviewees that this helped accelerate the development and competitiveness of the industry. However, the ability to expand abroad and thereby reach economies of scale also played a key role in ensuring competitiveness within the Danish offshore industry.

Interviewees have ascribed the reduction of costs to three primary factors. The first factor is the aforementioned economies of scale because of internationalisation. Secondly, industry organisations have been good at predicting what the market needs and demands from the Danish companies within the industry in terms of skills and competencies. And thirdly, the Danish ecosystem has been defined by a prevailing *open-book* principle. This has allowed for knowledge and experience to flow more freely. Interviewees have described this as an important factor, because it has ensured development of both skills and competencies and supported cost reductions among the companies in the value chain. In turn, this has increased competitiveness for the Danish offshore wind industry to an extent where it would be possible to engage the Danish offshore wind value chain in international projects, especially demand for job creation.

23 QBIS, 2020
24 QBIS, 2020

5. Network and organisation

Section 5 outlines the influence of network and organisation linking knowledge and competencies, subsequently describing the influence in terms of creating and retaining local jobs in the Danish offshore industry. Firstly, section 5.1) outlines how networks and relations to other related industries have resulted in an influx of existing competencies and skills to be adapted to the specifics of the offshore wind industry. Secondly, in section 5.2 it is described how organised networks of local suppliers have facilitated their connection to the demand for jobs in the emerging industry and how these subsequently have been retained. Section 5.3 includes a brief outline of how trust, collaboration, and local entrepreneurship have constituted a prevalent factor for the Danish offshore industry, followed by section 5.4 addressing how networks have acted as a driver for increased specialisation and competitive development.

Key takeaways

Network and organisation of the stakeholders engaged in the offshore wind ecosystem have been pivotal in terms of ensuring local (as well as national) job creation, and furthermore to retain the jobs created. An important factor has been the ability to organise, develop, and direct local competencies and ensuring the right match with main suppliers of the offshore projects. Linked to this, a high degree of trust and horizontal cooperation has been essential for sector growth, job creation, and competency development.

Initially, relations and network to other related sectors (offshore oil and gas, onshore, and other) have ensured that the offshore wind sector has experienced an influx of readily available competencies from these sectors. This was e.g., facilitated by organizing offshore wind under the same cluster organization as offshore oil and gas.

Organizing and matching local competencies, e.g., residing within SMEs, have been important in terms of making them interesting and relevant for the major main suppliers in projects. Anholt Windfarm serves as a great example of how this has been possible. Efforts to enable local SMEs with relevant capabilities and knowledge on e.g., necessary security measures to engage in offshore wind, has helped to consolidate local economic development for the project.

Generally, organized knowledge base networks have supported development, sector growth, and specialization of the workforce. This again, as a driver for competitiveness within the Danish offshore sector as the sector matured, and as such, supported job creation and job retention both locally but also based on an increasingly international order book.

5.1. Developing networks to ensure growth and collaboration

The conducted interviews indicate that network and relations to stakeholders in related industries have played an important role in terms of creating jobs in the Danish offshore wind industries, especially in the early 00s. As the industry emerged and a demand for qualified skills developed, no specialised knowledge

on how to build and operate wind turbines offshore existed. Due to networks and relations to other industries, Denmark was able to quickly attract and develop already existing competencies and skills from other related industries (like offshore oil and gas, onshore wind, and consulting engineers) to the offshore wind industry.

Case example: Esbjerg

Offshore Centre Denmark was established in 2003 as a cluster organisation based in Esbjerg. The objective was to create a network centred around the Port of Esbjerg. Initially, the organisation was formed with a focus on oil and gas, but increasingly offshore wind became of interest. Specifically, Offshore Centre Denmark initiated B2B matchmaking events to create networks between companies in the sector, but also to create alliances with other networks in Denmark. Port of Esbjerg is a showcase in terms of how it was possible to transit from primarily being a harbour centred around offshore oil and gas to also include wind, thereby fostering local development. The B2B matchmaking resulted in local companies working closer together, subsequently creating jobs in the sector. Offshore Centre Denmark have changed the Energy Cluster Denmark, also due to an increasing international focus. The cluster organisation is a non-profit organisation.

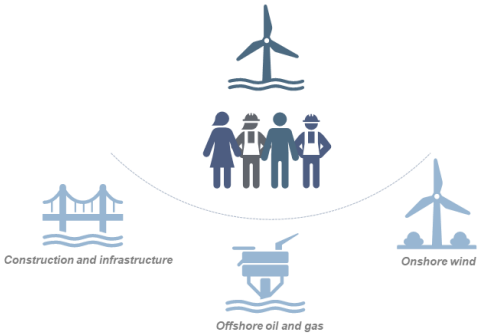
Source: Content from interviews, State of Green 2021 and Langkilde et al. 2015.

In the early 00s, Denmark already had existing competencies and skills from offshore oil and gas, a successful history of building and operating onshore wind turbines as well as competencies and skills on how to project, plan, and execute large infrastructure projects. The Danish offshore industry was successful in attracting and developing these skills and competencies to make up what would later develop to become an offshore wind ecosystem.

The spill over of competencies and skills from one industry (for instance, oil and gas) to the offshore wind industry was established through, among other things, collaboration and relations. The interviews suggest that by having such networks to other related industries, the distance between the industries in effect became shorter. This also strengthened the ability to move between jobs in different industries and created a job supply directed towards the offshore wind industry.

A good example of these networks is e.g. how a Danish cluster organisation located in Esbjerg included both offshore oil, gas, and wind. Similarly, it has been described how construction contractors and consulting companies, that had otherwise been engaged in infrastructure and oil and gas, formed internal units focused on offshore wind.

In practice this meant that the job market and the ability to specialise one owns competencies and skills further expanded with the offshore wind industry. As specialisation in offshore wind was still under development, the offshore wind industry was able to have an uptake of various basic job types, e.g., welders, electricians, and mechanics but also various types of engineers, construction contractors, and consulting services. For example, the designing of offshore wind farms called for additional competencies and skills than those of the onshore wind companies, since parameters such as



safety, working and building in hights and in a rough environment played a key role at sea. Knowledge and skills regarding some of these aspects were possible to draw from offshore oil and gas and bridge infrastructure construction.

The results of these relations are twofold. It allowed for spill-over effects particularly in the period where the industry matured and made it possible to develop specialised offshore knowledge. Furthermore, it ensured an expansion in the job market for an array of job types of which there was an abundance of. Interviewees have described how there has been an interacting influx of both competencies, skills, and job possibilities between the industries to eventually ensure both growth within the offshore wind industry but importantly also job creation.

5.2. Organising the local competencies and skills

The ability to engage and safeguard jobs in the offshore industry has largely been ascribed to the ability to organise local small and medium-sized enterprises (SMEs) and direct their competencies and skills towards the specifics of the industry. Interviews and supplementing literature point to the fact that organising, preparing, and matching local competencies and skills with major main suppliers have been fundamental in the Danish case, first and foremost to develop local jobs within the industry but also to retain jobs as maturity increased.

The mechanisms underlying the ability to match local SMEs with the major main suppliers have to a large extent been organised leadership engaged in looking forward on behalf of the SMEs. Interviewees have described how the SMEs will usually struggle to find the capacity to get an overview of necessary requirements as well as the need for upskilling to enter and operate in offshore wind. In Denmark, both the industry and cluster organisations and network have played an important role to equip the SMEs, which in effect have meant that they have been able to enter the offshore wind market. It has been underlined how this would likely not have been possible for many of the SMEs engaged in the industry today, as they would simply not have the capacity to connect with and operate in the industry.

Case example: Anholt

Port of Grenaa is a good example of how it was possible to integrate local suppliers in the installation of Anholt Wind Farm through network, collaboration between main stakeholders, and capacity building. In 2010, Djurs Windpower (later DWP System Supplier) was formed by around 10 local companies with the ambition to strengthen their competencies and skills within the offshore wind sector prior to the establishment of Anholt Windfarm.

It is suggested that a little more than 300 jobs were secured through DWP System Suppliers in connection to establishment of Anholt Windfarm. Since then, the network has grown to more than 30 members located in different parts of the country. DWP members have successfully been able to internationalise their businesses and have been working in other parts of the world since 2013.

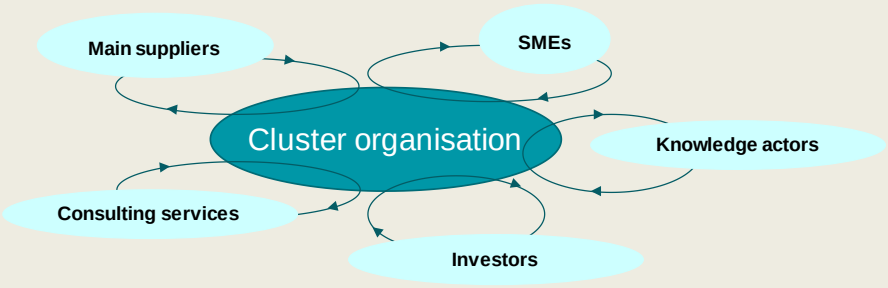
In the first years, DWP System Supplier was partly supported financially by the Municipality of Norddjurs. Since 2014/15, the network has solely been reliant financially on their members. The suppliers cover a wide range of services, contractors and subcontractors as well as suppliers of material and equipment supply.

Source: Content from interviews and QBIS 2020

On top of this, cluster and network organisations especially have worked to connect the SMEs with the main suppliers. Setting up matchmaking events between local SMEs and main suppliers of specific projects is a very concrete example of how these connections were made. By facilitating engagement, the cluster organisations provided that the SMEs were involved in the projects initiated and became a part of the value chains. As the initial connections were made, the cluster organisations furthermore took lead on equipping the SMEs with sufficient knowledge on the necessary requirements. In effect, the Danish examples suggest that by organising and supporting locally anchored SMEs, not necessarily equipped with competencies and skills to engage in the offshore wind industry, it was possible to connect them to the industry and engage as subcontractors to the main suppliers on projects. This created new market possibilities for local SMEs as well at linked them to the growth of the industry.

Cluster organisations

A cluster organisation can be characterised as a politically independent organisation, acting on behalf of the interests within a sector or cluster. The cluster organisation facilitates collaboration and connections between stakeholders within the sector and supports synergies between these. Furthermore, the organisation often works strategically with the cluster's profile, competencies, and orientation in relevant markets, or performing activities to enable and make stakeholders in the ecosystem noticeable in the market. The figure below illustrates examples of stakeholders to be engaged in a cluster organisation.



Source: Content from interviews, http://clusterexcellencedenmark.dk/ and Langkilde et al. 2015

As the industry has matured, focus on organised networks are increasingly centred around competitiveness in the offshore wind market. In an industry where development has been defined by high specialisation, it can be a challenge for minor stakeholders (e.g., SMEs) in the ecosystem to get an overview of the necessary steps to comply with market development and demands. Thus, the organised networks in Denmark revolved around the ecosystem as a whole and helped SMEs in particular with the necessary steps to orient towards the market. In effect, this has supported the retention of locally anchored SMEs, thus linking them stronger to the industry. Concrete examples show how local SMEs initially were engaged on a single offshore project but later have developed to work as subcontractors both nationally and internationally.

In sum, the efforts to organise local competencies, reflecting a market orientation and focus on creating a strong and competitive ecosystem, have supported not only job creation but also job retention.

5.3. Trust, collaboration, and local entrepreneurship

Interviews conducted indicate that the industry in Denmark in the early stages was defined by a large degree of trust, collaboration and willingness to succeed. With an industry in rapid development, which at the same time is defined by highly specialised knowledge, high costs, and a need to combine a broad array of skills across multiple units, failure will be an invariable element, especially early in the process. Thus, the willingness to accept failures and build on these going forward will be a necessary part of successful development. The interviews suggest that in the Danish case there was an accept and, importantly, an intention to overcome and learn from past failures across the ecosystem. That played a vital role in the growth of the industry and consequently the demand for job creation.

Furthermore, the development of the offshore wind industry in Denmark built on experience from the onshore wind industry in terms of the need to invest with a certain risk included. The conducted interviews indicate that smaller local enterprises as well as larger ones saw an interest in entering the offshore industry and were willing to invest and take the risk associated with this. In turn, this had a positive influence on the growth of the offshore wind industry.

5.4. Organised knowledge network

The conducted interviews indicate that the formation of knowledge networks played a role as a prerequisite for establishing knowledge, skills, and competencies to develop and retain jobs within the industry. This was particularly the case as the industry matured in Denmark. Especially, this is related to the fact that the development and ability to apply specialised knowledge and experience is essential for the companies engaged in the industry to stay competitive both individually but also as a value chain.

The Danish offshore wind ecosystem in general is known to have a large degree of transverse collaboration and sharing of knowledge between companies, educational institutions, and organised networks. The combination of close collaboration between stakeholders – both within and outside organised networks – and the so-called *open-book* principle, supported the ability to develop and renew knowledge and competencies and to refine existing skills. This again was a driver to ensure competitiveness within the Danish offshore industry as the industry matured with both growth potential and job retention stemming from an increasingly international order book.

The so-called *open-book* principle or approach was, according to interviews, an important criterion for successful collaboration and development. This approach implied that producers and suppliers would share insights and experience from each other's development processes. In addition, interviewees have pointed out that in the early 00s, contracting with one supplier was to a large extent the norm, but it was quickly realised that this would preclude the wind turbine manufacturers from collaborating or contracting with others. Thus, collaboration in broader networks became the norm. Interviews point to the fact that the development of a higher degree of broad collaboration within the ecosystem allowed for faster specialisation through sharing of knowledge from past experience and knowledge gains. As companies and stakeholders within the industry allowed for a freer flow of knowledge and experience, both through the broad networks but also through the *open-book* principle, it became possible to raise the lowest common denominator faster in terms of competencies. The close collaboration also increased the capacity for sub-contractors to manage and handle large and changing influx of orders.

Lastly, content from the interviews suggests that the tight relations between stakeholders within the Danish offshore wind ecosystems have resulted in the possibility to engage in international projects with relatively complete Danish supply chains. Due to competencies and skills residing within full supply chains of Danish companies, it was possible to expand the market internationally, thereby seeing an increase in the job opportunities. The Danish wind power manufacturers were able to rely on their suppliers in the international markets, applying their first mover advantages and allowing for the initial costs associated with an offshore wind solution not being repeated. However, there are also examples (from Esbjerg) of local suppliers having successfully integrated into the global offshore wind supply chain, successfully leveraging their assets, capabilities, and global set-up from the oil and gas industry.

The results presented above is supported by a network analysis by Andersen et al. 2014 indicating that the density of the Danish offshore wind knowledge network has increased between 2006 and 2014. This indication is supportive of the conclusions drawn from the conducted interviews which suggest that the density of the knowledge networks has increased over time and been important for both the development of the industry but also the sharing of knowledge and experience between stakeholders in the Danish workforce engaged in the industry.

6. Competencies and skills

Section 6 outlines how job creation in the Danish offshore industry to a large extent was based on competencies from related industries in the early 00s. Section 6.2 summarizes main findings on how it was possible to increase the level of specialisation within the Danish offshore industry as it matured. Lastly, section 6.3 elaborates on how targeted initiatives within the industry and being able to look forward in terms of market industry development has been described by interviewees as defining to ensure competitiveness and eventually job retention.

The growth of the Danish offshore wind industry in the 00s created a demand for a skilled workforce. Relevant skilled labour already existed in other industries and was to some extent transferred, predominantly from offshore oil and gas, construction, consultancies, and onshore wind.

Key takeaways

In the early stages of the offshore wind sector development in Denmark, relations and network to other related sectors ensured that the sector saw an influx of competencies and skills from other sectors. Relevant competencies and skills already existed in other sectors, probably and most notably from sectors like oil and gas, onshore wind, and other related sectors played a role in relation to this.

Specialisation in job types and functions have played an important role in terms of ensuring both a competitive Danish offshore sector and, importantly, a competitive Danish offshore workforce. This, to retain jobs as the sector developed and competition increased. In the early stages of maturity, specialisation has primarily been described by a *learning-by-doing* approach. Interviews point to the fact that this process of specialisation to a large extent was undertaken more formalised by major companies and also educational institutions later as the sector matured. This resulted in a continuous specialisation of the Danish workforce. The ability to maintain high levels of specialisation and competitiveness has been identified as a key driver for job retention. Conversely, the inability to upskill and develop specialisation of the workforce has been identified as a potentially vital barrier for job retention as the offshore wind market today is largely governed by international competition.

6.1. Emerging offshore wind; competencies and skills

As described in previous sections, competencies, skills, knowledge, and experience have been drawn in from other industries in the early 00s as the offshore wind industry emerged. Especially, it has been underlined how competencies and skills were drawn in from the Danish offshore oil and gas industry. Know-how on how to project and plan large infrastructure projects, how to design and build in rough conditions, at deep waters as well as knowledge on the necessary requirements and considerations as to environmental aspects, including approval processes, were included from other industries to support what would later become the Danish offshore industry. The fact that a new market emerged where already existing competencies and skills could be applied increased the job opportunities for the workforce to a large extent. Interviewees have

described how many were attracted to offshore wind, as it received much attention at the time as well as the fact that Denmark had a good track record of building onshore. Furthermore, offshore wind provided an opportunity to be able to work with new technology and be part of this development. In the early 00s, wages paid in offshore wind were lower than in offshore oil and gas. Despite this fact, it was still possible to attract skills and competencies. As competencies and skills already existed in related industries, the Danish offshore industry had a foundation of competencies and skills to build on in the initial stages where the industry emerged. The fact that the industry provided sufficiently attractive job opportunities resulted in an inflow of jobs to offshore wind.

6.2. Increased degree of specialisation alongside maturing of the industry

Through the engagement of competencies and skills from other industries as described in the previous subsection, Denmark was able to specialise competencies and skills in offshore wind in parallel with maturing of the industry, and through that, to retain jobs. It is, however, important to underline that this process of specialisation to a large extent was characterised by a *learning-by-doing* approach. Interviewees have described how the culture was governed by a willingness to invest time and effort although there was a lack of earlier industry specific experience to draw on. Thus, mistakes were made but with important learnings. The result was a learning-as-you-go approach: When a fitter or welder would handle various task on an offshore wind project in the early 00s, the tasks of the job specifications were narrowed more and more down as the industry matured. This approach and development have been described by interviewees to have characterised the majority of job types engaged in the offshore wind industry

Case example: Esbjerg

Port of Esbjerg is probably the best example of how it has been possible to utilise the competencies from offshore oil and gas and build on this to develop offshore wind specific knowledge and furthermore also to develop jobs based on this. Semco is an Esbjerg-based global leader in production, installation, and service of offshore substations and transition pieces. Prior to the establishment of the first offshore wind farms, Semco was a main supplier to the Danish offshore oil and gas sector. After being a main supplier in the first Danish offshore wind projects, Semco has developed a specialised wind division and has later become one of the most important international suppliers of offshore wind substations and transition components.

Source: Content from interviews and QBIS 2020

Moving into the 10s, the process of specialisation of the workforce in offshore wind is described as being more of an interacting effect between the companies engaged in offshore and the educational institutions. Notably, at this point many of the companies and main suppliers in the industry knew the specifics of the requirements and needs, and the educational institutions knew how to accommodate these. Upskilling, training, and education have also been undertaken by some of the larger companies engaged in offshore wind, as they have had the capacity and competencies to invest in and develop this. This interacting effect between companies and educational institutions (both professionally trained but also higher education) and continuous ability to increase specialisation within the workforce employed in the industry, is described as having kept the Danish offshore wind industry at the forefront of competition, thereby allowing for a high job retention in Denmark.

In order to maintain high and competitive levels of specialisation, test facilities and demo plants have been stated to be of great importance ensuring development of new and improved technology, including the ability

to apply this. This, to maintain sufficiently high levels of specialisation within the national industry's workforce and therefore also to retain jobs. This fact has, however, also conversely been described as constituting a barrier of the ability to retain jobs in recent years. As international competition within offshore has increased significantly, it becomes increasingly more important to secure a workforce at the forefront of competition internationally to retain jobs.

6.3. Targeted initiatives and looking forward

In continuation of the above, contents from the interviews have underlined one key factor; namely the importance of looking forward in terms of future requirements and needs, to enable continuous industry development and thereby competitive industry growth. While this might be quite a general aspect of competition, also applicable in many other industries, this is complicated in offshore wind due to the broadness of stakeholders that needs to come together to successfully "execute" the development, construction, operations and maintenance, and decommissioning of windfarms. Therefore, it has been emphasised as important that major players or organised units (cluster or network organisations) take a lead on the strategic perspective and future competency and skill requirement assessment on behalf of the ecosystem, eventually with the intend of being able to target initiatives and outline a direction for the industry as a whole. This to ensure that the required knowledge and skills are developed to retain specialised jobs and to remain competitive on an increasingly competitive international market.

Experience from Denmark suggests that the Danish offshore wind industry has succeeded in being a first mover and drawing on the advantage of this in terms of having developed the technology, knowledge, and skills to excel in the market. However, this has also been addressed by interviewees as an increasingly challenging task as competition in the market is increasing. Thus, the ability to be visionary in terms of requirements and needs and develop skills and knowledge in line with this will be an important task in relation to retain jobs. In continuation of this point, interviews have pointed to the fact that proceeding to continuously attract and develop specialised skills is experienced as a challenge today. For example, the ability for higher educational institutions to attract enough and qualified students is as an important factor for Denmark being able to retain a highly specialised and internationally competitive offshore wind industry and workforce.

7. Conclusions

This chapter presents the key findings of the analysis (Section 3-6).

7.1. Synthesising key findings

Job creation in the offshore wind industry in Denmark has been powered by the ability to meet the growing demand for skills at local, national, and international level fuelled by the growth of the industry. The analysis indicates that job creation has been triggered by an intrinsic interplay between factors related to the four dimensions of the model (policy/regulation, economic and investment environment, organisation and networks, competencies and skills). Moreover, there is not a one-size-fits-all model to ensure sufficient skills; rather that mechanisms for job supply are experienced to be more locally anchored, and different models have evolved at different sites. Job creation has mainly been driven by businesses and local stakeholders to meet market opportunities and demands and smaller extent a result of national employment policies.

The offshore wind industry was subject to several favourable **policy and regulatory initiatives** such as the guaranteed price on electricity produced by offshore wind turbines or the example of requirements to establish offshore wind farms for projected coal power plants to be approved. These initiatives, together with a local political will to invest in the industry, were instrumental in creating growth and thereby a demand for employment in the industry. Establishing the offshore wind industry was largely fuelled by several concrete initiatives by the Danish government. The shortages in fossil fuels in the 70s and 80s created an incentive to focus on alternative energy sources, followed by increased environmental concerns voiced in the 1987 Brundtland report, among others. In the 1996 energy action plan, Energi 21, several favourable conditions for growth in the offshore wind industry was highlighted, including setting up a committee to design an action plan for expanding offshore wind production and ensuring its connectivity to the grid, mapping a framework for developing offshore wind and requirements for utility companies to establish five 100 MW offshore wind demonstration parks. Another policy development, fuelling the Danish offshore wind industry, was the Danish Ministry of Energy and Environment's use of *the right of approval*, meaning that utility companies were required to establish offshore wind farms too when establishing coal power plants. Lastly, a political agreement ensured a guaranteed price on electricity produced by offshore wind turbines, a political initiative which was highlighted among interviewees as a very important framework condition for companies to be able to create an economically sustainable business case.

Establishing the offshore wind industry and creating a foundation for growth in the industry and thereby a general demand for jobs was largely driven by **policy initiatives anchored at governmental level**. Supporting these policy initiatives, investments made by large energy and wind power companies were pivotal, as the policy initiatives made the business case for the companies economically viable. The ability to reduce costs has played a vital role to keep the Danish offshore industry competitive. Offshore wind is associated with large costs of energy production, and the ability to lower these costs across the supply chain has been important to ensure the industry's competitiveness. In Denmark, this has been implemented by focusing on streamlining processes, industrialisation, and specialisation as well as introduction of new technology. However, the Danish offshore industry has also been able to benefit largely from a first mover advantage on the international market by bringing the Danish supply chain to the international market and integrating it in

projects abroad. This enabled retention of Danish jobs and ensured that the Danish offshore wind industry and Danish industry jobs were able to expand and remain competitive internationally.

While policy initiatives were instrumental in assuring the creation and growth of the industry, the actions to ensure the **adequate supply of skills and knowledge** were driven by initiatives in the large wind turbine and utility companies, and later also by initiatives derived from cluster organisations. The success of these initiatives (such as upskilling and job training of employees from other industries) in terms of job creation and subsequently job retention was largely dependent on close collaboration in the offshore wind ecosystem or network, that is, of factors related to the second dimension **(network and organisation).** As such, job creation was largely based on close cooperation in the ecosystem.

In terms of **network and organisation**, a key factor in job creation has been the fact that especially the large wind power companies had built a strong network of suppliers around them in the onshore wind market. They were able to bring many of these suppliers with them to the offshore market and help them upskill their employees. In addition, in several cases the industry and cluster organisations have had a good overview of the competencies and skills needed and have helped create this overview and facilitate matchmaking between the different companies in the value chain. One case example even included the local municipality that engaged in the process of organising and matching local competencies and skills. Furthermore, local authorities have invested in infrastructure and facilities to enable local anchoring of offshore wind companies, thus helping to create and later retain jobs within the industry. All in all, the strong networks in the ecosystems coupled with the initiatives from local authorities have resulted in that the local suppliers first of all have been able to deliver their services to the offshore wind industry and over time to handle an increasing order book, which in turn has contributed to job creation. Secondly, the interviews and case studies show that several suppliers have been able to follow the wind power producers abroad, thus securing job growth and job retention.

Competencies and skills also play a key role in securing adequate skill supply. When establishing the first wind farms, Denmark was able to draw on skills and competencies from other industries like offshore oil and gas, onshore wind, and consulting engineering. Later, particularly the large wind power companies have upskilled employees from other industries through job training. With a growing maturity of the Danish offshore wind industry, especially the developers, larger main suppliers, and industry organisations have supported upskilling and competency development through job training and upskilling. This has been described by interviewees as being in an interacting effect with educational institutions. However, the role of the educational institutions has also been described as in more of a reactive role where companies have prescribed the needs. It is interesting to note that in the early established offshore wind parks, the industry associations and the local government played a minor role in securing adequate job supply, whereas in the later established offshore wind parks, these stakeholders played a key role from the very beginning.

Both universities and vocational education schools applied a rather reactive approach to ensuring adequate supply of skills and competencies. The large wind power companies were proactive in demanding skills and competencies, and especially the universities reacted quickly to this but were not in lead of the development. Throughout the 00s, the universities became increasingly proactive and started approaching both primary and secondary schools trying to ensure that more students would choose an education directed towards offshore wind. Interviews show that for the industry to remain competitive it is important that both companies,

universities, vocational education schools, and industry organisations proactively work together to ensure the right competencies and skills also in the future.

Below, key learnings for job creation based on the Danish offshore industry case study are listed. The first three key learnings have been crucial for securing industry growth, thus forming the basis for the subsequent job creation. The next five learnings more specifically address the issues relevant for ensuring job growth.

7.2. Key Learnings

- **Political will and support for sufficient regulatory framework conditions for industry growth is important**. The Danish case suggests that it is crucial to remove regulatory barriers and scrutinise regulatory framework conditions to ensure favourable conditions. Removing procedural barriers and scrutinising relevant framework conditions are important as e.g., comprehensive approval processes and procedures involve lot of resources and costs prior to establishment. Similarly, adapting the framework conditions can work as an enabler, especially in terms of de-risking the projects, thereby securing the necessary resources as well as investments. Furthermore, the Danish case exemplify a significant political will and push for the establishment of the first projects in Denmark. Following these first projects, Denmark was able to build on prior experience and knowledge.

- **At local level, municipal initiatives to ensure e.g., the necessary infrastructure have been crucial for the local growth of the industry**. Examples from Denmark illustrate that local authorities have facilitated relevant adaptations to local infrastructure to support the establishment and development of locally anchored offshore wind projects. For example, by adapting and increasing harbour capacity or ensuring that onshore shipping of larger windmill parts was possible on local road networks.

- **Favourable economic conditions for the offshore wind industry have been of central importance to attract and retain investments** and thus for the industry to grow. The Danish case suggests the importance of considering possible or potential financial models that will enable the ability to attract the necessary investments. In relation to this, results suggest that de-risking the projects play an important role in terms of attracting investors.

- **Enabling cost-out as a combination of collaboration within a strong supply chain, an open-book approach, and the ability for Denmark to benefit from the potential in the international market**, **have helped ensure competitive momentum for the Danish offshore wind industry**. The Danish wind power manufacturers have been able to use their first mover advantage to target international markets and involve their suppliers in projects abroad. Numerous competencies and skills reside within the existing supply chain of Danish wind power companies, which made it possible to expand operations to international market. The fact that the market grew supported both job retention and job creation in the offshore wind industry.

- **Network and organisations within the industries and local competencies** have played an important role in terms of engaging local workforce (residing within small and medium-sized enterprises) in local offshore wind projects. The Danish case suggests that to enable small and medium-sized enterprises to play a role in the offshore wind industry, an organisation around these is necessary since the industry is characterised by complex structures, networks, and technical specifications, which can be challenging

to face. Thus, an organisation, for instance a cluster organisation, which can help SMEs with understanding the necessary requirements in the industry and the prerequisites needed for engaging in offshore wind projects, can play a vital role in terms of engaging small and medium-sized enterprises.

- **Network and connections to other related industries have helped ensure an inflow of competencies and labour when the Danish offshore wind industry was in its infancy**. **Specifically, Denmark's existing onshore wind industry played a major role in the offshore wind job creation.** The existing onshore supply chains and the close collaborations established in these resulted in Denmark already having competencies in relation to how to build and erect windmills, including connection to the grid, thus giving the wind power manufacturers an excellent starting point to enter the offshore wind market. In addition, competencies from offshore oil and gas have meant that it was possible to draw on knowledge regarding large operations offshore, which differ substantially from building onshore wind farms. Moreover, Denmark already had competencies and experience from infrastructure projects (e.g., bridge construction) meaning that the offshore wind farms could draw on experience in terms of projection, planning, and execution of larger infrastructural offshore projects. Thus, **drawing on already existing competencies and skills from other industries** has helped ensure an influx of relevant labour to the offshore wind industry, especially in the initial stages. Close relations and connections between the stakeholders in the Danish industry have helped ensure the availability of both relevant skills and competencies. It is suggested that the short distance between stakeholders engaged in e.g., offshore oil and gas and onshore wind meant that it was easy for people with relevant qualifications and skills to switch between jobs, and in effect the job market they operated in expanded with the introduction of the first offshore projects in Denmark.

- In relation to the above key findings, **Denmark's first mover advantage on offshore wind played a significant role**. The Danish wind power companies were "forced" to look for competencies inside Denmark, since none of the competencies could be sourced directly from abroad. Here, the existing onshore wind supply chains played a key role since collaboration in the supply chain was already in place. This fuelled job creation within the offshore wind industry and also paved the way for additional job creation through upskilling of employees coming from other industries.

- **The job creation was very much a result of visionary private industry companies.** As mentioned, the framework conditions for the offshore wind industry focused on ensuring the conditions for industry growth, whereas initiatives for securing job creation were not in place. Thus, the job creation happened as a result of private companies seeing a market potential for offshore wind (driven by the framework conditions). The wind power companies used their existing supply chain network related to onshore wind projects to expand into the offshore wind industry, coupled with knowledge from the oil and gas industry. Moreover, the wind power companies took it in their own hands to ensure upskilling and training of new employees coming from other industries and initiated a collaboration with universities thus securing future offshore wind competencies.

- **With maturity of the industry, specialisation in job types and functions** is suggested to play an increasingly important role. Results from the Danish case exemplifies how the industry has experienced a significant change in the level of technical requirements and level of specialisation needed. This is

first and foremost due to the complex composition of technical requirements for building offshore wind farms and integrating offshore wind in the grid. Thus, the ability to increase the level of specialisation and enable use of increasingly more technical requirements and technical development is important to create and retain jobs within the industry. The Danish case is not unambiguous in terms of how it is done; both main suppliers, network organisations as well as higher educational and professional institutions are suggested to be able to play a role.

- **In Denmark, local job creation has happened without local content requirements.** Job creation in the Danish offshore wind industry has happened independently of any local content requirements. On the contrary, results presented in the present report suggests that business initiatives and a focus on growth, upskilling and specialisation have ensured both industry growth, job creation, as well as retention. The absence of local content requirements has implied that the wind power companies have had the opportunity to focus on growth and not on involving specific local stakeholders. However, due to the existing onshore wind value chain collaboration and the fact that wind power companies were able to draw on offshore oil and gas competencies, it has often been local stakeholders that have been involved and also where job creation has occurred.

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