SOUTHWIND

Ripple Effect Analysis - O&M port Kongsgård

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ABBREVIATIONS

ASV	Autonomous survey vessel	OEM	Original equipment manufacturer
AUV	Autonomous underwater vehicle	OpEx	Operational expenditures
CSOV	Commissioning service operation vessel	OSS	Offshore substation
BoP	Balance of Plant	O&M	Operations and maintenance
CI	Confidence interval	OW	Offshore wind
CPS	Cable protection system	OWF	Offshore wind farm
CTV	Crew transfer vessel	PQQ	Prequalification Questionnaire
CLV	Cable lay vessel	R&D	Research & Development
DP	Dynamic Positioning	Ro-Ro	Roll on - roll off
EIA	Environmental impact assessment	ROV	Remote operating vehicle
EPCI	Engineering, procurement, construction, installation	SAA	Service availability agreement
FOU	Foundation	SNII	Sørlige Nordsjø II
FTE	Full-Time equivalent	SOV	Service operation vessel
GW	Gigawatt	SME	Small and medium enterprises
GWO	Global Wind Organization	TEU	Twenty-foot equivalent unit
IAC	Inter array cable	T&I	Transportation and installation
JU	Jack-Up	TSO	Transmission system operator
MSI	Main soil investigation	TSV	Trenching support vessel
MW	Megawatt	UiA	University of Agder
NDT	Non-destructive testing	UN	Utsira Nord
NOK	Norwegian Kroner	UXO	Unexploded ordnance
NVE	Norwegian Water Resources and Energy Directorate	WTG	Wind turbine generator

EXECUTIVE SUMMARY

The Norwegian Government announced in spring 2022 its ambitions to allocate 30 GW of offshore wind capacity in Norwegian waters by 2040. The pre-qualification deadline for the 1,5 GW offshore windfarm Sørlige Nordsjø II (SNII) phase 1, is the 1st of November 2023. An auction is expected to follow in February 2024.

Port infrastructure is key for the successful construction and operation of offshore windfarms. While the marshalling port requires large storage areas and considerable water depths as well as conditions feasible for jacking with large installation vessels, the requirements linked to an operation and maintenance (O&M) port are limited.

Kongsgård in the Port of Kristiansand is well located to support the operational phase of SNII. Its track record in the offshore industry and competencies of the local business community, together with existing suitable infrastructure as well as available areas in the port which allow for new developments, make Kongsgård an attractive option for developers and turbine suppliers.

For the possible establishment of the O&M port for SNII at Kongsgård a ripple effect analysis, focusing on positive impacts on the local municipality of Kristiansand, has been conducted. The establishment of an O&M port is forecasted to create continuous, reliable revenue streams along the 30 years of operation of SNII Phase 1. By diversifying the service portfolio offered by the port it has the potential of decreasing the reliability on the conventional offshore industry for both the port and other suppliers/service providers. The findings indicate that the establishment of an O&M base in Kongsgård can be expected provide between 83 and 113 full time equivalent jobs per year in the local community throughout the offshore wind farm's operational lifespan (between 2,490 and 3,390 full time equivalents in total over lifespan), and a yearly expenditure on local supply chains between NOK 75 and 135 million (between NOK 2,250 and 4,050 million over lifespan).

Depending on the involvement of the local supply chain, these economic impacts may be increased considerably, and further opportunities will arise looking at SNII phase 2 (1.5 GW) and further envisaged offshore wind developments of up to 11.5 GW in vicinity to the SNII-site.

The establishment of an O&M port will require developing new competences within the local business community and attract professionals eager to be part of the renewable industry. Educational institutions and local businesses will develop study programs, apprenticeships, and collaborations to enhance competence development and retraining of workers and professionals with experience from oil and gas. Due to the perspective of 30 years of operation, generations of professionals will have the opportunity to join the new industry based in Kristiansand and benefit from long term career perspectives.

Research and development activities will increase their focus on offshore wind, and it is expected that available funds will be increasing for projects relevant for O&M in offshore wind and offshore wind in general. Lastly, it is anticipated that Kristiansand will benefit from an enhanced focus on sustainability and has the chance to change the perception of the region promoting its focus on servicing renewable industries and becoming a green port.

1. INTRODUCTION

Norway's "Hywind Tampen" is currently the world's largest operating floating offshore wind farm (OWF). Developed by Equinor, the 88 MW floating OWF supplies the oil and gas fields Snorre and Gullfaks in the Norwegian North Sea. Other offshore wind (OW) projects currently operational in Norway are only pilot projects.

In the spring of 2022 however, the Norwegian government set the ambitious target to allocate areas for 30 GW offshore wind by 2040, which is almost on par with Norway's total installed capacity for hydro power electricity production in 2022. As shown in Figure 1, 20 areas were highlighted by the Norwegian Water Resources and Energy Directorate (NVE) in a recent report identifying areas permitting the allocation of said capacity by 2040 (Norges vassdrags- og energidirektorat, 2023).

Figure 1: Offshore wind development areas in Norway

The first commercial scale OWF in Norway, SNII and Utsira Nord are scheduled to be commissioned by 2030. The production of renewable energy at SNII phase 1 will be awarded to one applicant through a pre-qualification process, followed by an auction. The pre-qualification deadline has been postponed until the 1st of November 2023.

While the floating OW project Utsira Nord is located in west of Stavanger, the site of the SNII OWF is located in the southern North Sea (see Figure 2) bordering the Danish exclusive economic zone in shallower waters allowing the installation of bottom fixed foundations.

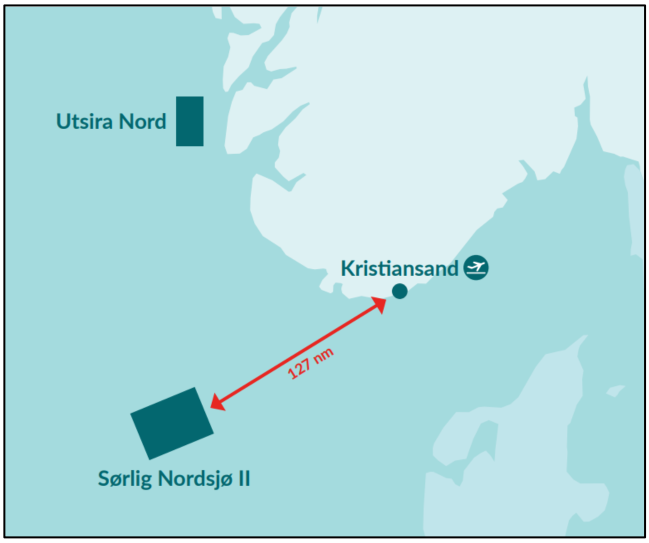


Figure 2: Location of SNII and Kristiansand

After being awarded the rights to develop the OWF through an auction-process, the successful developer/consortium will advance the plans for executing all required environmental impact assessments and deepen the dialogue with main stakeholders such as component suppliers, marine contractors and port operators.

A crucial element of any offshore construction project is the marshalling port, which requires large storage areas and infrastructure to accommodate floating or jack-up installation vessels. While the Port of Kristiansand's location as well as existing infrastructure is not suitable to compete with other marshalling port developments, its well positioned to function as an O&M hub servicing the offshore windfarm during its 30 years of operation.

Kongsgård in the Port of Kristiansand is well positioned to serve as the base port for SNII thanksto following characteristics:

- Distance to the SNII area
- Track record in the offshore industry
- Existing suitable infrastructure
- Onshore areas open for new developments

Additionally, the surrounding infrastructure of the port and an existing network of industrial partners (Southwind) make Kongsgård an attractive option for developers and contractors seeking to establish an O&M base for SNII.

2. SCOPE OF WORK AND REPORT STRUCTURE

The focus of the present report is the analysis of the ripple effects originating from the establishment of an O&M port servicing the 1,5 GW SNII OWF for 30 years in the Port of Kristiansand.

Economic impacts are quantified taking into account the particularities of the port and the OWF SNII Phase 1. These quantitative ripple effects include employments rates and resulting income taxes as well as operational expenditures and expected port calls.

Furthermore, qualitative ripple effects which are expected to have an effect on the local business community are identified and described such as competence development and re-training, R&D, sustainability and the perception of the Port of Kristiansand.

Before presenting the mentioned variety of effects, the report introduces tasks and services relevant for operating and maintaining an OWF, as well as professions and pre-requisites to work in the offshore wind industry (see chapter 3.). Subsequently, existing infrastructure in and around Kristiansand and the status of current operations performed in the port is presented (see chapter 4.).

A short description of expected activities facilitated by the Port of Kristiansand during the O&M phase of SNII forms the basis of the quantitative and qualitative analysis of ripple effects (see chapter 5.).

Considering the mentioned ambitions of the Norwegian government, the potential for considerable positive economic ripple effects is recognized. The report touches upon opportunities arising for Kongsgård thanks to these envisaged offshore wind developments. Lastly it presents further opportunities to increase the engagement of the port with the offshore wind industry beyond regular O&M port activities as well as recommended next steps to be pursued by Southwind and its partners.

3. IMPACT OF ESTABLISHING OFFSHORE WIND O&M PORTS

This chapter describes a comprehensive theoretical framework used to analyse local ripple effects. Furthermore, the chapter introduces activities and services relevant for operating and maintain an OWF. This theoretical foundation serves as basis for the qualitative and quantitative ripple effect analysis focussing on Kongsgård and the SNII OWF.

3.1 Introduction to local ripple effect analysis

The considered impacts of the establishment of an O&M port at Kongsgård can be categorized into three primary types:

Direct impact: Impacts on industries associated with operation, maintenance, and project development. These impacts primarily arise from investments made during the operations phases of the facilities. They are influenced by various activities, including the procurement of materials, as well as equipment and machinery rentals and fuel purchases.

Indirect impact: Refers to the effects of inter-industry purchases that arise from direct spending on materials, equipment, and labour. It also encompasses support activities associated with the operations of the facilities.

Induced impact: Pertains to the downstream impacts that occur across all local industries because of consumers' spending. These expenditures stem from increases in personal income generated by the direct and indirect effects of the facilities. These impacts signify the economic advantages experienced locally, as workers involved in these facilities contribute to the local economy by spending their income on goods and services within the community.

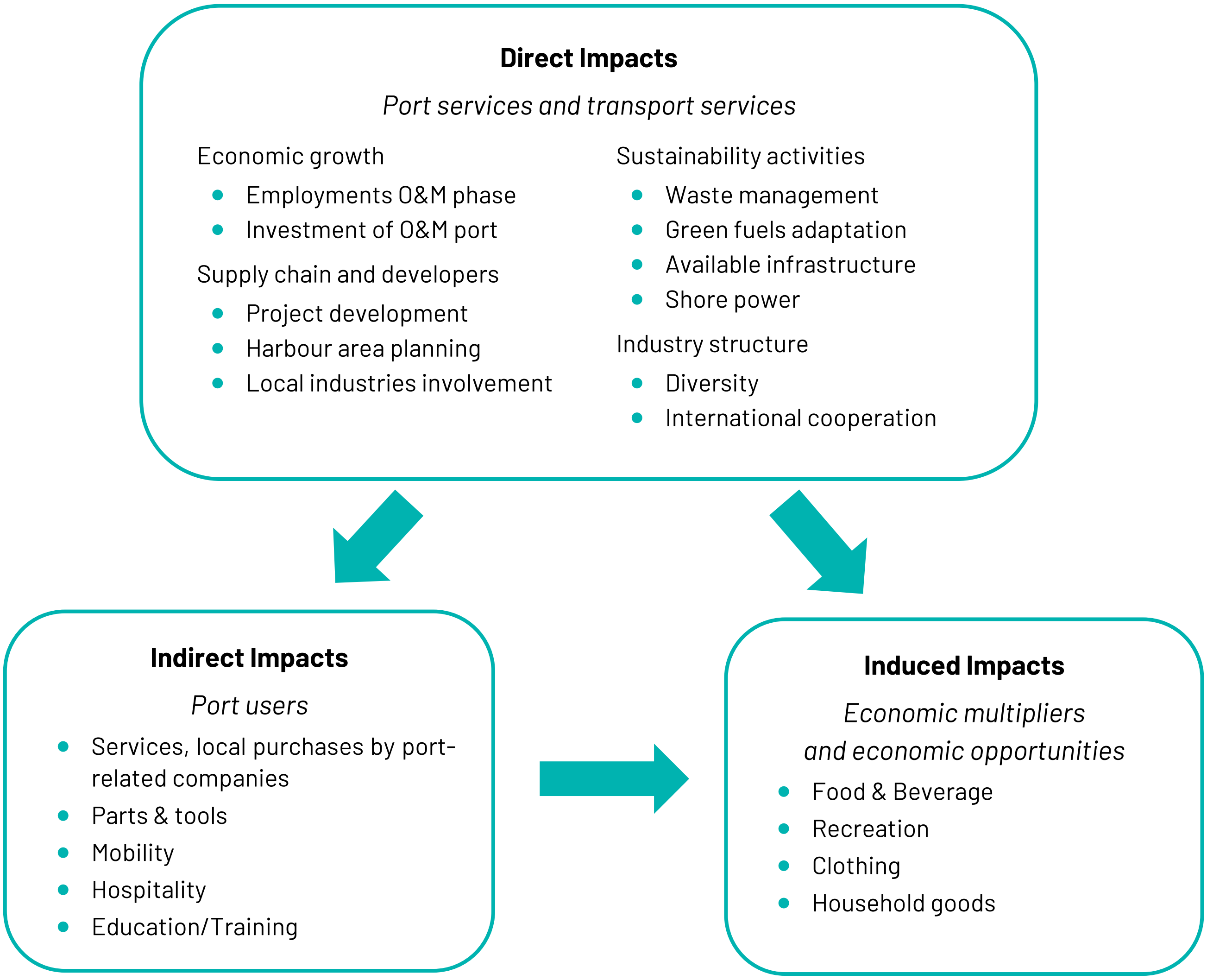


Figure 3: Mapping of the industrial sectors influenced by port activity

3.2 Phases of offshore wind projects

Prior to presenting opportunities associated with the establishment an O&M hub for offshore wind, this chapter introduces the phases of an offshore wind project and outlines an O&M port's primary functions.

The life-span of an OWF can be divided into five stages, illustrated below in Figure 4.

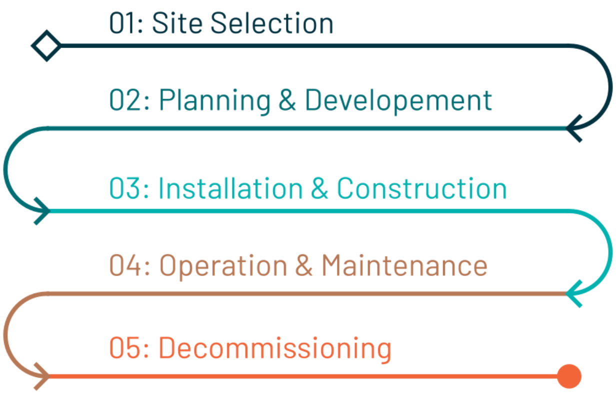


Figure 4: Stages of OWF construction projects

As per the current approach in Norway, suitable offshore sites are selected and defined by governmental bodies. The permit for surveying the site, performing environmental impact assessments and construction of a windfarm is awarded in a pre-qualification and tendering process.

In the second stage, the developer undertakes the required environmental impact assessment and surveys, develops the layout of the windfarm, performs bathymetry surveys, boulder surveys, and main soil investigations, gets the construction permits and initiates procurement processes to contract marine contractors for the various packages.

In the construction phase, the jacket structure and topside of the offshore substation as well as the export cables are installed. A marshalling port is mobilised to store foundation- and later wind turbine generator (WTG)-components and perform required pre-assembly works before loading them out onto the transport or installation vessel.

A jack-up or floating installation vessel is deployed to install WTG foundations, laying, pull-in and termination of inter-array-cables is performed with dedicated cable lay and trenching vessels. The WTG tower, nacelle, and blades are lifted and positioned by the main crane of a jack-up vessel and technicians access the turbine to perform the bolting works. The original equipment manufacturer (OEM) will mobilise and access every turbine with a commissioning service operation vessel (CSOV) providing accommodation for the technicians, spare parts and tools, and access every turbine to perform the final commissioning of the WTGs.

Upon completion of the installation phase of the OWF, the O&M phase starts. In case the OWF is close to shore (<=60km), crew transfer vessels (CTVs) can be deployed for the transfer of material and technicians to the WTGs. For OWFs further offshore, the transit times become too large to perform the required tasks during a single day. For these wind farms, typically a service operation vessel (SOV) is mobilised. These vessels do not only accommodate the crew for several weeks but also carry spare parts and the required equipment to perform the scheduled tasks. If adverse weather conditions prevent timely transit to the port, crew changes will be conducted via helicopter. Helicopters may also be employed when there are critical failures, particularly involving the offshore substation (OSS), and the regular ways of access are not feasible.

To ensure the smooth functioning and upkeep of offshore wind farms, dedicated O&M ports are established. These ports facilitate the deployment and coordination of personnel, vessels, equipment, and resources needed to service the OWF. O&M ports are strategically located near the OWF sites to minimize travel time and costs. Being in close proximity allows quicker response times to address maintenance issues, especially for unplanned events. The establishment of suitable O&M ports plays a crucial role in ensuring the reliability, safety, and efficiency of an OWF.

After the typical OWF lifetime of 30 years, the OWF is decommissioned. Again, specialised vessels and tools need to be deployed. The components are transported to shore and further treated to prepare their recycling or re-use as far as possible.

3.3 Tasks and services relevant during construction phase

During the development of O&M port infrastructure, various services may be needed depending on the extent of required investments and upgrades:

Engineering and design services: Civil and structural, electrical, and mechanical engineering are essential for designing port facilities, electrical infrastructure, and equipment needed for port operations.

Environmental and regulatory services: Conducting Environmental Impact Assessments (EIAs) for the port and surrounding ecosystem and obtaining necessary permits and approvals from relevant regulatory authorities.

Construction and installation services: Overseeing, coordinating, and scheduling of construction activities including the construction of underwater structures and the establishment of essential infrastructure like power supply, utilities, and communication systems.

Logistics and transportation: Planning and managing the procurement, delivery and movement of materials, components, and equipment, as well as the transportation of personnel to and from the port site.

Consulting and advisory services: Providing financial and economic analysis to assess economic viability, along with offering legal and contractual services.

Health and safety services: Formulating comprehensive health and safety plans, conducting risk assessments, and setting protocols to ensure a secure working environment.

3.4 Tasks & services relevant for operational phase of O&M port

Commonly, the OEM selected by the developer of the OWF will be responsible for the O&M activities linked to the WTGs at least in the first five years of operation. The OEM will need a workforce to manage the activities in the port, vessel(s), technicians, and further onshore office personnel. The developer of the OWF normally take responsibility for further regular inspections of the OWF, including the inspection of the subsea cables, scour protection, foundations and the OSS.

In summary, a variety of tasks and services are relevant for the O&M phase of an OWF, as are presented in the following Table 1, Table 2, Table 3 and Table 4.

Table 1: Operation of an Offshore Wind Farm

Services relevant for operation of an OW	
Safety	
Training	Provision of Global Wind Organisation accredited courses for offshore personnel (Basic Safety; Rescue Training; Working at heights etc.)
Site security	Personnel and dedicated provisions to ensure that only authorized personnel are accessing the port facilities.
HSE equipment	Personal protection equipment etc.
HSE inspections	Inspections performed in the port facilities, deployed vessels, WTG and OSS.
Emergency response and coordination	Coordination of emergency responses, onshore but especially offshore.
Logistics	
Onshore Logistics	Personnel and equipment to transport containers, spare parts etc. in the port and transfer goods as needed to the vessel.
Warehouse management. & (long) term storage	Personnel, software etc. required to track and manage incoming, outgoing materials, spare parts etc. in indoor warehouses and outdoor storage areas.
Workshop	Personnel and tools to perform specific welding, repair works onshore.
Marine Coordination	Coordination of any vessels entering, leaving, operating in or nearby the offshore windfarm from a dedicated marine coordination centre.
Communication	Establishment and maintain communication network between deployed vessels and onshore personnel.
Provision of vessels and servicing of deployed vessels/Port calls	
Vessel provision	Provision of SOV/CTV etc. for maintenance activities.
Crewing	Provision of qualified ship crew as well as technicians for maintenance tasks.
Piloting	Ensure safe passage of vessel through fjord and to berth in the port.
Bunkering and power supply	Fuel and power supply to vessels berthing in the port potentially including the provision of green fuels.
Catering	Supply of food and other goods of daily need to the vessel.
Waste management	Receiving of sewage water, oils, lubricants etc. from the vessels and further treatment of any waste as per applicable regulations.
Planning, Monitoring & Forecasting	
Scheduling & planning	Planning and scheduling of required onshore and offshore operations, organisation of required resources and equipment, documentation.
Remote condition monitoring	Monitoring of data collected by sensors installed in the offshore windfarm e.g. the drivetrain of the WTG.
Data and risk analysis	Analysis of provided data and associated risks. Development and execution of risk plans. Analysis of performed maintenance/repair works, failures etc.

Analysis & Forecasting (weather, yield)	Monitoring, analysis and forecasting of weather data, provision of weather reports and analysis, forecasting and reporting of yield.
Market analysis/prediction	Analysis of development of electricity prices, predictions in combination with yield assessments.
Further specialized services	
Legal support	Any potential disputes between suppliers, employers, subcontractors, warranty related issues, regulatory considerations etc.
Environment	Provision of solutions to enhance biodiversity, increase sustainability. Experts and surveys to assess environmental aspects linked to the O&M operations e.g., analysis of biodiversity in deployed fish-hotels etc.
Finance/Accounting	Monitoring the finances, accounting and perform required actions.
Insurance	Provision of insurance policies relevant for any party involved in the port and offshore activities.
Stakeholder management and marketing	Managing of all relevant stakeholders such as employers, subcontractors, local (business) community, politicians, port authority etc.

The WTGs and the Balance of Plant (BOP) of the OWF will have a defined scheduled maintenance regime including periodic inspections. Unplanned maintenance activities will need to be carried out on an ad-hoc, responsive basis. The following Table 2 lists services which need to be provided by the supply chain to allow the execution of these activities.

Table 2: Services linked to the maintenance of an OWF

Services linked to the maintenance of an OWF	
Vessel/barges	Provision of SOV as well as survey vessels for planned maintenance activities such as subsea surveys. Provision of vessels/barges required to perform main component exchange campaigns.
Specialised tools	Provision and operation of specialized tools such as working class ROVs and respective survey equipment. Maintenance and calibration of respective positioning and survey systems on any deployed vessel.
Crewing/Personnel	Provision of qualified ship crew as well as technicians and experts for maintenance tasks.
Transit	Ensure safe passage of vessel through fjord and to berth in the port with piloting services.
Material	Provision of rock material for cable stabilisation and scour protection repairs.

The frequency of the maintenance tasks not only depends on existing regulations outlined in the permit of the OWF but also the strategy of the developer and the maintenance manuals of the WTG supplier and equipment providers, as well as the environmental and metocean conditions and seabed morphology. An overview of expected works linked to the maintenance of OWFs and their frequency are listed in Table 3.

WTGs are visited on average five times per year, with major inspections typically performed every 12 months. It is expected that by 2030, the interval for major inspections of the WTGs of the newest generation will be prolonged; depending on the WTG-model, potentially up to 24 months.

Inspections at the WTG foundations are commonly performed depending on their condition. Subsea inspections may be executed every two to four years. As per the permit, it can be expected that inter-array-cables are to be inspected in the first years after their installation to ensure the required depths of coverage is maintained. Further inspections/surveys of cables including the scour protection may be performed every two years depending on the strategy of the developer, the metocean conditions and results of previously performed (scour) assessments.

Due to considerable failure rates of cable protection systems and wear of cables installed in the North Sea, developers may increase survey activities to thoroughly monitor the status of the cables. Furthermore, lessons learned from operating OWFs will certainly be addressed during the design process of the scour protection and selection of cable protection system (CPS).

Considering the expected fishery activities along the export cable route of SNII, developers may decide to survey the export cables more frequently than it is usual in other offshore wind projects. However, maintenance works at export cables should usually be very limited.

Subsea surveys to inspect the jacket foundation of the OSS, J-tubes, scour development and scour protection, are expected to be performed every two years. Novel technologies such as autonomous survey vessels and autonomous underwater vehicles potentially have reached higher maturity levels by 2030 and may become viable options for the O&M phase.

Table 3: Unplanned & planned maintenance activities – WTG/FOU

Component	Inspection/Repairs	S*	US**	Frequency	SOV / Helicopter[1]	Survey Vessel	ROV / Drone	JU/ CLV+TSV
*S= scheduled; **US= unscheduled								
WTG	Major inspection incl. - Blades - Davit Crane - Ladders - Lift / Hoist - Electrical equipment - Hydraulics - Drive train - Exchange of lubricants - Paint/Coating	•		Every year (may be altered to longer intervals by 2030)	•		•	
WTG	Troubleshooting, unplanned repairs etc.		•	3-4 times a year per WTG	•		•	
WTG	Main component exchange		•	Not expected				•
FOU	Functionality of anodes	•		First 2 years annually, then depending on condition e.g. every 4 years		•	•	
FOU	Corrosion protection (visual inspection) – Above water – Underwater	•		Every 2 to 4 years		•	•	
FOU	Welds (NDT inspection plan)	•		Every 2 to 4 years		•	•	
FOU	Bathymetry/Scour, Scour protection			Every 2 years. Potentially specifically after severe storms		•	•	
FOU	Scour protection repair		•	Not expected	2		•	

[1] Helicopter may be used in case transfer of personnel in SOV in-time is not possible. Also the OSS may be serviced with a helicopter instead of a vessel.

[2] Fallpipe vessel to be mobilised and ROV.

Table 4: Unplanned & planned maintenance activities – IAC/OSS

Component	Inspection/Repairs	S*	US**	Frequency	SOV / Helicopter[1]	Survey Vessel	ROV / Drone	JU/ CLV+TSV
*S= scheduled; **US= unscheduled								
IAC	Survey – Bathymetry – Visual – TSS440	•		Every 2 years		•	•	
IAC	Replacement/Repair		•	Not expected.				•
IAC	Re-burial		•	Not expected.				•
IAC	Cable protection		•	Not expected.	2			
OSS	Inspection and maintenance on topside – Electrical systems – Safety systems – Cooling systems – Oil replacement – Crane – Paint/Coating	•		Yearly inspections	•		•	
OSS	Jacket foundation (subsea) – Corrosion – Marine growth			Every 2 to 4 years		•	•	
OSS	Anodes			First 2 years annually, then depending on condition e.g. every 4 years		•	•	
OSS	Scour (Protection)			Every 2 to 4 per years		•	•	
OSS	Scour protection repair		•	Not expected	2		•	
OSS	Main component exchange – Switchgear – Transformer		•	Not expected				•
Export cable	Survey – Bathymetry – Visual – TSS440	•		May be required in first years after installation; then every 2 to 4 years			•	
Export cable	Re-burial		•	Not expected				•
Export cable	Repair/exchange		•	Not expected				•

3.5 Job profiles relevant for the operational phase of an O&M port

Based on the tasks to be performed during the O&M phase of OWFs, specific job profiles are relevant for operators of the OWF, the service contractors, suppliers and OEMs. These roles can be broadly categorized into three main categories; ship crew, engineers and experts, and workers and technicians. An overview of job profiles for each of these groups is listed in Figure 5.

Workers and Technicians

approx. 40 %

Onshore

- Crane/Forklift Operator
- Warehouse manager
- Site Administrator
- Site security
- Rigger

Offshore

- Crane Operator
- Remote Operated Vehicle Technician
- Electrical/ Hydraulics Technician
- Paint/Coating Repair
- Wind Turbine Technician
- Blade Repair Technician
- Site Administrator

Ship Crew

approx. 20 %

- Deckhand / Mate – CTV/SOV
- Crew - CTV/SOV
- Master - CTV/SOV
- Engineer - CTV/SOV
- Marine Steward
- Captains/ officers

Engineers and Experts

approx. 40 %

Onshore

Approvals Compliance Manager
Accountants & Lawyers
SCADA Engineer
Wind Yield Performance Analyst
QHSE Manager
Human Resources Manager
Contracts & Commercial Manager
Procurement Manager
Risk Manager
Quality Manager
Package Manager - Grid / Transmission

Offshore

Heavy Lift Supervisor
Electrical Technician Supervisor
Environmental expert
QHSE Manager
Quality Manager
Geotechnical expert
Package Manager - Grid / Transmission
Coating specialist (Frosio III inspector)

Figure 5: Job profiles relevant of the O&M phase

3.6 Pre-requisites to provide skilled workforce to OW industry

In order to offer skilled workforce to be involved in maintenance activities of an offshore wind-farm, certain pre-requisites need to be taken into consideration:

A. Organizational requirements
Organizations supplying personnel to OWF projects should have relevant industry accreditations, provide comprehensive safety and technical training, ensure employees undergo medical evaluations, and maintain robust insurance. They should also be compliant with all regulations, uphold a strong safety record, conduct thorough background checks on personnel, and establish clear contracts with high standard requirements to both employees and hiring companies.

B. Personal requirements
In addition to labour law requirements, working on an offshore wind farm requires a combination of technical skills, accredited safety training, and physical fitness. The specific prerequisites can vary depending on the developer/location of the OFW but always include extensive up-to-date training requirements.

Table 5: Training Requirements for OW personnel

Training Requirements			
Ind. Code	Description	Ind. Code	Description
SART-H	Advanced Rescue Training	BTTI	Installation
ST, AST	OWF Safety Training	LCI	Lift commissioning and Inspection
CHBU, CHIM	Crane and Hoist operation / Inspection	LSA	Life Saving Equipment / Appliances
BTTE, ES	Electrical / Electrical Safety	MHR-P	Manual Handling
Medical / PF	Medical check & good physical fitness	M	Mechanical
ES, AES	Electrical Safety	OFL	Offshore Limited Access
FAR, EFAR-P	Fire Awareness Training	ONL	Onshore Limited Access
BTTH	Hydraulics	PFS / PFS-R	Pressure Fluid
LA / LARS	Lifting Appliances	SEA-U	Sea Survival
WAH / WAHR	Working at Heights	HUET	Helicopter Underwater Emergency Training
ST-L1	Surface Treatment (FROSIO)		
INSL-L1	Insulation (FROSIO)		

3.7 Opportunities emerging by establishment of O&M port for OW

For countries with limited local manufacturing capacities for main OW components, the installation and O&M phase become primary contributors to the local economy. Focusing specifically on the O&M phase, smaller domestic ports are important as distances to the site are of highest relevance and requirements are less extensive and complex compared to installation hubs.

The following list provides a general overview of some key potential benefits that can be expected with the establishment of an offshore O&M hub at Kongsgård:

1. Improved port infrastructure and supporting facilities as well as regional infrastructure
2. Increase in port revenue from OW
3. Hiring of local crew (O&M only)
4. Increased local consumption (induced) affecting e.g. hotels, restaurants, public transport
5. Diversification of the local port economy
6. Improved capabilities of local suppliers
7. Increased access to new markets abroad
8. "Greening" local ports and businesses
9. Interregional synergies and capacity building
10. Enhanced local activity, jobs, and economic resilience
11. Competence development through educational partnerships

After introducing the premises at the Port of Kristiansand and Kongsgård in chapter 4. , specific impacts on the local economy including opportunities for the local workforce, supply contracts, synergizing with the oil and gas sector and fostering competency development are presented in chapter 5.

4. INTRODUCTION TO KONGSGÅRD & SOUTHWIND

In this chapter, an overview of the Kristiansand municipality and the current status of the Port of Kristiansand is given. Next, the service providers operating in Kongsgård are described. Finally, a brief description of Kongsgård as an O&M port is detailed.

4.1 Kristiansand and local infrastructure

The Kristiansand municipality is located in the southern part of Norway and is the capital of Agder county. With a population of approximately 115,000, Kristiansand is the fifth largest city in Norway and a major economic hub. This urban centre is well positioned to leverage the Port of Kristiansand and supporting local infrastructure to develop new green industries in Norway. The city's is well connected via road and a modern airport in proximity offers both domestic and international travels.

Additionally, the city's industrial zones and business parks cater to a wide spectrum of industries. Kristiansand is home to a range of industrial sectors, including manufacturing, logistics, energy and maritime services. Figure 6 presents relevant infrastructure in and around Kristiansand.

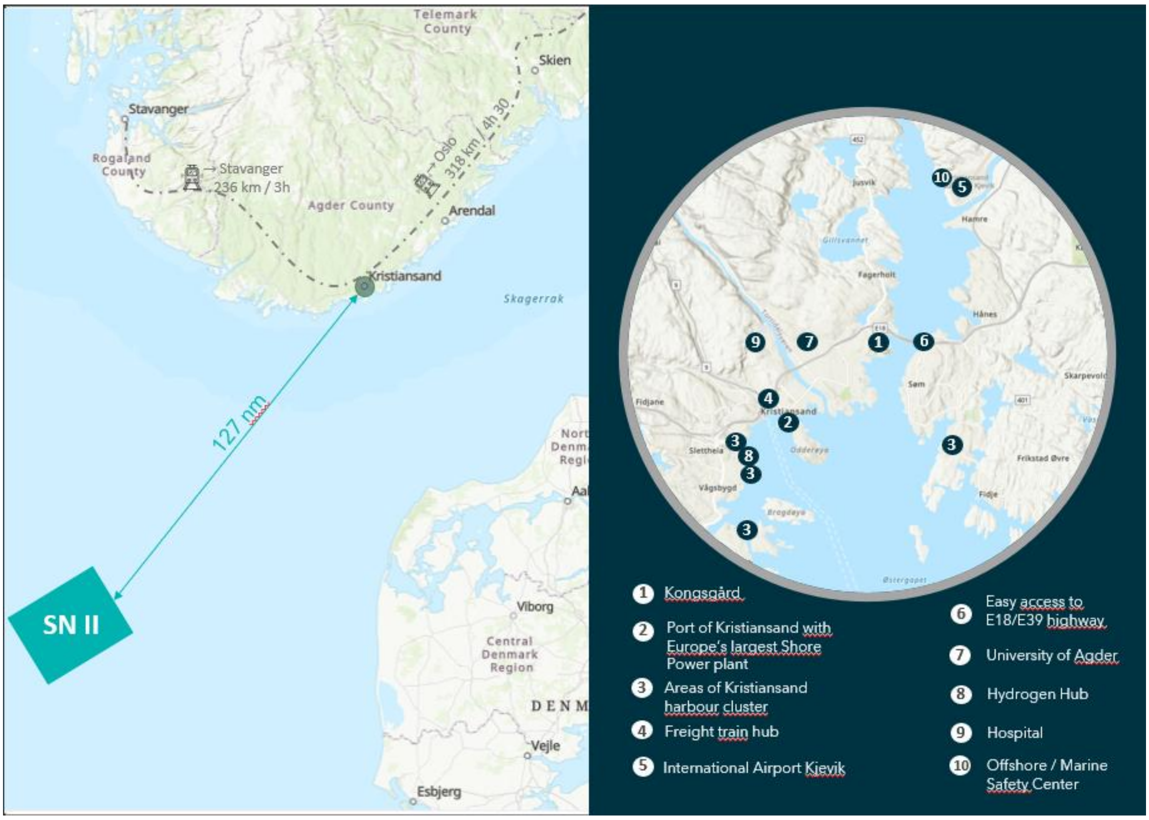


Figure 6: Relevant infrastructure in and around the port of Kristiansand

4.2 Port of Kristiansand

The Port of Kristiansand is a public harbour, owned by the Kristiansand and Lindesnes municipalities through the inter-municipal company "Kristiansand Havn IKS". The Port of Kristiansand is a central industrial processing and offshore-related hub, as well as the southernmost maritime port in Norway strategically positioned close to the continental European markets.

Consequently, the Agder region is a major export hub for processed Norwegian goods, with many exporters located nearby the port. Additionally, Kristiansand has developed into a logistics and transport hub connecting the western and eastern regions of Norway, serving as a natural extension of the E39 road to Denmark.

The most important areas in the Kristiansand harbour cluster are shown in Figure 7.

Figure 7: Harbour & quay areas of the Port of Kristiansand

In recent years, the Port of Kristiansand has made several investments to strengthen its service offering for local industry. In 2014, Port of Kristiansand opened a new quay front in Kongsgård to accommodate the offshore sector. Since then, there has been a significant increase in the number of offshore calls in the Port of Kristiansand. In addition, the Port of Kristiansand has one of Europe's largest shore power systems and the ability to provide power to various kinds of vessels.

As presented Port of Kristiansand ripple effect analysis report completed in 2019 (GEMBA Seafood Consulting, 2020), there are four primary industrial activities at the port: ferry and cruise activities, general goods and container handling as well as logistics, offshore supplementary services and mineral treatment, illustrated below in Figure 8. Each business area is elaborated upon in the following sub-sections.

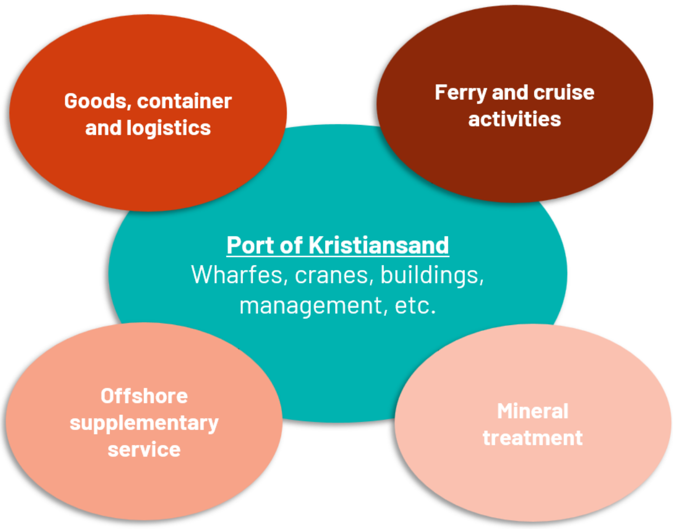


Figure 8: Industrial activities at the Port of Kristiansand

4.2.1 Ferry and cruise activity

- Leading ferry and cruise terminal in southern Norway (incl. Color Line and Fjordline)
- 1.2 million passengers, 332,000 cars, 404,000 tons of ro-ro cargo annually
- Cruise industry 88,000 passengers

4.2.2 Goods, container handling and logistics

- Proximity to continental Europe makes it an attractive export hub
- 51,300 TEUs handled in 2019; 37,150 exported and 14,150 imported
- Container terminals operated by Greencarrier and Seafront Logistics

4.2.3 Offshore supplementary services

- Established offshore supply port servicing oil and gas sector
- Presence of large offshore equipment manufacturers
- 1,444 mooring days spent by vessels in the port in 2019

4.2.4 Mineral treatment

- Mineral processing industry in Agder relies upon port for import of raw materials and export of finished products
- Leading companies are Glencore Nikkelverk and Elkem.

4.3 Kongsgård as an offshore wind O&M port

The Port of Kristiansand has ambitions to become the region's leading offshore supply port. According to the Port of Kristiansand large, positive ripple effects are generated for the region's business community with each port call as a variety of companies become involved in the value chain when an offshore vessel is docked. It is estimated that each port call generates several million NOK in commissions for the surrounding business community (Port of Kristiansand, 2023).

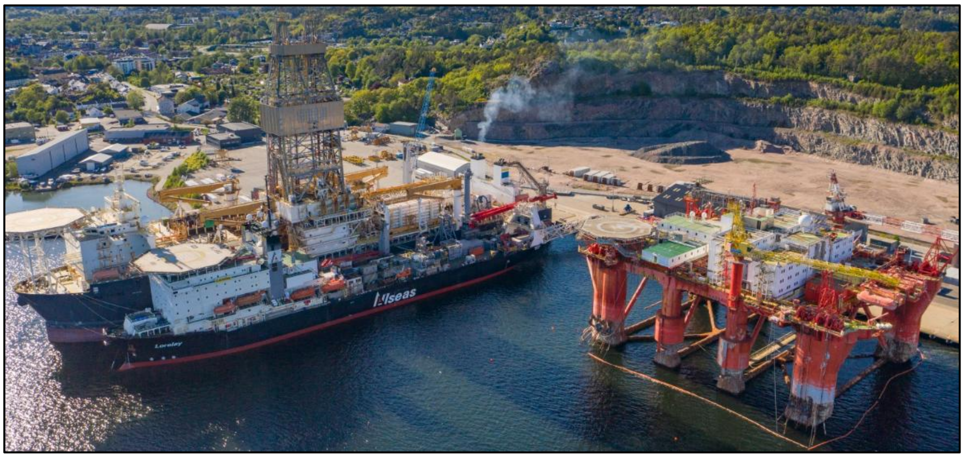


Figure 9: Aerial view of Pier 35 and 36 at Kongsgård

A ripple effect analysis were conducted for 2014 and 2020, based on economic data from 2013 and 2019 respectively. According to the study, economic activity decreased from 2013 to 2019, effecting e.g., employment, revenue, value and tax creation (see Table 6). This is attributed to the decline of the oil & gas sector, including offshore supply services, which is a significant industrial driver in Kristiansand (GEMBA Seafood Consulting, 2020).

Table 6: Main results from 2013/2019 ripple effect analysis of Port of Kristiansand

	2013	2019
Employment (FTEs)	12,119	9,611
Revenue (NOK million)	31,148	22,846
Value creation (NOK million)	10,270	7,845
Tax creation (NOK million)	1,261	911

The Port of Kristiansand and the municipality are eager to increase revenues from the offshore industry and attract in particular the offshore wind industry by establishing an O&M hub for the offshore windfarm SNII. The present infrastructure is already capable of functioning as an offshore wind O&M port. However, investments will need to be undertaken in alignment with relevant stakeholders to develop available areas in the optimal manner to accommodate onshore personnel involved in the O&M phase and facilitate the operation of SOVs and other vessels deployed during the windfarm's operational lifetime. Port of Kristiansand provides further flexibility, as not only Kongsgård but as well other areas of the port may be made available for OW-operations if deemed necessary (e.g., for phase 2 and 3 of SNII).

4.4 Southwind

As the facilitating partner recognized by Kristiansand municipality, Southwind is leading the initial phase of attracting interest and coordinating resources for OW developments in the Port of Kristiansand. Southwind has two main goals: the establishment of an OW O&M base in Kristiansand, and the establishment of an National Competence Center for Offshore Wind.

To achieve the set goals, Southwind will operate as a facilitating partner, coordinating between public (Kristiansand municipality/Port of Kristiansand/University of Agder) and private resources in the exchange of experience, expertise, communication and contact between all stakeholders. The founding companies of Southwind, as well as partner companies, form a comprehensive local supply chain willing to support the development of an offshore wind sector.

Table 7: Southwind - founding companies and partners

Company	Product or Service
Founding companies of Southwind	
On & Offshore Services	Maintenance and modification of vessels and land-based installations.
Techano Group AS	Load handling and lifting equipment solutions
Skeie Group	Industry and real estate
Seafront	Leading port operator in the Kristiansand Port, stevedore & freight forwarder
Broomstick	Market leading production company for marketing strategies and material
NorDrill	Leading engineering company, supplier of state-of-the-art top drive systems
Partners of Southwind	
Aurora Offshore	Vessel provider
Advokatfirmaet Kjær	Law firm specialising in commercial law and litigation
Greenstat	Charging and fuel stations incl. developing H2 supply
North Ammonia	Green ammonia solutions for maritime sector
O. E. Hagen AS	Underwater services (inspection, cleaning, repairs, etc.) with divers & ROVs
OneCo Safe Yards	Broad range of vessel services, including classification & repairs
Origo Solutions	Supplier of control systems for windfarms
Pareto Shipbrokers AS	Shipbroker services
RelyOn Nutec	GWO certified safety training for windfarms
On&Offshore Elektro	Varies products and services including solar energy, wind turbines, peak shaving, energy storage, energy economization & energy recovery solutions
Global OnSite	Supplier of hydraulic & pneumatic products. GWO certified technicians
Siem offshore	Offshore support vessel operator
Smart Inspection AS	Data services
Vind	Platform for screening and designing windfarms
Innoventus Sør	Non-profit actor contributing to establishing and preserving jobs in Agder
Hotel Norge	Conference hotel
Hydroscand	Provide hose and fluid components
Servi Group	Supplier of hydraulic equipment and services
Mementos	Renewable energy consultancy
Norsjór	Laser system to removing fouling

5. RIPPLE EFFECT OF O&M ACTIVITIES AT KONGSGÅRD

Due to the around 130 nm distance between Kongsgård and the offshore windfarm SNII, it is necessary to deploy a SOV with dynamic positioning (DP) capabilities to conduct the regular O&M activities. The SOV serves as accommodation for technicians, provides deck space for storage and handling of spare parts and tools, and manages the waste. For the scenario analysed in this report, regular crew changes at the port of Kongsgård are assumed every 14 days. These port calls will also be utilized for restocking the ship with spare parts and essential supplies, refuelling, and disposing of sewage and waste.

An onshore team will be responsible for planning and managing the O&M activities, including back-office engineering capabilities. This team will ensure 24/7 monitoring of the wind farm and be capable of performing remote interventions. To optimize the maintenance regime, condition monitoring systems and structural health monitoring systems will be deployed. For further regular inspection and maintenance tasks such as underwater surveys, structural inspections of foundations and OSS, maintenance of the electrical equipment, local service providers will be contracted by the developer. Respective survey vessels may depart from their home ports, but in case Kongsgård port facilities allow for that, the usage of the O&M port for these survey vessels may be beneficial and should be discussed with relevant service providers and the developers.

Planned maintenance campaigns of the OSS are to be performed via another SOV or helicopter. However, these campaigns are assumed to be performed in a flyby operation without accessing the O&M port. In case main components need to be repaired and/or replaced, specialised vessels such as cable lay vessels, or jack-up vessels need to be deployed. It is assumed, that such vessels are not operating from Kongsgård, and respective spare parts are not stored at its warehouses.

5.1 Employment rates, income and taxes during O&M phases in OW

Procurement and manufacturing are the most labour-intensive parts of the supply chain in an offshore wind project and are therefore often the focus of local content discussions. However, for countries with limited manufacturing capacities linked especially to main components of offshore wind, the installation and O&M phase becomes the main driver of impacts on local industry.

The share O&M phase share of total labour required in an OWF project varies depending on several factors, including project size, turbine model, site conditions, O&M strategy, and operational lifetime. However, generally O&M activities account for a significant portion of the total labour of an offshore windfarm project from planning to decommissioning; O&M activities for both the WTGs and BoP account for approximately 20 % to 30 % of the total labour in an OWF project.[3]

The job creation potential in absolute figures is expressed by the employment factor, FTE/MW.

[3] See e.g. (IRENA, 2018)

5.1.1 Expected employment rates during O&M in 2030

Over the past years a trend showing a reduction of the required work force per MW has been observed. This can mainly be attributed to the technological advances and experiences gained in past projects and is expected to continue, as condition monitoring systems advance, and the wind turbines of the newest generation reduce the number of WTGs to be serviced. While 2018-2020, WTGs of nominal capacities of about 8 MW were commonly installed, in 2030 WTGs with capacities of 22 MW are expected to be available on the market. For an 1,5 GW OWF, the number of locations hence potentially decrease from about 188 WTGs to 67 WTG constituting about 65% less locations to be approached for planned maintenance campaigns.

Employment factors estimated in a selection of previous reports[4] and Kongstein's experience from past and ongoing projects were used as input data of the simulation model. The expected value of the total number of direct, indirect and induced FTE's/MW together with the 90 % confidence interval have been determined based on a common statistical method. Before running the simulation, the input data was extrapolated and weighted to account for the above-described foreseeable developments. The results of this estimation can be seen in Figure 10, with the 90 % confidence interval ranging from 0.118 FTE/MW to 0.161 FTE/MW and the best estimate of 0.138 FTE/MW.

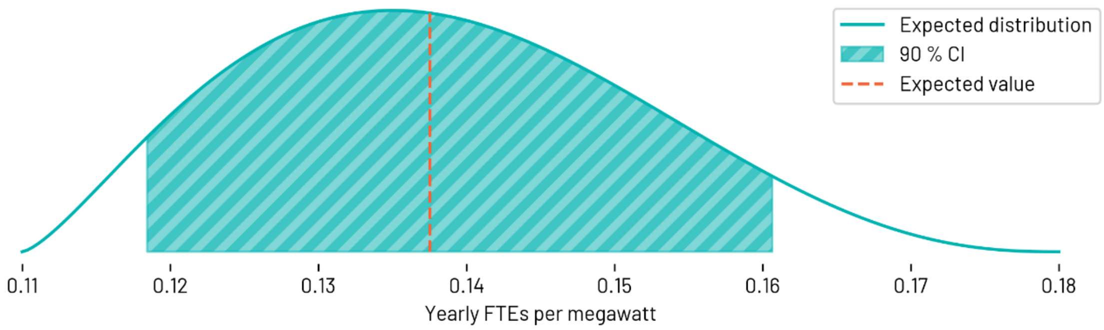


Figure 10: Expected FTEs per megawatt and 90 % confidence interval (CI)

5.1.2 Expected employment rates during O&M in Kristiansand

Considering the outcome of the model used in the previous chapter, a total labour demand of 177 to 242 FTEs per year can be expected to be generated by a 1,500 MW OWF like SNII phase 1, considering direct, indirect and induced effects as introduced in Chapter 3.1 . However, the required workforce will partially be covered by employees of the developer and the OEM reducing the number of personnel of the local supply chain getting involved. Ultimately, that share of the local workforce is depending on the developers and OEM's strategy as well as the capabilities of the

[4] See e.g. (IRENA, 2018), (Briggs, et al., 2021), (Carbon Trust, 2020), (Glasson, Durning, Olorundami, & Welch, 2020), (ICF Resources, 2022), (QBIS, 2020), (SSE Renewables, 2019).

local workforce and supply chain. For the considerations in this report, it is assumed that about 60 % of the direct workforce is subcontracted by the developer/OEM.

Chapter 0gives an overview of relevant job profiles for the O&M of SNII, estimating a share of 20 % for ship crew, 40 % of technicians and 40 % of engineers/experts. Considering the experience of Kristiansand and Kongsgård in the maritime industry, it is expected that the demand for ship crews can be covered by the local workforce as of today. The experiences from the O&G industry linked to services such as subsea surveys, monitoring, risk analysis, forecasting etc. will allow the local workforce to cover large parts of the demand of qualified workforce, although dedicated training programs will be needed. Re-training is certainly required for personnel becoming technicians to service WTGs and other elements of the windfarm. Expecting reasonable efforts will be made in the county of Agder to facilitate the required educational programs, it is assumed, that the local workforce can cover 40-60 % of the demand of subcontracted personnel. Details about elements of competence development are discussed in further detail as part of the qualitative ripple effects in chapter 5.

For the following calculations it is assumed that 65 % of the FTEs are generated directly by the project, 20 % in the indirectly related industries, and 15 % are induced in not directly related industries, which results in 69 to 113 FTEs generated in the local business community.[5] The calculations are based on the first phase of SNII, with a nominal power of 1500 MW and a projected lifetime of 30 years.

Table 8: Expected FTEs generated by the O&M activity of SNII in Kongsgård

	LOW	EXPECTED	HIGH
Total FTEs per megawatt	0.118	0.138	0.161
Total FTEs of SNII Phase 1 (1500 MW)	177	207	242
Direct FTEs (65%) of Total FTEs	115	135	158
Direct FTEs supply chain contracts (60%)	69	81	95
Direct FTEs covered by local workforce (60%)	42	49	57
Direct FTEs covered by local workforce (50%)	35	41	48
Direct FTEs covered by local workforce (40%)	28	33	38
Indirect FTEs (20%) of direct overall	23	27	32
Induced FTEs (15 %) of direct overall	18	21	24
Total FTEs in local industry (60% local of direct FTEs)	83	97	113
Total FTEs in local industry (50% local of direct FTEs)	76	89	104
Total FTEs in local industry	69	81	94

[5] As a reference, experience with the operation of the 588 MW OWF Beatrice in Scottish waters indicates 90 FTEs are working in the OWF's O&M hub in the Port of Wick. See (SSE Renewables, 2019).

(40% local of direct FTEs)			
Total FTE-years during 30 years lifetime in local industry (60% local of direct FTEs)	2490	2910	3390
Total FTE-years during 30 years lifetime in local industry (50% local of direct FTEs)	2280	2670	3120
Total FTE-years during 30 years lifetime in local industry (40% local of direct FTEs)	2070	2430	2820

5.1.3 Expected income of personnel involved in O&M of SNII

Based on the estimations above and the average salaries for the most important work groups, the economic impact can be projected. The FTEs directly employed by the project SNII phase 1 are assumed to be split 20 % for the ship crew, 40 % for the workers and technicians, and 40 % for the engineers and experts as per chapter 3.5 .

According to the Norwegian salary statistics, the average yearly salary for members of the ship crews is about NOK 950,000. While for the workers and technicians NOK 730,000, and for the engineers and experts NOK 1,060,000 average gross incomes can be expected. The indirect and induced FTEs are disclosed as a single category with an average yearly salary of NOK 635,000.

The resulting total gross incomes are shown in Table 9 and Figure 11, considering that 60 % of direct FTEs associated with supply contracts are covered by the supply chain in Kristiansand.

Table 9: Estimated job creation & income in million NOK

	LOW			EXPECTED			HIGH		
1	FTEs	Income		FTEs	Income		FTEs	Income	
		Yearly	Lifetime		Yearly	Lifetime		Yearly	Lifetime
Ship Crews	8	7.98	239.40	10	9.31	279.30	11	10.83	324.90
Workers and Technicians	17	12.26	367.92	20	14.31	429.24	23	16.64	499.32
Engineers and Experts	17	17.82	534.74	20	20.79	623.87	23	24.19	725.72
Indirect and induced	41	26.03	781.05	48	30.48	914.40	56	35.56	1,066.80
Total	**83**	**64.10**	**1,923.11**	**97**	**74.89**	**2,246.81**	**113**	**87.24**	**2,616.74**

Although actual percentages may vary the projected O&M port in Kongsgård indicates a considerable opportunity for the local workforce. Across the operational life 30 years of the OWF SNII phase 1, the O&M port may generate gross incomes of approximately NOK 1,925 to 2,620 million in the local supply chain.

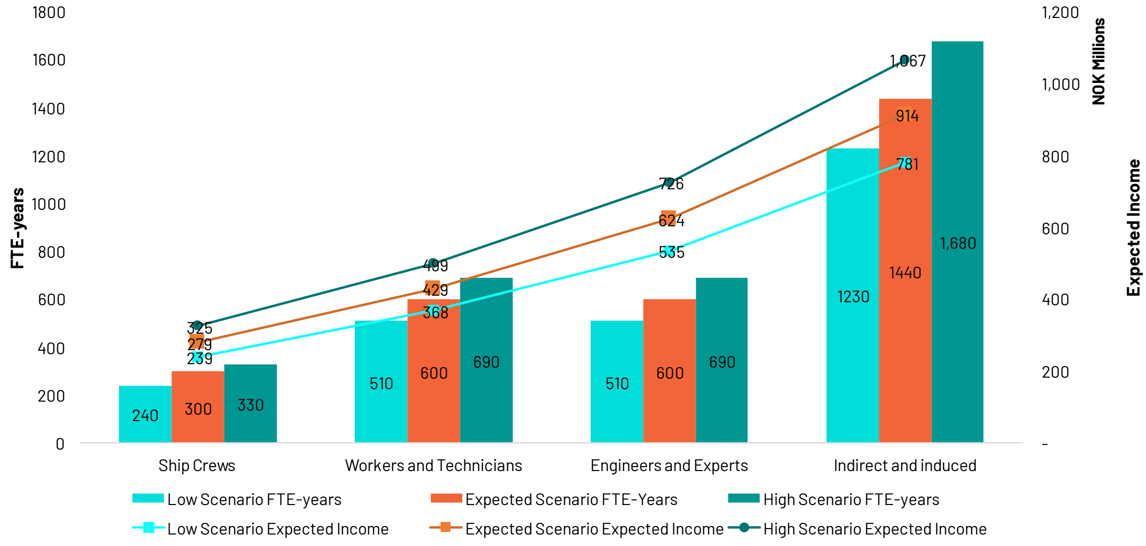


Figure 11: Expected income generated during O&M of SNII phase 1 in local supply chain

5.1.4 Expected tax of personnel involved in O&M of SNII

In this study, the local tax revenue is estimated based on the job creation and income brought to the local workforce in Kristiansand. The income tax in Norway splits into a base rate and the bracket tax added to the base rate depending on the income. The estimated income is presented in the following table, considering the income tax of 22 % and progressive taxes. As per the year 2023, bracket taxes are split into five steps. For the assumed income of indirect & induced jobs, step 2 applies with 4 % bracket tax, while step 3 of 13.5 % apply to technicians and workers, and step 4 of 16.5 % for engineers and experts.

Table 10: Estimated income taxes in million NOK

	LOW		EXPECTED		HIGH	
	Yearly	Lifetime	Yearly	Lifetime	Yearly	Lifetime
Ship Crews	1.9	55.9	2.3	69.9	2.6	76.8
Workers and Technicians	2.5	76.1	2.9	89.5	3.4	102.9
Engineers and Experts	4.6	140.6	5.4	165.4	6.3	190.2
Indirect and induced	4.7	142.1	5.5	166.3	6.5	194.0
Total	**13.8**	**414.6**	**16.2**	**491.1**	**18.8**	**564.0**

After considering the tax deduction (personal allowance and the minimum standard deduction),[6] the taxes generated by local workforce accumulate to 13.8 to 18.8 million NOK per year, and 414.6 to 564.0 million NOK for the lifetime of SNII OWF.

[6] Personal allowance amounts to NOK 79,600, and the Minimum standard deduction is 46% of the income with an upper limit of NOK 104,450 in 2023. See (Skatteetaten, 2023).

5.2 Operational expenditures during O&M of SNII

Commonly, the OEM, selected by the developer of the offshore windfarm will be responsible for the O&M activities linked to the WTGs at least in the first 5 years of operation (the defect notification period). The OEM will need workforce to manage the activities in the port, vessel(s), technicians, and further onshore office personnel. The developer will need to subcontract service providers e.g., to carry out subsea inspections of inter-array cables, export cables, scour protection, foundations, or perform inspections and repairs on the OSS. Details about required services can be found in chapter 3.2 .

Hence, the O&M phase generates an income for local ports for docking fees of SOVs, rent of space and facilities for developer's and OEM's local O&M operations. A single O&M project will therefore typically represent only a small part of the port's total revenue per annum. However, the O&M phase generates a steady flow of income for the port over a longer period of time considering the variety of relevant tasks, services and personnel previously presented in chapter 3.

The extent of operational expenditures is highly depending on the specific O&M strategy, the selected turbine model, the location of the windfarm, the OWF layout and metocean conditions.

The median of estimates from a selection of previous analyses is NOK 0.58 million per MW and year, with the analysed OWFs consisting of WTGs with nominal capacities between 7 and 15 MW.[7] However, O&M costs are expected to further decrease towards 2030 thanks to improved condition monitoring and less failure prone components installed in the newest WTG models. Also, the reduced number of WTGs required to be serviced due to increased nominal capacities of up to 22 MW in 2030, will lead to a reduction of operational costs per MW. Over the lifetime of an OWF, the maintenance costs generally decrease gradually as less errors are expected to occur and less surveys (e.g. subsea IAC inspections) are required to be performed regularly.

Based on the estimates from the selection of previous analyses and Kongstein's experiences, also taking into account the described developments and characteristics of the SNII OWF, average operational expenditures per MW and year for SNII are estimated to be between 0,25 and 0,45 million NOK per MW per year, with an expected value of 0,3 million NOK per MW per year, as per Table 11.

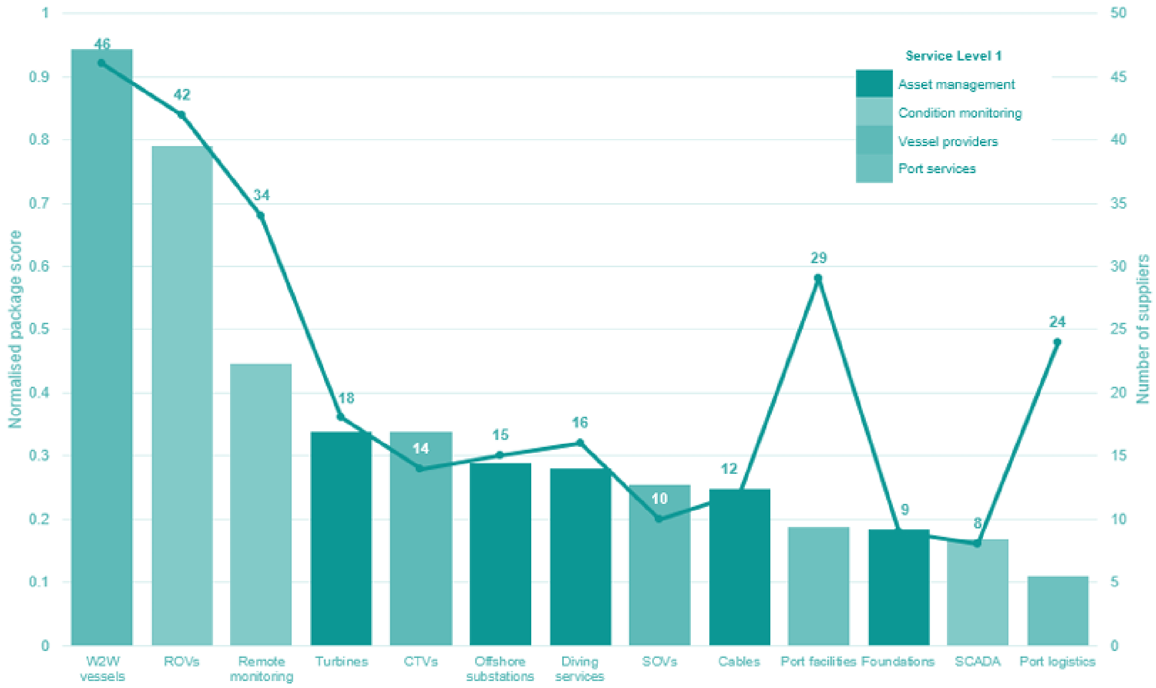
Naturally, the share of these expenditures which will be directed to the local supply chain depends on the available capabilities. Also, governmental regulations defining shares of local content to be achieved by the developers linked to specific counties can have an effect. Currently, however, no specific local content threshold was defined by the Norwegian authorities for SNII.

Looking at whole Norway, the existing supply chain can cover a large share of services relevant for O&M. The industry target of covering 80% of the services related to O&M locally, is regarded

[7] See e.g. (ICF Resources, 2022), (QBIS, 2020), (SSE Renewables, 2019), (PEAK Wind, 2022), (BVG Associates, 2019), (Musial, et al., 2022), (Stehly & Duffy, 2022).

as achievable by 2050 as O&M is an area of the supply chain where Norway can draw on its track record in maritime and offshore industries (THEMA Consulting Group, 2021; RCG Nordic, 2023).
(RCG Nordic, 2023)

Figure 12, provided by RGC Nordic, indicates strength of the current Norwegian supply chain relevant for O&M activities in offshore wind.



(RCG Nordic, 2023)

Figure 12: OpEx ranking by "domestic strength"

5.2.1 Operational expenditures during O&M of SNII directed to local suppliers

Looking into Kristiansand including the Southwind partners, it is evident that covering a share of 80 % of the O&M services locally may not be reached. However, the services to perform scheduled maintenance works of the WTGs will be the largest portion of the OpEx. Subject to development of commodity prices and labour costs, service fees of about 3,500,000 NOK per WTG and year can be expected for the WTG services under a service availability agreement (SAA). And already today Southwind partners do cover specific parts of the O&M scope which are likely to be subcontracted to local companies, including the provision of SOVs:

- Onshore logistics, warehouse management etc.
- Provision of vessel crews for SOV
- Blade technicians for blade inspections and repairs
- ROVs and performance of ROV surveys
- SCADA monitoring and analysis
- GWO trainings

- SOV/W2W vessel
- Data analysis and forecasting

Hence, considerable potential for the local supply chain does exist despite the lack of OW experience. Based on the aforementioned estimated operational expenditures per MW and year for SNII of between 0,25 and 0,45 million NOK (expected value of 0,3 million NOK), operational expenditures are estimated to range between 11,250 million NOK and 20,250 million NOK in total across the lifetime of 30-years (see Table 11).

The same table demonstrates that further potential exists for increasing the total value of contracts received by the local supply chain as at this stage a maximum investment of 30% directed to local companies is considered.

Table 11: Expected investment in local supply chain

	LOW	EXPECTED	HIGH
OpEx, per megawatt and year	0.25	0.3	0.45
OpEx for SNII phase 1, per year	375	450	675
OpEx for SNII phase 1, 30-year lifetime	11,250	13,500	20,250
Assumed investm. in local supply chain 30%	3,375	4,050	6,075
Assumed investm. in local supply chain 20%	2,250	2,700	4,050
Assumed investm. in local supply chain 10%	1,125	1,350	2,025
based on OpEx estimation for SNII phase 1; All values in million NOK			

Considering phase 2 & 3 of SNII, potentially increasing the installed capacity to 7 GW or even 11.5 GW, the opportunities for local businesses will be further enhanced. Several other development areas for OWFs are also planned in reach of Kongsgård, as described in chapter 6.

5.2.2 Expected port calls at the Kongsgård O&M Hub

As discussed before, docking fees for vessels linked to the O&M activities in SNII may constitute a steady source of income for the Port of Kristiansand. An SOV (operated by the OEM, developer or a subcontractor) can be expected to enter the port every two to four weeks to perform crew change, restock food and water, bunkering, etc., resulting in 13-26 scheduled port calls per year.

Further vessels deployed for seabed surveys, cable inspections etc. may also enter the port (see chapter 5.), however, the amount of port calls will be limited due to the short duration of these campaigns. Activities may be increased if Kongsgård become the port to facilitate major component exchange campaigns. As discussed before, in the event a vessel (instead of helicopter) is deployed to service the OSS, another SOV may be operating in the OWF, however a fly-by operation is likely to be performed avoiding the need to enter the port of Kongsgård.

Further activities before starting the construction of the windfarm may also be performed utilising the Port of Kristiansand such as main soil investigations, boulder campaigns, UXO campaigns, seabed surveys. For details about future opportunities for the Port of Kristiansand, please see chapter 6.

5.3 Infrastructure development & port upgrades

The establishment of an O&M port can serve as a catalyst for a substantial enhancement of local infrastructure, resulting in a lasting impact across various sectors. This may encompass the development of expanded parking facilities, access roads, office buildings etc. An example showcasing potential impacts is the Port of Wick in the far northeast of Scotland.

The Port of Wick is the O&M base for the 588MW Beatrice Offshore Windfarm. Over £20m was invested in redeveloping Wick's harbour front, bringing direct and indirect economic benefit to the local area with over 75% of the workforce involved in the O&M construction from the local community (SSE Renewables, 2019).

As presented in chapter 4, Kristiansand already possesses well-developed local infrastructure both within the city and its surroundings. Hence, servicing the SNII OWF of 1,500 MW may not influence infrastructure investments beyond the areas close to the quays to a notable extent.

Also, the port infrastructure at Kongsgård is already developed. Pier 35, which is foreseen to be available for the O&M phase of SNII, as well as Pier 36 which may also be used if needed, have been servicing the offshore industry since 2014 (see Figure 13). The area directly behind the quayside of pier 36 is available for developing and constructing new facilities (ca. 45,000m^2). Infrastructure such as electricity, sewerage, water and fibreoptic cables already exist in the area, available for new buildings constructed in that area. Naturally, such developments require investments and workforce which will be directed to the local business community.

Further investments may become necessary to accommodate future offshore wind developments as well as extending the envisaged offshore wind service portfolio of the Port of Kristiansand as outlined in chapter 6. That may include preparing the quay(s) for jacking activities, providing additional storage facilities for long-term storage of strategic components, additional office buildings etc.

Figure 13: Port infrastructure foreseen for OW O&M hub

5.4 Competence development

Competence plays a vital role in driving economic growth and enhancing the competitiveness of companies. In the region of Kristiansand, a rich availability of skills and expertise is present at all levels, facilitated by a university, research and educational institutions.

As many offshore industries, the offshore wind industry demands a large variety of specialized skills (see chapter 0). These jobs range from SCADA engineers and WTG technicians to ship crew and warehouse managers: including; personnel required by the O&M port, the OEM, developer as well as local suppliers and service providers.

Hence, the establishment of the O&M port will not only create opportunities for local turnover and jobs but also drive skill development initiatives in the region. The University of Agder can play a significant role in responding to these upcoming needs and is actively engaged in preparing individuals to participate in the OW sector.

5.4.1 University of Agder

The establishment of the O&M port can be expected to drive skill development initiatives, including study programs, apprenticeships, and educational partnerships. The University of Agder (UiA) has already started to respond to the upcoming needs for specialized personnel.

Some relevant notes concerning UiA's involvement and generally the importance of the involvement of academia:

- At the University of Agder, research is performed linked to wind power development in several Norwegian municipalities and the challenges and opportunities for wind power from a local community perspective.
- The University of Agder announced in May 2023 that it will join forces with Å Energi, Skeie Group and launch the country's first specialized study program in offshore wind (University of Agder, 2023).
- Agder has previously succeeded in supporting in important industry developments: "With the development of offshore wind in Agder, we face many of the same challenges as when Node, the University of Agder and the supplier industry in the region came together to develop expertise in the field of mechatronics engineering," says Vasstrøm, associate professor at Department of Global Development and Planning (University of Agder, 2023).
- Also, when developing international industry that specializes in development, preparedness and maintenance for the O&G industry in Agder, the main explanation for its success is that actors from the business world and academia came together with a shared goal (University of Agder, 2023).

5.4.2 Research and development

Another expected effect of establishing an O&M port in Kristiansand is the enhancement of research and development in areas linked to offshore wind, particularly between academia and local industry and businesses. Many fields of research are currently of interest including the examples listed below.

Not only educational institutions but also local businesses can expect increased funds for research and development efforts linked to offshore wind. Certainly, these funds will partly be specifically directed to technologies and ideas fostering sustainability in general and enhancing biodiversity in ports and offshore wind projects in general.

Table 12: R&D linked to O&M of an OWF

R&D linked to O&M of an OWF	
R&D	• Autonomous systems (survey vessels; underwater vehicles) • Augmented reality • Condition monitoring, data analysis and prediction/forecasting • Aquaculture & multi-use, enhancement/protection of biodiversity • Decarbonised maritime (fuel saving; engine efficiency; green fuels) • Recycling and circular economy

5.4.3 Synergies with oil and gas

Apart from the educational institutions, it's the local industry which will enhance the competence development and promote the offshore wind industry as an attractive field of working. The aim is not only to train new professionals but also to capitalize on the existing expertise from the offshore and marine industry, such as oil and gas.

With the local industry offering experience in the offshore industry, there are opportunities to transfer skills, services and knowledge to the OW industry. To fully leverage existing competences, it is recommended to develop a detailed guide for local professionals and companies, showcasing the opportunities available and matching their relevant competences to the offshore wind sector's requirements.

Similar efforts are currently widely undertaken in Australia e.g., by the developer of the OWF "Star of the South" and the state government of Victoria. With plans to realize the first OW project by the end of the decade and high emphasis on local content, considerable efforts are undertaken to retrain workforce with vast experience in the oil and gas industry. Figure 18 and Figure 19 in the appendix show the results of an assessment estimating that 57% of the professionals from oil and gas have a "high skill overlap" with the OW industry.

In response to downturns in the oil and gas sector, local industry has had to reduce staff levels in recent times, a move that cascaded down, affecting employment at subcontractor firms. The establishment of an O&M port will provide a broader base for local industry, making it more resilient and less susceptible to single specific market fluctuations.

Large local O&G companies like NOV, HMH, Siem Offshore and MS Group benefit directly from a local O&M port. Their existing competencies, infrastructure, and corporate presence make it an attractive hub for potential investors.

5.4.4 Sustainability

Sustainability is yet another aspect which will gain increased attention thanks to the activities in offshore wind sector in the Agder region. Governmental bodies, as well as developers and main component suppliers, have substantially increased their focus on operating sustainably in the past years, aiming to reduce greenhouse gas emissions across their operations and supply chain, reduce waste and undertake steps towards the establishment of a circular economy.

Consequently, criteria linked to sustainability are commonly incorporated in the subcontractor selection-processes, including the O&M port. On one hand, that fact will open opportunities for local companies to provide innovative ideas and solutions to foster sustainability in offshore wind. On the other hand, it puts certain expectations towards future installation and O&M ports to invest in sustainable services, such as green shore power and alternative fuels.

Therefore, the establishment of an offshore wind O&M port has the potential to enhance relevant activities linked to R&D (see subchapter 5.4.2) and trigger the development of innovative solutions enhancing the biodiversity in the port.

As SNII phase 1 is expected to be commissioned in 2030, the deployment of an SOV running on green fuels may not be economically feasible. However, the OEM and/or developer may decide to look for vessels which are "green fuel ready". In the long run, it can be expected that developers and OEMs involved in O&M activities may demand the provision of green fuels (e.g. green hydrogen).

Naturally, the activities in OW itself may change the region's environmental profile and perception. Transitioning from oil and gas to OW can yield business advantages, attracting investors and a skilled workforce passionate about being part of a green industry.

5.5 Further impacts on the local community

As mentioned above, the most probable concept for O&M of the WTGs of SNII or any other offshore wind farm in this area is the deployment of SOV, leading to a crew change being performed in Kongsgård approximately every two to four weeks. Hence, 13-28 port calls of the SOV staffed with 60 crew members, technicians, engineers would lead to 780 to 1560 persons per year, embarking/disembarking the SOV at pier 35. Thus, requiring overnight stays in hotels, making purchases in local supermarkets and restaurants, using public transport etc.

Additional personnel will be entering/leaving the port in case further vessels are utilizing Kongsgård. Therefore, the indicated number of persons embarking/disembarking and potentially requiring accommodation and other amenities every year may increase.

As especially the professionals working in the onshore port facilities and offices might relocate permanently to Kristiansand, a minor effect on the tax revenue and the local real estate market can be expected. This will include the housing market, as well as additional services like builders, renovating companies, relocation companies etc. The magnitude of these effects will naturally be dependent on the number of vessels to be serviced from Kongsgård.

Table 13: Side-effects of O&M port establishment

Affected services due to increased activity in the port
• Hotels • Real estate services (construction, realtors, renovations, etc.) • Restaurants • Shops for daily needs (groceries, cloths, etc.) • Recreational amenities • Public transport such as taxis, airport, and rail station

Establishing the O&M hub for SNII phase 1 will only have a limited impact on the above-mentioned aspects but considering the full potential of the OW sites in the southern North Sea in Norway of up to 11.5 GW, as well as other OWF projects in the vicinity of Kristiansand, the resulting effects can become considerable for the local community.

6. FUTURE OPPORTUNITIES - BEYOND SNII PHASE I

In chapter 3.3, the report outlines a base case for O&M activities facilitated by the Port of Kristiansand. The ripple effects analysed in chapter 5. are considering these boundaries and looking at the 1,500 MW OW development of SNII phase 1.

Additional impacts on the local community and economy of Kristiansand will be generated in case the port is offering its O&M services not only to SNII phase 1 but also to further OW developments in the southern North Sea, Skagerrak and Kattegat. There are plenty of upcoming OWF projects expected to be operating in the next decades within range of the Port of Kristiansand.

Furthermore, the portfolio of services considered in this report may be extended considering pre-installation works as well as O&M activities currently not included in the ripple effect analysis such as main component exchange campaigns.

6.1 SNII phase 2 and further OW developments

SNII is set to become the first commercial scale bottom fixed OWF in Norway. Located in the far south of the North Sea, the area was designated for offshore energy production on 12th June 2020, with a capacity allocation of 3,000 MW. The development of the SNII wind farm will take place in two phases, each with a capacity of 1500 MW.

SNII Phase 1 and Phase 2 are both located within the so-called Sørvest F (see Figure 14) which constitutes a potential extension to the SNII site and may become part of a future auction in 2025. Further areas in vicinity of SNII (Sørvest A to E) are currently assessed. Combined, these sites are suitable to accommodate the installation of a capacity of up to 11.5 GW.

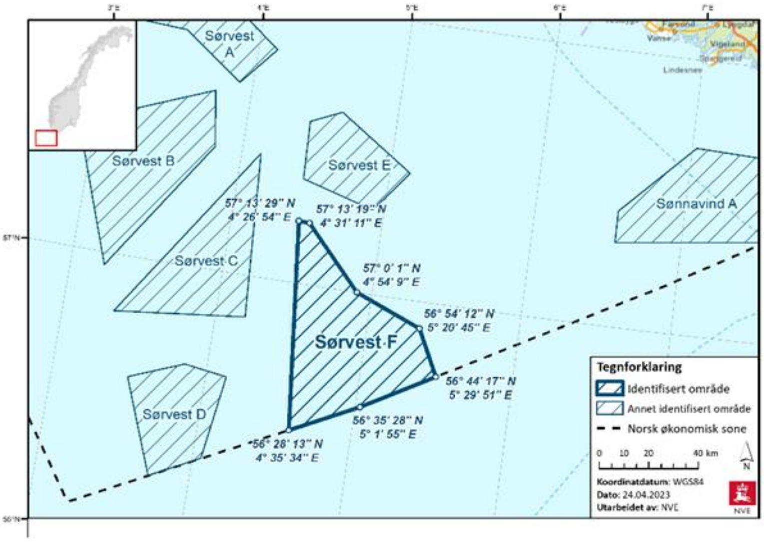


Figure 14: Potential offshore wind sites in the Norwegian southern North Sea

Figure 15 shows OWF sites that are currently in the planning or under construction phases, situated within a 300 km radius of the Port of Kristiansand. This radius is considered the maximum feasible distance for the provision of O&M services. Further details about these OWFs are documented in Table 14, including the current developmental stage, projected capacity, and anticipated commissioning year. Only OWFs with confirmed commissioning years are considered.

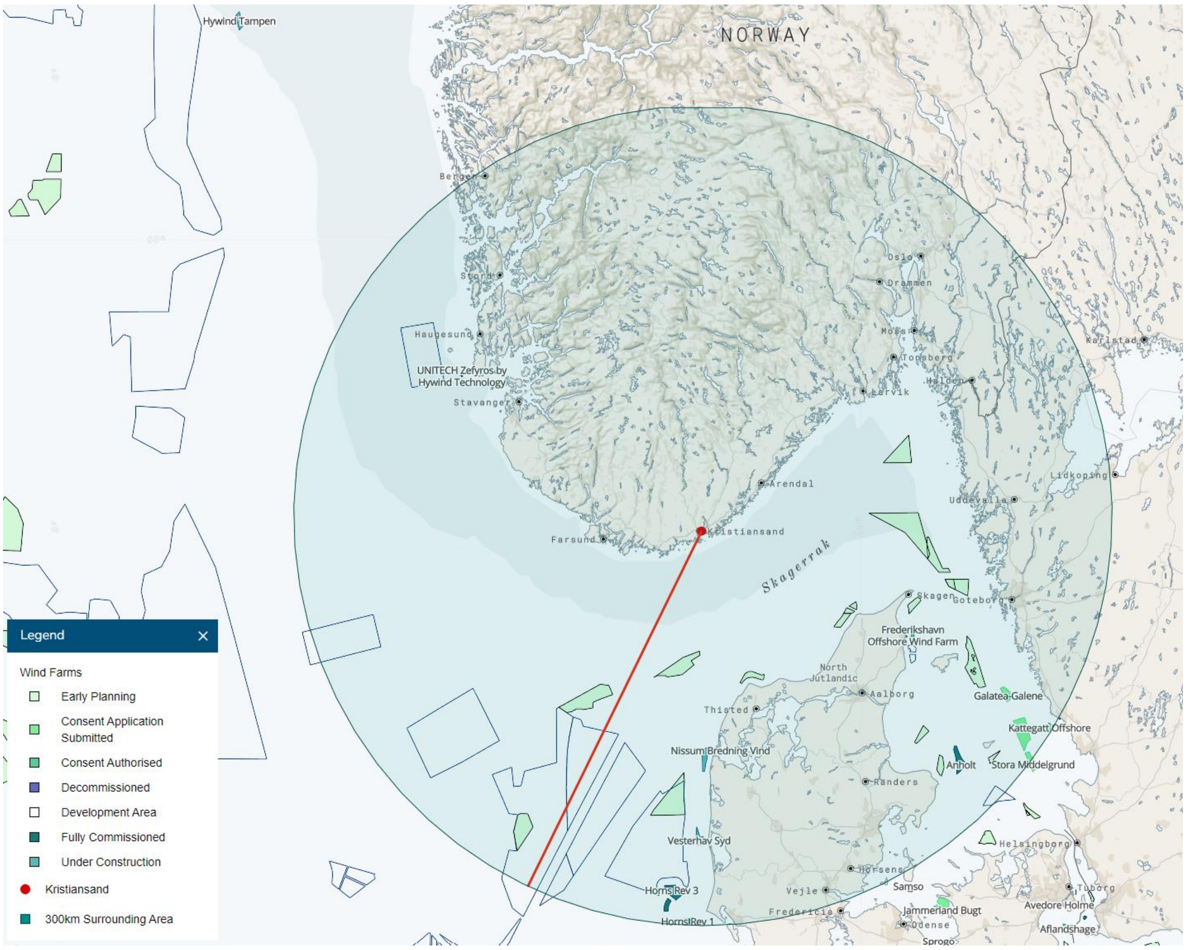


Figure 15: Port of Kristiansand and surrounding OWF within 300 km

Table 14: Future OWFs that could potentially be served from an O&M port in Kongsgård

PROJECT	STATUS	CAPACITY	COMMISSIONING YEAR
Vesterhav Nord	Under Construction	180 MW	2024
Vesterhav Syd	Under Construction	180 MW	2024
Stora Middelgrund	Consent Application Submitted	860 MW	2027
Odin Offshore Wind Farm	Early Planning	1500 MW	2028
Hirtshals Havn Syd	Early Planning	500 MW	2028
Frederikshavn Nord	Early Planning	500 MW	2028
Jyske Banke Nord	Early Planning	1050 MW	2029
Mareld	Consent Application Submitted	2500 MW	2029
Bøchers Banke Havvindmøllepark	Early Planning	1100 MW	2030
Bøchers Banke	Early Planning	1100 MW	2030
Sønderbjerg Havvindmøllepark	Early Planning	285 MW	2030
Utsira Nord - Phase 2	Early Planning	500 MW	2031
Vidar	Early Planning	1400 MW	2031
Kattegat South	Consent Authorised	1200 MW	2031
Nordsøen - Tender 2	Developing	1000 MW	2032
Poseidon Nord	Early Planning	800 MW	2032
Utsira Nord - Phase 3	Early Planning	500 MW	2033
Sørlige Nordsjø II - Phase 2	Developing	1500 MW	2035
Nordsøen - Tender 6	Developing	1000 MW	2036

Figure 16 illustrates the projected capacity of OWFs as currently planned, situated within the 300 km radius around Kristiansand, accumulating to 17.7 GW by the year 2036. Exemplifying the tremendous opportunity for servicing OWFs from Kongsgård.

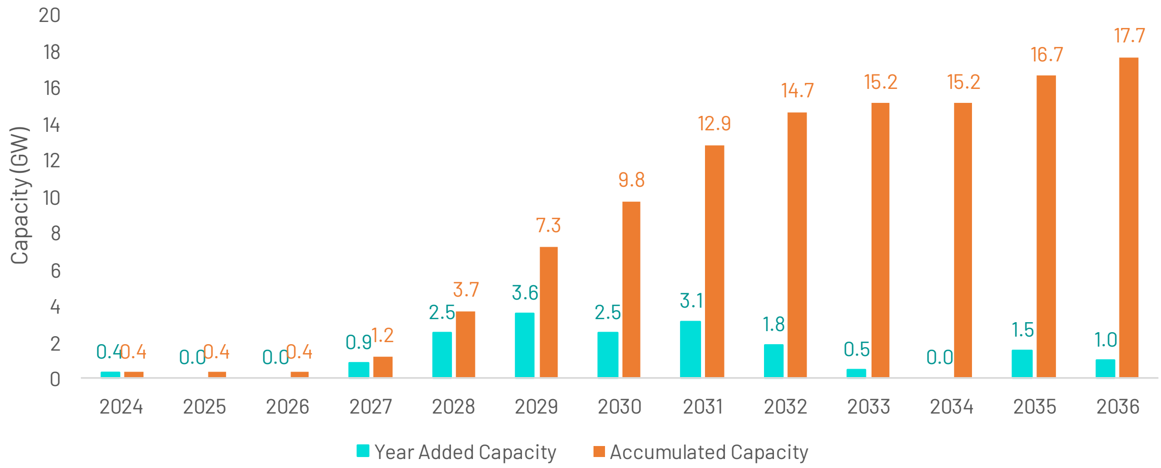


Figure 16: Added capacity of future OWFs served from O&M port in Kongsgård

These envisaged developments constitute considerable opportunities for job creation, increased tax contributions and investments beyond the previously estimated impacts of SNII phase 1 on the local community.

Applying the assumptions linked to the employment rate as per chapter 5. (0.118 FTE/MW, 0.138 FTE/MW and 0.161 FTE/MW), the use of Kongsgård as an O&M port for the abovementioned projects can potentially result in more than 900 local FTEs, including direct, indirect, and induced jobs. As well as accumulated incomes of up to 1,030 million NOK per year by 2036, estimated based on a 60% share of local employments of direct FTEs (see also chapter 5.1.2).

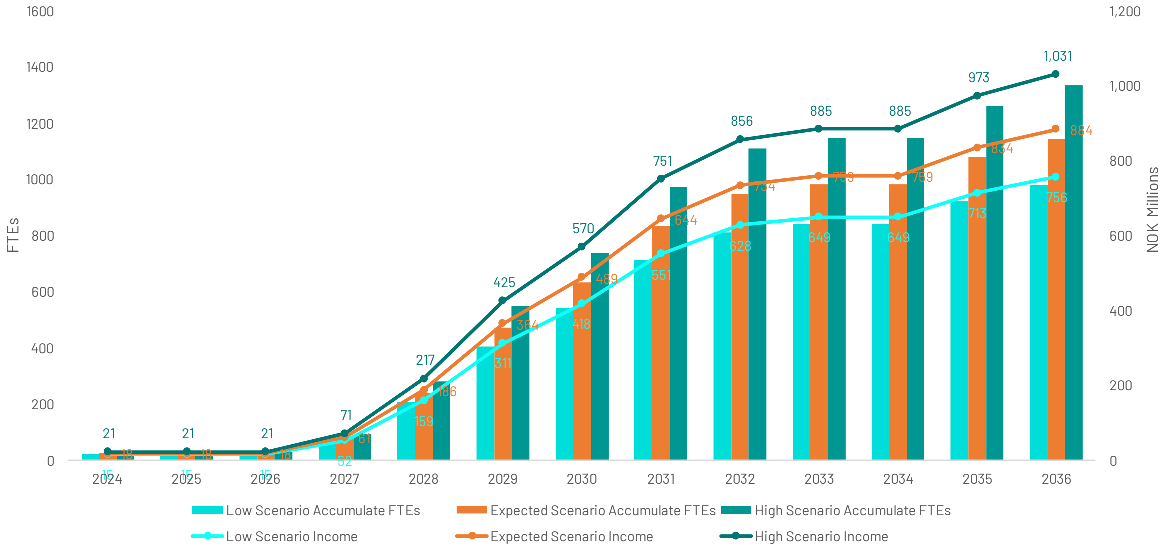


Figure 17: Expected Economic Impact for Kristiansand

6.2 Further opportunities beyond regular O&M activities

In dialogues with OEMs and developers, Southwind AS and the Port of Kristiansand should define, what services (apart from facilitating the regular WTG O&M campaign and performing onshore controlling, monitoring and forecasting activities) could be offered by the local business community. These considerations shall include:

- Facilitation of surveys performed before start of the construction phase such as:
  - Surveys linked to the Environmental Impact Assessment (EIA)
  - Main Soil Investigation (MSI)
  - UXO and/or boulder surveys
- Facilitation of regular OSS O&M campaigns
- Facilitation of unplanned mayor component exchange campaigns
  - Long-term storage for strategic/critical spare parts
  - Berthing of jack-up vessel/barges, CLV/TSV for main component repairs and exchanges

7. CONCLUSION

Kristiansand as an offshore wind O&M port
Kristiansand stands as an ideal location for an OWF O&M port. A vision to set up an O&M hub at Kongsgård will enable the municipality and its business community to capitalize on the OW industry. Chapter 4 demonstrates why this Kongsgård is an optimal location for OW related activities, highlights related industries and their relevance for this project.

Effects on local supply chain
The establishment of an O&M hub in Kristiansand can be expected to lead to considerable investments in local supply chains. If 20% of the required services are contracted locally, total investments of between NOK 2,250 to 4,050 million on local supply chains can be anticipated along the lifetime of the OWF – for phase 1 of SNII alone. Further developments in the region of up to 11.5 GW could multiply these opportunities.

Increased demand for local labour
A local workforce with skills relevant for O&M activities in OW will be demanded along the operational phase of SNII. Total direct, indirect & induced employments locally can be expected to accumulate to between 83 to 113 FTEs per year and generate income for local workforce of approx. 2,000 to 2,500 million NOK along the operational life of SNII phase 1.

Competence Development
Training is key to increase the ripple effects induced by establishing the O&M hub as they are highly dependent on the extent of services which can be covered by the local workforce and supply chain. The local business community, education institutions and municipality can ensure the training and re-training outlined in chapter 3 - enabling local professionals to work in the offshore wind.

Extending the service portfolio
Offering further services than those which are described in chapter 5 can increase the positive effects on the local workforce, supply chain and community. Such services may not be limited to the O&M phase, and include provision/supply of jack-up barges and vessels, engineers, ship crew, technicians, port infrastructure for main soil investigation, environmental impact assessments/UXO/boulder/bathymetry and storage of strategic spare parts and execution of main component exchange campaigns.

Infrastructure Development
The existing developments at Kongsgård (Pier 35 and 36) are well positioned to service the SNII OWF. Kongsgård has serviced the offshore industry and provides sufficient space and possibilities to meet the future demands of offshore wind developments, including preparation for jacking activities, additional storage facilities, and office buildings. These enhancements serve as a catalyst for the long-term growth and advancement of the local infrastructure, creating opportunities for the local business community.

Pressing Timeline
Although the deadline for pre-qualification submission was postponed and the following auction will be delayed, it is crucial that Southwind and its partners manifest their ambitions to establish the O&M hub for SNII sooner than later. After submitting the pre-qualification, the developers will focus on building/detailing their business case to prepare for the auction expected in summer 2024.

Green Fuels
Green shore power will be available at Kongsgård and possibilities to supply green fuels such as green hydrogen or green ammonia should be emphasized by Southwind. Considering the focus and commitment levels on sustainability, all key players committed to embrace such possibilities as part of the collective efforts reduce greenhouse gas emissions associated to the operations.

NEXT STEPS

Despite the long-term project timeline for SNII, there are considerable risks in further delaying the early-stage planning for Kongsgård as an O&M port. Most notably, the risk of other players and ports gaining traction in the establishment of the O&M port for SNII. Thus, to mitigate these risks and realize the positive local benefits from establishing an O&M port in Kristiansand, the following immediate steps are proposed.

Communication initiatives:

- Get in contact with port authorities who have successfully established an offshore wind O&M port in the past years (e.g. the Port of Wick in the UK)
- Engage with actors that will operate at Kongsgård (T&I, O&M, developers, OEMs, etc.) to understand their requirements for an O&M port
- Host workshops with various OW stakeholders in H2 2023

Promoting Kongsgård:

- Establish communication and marketing channels for promoting Kongsgård as the O&M port for SNII
- Engage with key stakeholders and promote the existing competences in Kristiansand to ensure that the Port of Kristiansand becomes the favoured choice of developers/consortia for the future SNII O&M base

Services and infrastructure in Kongsgård:

- Coordinate with OEMs and developers to identify services which can be offered by Southwind partners and other local businesses during the O&M phase. Additionally, identify additional services beyond regular O&M activities (those indicated in 6.2)
- Start discussions and planning for infrastructure developments behind Pier 36
- Accelerate iniatives with University of Agder regarding National Competence Center for Offshore Wind

- Further assessments required:

- Regional ripple effect report in Agder region with PwC
- Bid preparation workshop in H2 2023. With key Southwind partners to prepare the most cost effective and attractive service proposal. (How to create an O&M-Hub in Kongsgård, further stakeholder assessment increasing UVP quality)
- Report focusing on Kongsgård supporting the installation phase of SNII

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APPENDIX A. OIL AND GAS TO OFFSHORE WIND

Excerpts of the "guide for workers" published by the developer of "Star of the South", which will potentially be the first OWF realized in Australian waters (Star of the South, 2023).

Offshore oil and gas to offshore wind

The offshore oil and gas industry shares similar skills, training requirements and workplace conditions. Many current offshore oil and gas workers are well placed to make the shift into offshore wind.

Comparing skills and roles

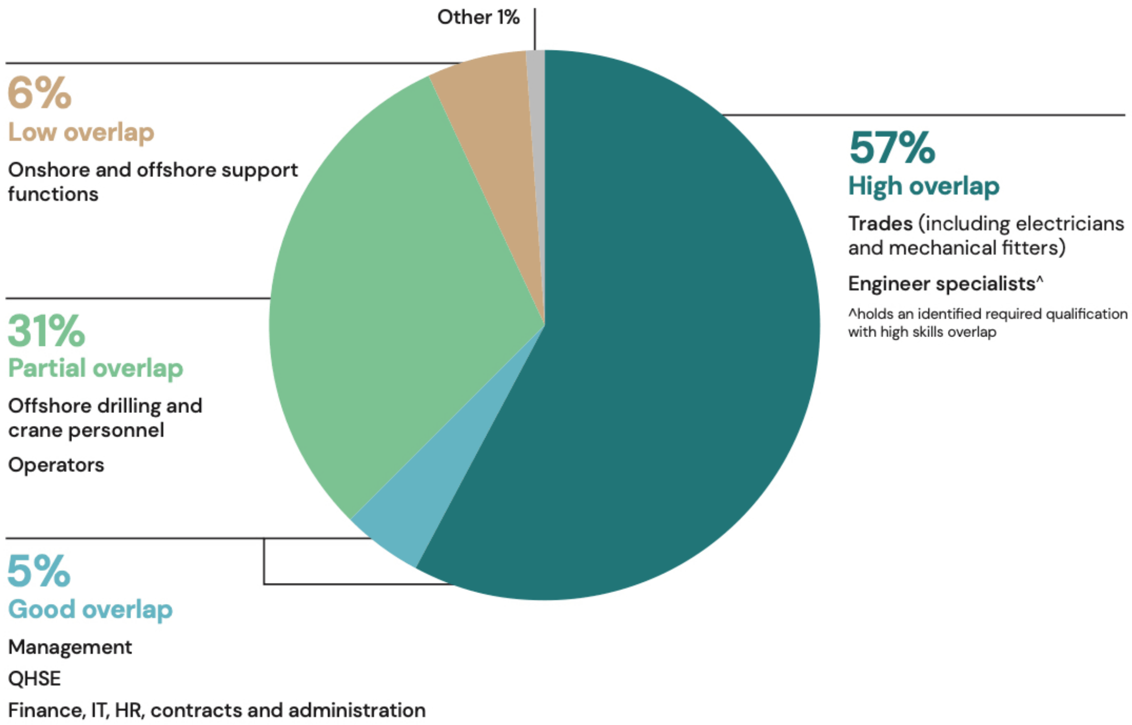

Figure 18: Skill comparison oil & gas and offshore wind

Current role	Skills match	Offshore wind role – potential match	Potential training requirements
Trade-based roles, such as Electricians and Mechanical Fitters	High	Mechanical/Hydraulics Technician Electrical Technician/Supervisor Installation Technician Wind Turbine Technician Blade Repair Technician	• GWO Basic Safety Training • IRATA Rope Access • GWO certified Blade Repair Training / Certificate III in Engineering Composites • DG and RB certifications • BOSIET or HUET (dependent on role) • GWO Basic Technical Training
Engineering specialists, such as Electrical Engineers	High	Planning Manager Project Engineer Project Manager – Grid/ Transmission Cable Installation Manager Carousel Engineer Commissioning Engineer SCADA Engineer Control Room Technician	• GWO Basic Safety Training • Masters or post graduate study in relevant engineering field (dependent on role) • GWO Basic Technical Training • HUET
Health, Safety, Environment and Quality Manager	Good	Quality Manager QHSE Manager Risk Manager	• GWO Basic Safety Training • HUET
Office based roles, such as IT, Finance, HR and Administration	Good	Contracts and Commercial Manager Procurement Manager Planning Manager Quality Manager Human Resources Manager Risk Manager Environment and Approvals Manager Site Administrator Warehouse Stores Assistant	• GWO Basic Safety Training • MSIC • HUET
Operators	Partial	Installation Technician Tension Operator Wind Turbine Technician Blade Repair Technician Apprentice Mechanical/ Hydraulics Technician	• GWO Basic Safety Training • MSIC • DG and RB Certifications • BOSIET or HUET (dependent on role) • GWO certified Blade Repair Training / Certificate III in Engineering Composites • GWO Basic Technical Training
Offshore Drilling Personnel	Partial	Installation Technician Tension Operator Wind Turbine Technician Blade Repair Technician Painter / Rope Access Technician	• GWO Basic Safety Training • GWO certified Blade Repair Training / Certificate III in Engineering Composites • Working at heights certification • IRATA Rope Access qualification • GWO Basic Technical Training
Offshore Crane Operator	Partial	Deck Supervisor Crane Inspection Engineer Rigger Foreperson Heavy Lift Supervisor Crane Operator Trainee Integrated Rating Tension Operator	• LEEA LEG training • Working at heights certification • PMASUP 305 Operate Offshore Crane (or equivalent – Stage 3 Crane Operator)

Figure 19: Roles in offshore wind for O&G professionals