Hampton Roads Alliance

# Hampton Roads Supply Chain Analysis

## Project Report

**ASSIGNMENT** B400011-S00
**DOCUMENT** B-400011-S00-REPT-002

XODUS

Boston

CIC Boston, 50 Milk Street
16th Floor. Boston MA
02109. USA

T +1 (0)8572 631772
E info@xodusgroup.com

www.xodusgroup.com

# REVISIONS & APPROVALS

This report has been prepared by Xodus Group Ltd exclusively for the benefit and use of Hampton Roads Alliance. Xodus Group Ltd expressly disclaims any and all liability to third parties (parties or persons other than Hampton Roads Alliance which may be based on this report.

The information contained in this report is legally privileged and strictly confidential and intended only for the use of Hampton Roads Alliance. This report shall not be reproduced, distributed, quoted or made available – in whole or in part – to any company, person, regulatory body, or organization other than Hampton Roads Alliance without the prior written consent of Xodus Group Ltd.

The authenticity, completeness and accuracy of any information provided to Xodus Group Ltd in relation to this report has not been independently verified. No representation or warranty express or implied, is or will be made in relation to, and no responsibility or liability will be accepted by Xodus Group Ltd (or any of its respective directors, officers, employees, advisers, agents, representatives and consultants) as to or in relation to, the accuracy or completeness of this report. Xodus Group Ltd expressly disclaims any and all liability which may be based on such information, errors therein or omissions there from.

| REV | DATE | DESCRIPTION | ISSUED | CHECKED | APPROVED | CLIENT |
|---|---|---|---|---|---|---|
| R02 | 15 Jun 21 | Report issued for review | AL/DW/BQ | DW/AL | JT | |
| R01 | 08 Aug 21 | Interim report issued for review | JT | DW/AL | JT | |

# CONTENTS

# EXECUTIVE SUMMARY

The Hampton Roads Alliance is the main driver for offshore wind supply chain development in Virginia. The assets the region has are well positioned to create a hub for the construction, operations and maintenance of not only the Coastal Virginia Offshore Wind (CVOW) project, but most likely Kitty Hawk in North Carolina (NC) and other projects to the north, if not the entire East Coast. The recent executive order issued by NC setting an offshore wind (OSW) capacity target of 8 GW by 2040 further bolsters the attractiveness of Hampton Roads as an OSW hub. With CVOW planned for commissioning in 2026, there has been a surge of activity in the area and many OEMs and Tier 1s are interested in Hampton Roads as a US location. The announcement of key supply chain package awards in Q3 2021 will add clarity to the supply chain needs and workforce requirements, and project implementation will come quickly. With 11 Construction and Operations Plans (COPs), including CVOW, in the Bureau for Ocean Energy Management (BOEM) pipeline there is fierce competition between ports and states in economic development and business attraction activities.

The nascent state of OSW in the US has created a fragmented approach to the industry as there is currently limited line of sight on future projects with a project-to-project, as opposed to an industry wide, focus. While there is little doubt future projects will be approved in the near term, there was a reluctancy by many OEM/Tier 1s to commit to establishing local operations and instead the majority of components in the near term will be imported. With the approval of Vineyard Wind, the mindset of major suppliers is shifting and there is an urgency to develop local manufacturing operations in the US. Hampton Roads is well suited to gain share in this growing industry.

Through research and interviews with Developers and OEM/Tier 1s, four overriding factors that OSW companies look for in locations for operation were identified. These are: an existing supply chain to support not only local projects, but multiple projects in varied locations; an available, trained workforce to meet project demand at the various phases of development; available quayside (or proximity) land and physical infrastructure to support the requirements of OEM/Tier 1s; regional commitment to growing the industry and demonstrable programs to support industry growth. In accordance with the type of operation, each of these factors are weighted differently, and the inadequacy of one (land as an example) may preclude engagement.

Based on existing and adjacent supply chain, Hampton Roads is ideally positioned to compete in the attraction and winning of corporate investments in support of the growing OSW industry. Competition is not just among states but among regions; Hampton Roads needs to compete against New England and New York (NY)/New Jersey (NJ). With a combined 16.5 GW of capacity planned in NY/NJ (~50% of the US current OSW target), Hampton Roads must position its assets, workforce and commitment to supporting the industry to counteract larger state projects. By implementing recommended actions, the region has an opportunity to reap significant economic benefits.

As has been seen in the more developed European OSW market, the attraction of an OEM or Tier 1 supplier is the fastest way to develop a supply chain as industry will cluster around that major entity. As a major recommendation, it is therefore critically important that the Hampton Roads Alliance focus on attracting a major package supplier to the region.

The second major recommendation is to invest in physical assets in the Hampton Roads region. While Hampton Roads is already well-positioned in this regard, ensuring the ports, transportation infrastructure, and facilities in the region are market-ready, identifying and implementing investments in physical asset development would be a differentiating factor that sets Hampton Roads ahead of the competition in the quest for an OEM/Tier 1.

The third major recommendation is based around collaboration with the Navy. Hampton Roads is home to a major naval base, with ship building/repair expertise, a large workforce with transferable skills, and an

established supply chain. Additionally, the Navy is a major energy consumer and has stated goals for increasing their renewable energy use. Hampton Roads could leverage these opportunities to increase the attractiveness of the region and accelerate OSW development by employing the Navy as off-taker for future OSW projects, capitalizing on supply chain synergies, employing ex-Navy workforce, and taking advantage of Navy technology such as UAVs, radar, etc.

The benefit of the recommendations proposed, while critical in attracting a large company, have great value across the entire supply chain and will create opportunities for existing Hampton Roads businesses to support OSW in multiple locations. It is essential that the Hampton Roads Alliance and other industry stakeholders provide consistent messaging on the narrative of Hampton Roads, and why it is so well suited to become an OSW hub on the US East Coast.

# 1 INTRODUCTION

## 1.1 General

The US OSW (OSW) market now represents a sizeable portion of the global OSW market, with state goals for capacity totaling 32 GW and 11.6 GW currently under contract. The Hampton Roads region has been at the forefront of this nascent industry, with the 12 MW Coastal Virginia Offshore Wind (CVOW) pilot project being the first operational US OSW installation in federal waters. Considering the impressive 2.6 GW CVOW commercial extension, the Kitty Hawk project in North Carolina (NC), and the recent executive order issued by NC with the stated goal of 8 GW of OSW capacity by 2040, Hampton Roads is poised to leverage its strengths to become an OSW hub for the East Coast. OSW presents a significant opportunity to help the Commonwealth meet its greenhouse gas (GHG) emission reduction mandates and goals, address the declining coal industry, provide economic development opportunities for businesses, and create thousands of jobs for Hampton Roads residents.

The economic benefits which Hampton Roads can realize from OSW will depend to a great extent on the success of the local supply chain in winning and delivering work on OSW projects. To support this ambition, the Hampton Roads Alliance (HRA) has engaged Xodus in order to delineate the supply chain needs and capabilities that exist in Hampton Roads and the surrounding area. The objective is to use these deeper supply chain insights to inform future strategic state and federal-level investments and to help companies throughout the supply chain make more targeted and meaningful connections that will lead to fruitful partnerships in the OSW industry.

## 1.2 Objective

This project has been undertaken with the objective of putting forth a comprehensive OSW supply chain assessment and gap analysis for the Hampton Roads region. This is based on the requirements of both Developers and OEM/Tier 1's, and the capabilities, qualifications and interest of Hampton Roads-based companies and neighboring states. This project identifies the Hampton Road's supply chain assets from both a technical and volumetric position and uncovers the supply chain gaps to help the HRA in its economic development efforts with regards to OSW. This analysis provides a set of recommendations for the HRA for a measurable, strategically focused OSW development plan based on available strengths and market forces in the final report.

Xodus followed a gate process to support controlled prioritization during this assessment with interim reporting following each stage, as follows:

A. Scoping the supply chain requirements (base analysis).
B. Identifying and assessing key sectors/sub-sectors (technical and volumetric review).
C. Analyzing strengths and limitations of Hampton Roads and comparing to neighboring states (gap analysis).
D. Recommendations for Hampton Roads for potential investments (final report).

## 1.3 Scope of Document

This report summarizes all work done to date and provides strategically focused recommendations based on regional strengths and market forces that will allow the HRA in its economic development efforts to support OSW. It is a comprehensive report covering all work carried out through entire gate process outlined in Section 1.2.

First, outputs from key Developer and OEM/Tier 1 interviews are detailed to provide a general overview the current state of supply chain development in Hampton Roads. A discussion of package selection, supplier procurement and contracting, the challenges and opportunities relating to local content, and the perceived strengths and areas of focus are provided. Xodus provides additional insight to topics discussed in Developer and OEM/Tier 1 interviews resulting from internal research and industry knowledge.

A summary of typical contracting strategies employed in the OSW industry is then given, for context. Following this, a categorization of companies from the Hampton Roads from the Supply Chain Connect Database, which is run by the Business Network for Offshore Wind (BNOW), is given. The companies in this directory are organized based on their relevance to different OSW industry sectors, as well as through further sub-classifications of the competencies of each company. An investigation into the industry sectors and the competencies within each sector was undertaken to catalog the companies within the database based on their skills and services. From there, a taxonomic breakdown of the OSW supply chain was used to group and classify the companies from the database in a way that more closely aligns with typical contracting structures for OSW projects. In doing so, strengths and weaknesses related to the OSW supply chain, based on the contents of the BNOW Supply Chain Connect Database, were identified and discussed. This exercise was carried out again following the results of a survey carried out by BW Research Partnership (BW) for the benefit of this study.

Job roles were categorized according to a supply chain taxonomy over a project lifecycle to quantify the jobs needed to support OSW in the region and help prepare the workforce to support both OSW in VA and the East coast. Specific job roles were identified within overarching categories to support in defining training competencies and the timing for required job types. In developing these larger categories of job roles the type of training needed and where the training could be delivered was identified. Assessing wider industry studies that attempt to quantify job numbers in OSW allowed for observations to be made about the volume of jobs, in terms of full-time equivalent (FTE) employment, that may be an economic benefit of a commercial scale OSW project.

The contents of the BNOW Supply Chain Connect Directory for the Hampton Roads area were mapped against the Xodus supply chain taxonomy and analyzed to identify supply chain sectors where companies are well positioned to meet, or adapt to meet, the OSW industry's requirements. The analysis of such companies was carried out using a consistent set of criteria applied to each supply chain element. Plots were then generated to visualize the strengths and weaknesses of the taxonomy sectors as a result of the scores received for each of the scoring criteria.

Finally, recommendations are presented as a culmination of the research and analysis performed over the course of this gate process. Xodus believes this approach will allow the HRA to develop an action plan for supporting and developing a robust local supply chain in Hampton Roads. Importantly, this exercise will help local communities and businesses gain a deep understanding of the OSW supply chain landscape to further assist them in realizing the associated economic benefits.

## 1.4 Glossary of Terms and Acronyms

### 1.4.1 Glossary of Terms

Developer – An OSW Developer is the owner and operator of an OSW farm. Generally, they are large multi-national energy producers and responsible for the delivery of the project in alignment with an agreed Power Purchase Agreement (PPA).

OEM – Original Equipment Manufacturer is a company that purchase parts from other manufacturers or suppliers and use them to assemble their finished products. In the context of this report the Wind Turbine Generator (Nacelle and Blades) providers are referred to as OEMs. OEMs are considered a Tier 1 contractor, see below.

Tier 1 – Considered the main suppliers of equipment or services to the project and generally contract directly with the Developer. Contracts are typically worth tens or hundreds of millions for the top level (Tier 1) packages such as Wind Turbine Generator (WTG) supply/installation or Balance of Plant (BoP) supply/installation. Generally, the Tier 1 contractor will take the risk for schedule and cost overrun and be penalized accordingly should they not comply with agreed delivery dates etc.

Tier 2/3 – Tier 2 and 3 contractors supply directly to the Tier 1 contractors. These are likely to provide a more bespoke or specific component or service such as turbine towers, secondary steel, cable protection systems or electrical equipment for example.

Tier 1s will have Tier 2/3s from which they exclusively source certain material/equipment/services (to guarantee price and schedule certainty) however, often, they will issue a competitive tender process to encourage competition in the supply chain. It is anticipated that Tier 2/3 contracts represent the best opportunity for the Hampton Roads supply chain to enter the industry with a focus on maximizing their primary services, in order to gain experience before expanding into further areas of interest.

### 1.4.2 Acronyms

| Acronym | Definition |
|---|---|
| AUV | Autonomous Underwater Vehicle |
| AWEA | American Wind Energy Association |
| BNOW | Business Network for Offshore Wind |
| BoP | Balance of Plant |
| BOSIET | Basic Offshore Safety Induction and Emergency Training |
| BW | BW Research Partnership |
| COP | Construction and Operations Plan |
| CTV | Crew Transfer Vessel |
| CVOW | Coastal Virginia Offshore Wind |
| EDO | Economic Development Organization |
| EHS | Environment Health and Safety |
| EPC | Engineering, Procurement, Construction |
| EPCI | Engineering, Procurement, Construction and Installation |
| FID | Final Investment Decision |
| FTE | Full-Time Equivalent |
| GIS | Geographic Information System |
| GWO | Global Wind Organization |
| HRA | Hampton Roads Alliance |
| HSE | Health Safety and Environment |
| IAC | Inter-Array Cables |
| IBEW | International Brotherhood of Electrical Workers |
| ISO | International Organization of Standardization |
| MBE | Minority Business Enterprise |
| NAICS | North American Industry Classification System |
| O&M | Operations and Maintenance |
| OEM | Original Equipment Manufacturer |
| OSW | Offshore Wind |
| PLA | Project Labor Agreement |
| PPA | Power Purchase Agreement |
| PPE | Personal Protective Equipment |
| R&D | Research and Development |

| | |
|---|---|
| RFI | Request for Information |
| RFQ | Request for Quotation |
| ROV | Remotely Operated Vehicle |
| SCADA | Supervisory Control and Data Acquisition |
| SME | Small and Medium-sized Enterprises |
| T&I | Transportation and Installation |
| WBE | Women Business Enterprise |
| WTG | Wind Turbine Generator |
| VBE | Veteran Business Enterprise |

# 2 INTERVIEWS

Here we discuss work done under the "Scope" phase of the gate process outlined in Section 1.2. Scoping of the supply chain requirements of Hampton Roads was carried out through desk-based research, as well as direct interviews with key players in the OSW supply chain, such as OSW Developers, OEMs, and Tier 1 suppliers.

With the agreed taxonomy as a baseline, interviews were held with various Developers, OEMs, and Tier 1 suppliers to gain a sense of their views on several topics. These topics included:

- How they define different packages that they put out for tender;
- How far their reach extends into the OSW supply chain;
- What the criteria and processes are for evaluating suppliers;
- Challenges associated with achieving high levels of local content;
- The impact of Project Labor Agreements and the utilization of union labor;
- How they perceive the assets and the OSW supply chain in Hampton Roads;
- How the OSW supply chain and assets in Hampton Roads compare to other regions/states;
- Where Hampton Roads and its supply chain should be focusing its efforts/investments.

Two templates of questions asked of both Developers and OEM/Tier 1 suppliers respectively, can be found in Appendix A to this report. The following companies (in alphabetical order) were interviewed to understand their needs and requirements in servicing and accessing the US OSW industry:

- Avangrid Renewables
- Boston Energy Wind Power Services Inc.
- Dominion Energy
- Nexans
- Ørsted
- Seaway 7
- Siemens Gamesa RE
- Ventower Industries
- Vestas Offshore

## 2.1 Developers/Owner Operators

Developers/owner operators (henceforth referred to collectively as "Developers") offered a range of views on their approach to the eastern US OSW market, the Hampton Roads supply chain, and their recommended areas of focus to improve supply chains and foster OSW industry growth. While some Developers are currently active in Europe where a supply chain is already well founded, there will be a transition period required where expertise and experience are established locally in the US. As the US OSW industry develops, the role of the Developers will not only be to deliver projects, but also to assist in this transition to a local supply chain. Their goal is to identify and work with OEM/Tier 1s that can deliver on their respective packages at the lowest risk for the lowest cost. Common elements expressed in these discussions will help form a useful basis for recommendations on how best to approach OSW supply chain and infrastructure development for Hampton Roads. The common themes identified are:

- Schedule uncertainty is the greatest risk in supply chain development;
- Delivery time schedules are critical;
- There will be a first mover advantage in establishing supply chain clusters;
- Communicating the strengths of Hampton Roads' to Developers is essential so they can assist in establishing the local supply chain;
- A regional approach to supply chain development with collaboration between states, such as the MOU between VA, MD and NC, would accelerate supply chain development on the east coast.

### 2.1.1 Project Timing and Supply Chain Development

The depth of knowledge around the Hampton Roads supply chain is directly correlated to the timing of project delivery. The companies with the most imminent projects have greater knowledge of the supply chain and its strengths and weaknesses. As projects move further out in the timeline, Developers' supply chain knowledge becomes less specific and more anecdotal. The more experience a Developer has in the local market, the more keen they are to engage with the supply chain in order to assist OEM/Tier 1s in maximizing local content. For instance, following the CVOW pilot project, Dominion Energy is better equipped to identify potential supply chain partners and assist their OEM/Tier 1s in finding the right team in the Hampton Roads region.

While packages vary between Developers, currently most are using a multi-contract approach to US OSW projects. Packages are largely divided by major components as a basis for RFPs (i.e. WTG, foundation, array/export cables, substations, etc.). Developers typically consider T&I to be a single package with some variation in their approach towards major turbine components and cables/substation equipment. An EPC/EPCI contract approach is favored, but is not currently feasible as such comprehensive packages would require experienced OEM/Tier 1 suppliers that are fully qualified and trusted by Developers, and the supply chain is not yet at that level of maturity in the US. Onshore construction is more likely to be contracted as EPC and design-build due to increased local experience and track-record. Developers have stated that while synergies and economies of scale are being sought across projects, this is difficult to achieve at the moment so a project-to-project approach is more likely.

Unlike more mature OSW markets throughout the world, OEMs and Tier 1s have not yet established operations in the US. Accelerating the development of the local supply chain, and thus the US OSW industry overall, will require these companies to set up shop locally. As mentioned previously, it is the role of Developers to assist OEM/Tier 1s in getting these companies established in the US.

### 2.1.2 Supply Chain Influence by Developers

Developers primarily influence OEM/Tier 1s by setting project requirements, which place the onus for cost, schedule and compliance on them. The same is true for local content requirements, and while they may make suggestions, Developers are careful in recommending what Tier 2 and Tier 3 suppliers are to be used. Developers do work with Economic Development Organizations (EDOs), such as the Hampton Roads Alliance and BNOW, to identify Tier 2 and Tier 3 companies to advance them in the eyes of OEM/Tier 1s in the region, especially for high priority and long-lead time components.

It is easier for Developers to pass along project requirements for local content when the definitions and metrics are clear. The Virginia Clean Economy Act governs project requirements in the state and helps provide clarity by setting a baseline for compliance, but does not offer hard requirements on spending or full time equivalent (FTE) hours as is seen in other states. Developers will educate their OEM/Tier 1s to a certain degree to ensure they understand what local content means and what the parameters they can use to measure it. Some Developers will work with OEM/Tier 1s in an effort to achieve compliance and bring economic development to the region, particularly if they already have a significant local presence, as is the case for Dominion Energy.

The criteria the Developers use for evaluating suppliers is typically dependent upon the Power Purchase agreement (PPA). If it is a price driven PPA, cost is the driving factor, if its local content driven then the supply chain plays a greater role. With CVOW at Hampton Roads, the Developer was not required to sign a PPA, therefore the ability of OEM/Tier 1s to incorporate the local supply chain in its response to RFPs is heavily weighted. Beyond cost, evaluation criteria used by Developers is the OEM/Tier 1s ability to stay on schedule and on budget, adhere to HSE standards, and incorporate emissions control/reduction measures. They also note the importance of economic development and priority hiring for workers, and OEM/Tier 1s must submit a plan detailing workforce, diversity and inclusion, and economic development partnerships (such as with WBEs, MBEs and VBEs).

Finally, the financial strength of OEM/Tier 1s is of critical importance and is highly scrutinized during the internal evaluation process by Developers. They are seeking to develop long-term relationships with high dollar-value contracts, therefore they need to ascertain that companies have adequate financial stability and longevity before entering their supply chain.

### 2.1.3 Supply Chain Maturity

Developers agreed that once the Vineyard Wind project in MA wins final approval, which has since occurred, there will be an acceleration in the development of the OSW industry in the US, and that local growth will outpace that seen elsewhere in the world. Having successfully executed the CVOW pilot project in the region, Hampton Roads has an advantage over other regions in that potential supply chain companies have a general idea of what is to be expected with the delivery of a larger scale project. While this is the case, all agree that the local supply chain is immature, and the major packages will be undertaken by external, more experienced players in the near term.

The time frame between contract execution and product delivery creates problems for local suppliers that are unaccustomed to the long periods between engagement and revenue that are common in the OSW industry. To keep the supply chain engaged is a challenge. Suppliers will need to be ready when project execution begins, and with design occurring in some cases up to two years before fabrication, it is essential to consider scheduling, planning, and training at an early stage.

A regional approach to supply chain development with collaboration between states in establishing manufacturing and clustering of suppliers was recommended by all Developers. This approach would assist in managing states' expectations, as manufacturing cannot be established in every state. Those being able to establish manufacturing facilities sooner than later will see a first mover advantage and a natural clustering of Tier 2 and Tier 3 suppliers will occur in those regions. Developers have indicated that attracting OEM/Tier 1 companies from Europe to set up in the US will help facilitate supply chain development, and it is important foreign companies understand how to accomplish market entry in the US context.

Project Labor Agreements (PLAs) play a major role in the Developer's plans and modelling based upon project criteria, but the extent is dependent upon where they are in the process. The closer to delivery, the more important PLAs become as RFPs and quotes are being generated. Developers later in project development tend to be involved in ongoing discussions and negotiations with local labor unions. Within Hampton Roads there is the intention of generating PLAs for each specific package in the near term.

### 2.1.4 Training and Workforce Development

A key strength of the Hampton Roads area is the availability of skilled labor. All Developers interviewed stated that given the presence of military, shipbuilding and coal export operations in the area they had no doubt that their labor needs would be met. While Developers note that many skilled workers would require specific additional training, such as GWO training to prepare them for field work offshore, these are generally short-term programs that could easily be implemented. Managing expectations regarding offshore rotational work, where workers may be required to spend multiple weeks at sea at a time, would be required as this type of schedule is

not common in the region. Many workers have the skills required but may not be willing to spend such time periods away from home, so the willingness of skilled workers to take part in this lifestyle must be ascertained.

Developers are actively engaged with local labor unions and training providers to ensure that training programs specifically for wind but also including various skills upgrades or specializations, are available and ready to meet project timelines. Timing is important in this regard to make sure that those going through the training have job opportunities upon completion. While some Developers stated a lack of knowledge or experience in the region with regards to preconstruction skills (engineering, environmental, etc.), all were confident in the ability to bring companies with this experience to the area, and there is a general openness amongst companies to pivot to take part in this industry. Developers more familiar with the region were confident that engineering/environmental companies are already present. All agreed that there are strong engineering departments in universities in the region, as well as numerous industry supporting degree and certificate programs, and so they do not doubt that the required competencies are available.

### 2.1.5 Hampton Roads Efforts and Focus

A key focus in developing the Hampton Roads supply chain is communicating the opportunities available in the region to potential supply chain entrants, and ensuring they understand the qualification processes and timelines associated with OSW projects. By highlighting the strengths of the Hampton Roads region with respect to its deep water port infrastructure that is free of bridges, expansive quayside space, and the availability of skilled labor, it will be able to differentiate itself with respect to other regions.

Hampton Roads ranked highly among Developers for raw material supply, with road and rail access to the port and availability of secondary steel. Challenges exist in the market for components such as flanges and transition pieces. A focus in establishing a "big steel" market would eliminate the need to look to external sources and could be leveraged across the country as the OSW industry develops. A shortage of Jones Act compliant vessels was noted by all as a major hindrance to the industry. For example, rock for scouring operations is currently sourced in Canada as a Jones Act compliant scour supply vessel does not exist, creating a major "choke point" for the industry. This points to an opportunity for Hampton Roads to advertise itself as a robust shipbuilding base, further benefitting the region and providing a major boost to OSW industry development in the US, overall.

OEM/Tier 1 companies have communicated to the Developers that incentives in the form of grants and tax relief would be beneficial in attracting them to set up in the region. Developers indicated that as fabrication capacity is built out, OEM/Tier 1s will also need to anticipate the demands of future OSW projects as technological advances are common in the industry (e.g. larger WTGs, increasingly complex cables, etc.). Regional collaboration was also mentioned by all Developers as a means to accelerate industry growth in the USA. The MOU signed between VA, MD, and NC was cited as a valuable approach to developing the supply chain in a wider geographical context. This would save resources that would otherwise be expended in competition with each other, and allow the region to compete more readily with other states further up the eastern coast.

## 2.2 OEM/Tier 1 Contractors

The OEM/Tier 1s interviewed expressed similar views to the Developers on the Hampton Roads supply chain while offering additional insights. They are typically more involved (and invested) in the broader supply chain and as a result were more specific in their evaluation and comments. Their role in projects is to deliver on the product or service defined in the package(s) for which they are responsible while meeting the requirements set by the Developers. The Developers set the timeframe and cost structure and it's up to the OEM/Tier 1s to meet the schedule and manage costs while delivering on quality standards. This necessitates a robust supply chain that is capable of achieving quality and schedule targets. As the OSW in the US is nascent this does not yet exist locally; neither for Developers nor for OEM/Tier 1s. Critical success factors include:

- Ability to meet project timelines. Uncertainty regarding project schedules within the supply chain is a major challenge.

- Multiple projects are required within the line-of-sight for OEM/Tier 1s to establish a local presence and build necessary confidence in the market (President Biden's recent announcement regarding OSW funding is adding confidence to the market)
- Project support and industry support scopes are different in size and complexity and OEMs/Tier1 are evaluating both.
- Identifying and matching companies with Developers and OEM/Tier 1s seeking local content is a challenge; a systematic approach to matchmaking is needed.
- Communication of opportunity, but also of timing, process, and risk are key to engagement and success.

### 2.2.1 Project Approach and Package Delineation

The supply chain is project based at this time. The OEM/Tier 1s interviewed would like to move to a market-based approach once activity ramps up in order to benefit from the efficiencies that would be created. As it stands, there are no fully approved commercial-scale projects in the US, so the OEM/Tier 1s are working on supply chain networking in anticipation of market growth and predictability. It is important to note that once a project obtains full approval and construction begins it will spread confidence within the OEM/Tier 1s that the industry is real and establishing a US supply chain is critical to meet price and timing goals.

Unlike with projects in EU, no OEMs currently have an established US presence, which must change in order to build the confidence and experience needed for larger packages (i.e. EPC/EPCI) to be issued. In EPC/EPCI contracts, the responsibility on OEM/Tier 1s is enormous as they are essentially executing the majority of the project, from design, through purchasing, construction, transportation, and installation. This requires a deep understanding of the industry and its stakeholders by OEM/Tier 1s, which will not be possible in the US OSW industry for some time. While many Developers would favor and EPC/EPCI approach, in transferring so much responsibility to a OEM/Tier 1, they first need to develop steadfast confidence in the company.

The OEM/Tier 1s have defined packages that are aligned with delivery of major project components (nacelle, hub, tower, etc.) and with more broadly defined packages (transportation, vessel procurement, etc.). Tier 2 packages are defined based on raw materials, subcomponents (bearings, lubricants, etc.), construction, quayside outfitting, and O&M. These more narrowly defined packages allow the OEM/Tier 1s to deliver very specific requirements to the supply chain, which may assist in simplifying the self-selection, evaluation, and qualification processes for Tier 2 and Tier 3 companies.

Packages can vary project-to-project based upon implementation timeframes and supply chain depth. Due to the time it takes to onboard a supplier and the criticality of components, the initial project(s) will rely heavily on companies already in the OEM/Tier 1s supply chain. The result is that early projects will be supported from established locations primarily in Europe and delivered to the US. These OEM/Tier 1s must also be flexible to local contract terms. In some contracts it is the OEM/Tier 1s responsibility to provide installation or O&M solutions where in others these may be controlled by the Developer. As the market opportunity increases, standardized US packages will emerge that will increasingly rely on a local supply chain.

### 2.2.2 Local Supply Chain Maturity and Timing

The OEM/Tier 1s realize that communication is critical to their success. However, it is important for these OEM/Tier 1s to understand it is not only communication of opportunity, but also of timing, process and risk which are key to engagement and success. A robust local supply chain will reduce costs and improve schedule visibility, thus reducing risk. OEM/Tier 1s have indicated that they tend to start looking for local partners at the state level, then to US-based companies that would be willing to set up in the local area, and finally to the wider US and abroad. They often look to their internal procurement teams to find prequalified companies that may be interested in entering the local market as a first step. Often times prequalified companies exist in their supply chain in an adjacent industry with transferable capabilities, such as in onshore wind or jacket manufacturing. There is a desire to partner with known and trusted quantities, thus companies that have worked in other

sectors on similar scopes may provide good partners in OSW. While all parties agree that a local supply chain is important, having confidence in that supply chain is most important.

As previously noted, there is a universal concern that the supply chain has not embraced the time between identification and actual revenue. Depending upon the complexity and criticality of the component, just the acceptance into the OEM/Tier 1s supply chain can take two years or more, with realized revenue potential being seen two years later. This points to the cost, both financial and resource, that may be required to become a preferred supplier. This timeline is not common in US industries.

There are major risks associated with sub-contracting new suppliers which must be mitigated. With regards to bid prices, immaturity in the supply chain means that Tier 2s and 3s are unaware of what the market will allow and may set prices too high. It is the responsibility of OEM/Tier 1s to educate the supply chain on what would be considered competitive bids in their niches so that benchmark prices can be established.

Due to inexperience, many potential suppliers are unaware of the stringent quality requirements in the OSW industry, which creates risk with respect to product delivery timelines and overall product quality. Again, education by OEM/Tier 1s would mitigate this, as well as implementation of robust quality management systems. Many OEM/Tier 1s indicated that they would not expect a newly qualified supplier to ramp up to high volumes in a short time, and that they will use dual sourcing to manage this risk.

### 2.2.3 Developer Influence on OEM/Tier 1 Supply Chain

The selection of supply chain partners for OEMs and Tier 1s is not typically influenced by the Developers. There are exceptions to this for the most complex or critical components, in which case Developers and OEMs may be concerned with potential manufacturing locations or processes. Developers may intervene to assist an OEM/Tier 1 if a supply or schedule impact is likely, at which point they would seek to get things back on track. As observed in the Developer interviews, Tier 2 suppliers may be recommended by Developers, but there is generally no obligation to use them. In most cases, the project requirements are pushed from the Developers to the OEM/Tier 1 suppliers who must then assume the risk for their supply chain and seek out local content.

OEM/Tier 1s have indicated that while Developers encourage good faith negotiations with local content suppliers, setting hard requirements through negotiations would give better guidance on how much local content must be accounted for. Sourcing local content can create price pressure, especially as benchmarks are yet to be established, so more easily quantified requirements would allow them to make better judgments on labor costs and prices. OEM/Tier 1s have indicated that while Developers encourage good faith negotiations with local content suppliers, setting hard requirements through negotiations would give better guidance on how much local content must be accounted for.

### 2.2.4 OEM/Tier 1 Role in Supply Chain Development

Based on the interviews conducted, the role of the OEM/Tier 1s on OSW supply chain development within the Hampton Roads region can be summarized by the following four categories:

- Timing
- Qualification Process
- Evaluation Criteria and Risk Management
- Communication and Education

#### Timing

The evaluation of supply chain partners is an exhaustive and well-documented process for OEM/Tier 1s, but is nuanced in the US OSW context. The qualification process for Tier 2 and Tier 3 companies can take multiple years in some cases, and this process must fit within the project timeline and schedule. OEM/Tier 1s must begin the process of engaging with suppliers well ahead of an RFI or RFQ, as once these stages occur OEM/Tier 1s do

not have time to develop relationships and ensure suppliers are adequately qualified. There are clear procedures for onboarding/qualification processes in the oil and gas industry that US-based companies may be familiar with. Many OEM/Tier 1s feel these processes will likely be transferred to OSW, but there will be a longer time period of getting to know suppliers because the supply chain is less straightforward than in oil and gas. Some OEM/Tier 1s indicated they will work backwards from the project completion date to establish a timeline for the onboarding process based on the criticality and complexity of the component/service being sought.

### Qualification Process

Suppliers must demonstrate that they have the ability to comply with and meet both industry and OEM/Tier 1 standards by undergoing a qualification process. This can be time consuming and costly, and OEM/Tier 1s have expressed that communicating qualification requirements can be challenging due to a general lack of experience regarding the OSW industry and its specifications. Adequately communicating requirements allows Tier 2s and 3s to self-select and reduces the number of companies that are interested and capable of delivering various packages. Some OEM/Tier 1s indicated that it can be challenging to provide adequate information to help the supplier meet requirements (i.e. specifications, drawings, standards, datasets, etc.) before signing an NDA. However, for critical components they are willing to provide whatever is required, and may work with the supplier throughout the approval process.

While OEM/Tier 1s are willing to assist their suppliers at any stage of the qualification process, especially for rare or long-lead time components, companies must be aware that there is a cost associated with the process and they must take it upon themselves to assume those costs and put in the work to get qualified. The OEM/Tier 1s also carry a cost burden by assisting in this process—one company indicated that they have hired two staff to deal explicitly with sub-contractor qualification in OSW, while another indicated they have a full division allocated to qualification.

### Evaluation Criteria and Risk Management

Beyond meeting qualification requirements, OEM/Tier 1s need confidence that the supply chain partners selected will be able to meet project goals and established timelines as delays, especially in key components, are very costly and can have a detrimental effect on project outcomes. It is thus extremely important to OEM/Tier 1s that their Tier 2 and 3 suppliers are financially stable. Sometimes an extensive risk assessment will be carried out for companies, particularly if they are tied into a business development scope. OEM/Tier 1s indicated that they are seeking local companies that are capable of pivoting to enter OSW without abandoning their core business. These adjacent industry companies will be better able to manage the risk associated with schedule uncertainty and long lead times as they will have additional revenue streams outside OSW. Supply chain partners are also scrutinized based on their approach to HSE, quality, shareholding structure, and compliance.

### Communication and Education

As potential Tier 2 and 3 companies generally lack experience in the OSW industry, it is essential that distinctions from traditional industries are adequately communicated. US companies are typically not familiar with the long durations between project award and execution, meaning the time between contract award and revenue are longer than they are used to. It is essential that these precisions are communicated so that companies are able to plan their involvement in the industry and meet project timelines.

A major challenge for OEM/Tier 1s is getting introduced to local partners. They generally need to find the partners themselves and rely on published databases, EDOs, and word of mouth. Depending on the location in the US, some OEM/Tier 1s develop a supply chain engagement plan where they screen what they can subcontract locally, reaching out to potential supply chain partners themselves. While Developers sometimes assist in identifying potential partners, this does not tend to be the norm. As OEM/Tier 1s are responsible for finding their own supply chain, they need a more systematic and streamlined process to do so. Communication between potential supply chain partners and OEM/Tier 1 companies, often through intermediaries such as EDOs, is critical is establishing a local supply chain in Hampton Roads.

### 2.2.5 Hampton Roads Strengths

The strengths of the Hampton Roads region can be summarized in the following categories:

- Physical Assets
- Existence of Adjacent Industries
- Workforce
- Regional Collaboration

A key strength of the Hampton Roads is its deep-water port facilities that are unimpeded by bridges. There is also significant land availability which is essential for OSW operations due to the enormous structures that must be manipulated during staging operations and mobilization. OEM/Tier 1s note that this port is well suited for steel fabrication, and rail access facilitates transport of raw materials such as steel plate for tower fabrication. Large size steel plate for specialty components is easily accessible by water.

Almost all OEM/Tier 1s interviewed stated the availability of skilled labor at Hampton Roads as a crucial strength of the supply chain in the region. Due to local concentration of adjacent industries, such as military, marine and energy, the transferability of technical skills means there is a strong labor pool that most other states on the east coast do not possess. Workers in the region have been described as hardworking and eager to get involved in the renewable energy market. While training gaps have been identified, OEM/Tier 1s are confident that filling these gaps is possible. Another benefit of the region is stated to be the comparatively low cost of labor.

Compared to neighboring states, Hampton Roads ranks quite highly, especially with respect to overall readiness. The MOU signed between VA, MD and NC is considered to put Hampton Roads ahead of other states as a regional approach is favored by many OEM/Tier 1s. Many OEM/Tier 1s have indicated that they are looking to pinpoint a state or regional focus so they can communicate with the supply chain more effectively.

### 2.2.6 Hampton Roads Efforts and Focus

Many of Hampton Roads' strengths are also areas where additional effort and focus has been identified. Areas of focus for developing the local OSW supply chain can be summarized as follows:

- Transfer of industry knowledge
- Partnerships and collaboration
- Targeted incentives
- Asset readiness
- Communication

There is general concern among some OEM/Tier 1s that the local supply chain does not yet have a good technical understanding of WTG components or the manufacturing capabilities needed for OSW. They feel it is important for communities to take the time to understand and communicate these specific requirements to companies, and that investment in this regard would be of great value. A suggestion was to create a course or training program on OSW and what it will bring to local industry so that adjacent industry companies will better understand where they might fit or what they could contribute. While these courses exist, there needs to be additional granularity to the content so that companies can get insight into their particular sector of interest (i.e. how to get involved in the WTG supply chain). These courses need to follow project timelines, so that interested companies will still have time to undergo the qualification process after obtaining the information they need.

A focus on building a regional supply chain as opposed to a local supply chain was raised several times. One OEM/Tier 1 suggested creating a supply chain free trade zone so that local content in VA could count within a specified region, such as that covered by the MOU, in order to attract local manufacturing and maximize available infrastructure. Finding ways to leverage this collaboration will be key to success in the region.

While incentives help in the short term, they are not considered sufficient drivers for decisions on where to establish manufacturing as they do not contribute enough to cost. There is value in providing tax relief, incentives, and grants for companies that are capable of going through the prequalification process due to the long timelines and lack of initial revenue they face. Having a mechanism to capture companies that have been approached by OEM/Tier 1s so that support can be given to them has been identified, as smaller companies will have a difficult time going through the qualification process unless such support is given.

Additionally, directing financial incentives towards workforce development and training programs/facilities in order to drive down costs is important, but these services must be flexible enough to follow industry growth. Collaboration between states and companies is important in this regard to ensure programs developed are not overly bureaucratic and actual meet industry needs.

While the port facilities of Hampton Roads are world-class, ensuring that laydown spaces have sufficient weight capacity ratings, and that other infrastructure meets requirements is very important in attracting supply chain players. Having pre-permitted sites ready for use would increase appeal. There will also need to be adequate and fairly priced support services with respect to having an increased workforce presence in the Hampton Roads region, such as housing, offices, IT equipment, transportation, etc.

While all the aforementioned efforts will go a long way to establishing a robust local supply chain, a critical component in making this a reality is communication. Developers, OEMs, Tier 1s, and potential supply chain entrants must be aware of opportunities that exist, allowing adjacent industries to identify where they might fit. Ensuring knowledge of the capabilities and opportunities in the Hampton Roads region are well understood will ensure the region is on the radar of companies looking to establish a physical presence in the US as the OSW industry develops. Information sharing sessions such as Friday Forums, organizations such as the Hampton Roads Alliance, and the efforts of other EDOs have made a lot of progress in this regard, however the focus on communication must remain a key priority moving forward. A streamlined, systematic approach to matchmaking between OEM/Tier 1s and local supply chain companies in needed.

# 3 CONTRACTING STRATEGIES

Ambiguous and complex procurement practices can be difficult to navigate at the best of times. This is then compounded when discussing nascent supply chain environments. A lack of awareness of opportunities and how these are contracted create a barrier to securing contracts.

Standardized and simpler procurement processes are considered key to solving some of these issues, however, in practice this can be difficult due the variety of contracting strategy combinations available to the Developers and OEM/Tier 1s sub-contracting. Therefore, providing support to local industry to help navigate the current context is critical.

The approach to contracting strategies in the OSW industry is generally influenced by multiple variables:

- Size and complexity of the project to be executed;
- Internal strength, experience and capabilities of the OSW farm developer;
- Influence of project financing availability and;
- Maturity of the local supply chain.

In the development of an OSW farm the developer usually prefers one of the below strategies (discussed in further detail in the following sections):

- A multi-contract strategy;
- An engineering, procurement, construction, and installation (EPCI) strategy;
- A hybrid/multi-contract/EPCI strategy.

Historically in the US, companies developing and operating solar, wind, and other renewable energy projects often work onshore. The contracting structures and forms used in such projects are very similar to other onshore infrastructure projects and often take the form of turn-key 'one-stop' contracts (an example of which is detailed in Section Error! Reference source not found.). The type of contracts applied to onshore projects do not c onsider the specific risks and challenges of operating in an offshore marine environment and we have seen this to be a key obstacle in project finance. The increased risk of cost and schedule overrun from multiple project interfaces currently presents too large of an unknown to banks/lenders (in the US) when the added challenges of an immature local supply chain and the Jones Act are also posing key project risks.

## 3.1 Multi-Contract Strategy

For a multi-contract strategy, the owner operator/developer will typically award separate contracts for the key elements of the wind farm (for example turbine supply, foundation supply, turbine installation, cable installation and foundation installation) see Figure 1. It has been seen that typically 9-10 main contracts can be awarded covering the main components of an OSW farm.

The multi-contract approach offers the greatest control over project development and the best opportunities for cost reduction, but it requires an owner operator/developer with very strong in-house engineering expertise, commercial skills, and experienced personnel. A multi-contracting approach requires the developer to play a greater role in managing interface risk and coordination between the various contractors. It is therefore often more suitable and preferred by large utilities or Developers with extensive experience in executing OSW project (such as Equinor, Ørsted and Avangrid). These large utilities/Developers may be less likely to be reliant on

project finance and as such can take this risk internally rather than pay a (perceived) premium for an EPCI solution.

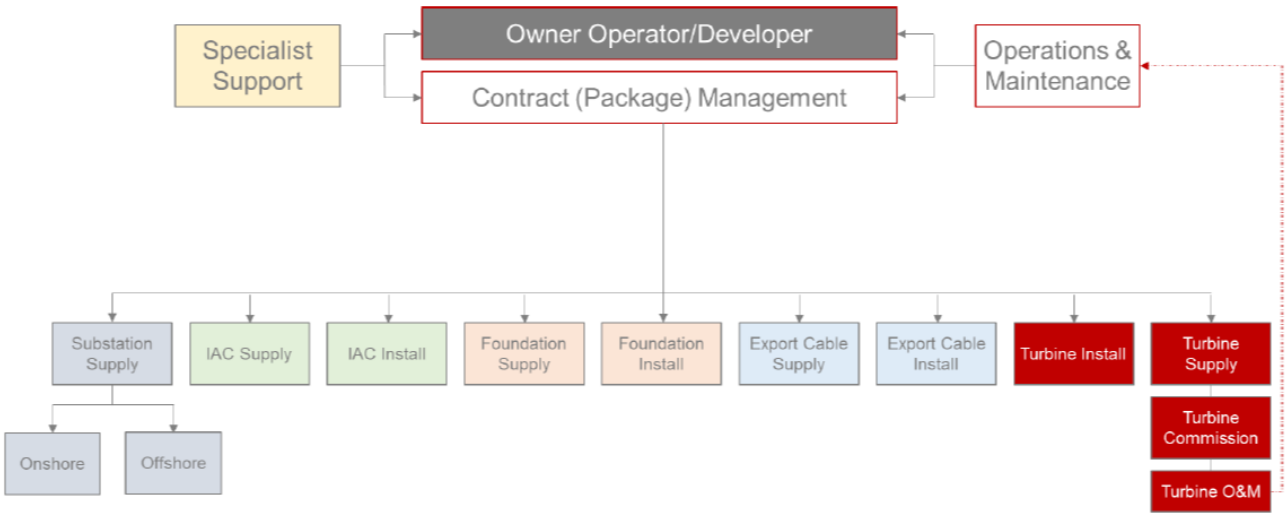


*Figure 1 Typical Multi-Contract Solution*

## 3.2 EPCI Strategy

An EPCI strategy has generally fewer (2-4) contracts covering larger scopes of work, see Figure 2, for example:

- Turbines: the supply/installation/operation of turbines under one contract;
- Balance of Plant: Supply/installation of foundations and cables under another;
- Transmission and Distribution: Supply/installation of substations (onshore and offshore) and export cables under another.

This strategy is viewed as a turnkey solution of the entire contractual scope, which would typically mean that the contractor takes on the cost, schedule and interface risk including coordination with sub-contractors.

This generally mean that the EPCI contractor will 'price-in' these additional risks to allow for contingency due to any project issues although most contractors are now willing to accept these risks as they have now learned a lot more about executing large scale OSW projects. From the developer's perspective the risk profile under an EPCI contract may however be preferable, particularly through the lens of independent Developers, less experienced utilities and/or their investors/financiers.

A complicating factor in respect of the above is that whilst the offshore oil and gas industry follow a well-established division of work-scopes banks/lenders, Developers and EPCI contractors involved in OSW EPCI projects may have different expectations as to what constitutes a reasonable division of risk.

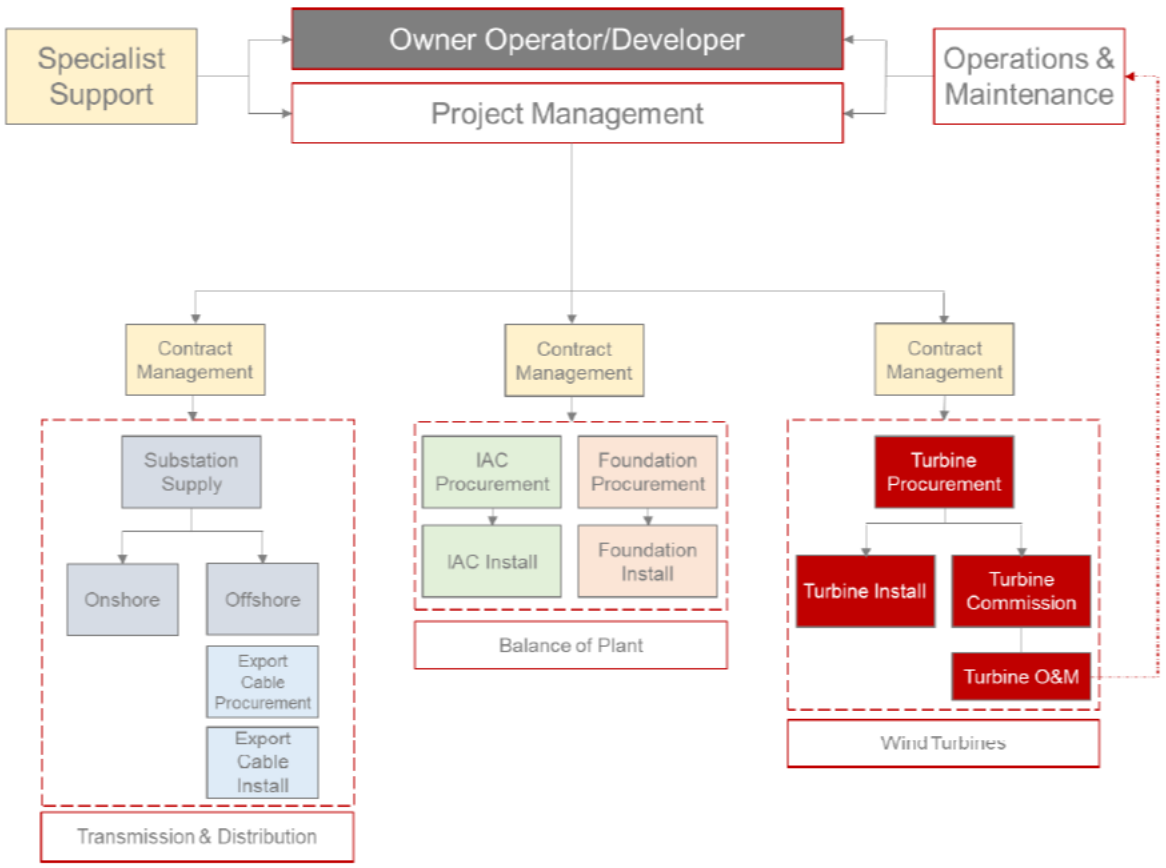


*Figure 2 Typical EPCI Contract Solution*

One example of a project that shows the shift in the UK and Europe toward this model include Seagreen, currently Scotland largest planned wind farm. This project has taken a 4 contract EPCI approach as detailed in Figure 3. Where companies such as Subsea 7, Nexans and other companies have taken on much of the work for each of the packages from design to completion.

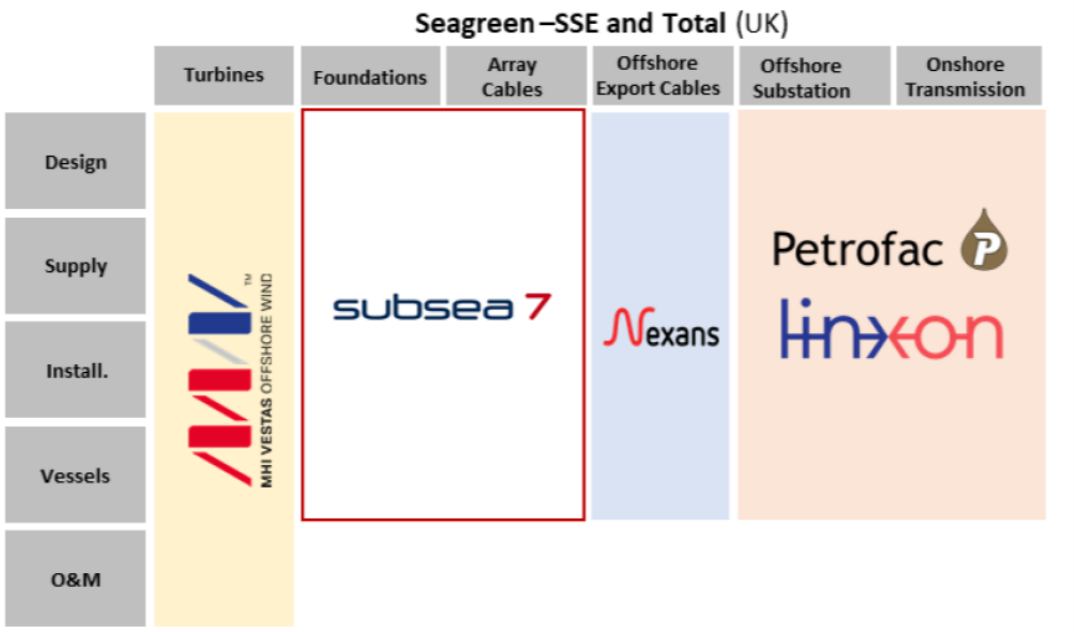


*Figure 3 Seagreen EPCI Contract Solution*

One of the two projects in the United States that is currently operational is the first phase of the Coastal Virginia Offshore Wind (CVOW) Project, that consists of two 6 MW turbines installed 27 miles off the coast of VA Beach, VA. This project is owned and operated by Dominion Energy, the public utility company in the state of VA, and is the precursor to a larger project of 2.6 GW of OSW power. This initial portion of the project was constructed under an EPCI contracting scheme where the OSW developer Ørsted was contracted to carry out the engineering, procurement, construction and installation of virtually all the major packages. The initial CVOW project and the larger project associated with it are unique in that these projects are the only projects in the US to be owned/operated by the company that serves as the local utility.

## 3.3 Hybrid Strategy

In some cases, a hybrid approach between multi-contracting and EPCI has been adopted. This involves combining certain major packages to reduce construction risk while balancing the amount of project oversight. A general framework of this strategy is outlined in Figure 4.

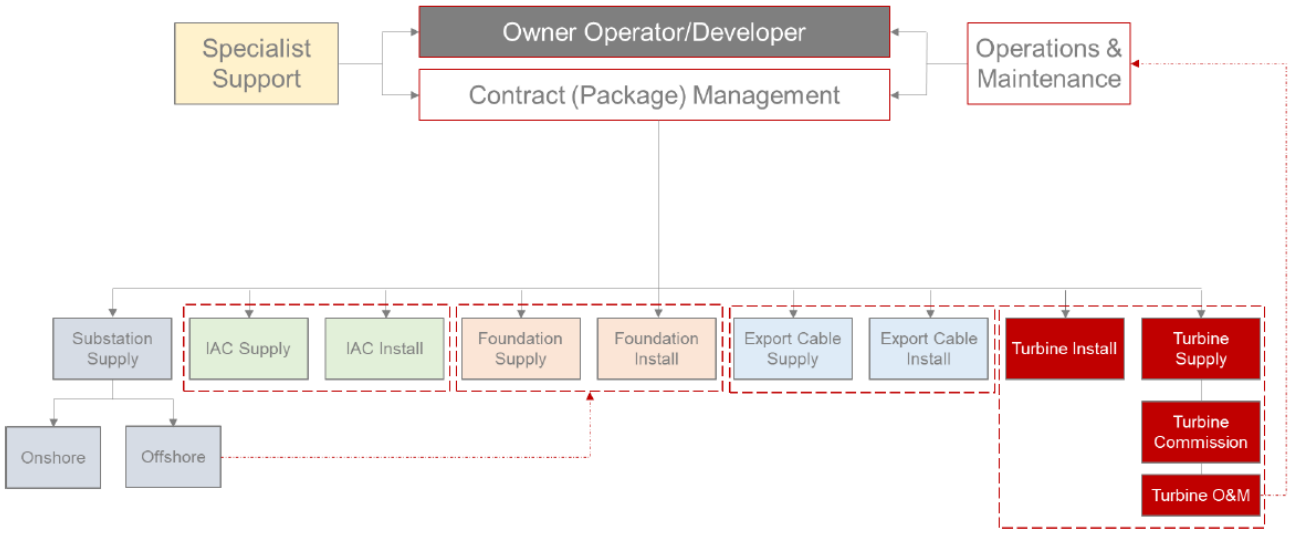


*Figure 4 Typical Hybrid Contract Solution*

The trade-off between project risk and oversight across the varying contracting strategies is detailed in Figure 5.

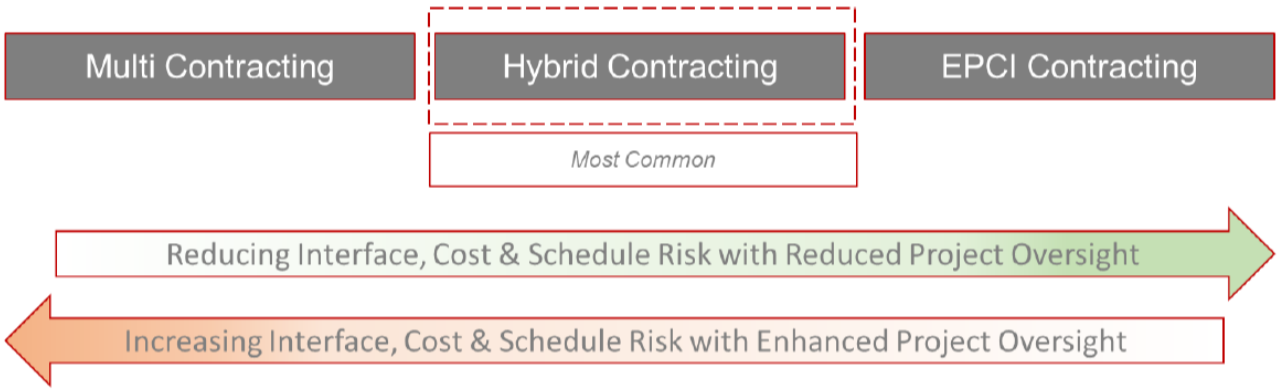


*Figure 5 Project Risk v. Project Oversight Across Varying Contract Strategies*

# 4 SUPPLY CHAIN BREAKDOWN

## 4.1 Virginia Offshore Wind Supply Chain Taxonomy

The State of Virginia has developed a website dedicated to OSW that is run by the VA Department of Mines, Minerals and Energy. Through this website companies can sign up to become a part of the larger Supply Chain Connect database that is run by the Business Network for Offshore Wind. The companies in this directory are organized both based on their relevance to different OSW industry sectors, as well as through further sub-classifications of the competencies of each company. For the purposes of this report, only the companies located within the Hampton Roads area of VA were investigated. The Hampton Roads area of VA was classified to consist of the Member Localities of the Hampton Roads Planning District Commission. A visual representation of these localities is shown in Figure 6.

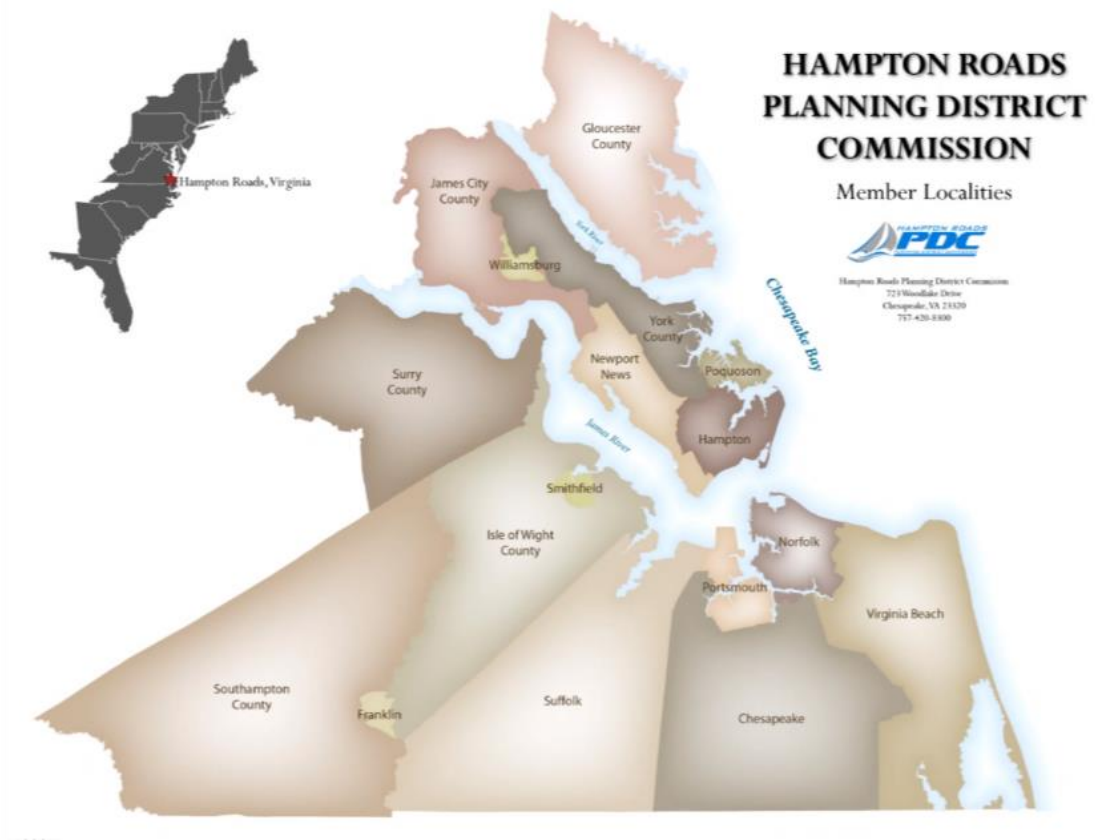


*Figure 6 Classification of the Hampton Roads Area of Virginia*

A running list of companies that registered for the directory, specifically through VA's OSW website, was provided so that a categorization and analysis of the companies from the Hampton Roads area of VA could be conducted. Based on the companies that were present within the list from VA's website, in addition to any other companies within the BNOW Supply Chain Connect Database from the appropriate region of VA, a grand total of 107 companies were investigated for the taxonomy analysis conducted in this report. To summarize the distribution of companies in the directory, prior to the BW survey, a chart was created in Figure 7 to show the number of companies listed within each industry sector. For companies from the Hampton Roads area of VA, a total of 14 different industry sectors were identified. However, it is important to note that one additional

category, referred to as Undefined, is represented in the analysis from this section, where companies that did not indicate to which sector they belonged were categorized.

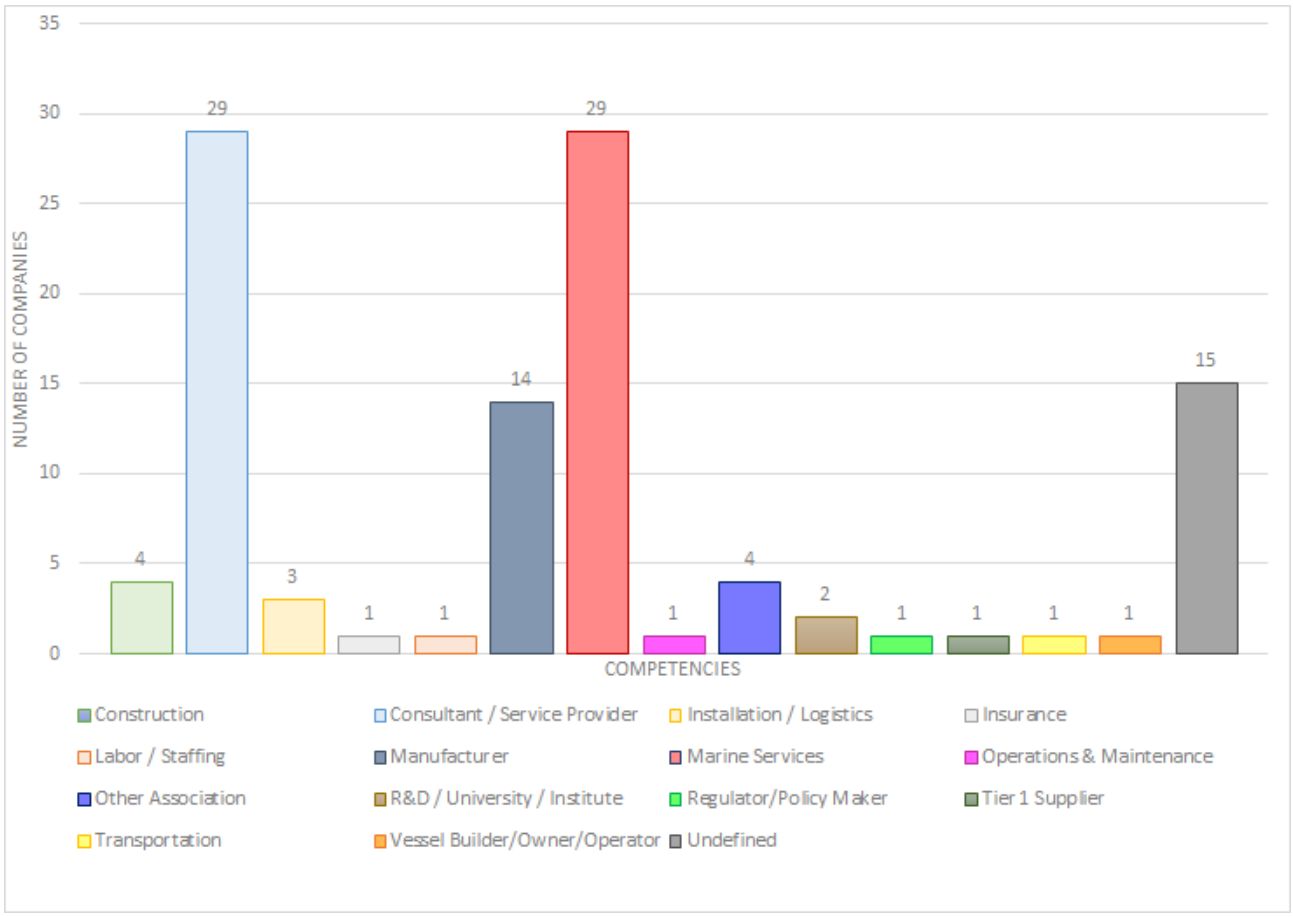


*Figure 7 Complete Industry Sector Breakdown*

### 4.1.1 Construction

The first industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Construction. Only a total of four companies from the Hampton Roads area were listed in this sector, some of these companies covered more than one of the competencies across the directory, with the total number of companies in each competency area given in Table 1.

*Table 1 Company Competencies in the Construction Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Construction | Engineering - Civil | 1 |
| | Cement / Concrete | 1 |
| | Towers and Accessories | 1 |
| | Underground Cables (High & Low Voltage) | 1 |
| | Fuel Handling Systems & Accessories | 1 |
| | Gaskets / Pipe Insulation Materials | 1 |
| | Street Lighting Equipment | 1 |
| | Power Transformers & Accessories | 1 |
| | Installation Cables / Conductors | 1 |
| | Upland Cable & Substation | 1 |
| | Primers / Coatings / Paints | 1 |
| | Powder Coating | 1 |
| | Anti-Corrosion Products | 1 |

Of the four companies listed within the larger database from the Hampton Roads area, there is a wide-ranging number of competencies totaling 13 in all. No two companies in this sector had similar competencies, shown by the fact that only one company fell within each of the competencies listed in Table 1. This was a common theme among many industry sectors, as will be shown in the following sub-sections, where highly specialized areas of competency such as Anti-Corrosion Products or Fuel Handling Systems & Accessories were only tied to one company in the database. While it is great to know the specialized capabilities of companies within the database, it invites the perception, especially in this case, that the Hampton Roads area is weak when it comes to companies in the Construction sector. While the raw data from the database paints this picture, the perception of the Hampton Roads area of delivering on construction related services will change. In Section 4.2 of this report, the classification of companies in the supply chain was looked at in a way that more closely aligns with typical contracting structures for OSW projects. The perception of the companies that can deliver on contracts related to construction was shown to be much stronger than it appears in the current section. The specialized capabilities of many companies in other industry sectors, that is to say in areas not listed in Table 1, are relevant to work related to onshore construction and offshore installation activities and are accounted for.

### 4.1.2 Consultant / Service Provider

The second industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Consultants/Service Providers. Representation in this industry sector was much greater than that of the previous section. A total of 29 companies from the Hampton Roads area were listed in this sector, and many of the companies from this sector covered more than one of the competencies outlined in the directory. The total number of companies in each competency area are given in Table 2.

*Table 2 Company Competencies in the Consultant / Service Provider Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Consultant / Service Provider | Ports and Harbors Infrastructure Analysis | 8 |
| | Surveying - Environmental | 2 |
| | Site and Permit Consulting | 5 |
| | Harbor Dredging | 1 |
| | Marine Engineering | 1 |
| | Project Management | 8 |
| | Coastal & Marine Spatial Planning | 5 |
| | Environmental Consulting | 4 |
| | Marine Acoustic Analysis / Permitting | 1 |
| | Ocean Soil / Core Testing | 3 |
| | Surveying - Ornithology & Marine Mammals | 2 |
| | Engineering - Environmental | 2 |
| | Engineering - Civil | 2 |
| | Evaluation & Optimizing of Energy Systems | 1 |
| | Computer / IT / Telecom / Security Consulting | 2 |
| | Maintenance of Security Equipment & Systems | 1 |
| | Risk Evaluation / Management | 1 |
| | Permit Processing | 2 |
| | Land for O&M | 1 |
| | Lay Down / Marshalling Area | 2 |
| | General Building / Offices | 1 |
| | Other Building and Construction Works | 1 |
| | Event Organizer / Media | 1 |
| | Public Relations / Advertising / Market Research | 2 |
| | Information / Public Relations Materials / Equipment | 1 |
| | Meteorological Testing | 1 |
| | Supply Chain Logistics | 1 |
| | Land for Prospective Manufacturers | 1 |
| | Management - Construction | 1 |
| | Installation - Foundation | 1 |
| | Surveying - Subsea | 1 |
| | Engineering - Foundation | 1 |
| | Geological / Geotechnical | 1 |
| | GIS Support | 1 |
| | Laying / Maintenance of Underground Cables & Accessories | 1 |
| | Laying / Maintenance of Subsea Cables & Accessories | 1 |
| | Marine & Underground Cable Systems | 1 |
| | Cables & Pipeline Trenches Construction Works | 1 |
| | Manpower Supply / Temporary Staff Hiring - Technical | 1 |
| | Manpower Supply / Temporary Staff Hiring - Administration | 1 |
| | Education & Training | 1 |
| | Freight Forwarding / Custom Clearance / Logistics | 2 |
| | Transportation Consulting | 2 |

| | | |
|---|---|---|
| | Sea Transport | 2 |
| | Air Transport | 2 |
| | Road / Railroad Transport | 2 |
| | Marine Cargo Services | 1 |
| | Insurance | 1 |
| | Foundations | 1 |
| | Various Iron / Metal Services | 1 |
| | Welding by Certified Personnel | 1 |
| | Steel Fabrication / Inspection | 1 |
| | Ship Repair | 2 |
| | Cable Protection | 1 |
| | Marine Support / Logistics | 1 |
| | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Life vests / Flotation Devices | 1 |
| | Health & Safety Consulting | 1 |
| | Vessels / Barges / Boats / Tugs | 1 |
| | Vessel Inspection | 1 |
| | Power and Fuels | 1 |
| | Rental of Cranes / Special Vehicles | 1 |
| | Lubricants / Seals | 1 |
| | Installation / Maintenance of Pumps & Compressors | 1 |
| | Diesel Fuel / Supplies / Gasoline | 1 |
| | Installation / Maintenance of Fire Fighting Equipment & Systems | 2 |
| | Cable / Line Joints / Fittings (High & Low Voltage) | 1 |
| | Subsea Cables (High & Low Voltage) | 1 |
| | Underground Cables (High & Low Voltage) | 1 |
| | Low-Voltage Motors & Accessories | 1 |
| | Firefighting | 1 |

As previously discussed a number competencies shown in Table 2 only had one company associated with the skill or service. In addition to this, overlapping competencies between different industry sectors were present. Skills such as civil engineering services accounted for two companies in this sector and referring to the Construction industry sector there was one additional company listed under the Engineering – Civil competency. The presence of these overlaps between industry sectors was seen across many of the sectors and are artifacts of the way in which the data is housed in the directory. This separation of companies with similar competencies was remedied in Section 4.2 of this report where the classification of companies in the supply chain was looked at in a way that more closely aligns with typical contracting structures for OSW projects. There are a few discernible strengths of the supply chain in the Hampton Roads area in the Consultant / Service Provider industry sector, specifically in the Ports and Harbors Infrastructure Analyses, Project Management, Site and Permit Consulting and Environmental Consulting competencies. In comparison with other competencies, there is greater depth of capability in these areas as there are a multiple companies with specializations in these areas.

### 4.1.3 Installation / Logistics

The third industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Installation / Logistics. Only a total of three companies from the Hampton Roads area were listed in this sector, and each of these companies covered more than one of the competencies outlined in the directory. The total number of companies in each competency area given in Table 3.

*Table 3 Company Competencies in the Installation / Logistics Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Installation / Logistics | Transport & Material Handling Equipment | 1 |
| | Equipment Rental | 1 |
| | Rental of Cranes / Special Vehicles | 1 |
| | Welding Equipment / Consumables | 1 |
| | Cement / Concrete | 1 |
| | Cranes / Lifts / Marine Cranes | 1 |
| | Tackles / Winches / Lifting | 1 |
| | Valves & Accessories | 1 |
| | Compressors & Accessories | 1 |

### 4.1.4 Insurance

The fourth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Insurance; only one company from the Hampton Roads area was listed in this sector. Table 4 shows that the only company in this sector registered its competencies to be identical to the name of the sector i.e. (Insurance). Additional companies in other industry sectors such as the Consultant / Service Provider, Marine Services and Undefined sectors include companies that indicate that they can deliver services related to providing insurance, however, these companies have not listed themselves as being within the Insurance industry sector. In a later analysis an investigation will be undertaken and likely show that the companies who can provide insurance from other industry sectors may not manage insurance as their primary business function.

*Table 4 Company Competencies in the Insurance Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Insurance | Insurance | 1 |

### 4.1.5 Labor / Staffing

The fifth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Labor / Staffing. Only a one company from the Hampton Roads area was listed in this sector, however this company had a wide range of competencies, unlike what was seen for the Insurance industry sector, from the directory. The competencies of the single company from this industry sector area given in Table 5.

*Table 5 Company Competencies in the Labor / Staffing Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Labor / Staffing | Installation / Maintenance of Electrical Systems | 1 |
| | Ship Repair | 1 |
| | Surface Treatment / Sandblasting | 1 |
| | Industrial Cleaning | 1 |
| | Other Installation / Mechanical / Maintenance Service | 1 |

### 4.1.6 Manufacturer

The sixth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Manufacturers.. A total of 14 companies from the Hampton Roads area were listed in this sector, and many of the companies from this sector covered more than one of the competencies outlined in the directory. The total number of companies in each competency area are given in Table 6.

*Table 6 Company Competencies in the Manufacturer Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Manufacturer | Project Management | 3 |
| | Stakeholder Engagement | 1 |
| | Event Organizer / Media | 1 |
| | Public Relations / Advertising / Market Research | 1 |
| | Photographic Services | 1 |
| | Printing / Copying / Graphic Layout | 1 |
| | Welding by Certified Personnel | 3 |
| | Forges, Rolled Ring, Machined & Hardened | 1 |
| | Steel Manufacturer | 1 |
| | Steel / Metal Pipes / Accessories | 1 |
| | Primers / Coatings / Paints | 1 |
| | Cement / Concrete | 1 |
| | Towers and Accessories | 1 |
| | Large SG Iron or Fabricated Steel Structure | 1 |
| | Foundations | 1 |
| | Transition Pieces | 1 |
| | Hatches & Accessories | 1 |
| | Jack Up Barge Fabrication | 1 |
| | Ship Repair | 4 |
| | Steel Work for Offshore Substation | 1 |
| | Marine Construction | 1 |
| | Diving | 1 |
| | Obstruction Light Control / Obstruction LED Solutions | 1 |
| | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Lifevests / Flotation Devices | 1 |
| | Safety Valves / Relief Valves / Bursting Discs & Accessories | 1 |
| | Working Clothes / Gloves / Safety Boots | 1 |
| | Ear Defenders / Safety Eyewear | 1 |
| | Installation / Maintenance of Rotating Electrical Machines | 1 |
| | Installation of Power Transformers & Accessories | 1 |
| | Power Generation / Microgrids | 1 |
| | Power and Fuels | 1 |
| | Generators & Accessories | 2 |
| | Installation / Maintenance of Generators & Accessories | 2 |
| | Signal Cables / Computer & Communication Cables | 1 |
| | Machining (Lathe / Milling / Drilling) | 2 |
| | Axial Compressors & Accessories | 1 |
| | Pumps & Accessories | 1 |

At first glance, one can see that only six of the 38 competencies listed within this sector recorded more than one company having that respective capability, skill or service. The fine granularity of the competencies listed within the database, while useful when looking for a highly specialized skill, makes it difficult to identify the strengths and gaps in different portions of the supply chain. When specifically looking at companies that have identified themselves as manufacturers, it is shown in Table 6 that only three companies have capabilities related to welding by certified personnel. However, when taking a step back and looking at all of the industry sectors identified in Figure 7, eight companies across these sectors are capable of providing this service. Welding will be a major skill set in developing OSW projects in the US, which will transcend multiple packages from top tier companies. The appearance of only three manufacturing companies with competency in welding does not paint the full picture of the strength in this area of the supply chain in the Hampton Roads region.

### 4.1.7 Marine Services

The seventh industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Marine Services. A total of 29 companies from the Hampton Roads area were listed in this sector, and many of the companies from this sector covered more than one of the competencies outlined in the directory. The total number of companies in each competency area are given in Table 7.

*Table 7 Company Competencies in the Construction Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Marine Services | Project Management | 5 |
| | Coastal & Marine Spatial Planning | 1 |
| | Ports and Harbors Infrastructure Analysis | 1 |
| | Cranes / Lifts / Marine Cranes | 6 |
| | Marine Cargo Services | 6 |
| | Sea Transport | 4 |
| | Land for O&M | 2 |
| | Lay Down / Marshalling Area | 2 |
| | Land for Prospective Manufacturers | 2 |
| | Education & Training | 1 |
| | Lubricants / Seals | 2 |
| | Power and Fuels | 2 |
| | Ship Repair | 4 |
| | Heating & Cooling Equipment / Accessories | 1 |
| | Pumps & Accessories | 2 |
| | O&M Vessel Operation | 2 |
| | Marine Support / Logistics | 5 |
| | Freight Forwarding / Custom Clearance / Logistics | 3 |
| | Insurance | 1 |
| | Supply Chain Logistics | 2 |
| | Port Agent | 2 |
| | Air Transport | 2 |
| | Containers / Carriages / Trailers | 1 |
| | Vessels / Barges / Boats / Tugs | 2 |
| | Other Transport & Material Handling Equipment | 1 |
| | Towing - Barge / Foundation | 1 |
| | Welding by Certified Personnel | 3 |

| | | |
|---|---|---|
| | Wires / Ropes / Chains / Straps & Associated Lifting Gear | 1 |
| | Marine Construction | 3 |
| | Weld Inspection | 2 |

The most robust industry sector for the Hampton Roads area was the Marine Services sector, which was home to 29 different companies spanning 30 different competencies. Since many of the companies had capabilities in multiple areas, as is shown in Table 7, many of the competencies within the sector saw more than one or two companies within them. This depth within the supply chain supplements its breadth in terms of the number of competencies in this sector. While having a broad supply chain is great, the depth of the supply chain encourages competition for contracts locally and consequently bolsters its strength. Due to the depth seen in the supply chain for this industry sector, Figure 8 was generated to show the breakdown of the number of companies that specialize in each of the competencies that have been listed. It is clear that the stronger portions of the Marine Services sector relate to Cranes / Lifts / Marine Cranes, Marine Cargo Services, Marine Support and Logistics and more as these areas see participation by five or more companies in the Hampton Roads area. On the other hand, areas such as Containers / Carriages / Trailers and Towing – Barge / Foundation are weaker in the sense that only one company in this industry sector believes that they can deliver these services.

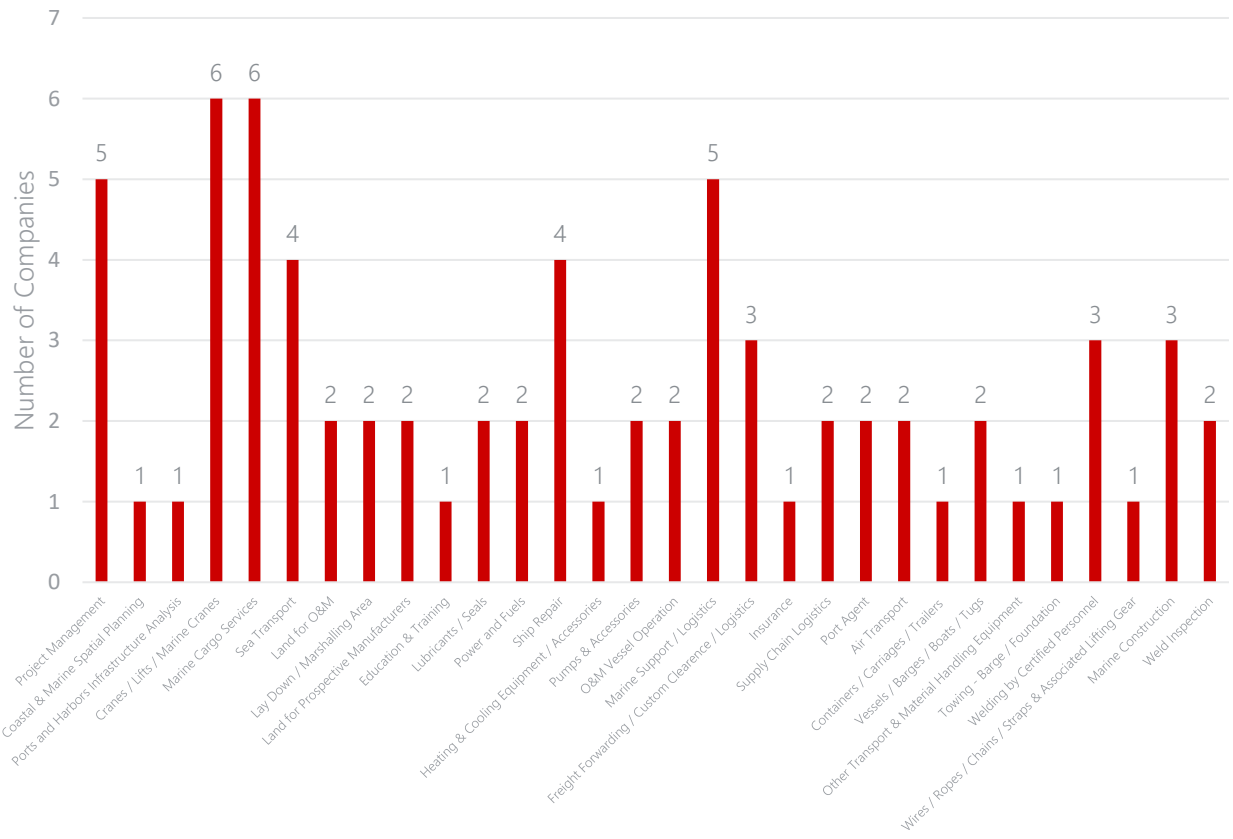


*Figure 8 Marine Services Industry Sector Breakdown*

### 4.1.8 Operations & Maintenance

The eighth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Labor / Staffing. Only a one company from the Hampton Roads area was listed in this sector, however this company had a range of competencies from the directory. The competencies of the single company from this industry sector area given in Table 8.

*Table 8 Company Competencies in the Operations & Maintenance Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Operations & Maintenance | Vibration Meters | 1 |
| | Synchronoscopes | 1 |
| | Multimeters / Service Instruments | 1 |
| | Metering / Instrumentation Equipment | 1 |

### 4.1.9 Other Association

The ninth industry sector where companies were listed within the BNOW Supply Chain Connect Directory were designated as Other Association. A total of four companies from the Hampton Roads area were listed in this sector and had a rather narrow range of competencies outlined in the directory. The total number of companies in each competency area given in Table 9 and show that the majority of companies within this sector provide education / training services while only one of the companies is tied to the Ports & Harbor Infrastructure Analysis competency.

*Table 9 Company Competencies in the Other Association Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Other Association | Education & Training | 3 |
| | Ports and Harbors Infrastructure Analysis | 1 |

### 4.1.10 R&D / University / Institute

The tenth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to R&D / Universities / Institutes. Only a total of two companies from the Hampton Roads area were listed in this sector. The two companies / institutes from this industry sector are registered in competencies that are identical to the name of the sector i.e. (R&D / University / Institute), as is shown in Table 10.

*Table 10 Company Competencies in the R&D / University / Institute Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| R&D / University / Institute | R&D / University / Institute | 2 |

### 4.1.11 Regulator / Policy Maker

The eleventh industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Regulators / Policy Makers. Only a one company from the Hampton Roads area was listed in this sector. The competencies of the single company from this industry sector area given in Table 11.

*Table 11 Company Competencies in the Regulator / Policy Maker Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Regulator / Policy Maker | Workforce Development | 1 |

The single company that was listed in this industry sector had a narrow range of capabilities as only one area of competency, related to Workforce Development, was represented. Regulators / Policy Makers most commonly come in the form of government agencies, an area of the supply chain that is highlighted in the taxonomy that has been put together in Section 4.2. If effort is put into attracting more government organizations to register in the supply chain database, the perceived strength of this industry sector will improve.

### 4.1.12 Tier 1 Supplier

The twelfth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Tier 1 Suppliers. Only a one company from the Hampton Roads area was listed in this sector. The competencies of the single company from this industry sector area given in Table 12.

*Table 12 Company Competencies in the Other Association Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Tier 1 Supplier | Vessels / Barges / Boats / Tugs | 1 |

Similar to what was seen in the previous section, the Tier 1 industry sector had a single company listed in the database with a narrow range of capabilities. This Tier 1 company specialized in the procurement and use of vessels, barges, boats and tugs which are a critical component to the OSW supply chain. Tier 1 suppliers generally tender on the major packages in the contracting structure of OSW Developers, however, many of the Tier 1 suppliers working in the OSW industry in the United States come from Europe as the experience in this industry is located there. A further investigation into the company that listed itself in this sector will identify if it is truly a Tier 1 supplier, or rather a company that would be better served sitting in the Marine Services industry sector in this directory.

### 4.1.13 Transportation

The thirteenth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Transportation. Only one company from the Hampton Roads area was listed in this sector. The competencies of the single company from this industry sector area given in Table 13. Only two of the six competencies that could be considered as competencies related to transportation are represented by the company from this industry sector. Competencies from other industry sectors such as Air Transport, Road / Railroad Transport, Transport and Material Handling Equipment, and Transportation Consulting are absent from Table 13.

*Table 13 Company Competencies in the Transportation Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Transportation | Sea Transport | 1 |
| | Supply Chain Logistics | 1 |

### 4.1.14 Vessel Builder / Owner / Operator

The fourteenth industry sector where companies were listed within the BNOW Supply Chain Connect Directory relates to Vessel Builders / Owners / Operators. Only one company from the Hampton Roads area was listed in this sector. The competencies of the single company from this industry sector area given in Table 14.

*Table 14 Company Competencies in the Vessel Builder / Owner / Operator Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Vessel Builder / Owner / Operator | Vessels / Barges / Boats / Tugs | 1 |
| | O&M Vessel Operation | 1 |
| | Vessel Inspection | 1 |

### 4.1.15 Undefined

The fifteenth industry sector where companies were present within the BNOW Supply Chain Connect Directory were companies that had no industry sector attributed. 14 companies from the Hampton Roads area were undefined in designation. The total number of companies in each competency area are given in Table 15.

*Table 15 Company Competencies in the Undefined Industry Category*

| Industry Sector | Competency | Number of Companies |
|---|---|---|
| Undefined | Engineering - Foundation | 1 |
| | Foundations | 1 |
| | Heavy, Dense Magnetite Concrete for Ballast or Offshore Base Structures | 1 |
| | Manpower Supply / Temporary Staff Hiring - Technical | 1 |
| | Manpower Supply / Temporary Staff Hiring - Administration | 1 |
| | Diving | 2 |
| | Insurance | 1 |
| | Weld Inspection | 1 |
| | Project Management | 1 |
| | Welding by Certified Personnel | 1 |
| | Other Building and Construction Maintenance | 1 |
| | Hoses & Accessories | 2 |
| | Gaskets / Pipe Insulation Materials | 1 |
| | Other Pipes / Hoses / Filters / Gaskets & Accessories | 1 |
| | Filters / Strainers & Accessories | 1 |
| | Hangers / Fastenings for Pipes / Hoses | 2 |
| | Non-Metal Flanges & Other Non-Metal Pipe Accessories | 1 |

| | | |
|---|---|---|
| | Steel / Metal Flanges / other Non-Metal Pipes | 1 |
| | Towing - Barge / Foundation | 1 |
| | Rental of Cranes / Special Vehicles | 1 |
| | Road Works/ Maintenance / Snow Clearing | 1 |
| | Ship Repair | 1 |
| | Steel Work for Offshore Substation | 1 |
| | Rock Drilling / Blasting | 1 |

## 4.2 Supply Chain Taxonomy

The supply chain can also be classified in a way that is more closely aligned with typical contracting structures for an OSW project. The taxonomy for OSW supply chain classification aligned with this approach presented in Table 16 is proposed to be used for the purposes of this study. The third phase of the study will assess the strengths and gaps of the local supply chain capability within these elements.

*Table 16 Offshore Wind Supply Chain Taxonomy*

| Supply Chain Area | Supply Element |
|---|---|
| Project development | Development and consenting |
| | Surveys |
| | Engineering & design |
| | Project management |
| Wind turbine supply | Rotor |
| | Nacelle |
| | Tower |
| Balance of plant supply | Export cables |
| | Array cables |
| | Offshore substation |
| | Onshore substation |
| | Foundations |
| Installation and commissioning | Turbine installation |
| | Foundation installation |
| | Subsea cable installation |
| | Offshore substation installation |
| | Onshore construction |
| | Ports and logistics |
| Operations and maintenance | Operations |
| | Turbine inspection and maintenance |
| | BoP inspection and maintenance |
| Decommissioning | Decommissioning |
| Sector support | Educational Institution/ Training Provider |
| | Government Agencies |
| | Trades, Labor and Workforce Organizations |

This approach comprises multiple supply elements that describe the broad requirements for products and services that enable the development, construction and operation of an OSW project. The elements within the categories of project development, wind turbine supply, balance of plant supply, and installation and commissioning generally represent Tier 1 and Tier 2 packages, or package areas, where supply is commonly fulfilled by a distinct provider or group of providers.

Due to the length of operational lifetime and range of services required, the operations phase of an OSW project typically comprises of hundreds of individual supply contracts. These services can be grouped into broad elements to enable analysis of supply chain capability. Similarly, the range of services required for wind farm decommissioning are varied but have been grouped for simplicity of analysis.

Sector support functions are not typically considered part of the OSW supply chain. However, this category and the constituent elements have been included for analysis as they are representative of the quality of the supply chain environment. Presence of good sector support organizations will be necessary for the growth and development of supply chain capability.

Figure 9 shows the number of Hampton Roads supply chain companies present in the Supply Chain Connect Database categorized by the supply chain elements outlined in Table 16. Figure 9 shows how the content of the Supply Chain Connect Database was mapped to supply chain elements. The Hampton Roads supply chain shows apparent strength in ports and logistics and wind farm O&M services. Higher levels of apparent supply chain capability in some elements, such as nacelles, towers, foundations and offshore substations are likely to be at lower tiers of supply. Further qualitative analysis of companies and their capability to supply the OSW sector will be undertaken in the third phase of this study.

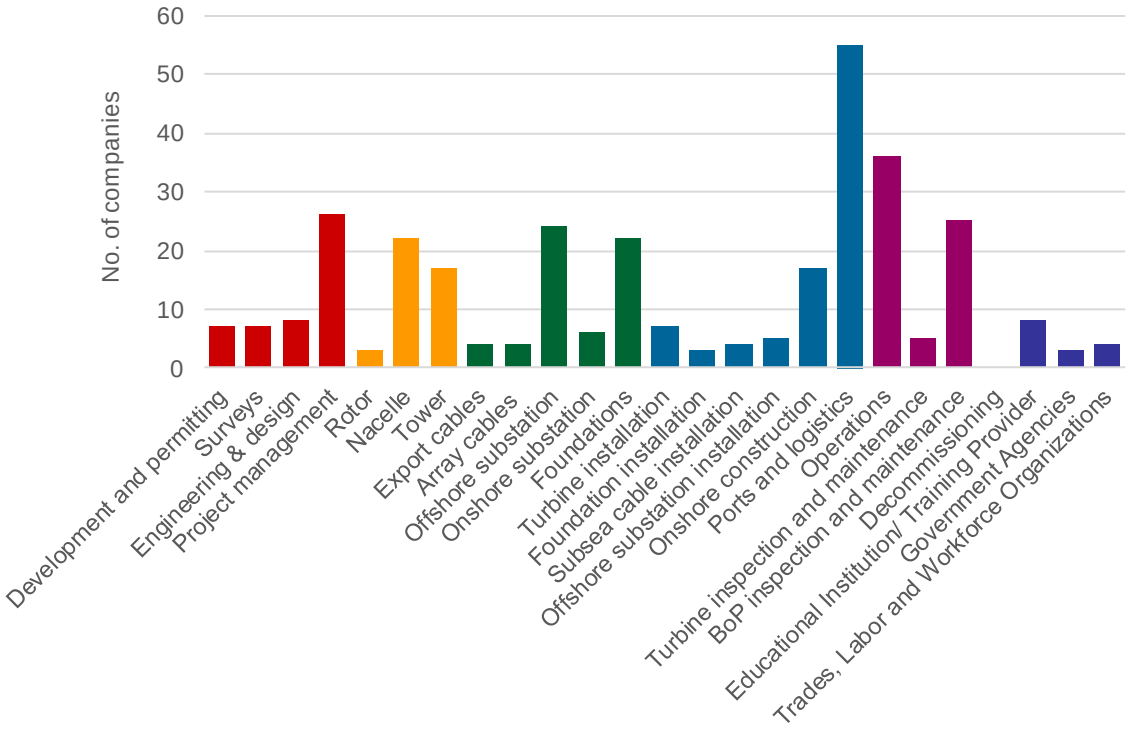


*Figure 9 Hampton Roads Supply Chain Categorized by OSW Contracting Area*

# 5 POST-SURVEY DATABASE ANALYSIS

## 5.1 Post-Survey Database Analysis

An analysis was conducted to show the changes in the contents of the BNOW Supply Chain Connect Database from the time the interim report was issued (April 2021) until completion of this study (June 2021). The efforts that were undertaken in this report were supplemented by work conducted by BW, who administered a survey to many companies in the Hampton Roads area of Virginia and beyond to gauge their interest and capability of becoming a part of the supply chain.

Upon the completion of the survey, an itemized list of companies that were identified and contacted by BW was used to map companies that registered themselves in the database after completing the survey, as well as to make predictions as to the number of companies likely to be present in each industry sector based on the responses that were received. It is important to note that not every company that completed the survey enrolled in the database, and that companies that were not contacted as part of the survey enrolled in the database between April 2021 and June of 2021. These companies may have entered their credentials as a result of coming across the database through word of mouth, a different marketing campaign, or by other means and not a direct result of the BW survey campaign.

## 5.2 All Industry Sectors

Following the BW survey there were increases in the number of companies listed in the database in nearly all industry sectors, with major increases in some sectors where the number of companies between April of 2021 and June of 2021 more than doubled.

A visualization of the change in the contents of the BNOW Supply Chain Connect Database is represented in Figure 10 where the contents of the database as they were in April 2021 are juxtaposed with the status of the database in June of 2021 and the projected number of companies in each industry sector based on the respondents to the BW survey that have not yet registered themselves within the database.

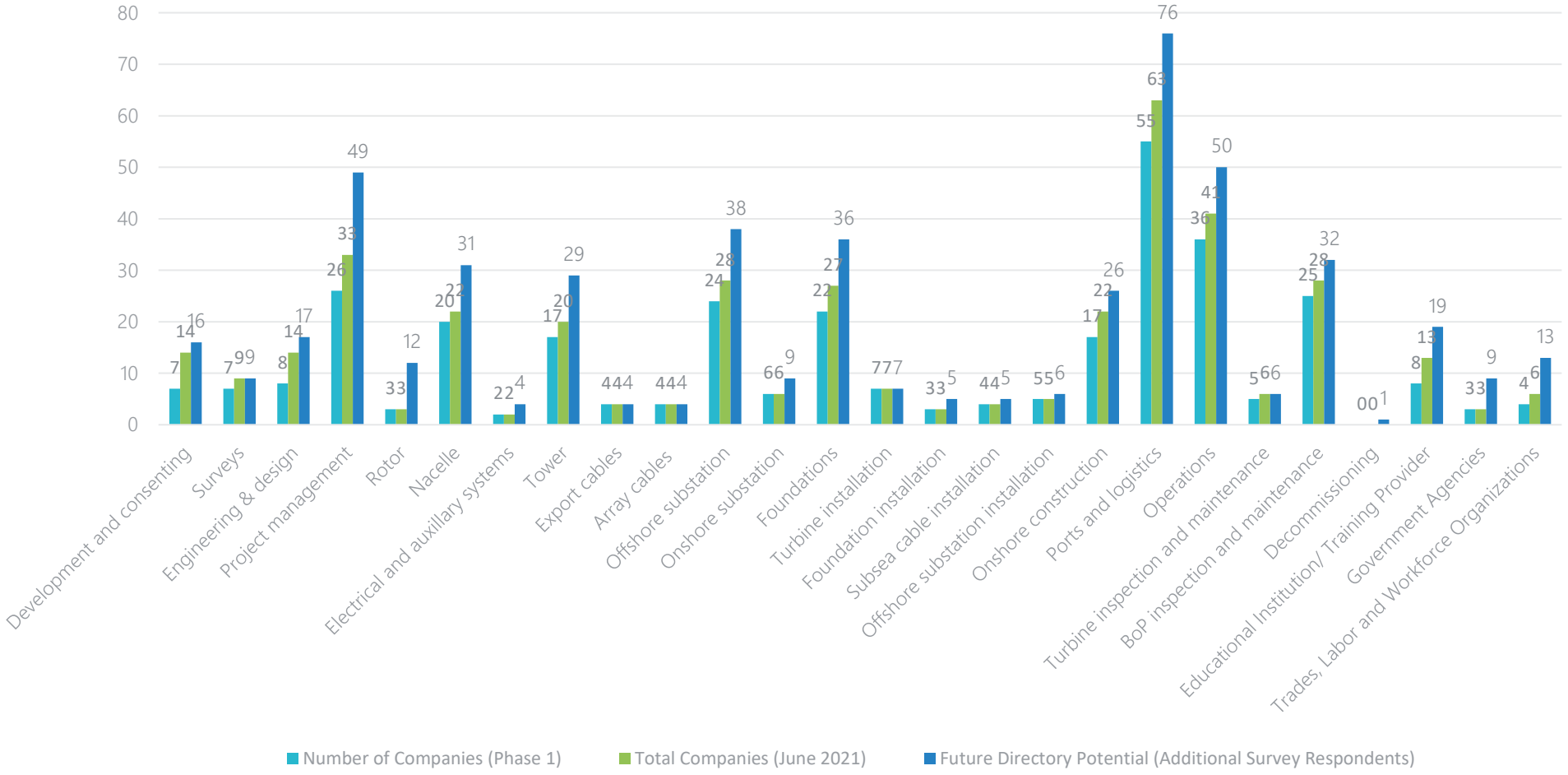


*Figure 10 Post-Survey Taxonomy and Database Growth between April 2021 and June 2021*

A breakdown of Figure 10 is presented in Table 17, where the total number of companies added to each industry sector along with the increase in the number of companies as a percentage of the companies that were listed in Phase 1 (April 2021). There was a total of 21 new entrants into the database over this time strictly within the Hampton Roads area. Keeping this in mind, there were an additional 74 respondents to the BW survey that were not represented in the database, indicating that there is room to strengthen the representation of companies from the Hampton Roads Region in the BNOW Supply Chain Connect Database. In the following subsections, database growth from the taxonomy themes in Table 17, were investigated further.

*Table 17 Post-Survey Taxonomy and Database Growth between April 2021 and June 2021*

| Taxonomy Theme | Taxonomy Category | Number of Companies (Phase 1) | Additional Companies (Phase 3) | Percent Increase | Future Directory Potential (Additional Survey Respondents) |
|---|---|---|---|---|---|
| Project Development | Development and consenting | 7 | 7 | 100% | 16 |
| | Surveys | 7 | 2 | 29% | 9 |
| | Engineering & Design | 8 | 6 | 75% | 17 |
| | Project management | 26 | 7 | 27% | 49 |
| Wind Turbine Supply | Rotor | 3 | 0 | 0% | 12 |
| | Nacelle | 20 | 2 | 10% | 31 |
| | Electrical and auxiliary systems | 2 | 0 | 0% | 4 |
| | Tower | 17 | 3 | 18% | 29 |
| Balance of Plant Supply | Export cables | 4 | 0 | 0% | 4 |
| | Array cables | 4 | 0 | 0% | 4 |
| | Offshore substation | 24 | 4 | 17% | 38 |
| | Onshore substation | 6 | 0 | 0% | 9 |
| | Foundations | 22 | 5 | 23% | 36 |
| Installation & Commissioning | Turbine installation | 7 | 0 | 0% | 7 |
| | Foundation installation | 3 | 0 | 0% | 5 |
| | Subsea cable installation | 4 | 0 | 0% | 5 |
| | Offshore substation installation | 5 | 0 | 0% | 6 |
| | Onshore construction | 17 | 5 | 29% | 26 |
| | Ports and logistics | 55 | 8 | 15% | 76 |
| Operations & Maintenance | Operations | 36 | 5 | 14% | 50 |
| | Turbine inspection and maintenance | 5 | 1 | 20% | 6 |
| | BoP inspection and maintenance | 25 | 3 | 12% | 32 |

| | | | | | |
|---|---|---|---|---|---|
| Decommissioning | Decommissioning | 0 | 0 | 0% | 1 |
| Sector Support | Educational Institution/ Training Provider | 8 | 5 | 63% | 19 |
| | Government Agencies | 3 | 0 | 0% | 9 |
| | Trades, Labor and Workforce Organizations | 4 | 2 | 50% | 13 |

## 5.3 Project Development

Some interesting takeaways from the Taxonomy Categories that sit within the Project Development theme were that there was a doubling in the number of companies with capabilities related to Development & Consenting. A few of these new listings were agencies/companies related to economic development, some of which had assisted in delivering the CVOW Project. Similarly, a 75% increase in the number of companies capable of providing services related to Engineering & Design with two of the additional companies having experience from CVOW and the same companies expected to hold contracts for the upcoming Dominion Energy Project and the Kitty Hawk Offshore Wind Project.

## 5.4 Wind Turbine Supply

Wind Turbine Supply Companies with capabilities related to Wind Turbine Supply saw the least amount of growth in the BNOW Supply Chain Connect Database, however there was significant growth that was expected as a result of the survey from BW. The contrast of what is represented in the database and what was found through the survey could be remedied by increased outreach and marketing to recommend to companies that took part in the survey to sign up via VA's OSW website. When including companies that responded to the survey, there was a quadrupling in the number of companies with expected capability when it came to the Rotor Taxonomy Category with other large jumps expected for the Nacelle and Tower components.

## 5.5 Balance of Plant Supply

In a similar fashion to what was observed for companies within the Wind Turbine Supply Taxonomy Theme, the Balance of Plant theme experienced minimal growth between Phase 1 of this project in April 2021 and the final phase of the project in June of 2021. Out of the five Taxonomy Categories, only two, those being the Foundations and Offshore Substation sectors, saw a large response from companies from the survey from BW.

## 5.6 Installation & Commissioning

The companies that were added in the Installation & Commissioning sector of the OSW supply chain, after the completion of the BW survey, were primarily related to the sectors of onshore construction and ports & logistics. These additions in tandem with the projected number of companies from the survey reinforced the strength that

the Hampton Roads area has around ports and logistics. This particular area of the supply chain vastly outnumbers any of the other supply chain categories, where 76 companies, including the projections are believed to have capability in the area.

## 5.7 Operations & Maintenance

The taxonomy categories in the Operations & Maintenance theme all saw some marginal increases in the number of companies listed in the directory. The representation of companies on the Operations side of things reached a total of 50 companies including the projections made based on the survey from BW. This solidified the strength of this area of the supply chain as the second greatest strength of the Hampton Roads area based on the analyses conducted in this report.

## 5.8 Decommissioning

One company responded to the survey and indicated that they had capabilities as it pertains to services needed for decommissioning. This was the first such company to have such capabilities in the Hampton Roads area, however the need for such capability will be greater much later in the project lifecycle for projects such as CVOW or the Dominion Energy OSW Project.

## 5.9 Sector Support

There were quite a few companies that responded to the survey from BW that fell within the Sector Support theme. In each of the categories, those being Educational Institutions / Training Providers, Government Agencies, and Trades, Labor and Workforce Organizations resulted in six, six and seven responses respectively.

# 6 JOB ANALYSIS

## 6.1 Job Roles

Supply chain package delineation is unique in the OSW industry. Due to the nascency of the industry job roles within do not always match established North American Industry Classification System (NAICS) codes. To allow for a more realistic assessment of job requirements in the OSW industry in the Hampton Roads region, this study assesses job functions by supply chain area. By taking a granular approach to job role definition, it is possible to make better estimates on workforce readiness, the timeline for engaging with the workforce, and to determine when the greatest number of workers will be required based on project schedule.

Job roles were considered in terms of supply chain elements as given in Table 18. The decommissioning and sector support functions were excluded from this list based on timing and relevance, respectively. In addition to the list, port development was also included as a function as this has relevance to the delivery of the commercial scale CVOW project. The industry sectors that are likely to see indirect and induced economic benefit were also considered. A full listing of job roles resulting from this exercise is given in Appendix C.

The job roles were then categorized according to area of expertise and minimum duration of training and certification required. The categories and minimum training and certification values are given in Table 18.

Table 18 Job Title Categories

| Category | Minimum Training/Certification/Experience Required |
|---|---|
| Manager | Formal education/combination of education and experience (5+ years) |
| Engineer | Engineering degree from university (4+ years) |
| Scientist | Science degree from university (4+ years) |
| Other University Degree | University degree other than engineering/science (4+ years) |
| Support staff | Requires some formal training (2+ years), e.g. admin, HR, etc. |
| Skilled trade - Specialist | Requires training and apprenticeship plus additional experience or specialization, e.g. senior vessel crew, supervisory roles, etc. (5+ years) |
| Skilled trade - Standard | Requires training/certification/apprenticeship (1+ years) |
| Non-skilled labor | Requires no formal training, only on-the-job experience |

### 6.1.1 Job Categories by Supply Chain Area

The job role categories that were generated are represented in Figure 11 to demonstrate in which project stage the various categories of workforce will be required. Here we see that science-based jobs are predominantly required in the project development phase, and that installation and commissioning has the broadest requirements, needing a significant range of skilled and specialist trade workers. Note that this representation does not show the number of jobs, rather the number of various job roles accounted for in each supply chain area.

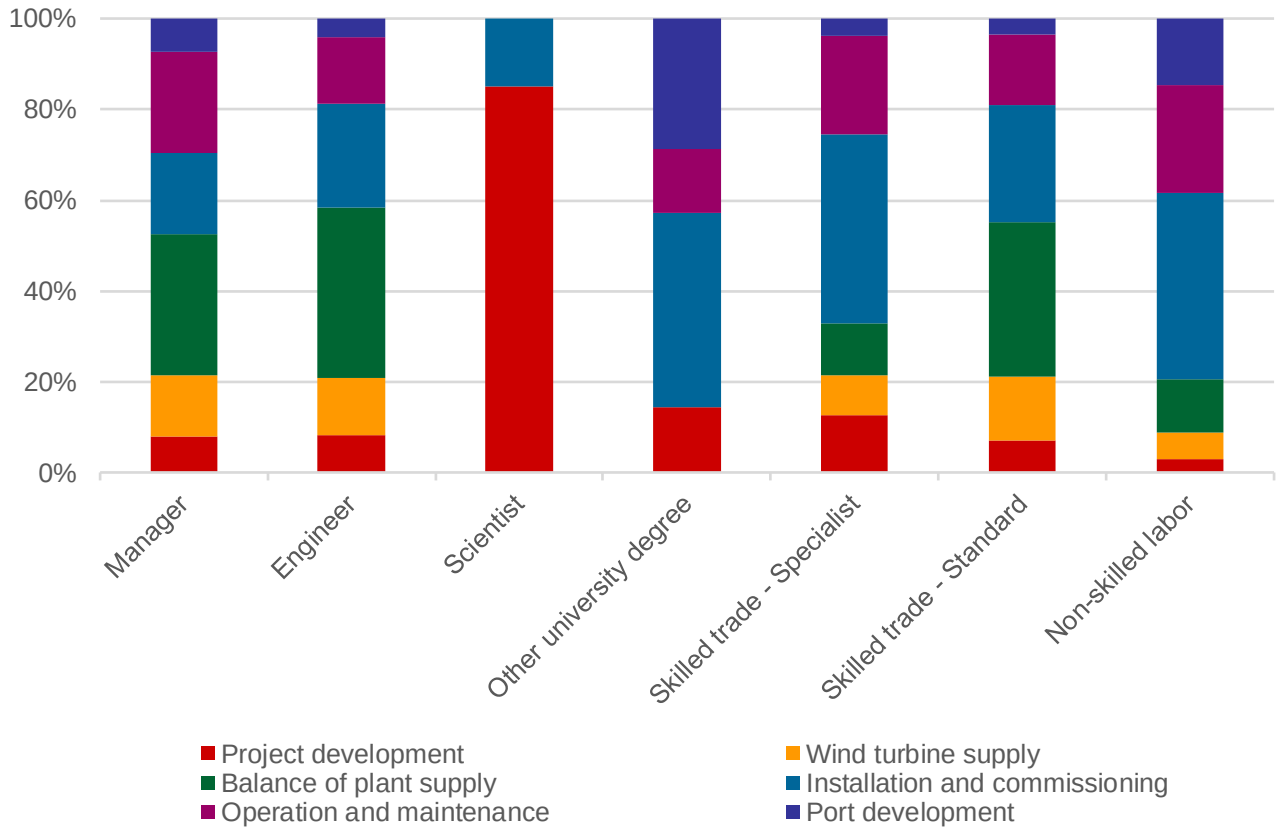


*Figure 11 Supply Chain Area Job Roles Requirement*

### 6.1.2 Job Categories and Project Timeline

Using the commercial CVOW project as a guide, and assuming that the project will be operational in 2026, the timeline given in Figure 12 was established based on best estimates. It is further assumed that the project will be fully commissioned by 2027. The timeline does not consider past 2030 as requirements during the operations phase are consistent, and decommissioning is excluded due to its late appearance on the timeline and lack of relevance for the current exercise.

| | Project development/manufacturing/installation | | | | | Operation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Supply element | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030+ |
| Development and permitting | | | | | | | | | | |
| Surveys | | | | | | | | | | |
| Engineering and design | | | | | | | | | | |
| Project Management | | | | | | | | | | |
| Nacelle | | | | | | | | | | |
| Rotor | | | | | | | | | | |
| Tower | | | | | | | | | | |
| Foundation | | | | | | | | | | |
| Offshore substation | | | | | | | | | | |
| Onshore substation | | | | | | | | | | |
| Export cables | | | | | | | | | | |
| Array cables | | | | | | | | | | |
| Foundation installation | | | | | | | | | | |
| Offshore substation installation | | | | | | | | | | |
| Subsea cable installation | | | | | | | | | | |
| Turbine installation | | | | | | | | | | |
| Ports and logistics | | | | | | | | | | |
| Onshore construction | | | | | | | | | | |
| Operations | | | | | | | | | | |
| Turbine inspection and maintenance | | | | | | | | | | |
| BoP inspection and maintenance | | | | | | | | | | |
| Port development | | | | | | | | | | |

*Figure 12 Project Timeline by Supply Chain Element*

By taking the cumulative job roles assigned to each supply chain area and applying them to the project timeline, inferences can be made regarding when greatest workforce need will occur. The result of this exercise is shown in Figure 13. By considering the minimum duration of training/certification or experience required for each job role, it is then possible to plan a timeline for engagement with workforce and labor organizations to ensure that personnel are available when they will be needed. This mitigates risk related to mismatch in training and job availability, which was identified as a challenge by OEM/Tier 1s. Please note again that Figure 13 does not refer to job numbers, but the number of job roles identified per supply chain area as given in Appendix C.

For instance, "Scientist" job roles are shown to be needed early in the project scope, dropping off in demand prior to operations. As this category requires at least 4 years of study, it is already too late for an individual to train as a scientist for this project, hypothetically. Additionally, Figure 13 shows that the "Skilled trade – Standard" job roles will have broad demand leading up to the operations phase, and peaking at this point. Here the timeline is such that this category of workforce still has time to be identified and adequately trained (depending on the specific role, task, etc.) for when maximum demand occurs. Future analysis and cross-referencing of job titles, timeline distribution, and training needs will provide additional insights into workforce readiness and preparation.

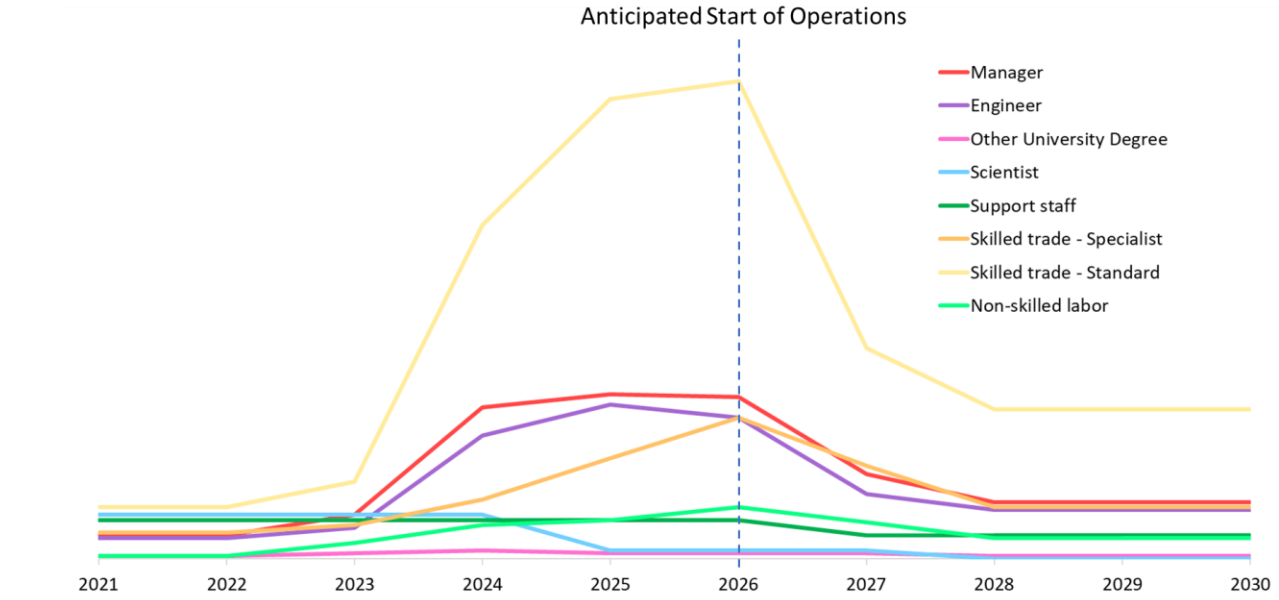


*Figure 13 Cumulative Job Roles and Project Timeline*

## 6.2 Offshore Wind Job Numbers

### 6.2.1 Calculation of Job Numbers

Offshore wind has the potential to provide a significant stimulus to the local, regional and national economy including crucially in industrial areas that have faced historic economic hardship. The economic benefit which an area can realize from OSW will depend to a great extent on the success of the local supply chain in winning and delivering work. Typically economic benefits are described in terms of the gross value added or the number of jobs generated as the result of development, construction and operation of an OSW project.

Typically, some form of Input-Output modelling is applied to assess the impact of economic activity. The method uses economic multipliers that detail the relationship between production and consumption and the interdependencies of industries in a given year. Applying relevant economic multipliers to expenditure related to an industrial activity allows for calculation of the direct, indirect and induced impacts on the overall economy, including the creation of full-time equivalent (FTE) employment. Direct impacts arise from the work undertaken by the project developer and its major suppliers. Indirect impacts relate to employment generated by the purchase of supplies and services by the companies that create the direct impacts. Induced impacts occur from earnings entering the economy as employees spend their pay checks in the region on food, clothing, and other goods and services.

FTE employment is a measure of the total number of people in paid work as the result of a project. One FTE job year is equal to one person employed full-time for one year. This FTE job could also be met by more than one individual working part-time to the equivalent of one full-time position. Although FTE employment has a technical

definition that is different from the common understanding of a job (in that FTE employment is time limited), the term 'jobs' is often used in place of FTEs when the economic benefits of an OSW project are being described.

Economic impact analyses that output FTEs make use of Standard Industry Classification (SIC) or North American Industry Classification System (NAICS) frameworks for categorizing and defining industrial activity under which statistical data can be collected. SIC/NAICS code statistical data offers a picture of the flows of goods and services but in many countries is only available for the onshore economy. Multipliers that are representative of the OSW industry are not always available, particularly in countries where it is a maturing sector. This means that conventional economic analyses of OSW need to map existing NAICS data onto OSW activities, thus introducing some uncertainty into the results.

### 6.2.2 Offshore Wind Jobs in Hampton Roads

An assessment of the potential economic impact of the commercial CVOW project on Hampton Roads and VA was undertaken in September 2020. The study estimated that via the approximately $8 billion of anticipated investment 6,300 FTE jobs (direct, indirect and induced) would be created in VA during the capex phase (including 3,900 in Hampton Roads) and 1,100 FTE jobs would be sustained annually throughout the operational lifetime (all in Hampton Roads), as shown in Table 19.

*Table 19 Timeline of Total (Direct, Indirect & Induced) Job Creation in Hampton Roads and Virginia from the Commercial CVOW project (Source: Mangum Economics[1])*

| | | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027+ |
|---|---|---|---|---|---|---|---|---|---|
| Development | HR Jobs | 229 | 229 | 229 | - | - | - | - | - |
| | All VA Jobs | 583 | 583 | 583 | - | - | - | - | - |
| Manufacturing | HR Jobs | - | - | - | 496 | 496 | 496 | - | - |
| | All VA Jobs | - | - | - | 665 | 665 | 665 | - | - |
| Installation | HR Jobs | - | - | - | - | 591 | 591 | 591 | - |
| | All VA Jobs | - | - | - | - | 873 | 873 | 873 | - |
| O&M | HR Jobs | - | - | - | - | - | - | - | 1,100 |
| | All VA Jobs | - | - | - | - | - | - | - | 1,100 |
| Total | HR Jobs | 229 | 229 | 229 | 496 | 1,087 | 1,087 | 591 | 1,100 |
| | All VA Jobs | 583 | 583 | 583 | 665 | 1,538 | 1,538 | 873 | 1,100 |

[1] *Potential Impact of the Development of the Offshore Wind Energy Industry on Hampton Roads And Virginia*, Mangum Economics, VA, September 2020

While it is certain that the development of commercial scale OSW infrastructure will be a stimulus for job creation and retention in the Hampton Roads area, the inherent uncertainties in predictive economic impact modelling mean the actual employment seen is likely to be different from the results of this early study.

The economic impacts identified in the study were based on consideration of the CVOW project at an early stage in its concept development. Before supply chain contracts are placed it is necessary to anticipate the value and location of project spend based on analysis of local, regional, and non-regional supply chain capability. Further analysis once supply chain contracts for the development, manufacturing, and installation of the project have been placed would enable more accurate calculation of the economic impacts, particularly in relation to FTE jobs.

The commercial CVOW project also presents some unique characteristics that introduce some additional uncertainty into early estimations of FTE employment. Just as OSW is a maturing sector in the wider US, the first commercial scale offshore projects in any region will present opportunities for new developers and suppliers to learn the requirements for successful project delivery. It is likely that economic multipliers will be less representative on projects where suppliers are transitioning to work in new markets or in new ways.

The large capacity of the commercial CVOW project also introduces challenge into to both estimating employment benefits and fair comparison to previously studied OSW projects. Few projects around 2.6 GW have been contracted to date and so mapping existing NAISC/SIC codes and economic multipliers to the project spend associated with the constituent supply of products and services may result in less representative estimation of economic impacts. Spend on some supply elements, such as financial and insurance services, is likely to result in relatively fixed employment opportunities regardless of increased costs associated with higher project capacity.

It should be noted that, alongside the consideration of uncertainties around estimated economic impacts, careful communication of analysis results related to job numbers is important to increase understanding among relevant stakeholders. Typically, the number of jobs "seen" due to investment are considered not to be the same as (and often less) than the jobs estimated. While this is in part due to differences in definition of jobs discussed earlier (where an FTE is a unit for measuring employment which indicates the workload associated with each post, rather than the career of any individual) it is also due to the high volume of indirect and induced FTE employment included in total output numbers. Indirect and induced jobs estimated to support the delivery of products and services will largely already exist and their contribution to the delivery of an OSW project will be made alongside their contribution to the delivery of other work. The number of individuals supplying indirect and induced services will be far greater than the number of indirect and induced FTEs estimated, where each individual's contribution to the delivery of a project will be small fraction of one FTE. This may not necessarily result in new jobs being seen by individuals and employers in an area where a high number of indirect and induced jobs are already supported, such as the Hampton Roads area, where strong supporting social and community services are already in place.

The economic impact study of the commercial CVOW project assumes all of the operation and maintenance activities will occur in or be immediately supported through the Hampton Roads and thus that all direct, indirect and induced employment resulting from project operations occurs locally. While it is likely that the vast majority of O&M work will be supported by the port infrastructure in the Hampton Roads area there will almost certainly be some attrition from the total spend occurring locally. Inspection, repair, and maintenance services for an OSW project are broad. Specialist services, tools and consumables, and replacement components are likely to also be sourced from outside the Hampton Roads area and thus the number of direct jobs supported locally is likely to be lower than the

initial estimate. With the number of direct jobs being lower there will also be an associated decrease in the number of indirect and induced FTEs to support the direct employment. Where direct impacts are seen in the Hampton Roads region it is also unlikely all associated indirect and induced impacts are also seen locally where workers are supported by goods and services from outside the Hampton Roads area.

### 6.2.3 Offshore Wind Jobs on Other Projects

To date there is no common consensus on the number of jobs created or maintained through investment in OSW projects. Differences in calculation methodologies and input datasets used at different times and locations means output estimations are inconsistent and have reasonable uncertainty. Few OSW projects have reported on the total number of jobs supported with enough transparency that would enable drawing meaningful conclusions at an industry level. While projects do tend to document economic benefits, including job numbers, reporting is often limited to positive local, regional or national impacts rather than for the total spend across the complete project lifecycle. Comparison at project level is therefore challenging due to differences in location, time, capacity, spend, technology choice, contracting strategy, local supply capability, and maturity of the sector.

The OSW industry has seen a decrease in the number of FTE jobs required to support the development of projects over the past decade. This downward trend in FTEs per MW capacity has been due to learning within the industry and efficiencies in project and supply delivery. However, the total number of jobs supported by the industry has increased due to the growth in annual installed capacity. In Europe, capex phase FTE jobs per MW of installed capacity have halved in just over a decade, as shown in Figure 14. It is reasonable to expect a similar trend to be seen in the US where projects following the first commercial scale developments will enable supply chain learning and delivery efficiencies.

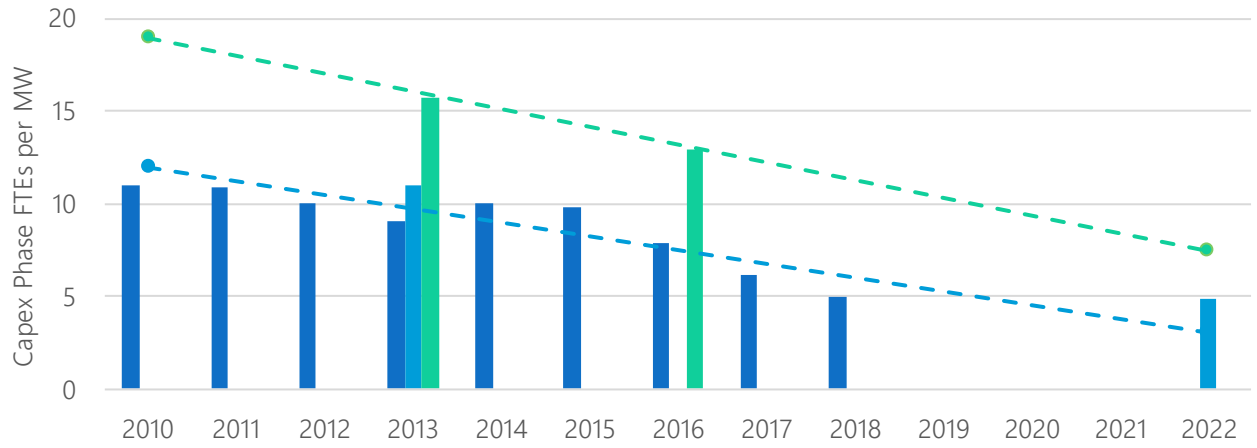


*Figure 14 Timeline of Capex Phase FTE Jobs per MW Capacity for a Range of Danish OSW Studies (Source: QBIS[2])*

[2] *Socioeconomic Impact Study of Offshore Wind*, QBIS, Denmark, July 2020

Similar supply chain learning and delivery efficiencies have occurred in the operations and maintenance of commercial OSW projects as the industry has matured, thus leading to a reduction in the number of FTEs required per MW of installed capacity. Technology innovation in the operations phase has in part also been driven by the desire to reduce the requirement for people to be present in the offshore environment for wind farm inspection and to reduce the number of in-person visits offshore for repairs.

Comparing the number of direct FTEs estimated to be supported through the development of the commercial scale CVOW project (from Mangum Economics report) with those of a generic 1 GW OSW project in Europe (from QBIS report), as summarized in Table 20, it can be seen that the number of O&M phase jobs has been anticipated to be at the same level once adjusted for difference in capacity. This may be unlikely to be seen in reality where O&M jobs typically do not scale linearly with increase in capacity and significant operational efficiencies would be expected to be found.

*Table 20 Comparison of Direct FTE Benefit of Generic Commercial OSW Project and Commercial CVOW Project (Source QBIS, Mangum Economics)*

| Lifecycle stage | 1GW OSW Project Total Direct FTEs per GW | CVOW Project VA Direct FTEs per GW | % comparison CVOW vs. 1GW OSW project | CVOW anticipated VA supply content in stage |
|---|---|---|---|---|
| Development | 574 | 121 | 21% | 35% |
| Manufacturing | 5,475 | 168 | 3% | 2% |
| Installation | 781 | 193 | 25% | 17% |
| O&M (25 years) | 1,907 | 1,923 | 100% | 100% |

# 7 HAMPTON ROADS SUPPLY CHAIN OPPORTUNITY ANALYSIS

The contents of the BNOW Supply Chain Connect Directory for the Hampton Roads area of Virginia were mapped against the Xodus supply chain taxonomy and analyzed to identify supply chain sectors where companies are well positioned to meet, or adapt to meet, the OSW industry's requirements. The analysis of such companies was carried out using a consistent set of criteria applied to each supply chain element:

- Experience in OSW: The number of companies in-state who have supplied to the OSW sector, either in the US or elsewhere in the world;
- Experience in adjacent industries: The strength and applicability of supply chain expertise in state supplying relevant adjacent industries, such as the marine and energy sectors;
- Market volume resilience: How much the success of supply chain companies will depend on the volume of installed OSW project capacity;
- Advantage for local supply: The nature of any competitive advantage for supply from in-state, considering possible logistics benefit or existing supply chain strength;
- Opportunity for export supply: The potential for in-state companies to supply projects down the US east coast or beyond, should capability be established;
- Relative project spend on supply area: Proportion of total lifetime project spend typically attributable to the supply chain category; and
- Investment case: Level of investment and market confidence needed to develop supply chain capability.

A scoring system was applied to each criterion as described in Table 21.

*Table 21 Scoring system for opportunity analysis*

| Criterion | Score 1 | Score 2 | Score 3 | Score 4 |
|---|---|---|---|---|
| Experience in OSW | No local companies with experience in OSW. | Local companies have no OSW experience but are known to be actively pursuing opportunities. | Up to two local companies with OSW experience. | More than two local companies with OSW experience. |
| Experience in adjacent industries | No known local companies with relevant experience in an adjacent industry. | Local companies with some relevant experience but are unlikely to offer a competitive solution in OSW. | Local companies with some relevant experience that may need some change in strategy or additional investment to support supply to OSW projects. | Local companies with some relevant experience and are likely to supply in OSW with minimal change in strategy or additional investment. |

| | | | | |
|---|---|---|---|---|
| Market volume resilience | Local companies' success is likely to depend almost entirely on orders from the OSW sector. | Local companies' success is likely to depend on >50% of order book from the OSW sector. | Local companies' success is likely to depend on <50% of order book from the OSW sector. | Local companies' success can be independent of orders from the OSW sector. |
| Advantage for local supply | No competitive advantage to local suppliers from either existing local supply capability or logistics benefit. | Minor competitive advantage to local suppliers, either from existing local supply capability or logistics benefit. | Competitive advantage to local suppliers, either from strong local supply capability or significant logistics benefit. | Competitive advantage to local suppliers from both strong local company experience and significant logistics benefit. |
| Opportunity for export supply | Significant logistics barrier to non-local supply or established competing supply harms export opportunity. | Some logistics benefit to local supply or established competing supply limits export opportunity. | No particular logistics benefit to supply or lack of established competing supply means non-local suppliers are not disadvantaged. | No particular logistics benefit to supply and lack of established competing supply means non-local suppliers will be required on nearby export projects. |
| Relative project spend on supply area | Spend in this area is <1% of project lifetime expenditure. | Spend in this area is between 1% and 1.5% of project lifetime expenditure. | Spend in this area is between 1.5% and 5% of project lifetime expenditure. | Spend in this area is >5% of project lifetime expenditure. |
| Investment case | Investment required to supply is significant enough to need public support and requires long-term confidence in OSW market. | Investment required to enable supply triggered by long-term confidence in OSW market. | Investment required to enable supply can be triggered by single OSW contract. | Little or no further investment needed to enable supply. |

## 7.1 Project Development

The project development category includes the services contracted prior to the developer reaching final investment decision (FID). This includes surveys and studies required to inform wind farm project and component design, as well as to obtain necessary construction permits.

35.5 % of the firms identified in the research phase of this study are operating in the development phase.

### 7.1.1 Development & Permitting

#### 7.1.1.1 Assessment

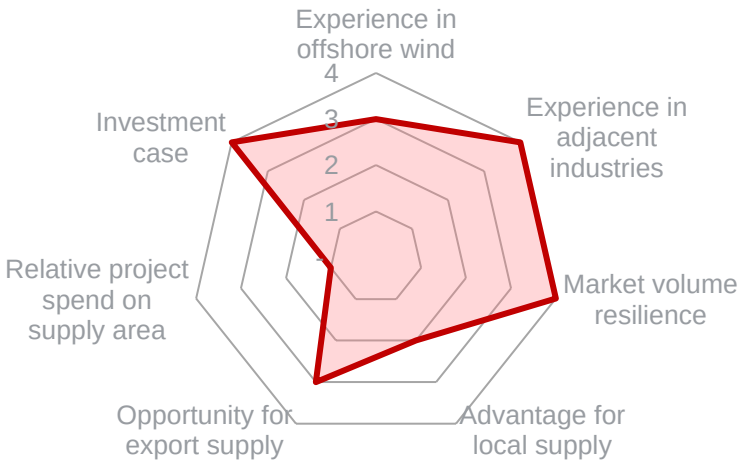


*Figure 15 Assessment of Hampton Roads' development and permitting opportunity*

- Experience in OSW – The experience to date relates to the experience gained to date from developing and permitting the pilot and commercial CVOW project. These efforts have been assisted by economic development agencies such as those in the City of Norfolk and Virginia Beach. Support in project development includes assisting with Site Assessment Plans (SAPs) and Construction and Operations Plans (COPs) through to owners engineering and permitting advisory.

- Experience in adjacent industries – The capability to support OSW developers in the development phase of the project comes from a deep-rooted experience in supporting large civil infrastructure and energy infrastructure projects onshore.

- Market volume resilience – The companies supporting development and permitting of OSW projects were largely established prior to the emergence of the US OSW industry and will support industries beyond OSW, although permitting for offshore infrastructure is not commonplace.

- Advantage for local supply – These services can be delivered from multiple locations with the only advantage of delivering locally being the ability to engage with local stakeholders, state authorities and non-governmental organizations (NGOs). Local firms may have some advantage due to their track record in supporting project development and permitting.

- Opportunity for export supply – Support for project development and permitting can be provided by non-local suppliers with negligible logistical barriers. Where other states have inexperienced local supply chain to support project permitting VA companies with experience have good opportunity to supply.

- Relative project spend on supply area – This portion of the project phase spend typically accounts for less than 1% of total project costs.

- Investment case – Companies in VA are already fully capable of providing support so no additional investment to supply is necessary.

#### 7.1.1.2 Discussion

With lease areas supporting multiple phased developments VA firms are well placed to capture this further permitting work for future phases both locally to the lease areas off the coast of Virginia but also along the rest of the east coast due to established relationships with OSW developers, such as Dominion Energy (CVOW) and Avangrid Renewables (Kitty Hawk (NC)). Additionally, a growing track record, combined with lessons learned, in the US OSW permitting process will position firms from the Hampton Roads area well for future opportunities.

## 7.1.2 Surveys

### 7.1.2.1 Assessment

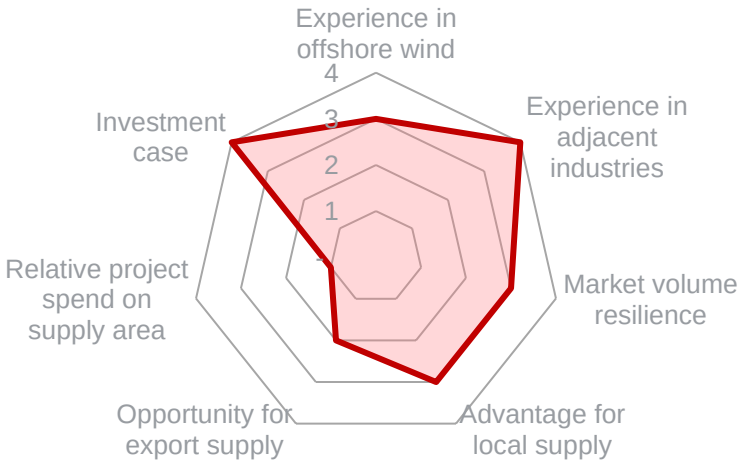


*Figure 16 Assessment of Hampton Roads' surveys opportunity*

- Experience in OSW – A few VA based companies have provided a variety of survey services for OSW projects including geotechnical, geophysical, environmental and metocean surveys. The presence of Fugro in the Hampton Roads area, one of the leaders in survey work done for OSW projects all over the world, is a major driver of this experience, although further suppliers provided geotechnical and material testing for the work that was done for the CVOW Pilot Project.

- Experience in adjacent industries – Surveying capability has the ability to be transferred from adjacent industries in particular onshore terrestrial environment surveys, of which there are a few firms that have previous experience in the area.

- Market volume resilience – Surveying is required in other industries but OSW presents significant opportunity for offshore surveying services.

- Advantage for local supply – Local understanding of the environment and marine logistics can be a key differentiator for survey services. Local vessels are often used to undertake environmental surveys.

- Opportunity for export supply – The logic of export supply is strong for the main site investigation work, as this is further offshore and less reliant on local knowledge of the environment. Onshore and nearshore site investigation and environmental surveys benefit from local expertise and understanding and therefore there will be limited opportunity for exporting these services if there are capable local suppliers in competition.

- Relative project spend on supply area – This portion of the project phase spend typically accounts for less than 1% of total project costs.

- Investment case – VA firms operating in the survey (onshore or offshore) market will need to make minimal investment to be able to support the OSW industry. The industry has seen large multi-national survey companies such as Fugro and MMT enter the US OSW market in the very early stages and dominate the large site investigation scopes. Where local survey firms will see success is in smaller nearshore and environmental focused scopes.

#### 7.1.2.2 Discussion

Surveying has emerged as a potentially area of good capability for the supply chain in the Hampton Roads area of VA. With lease areas supporting multiple phased developments VA firms are well placed to capture further survey work for future phases. VA survey firms should leverage their local knowledge to provide specialist survey pertaining to local environmental sensitives, such a as biological sciences, onshore surveys and nearshore geophysical and geotechnical surveys.

### 7.1.3 Engineering & Design

#### 7.1.3.1 Assessment

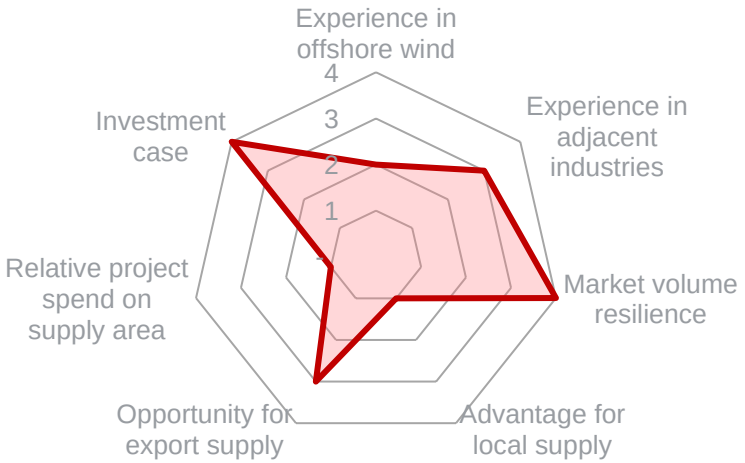


*Figure 17 Assessment of Hampton Roads' engineering and design opportunity*

- Experience in OSW – A limited number of companies from the Hampton Roads area have provided engineering and design services for the OSW industry to date. A few contracts have been awarded to firms with such capabilities, but for unrelated services such as transport logistics and geotechnical and material testing services.

- Experience in adjacent industries – The capability to support OSW developers in the development phase of the project comes from a deep-rooted experience in supporting large civil infrastructure and energy projects, such as onshore wind, solar and oil and gas. New entrants from adjacent industries will need to understand specific requirements of wind farm and component design.

- Market volume resilience – The companies supporting the OSW industry were largely established prior to the emergence of the US OSW industry and suppliers can support industries beyond OSW.

- Advantage for local supply – Competitive advantage is not defined by supplier location.

- Opportunity for export supply – As there is no strong logistics benefit to local supply, VA based companies could find opportunities to export services.

- Relative project spend on supply area – This portion of the project spend typically accounts for less than 1% of total project costs.

- Investment case – The expertise and equipment required for most project engineering and design services is used across several sectors.

#### 7.1.3.2 Discussion

Engineering and design encompass several industry sectors where may be opportunities for firms with a presence in the Hampton Roads area of VA. The engineering competencies that will likely garner the greatest number of opportunities for OSW related work include offshore, civil, electrical, environmental, and structural engineering.

### 7.1.4 Project Management

#### 7.1.4.1 Assessment

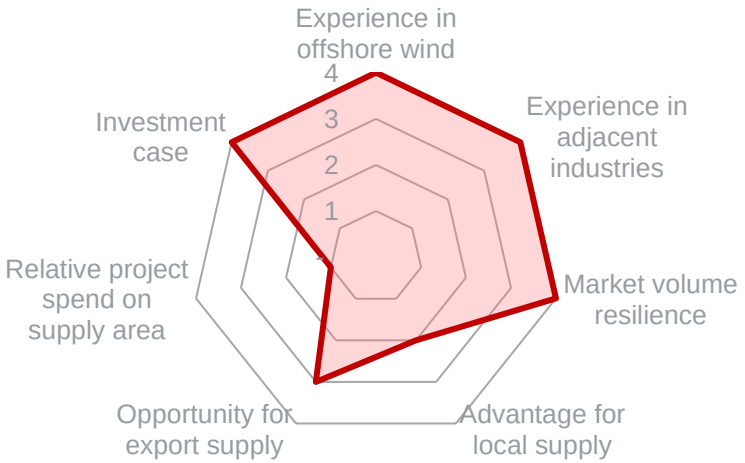


*Figure 18 Assessment of Hampton Roads' project management opportunity*

- Experience in OSW – The majority of OSW project management is undertaken by the project developer. Only a few VA based companies have provided a project management services, primarily for insurance coverage and port usage and logistics.
- Experience in adjacent industries – Provision of project management services can come from companies in adjacent industries with an understanding of OSW.
- Market volume resilience – Companies providing project management services are largely established independent of OSW opportunity and have capability to support a wide range of other sectors.
- Advantage for local supply – Most project management services can be delivered independent of location. Competitive advantage is based on capability and track record.
- Opportunity for export supply – VA based suppliers of project management services will be able to access multiple US projects.
- Relative project spend on supply area – This portion of the project spend typically accounts for less than 1% of total project costs.

- Investment case – Project management support services are often ubiquitous and can be applied to support other sectors. No additional investment required to support the OSW sector.

#### 7.1.4.2 Discussion

Early US OSW projects being created by project developers that are new to the sector with limited OSW experience in-house may create increased opportunity for some project management support services, though in time more of this requirement is likely to be undertaken by internal project development teams. External support services will still be required in areas such as financial, legal, insurance, recruitment and software where VA firms with project knowledge and track record will be able to supply.

One company with a presence in the Hampton Roads area has provided project management support services to US OSW projects to date; Compass Insurance Solutions provided insurance for the CVOW Pilot Project.

## 7.2 Wind Turbine Supply

The wind turbine supply category includes general components of the WTG supply contract. The assembly of the WTG is carried out by the WTG OEM with the elements of the rotor, nacelle, and tower; broad terms for several Tier 2 and below supply packages.

6.5% of firms identified in the research phase of this study are operating in the wind turbine supply phase.

### 7.2.1 Rotor

#### 7.2.1.1 Assessment

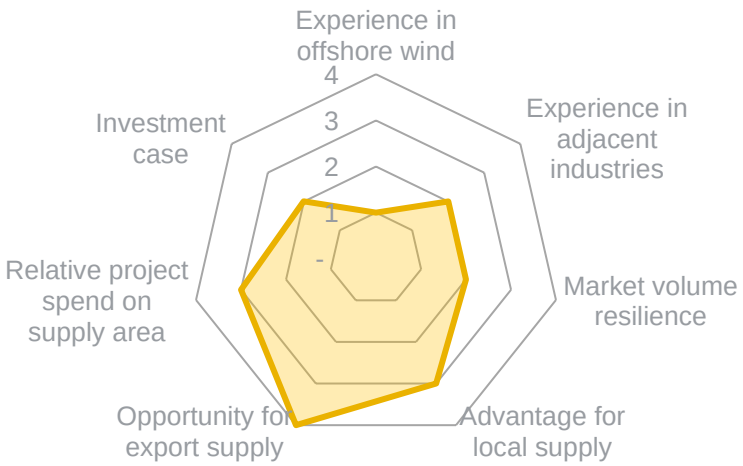


*Figure 19 Assessment of Hampton Roads' rotor supply opportunity*

- Experience in OSW – Major turbine OEMs have yet to establish a blade fabrication facility in the US to date. As a result of this there has been limited work associated with this portion of the supply chain in the US.

- Experience in adjacent industries – While specific opportunities do exist, particularly further down the supply chain (Tier 2 or 3), they face several challenges in terms of competing with experienced and established supply chains to the Tier 1s. The opportunity for companies in adjacent industries will likely depend on the location of US blade fabrication facilities.

- Market volume resilience – The same skills and tools (though at different scale) are also required in onshore wind.

- Advantage for local supply – Local supply of blades could reduce logistical challenges associated with marshalling.

- Opportunity for export supply – Blade manufacturers typically have a single blade facility to serve the whole nearby geographical market. Given the volume of projects along the East Coast there should be an appetite for a facility to be located in VA with the ability to export to the entire East Coast US industry.

- Relative project spend on supply area – This portion of the project spend typically accounts for around 4% of total project costs.

- Investment case – A high level of investment would be required to establish a blade facility in VA but the long-term US project forecast supports the investment case if a suitable location can be found. Although the investment case is unlikely to require public sector support, multiple states may be looking to incentivize manufactures due to the economic benefits a local fabrication facility would enable.

#### 7.2.1.2 Discussion

If VA could attract a major OEM blade manufacturing facility, this could support growth of a secondary supply chain. Incentives could be used to attract the manufacturer as the investment is large and by showing a willingness to co-invest in success VA would demonstrate further commitment to the OSW industry. The goal would be to form a cluster and both Tier 1s and developers would fully support such an effort. Suitably located land adjacent to a port is at a premium and would likely require significant refurbishments and modifications.

## 7.2.2 Nacelle

### 7.2.2.1 Assessment

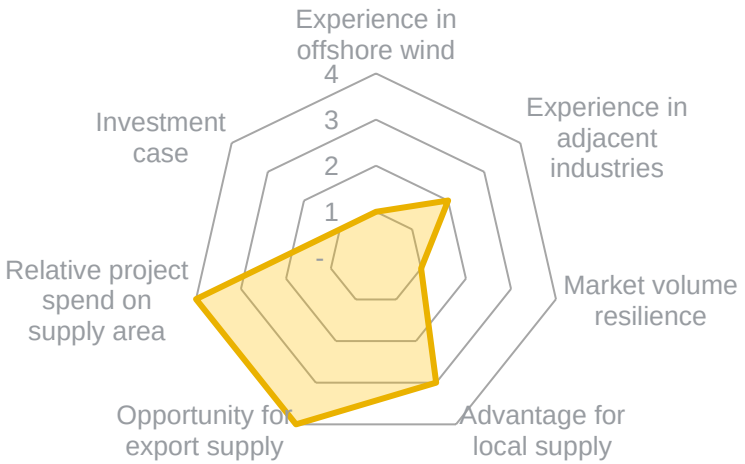


*Figure 20 Assessment of Hampton Roads' nacelle supply opportunity*

- Experience in OSW – Major turbine OEMs have yet to establish a nacelle assembly facility in the US to date. As a result of this there has been limited work associated with this portion of the supply chain in the US.
- Experience in adjacent industries – While specific opportunities may exist, particularly further down the supply chain (Tier 2 or 3), they face a number of challenges in terms of competing with experienced and established supply chains to the Tier 1s.
- Market volume resilience – A US nacelle assembly facility will be entirely dependent on the size of the OSW market.
- Advantage for local supply – Local supply of nacelles would reduce logistical challenges associated with marshalling.
- Opportunity for export supply – A nacelle assembly facility would serve the whole geographical market. Given the volume of projects in the US pipeline there could be appetite form the turbine OEMs to eventually establish US nacelle assembly facilities, which could be located in VA with the ability to export to the entire US industry.
- Relative project spend on supply area – this portion of the project spend typically accounts for around 10% of total project costs.
- Investment case – A high level of investment and a sizeable long-term US market would be required to establish a nacelle assembly in VA.

#### 7.2.2.2 Discussion

As with blade manufacturing, there is a gap in US supply to the industry. If VA could attract a major OEM nacelle assembly facility, this could support growth of a secondary supply chain. Incentives could be used to attract the manufacturer as the investment is large and by showing a willingness to co-invest in success VA would demonstrate further commitment to the OSW industry. The goal would be to form a cluster in the Hampton Roads area and both Tier 1s and developers would fully support such an effort. Suitably located land adjacent to a port is at a premium and would likely require significant refurbishments and modifications.

The establishment of a nacelle assembly plant in the state would provide significant opportunities for those in the manufacturing and services sector, both in nacelle assembly and in its component supply chain.

Although the requirements for suppliers are strict to achieve (turbine OEMs tightly control subcontracting opportunities and parts are generally standardized limiting opportunities for new suppliers) there may still be significant supporting supply chain opportunity. Nacelle components such as control and communication systems, HVAC, lighting, cabling, and secondary steel and machined parts such as brackets, plating, handrails, flooring and ladders could be supplied by companies from the Hampton Roads area.

### 7.2.3 Tower

#### 7.2.3.1 Assessment

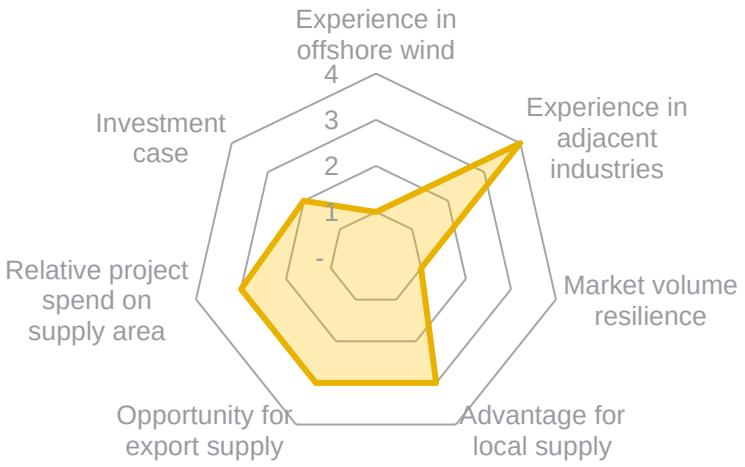


*Figure 21 Assessment of Hampton Roads' tower supply opportunity*

- Experience in OSW – Major turbine OEMs will procure towers as a sub-contract to the turbine supply contract, however there are currently no tower manufactures in VA and the emergence of a tower facility in NY will likely garner a significant amount of use from the US OSW industry as a whole.

- Experience in adjacent industries – Sub-supply opportunities will exist, particularly further down the supply chain (Tier 2 or 3) to support tower internals secondary steel manufacturing. The heavy steel manufacturing industry in the Hampton Roads area shows clearly established base from adjacent industries as a result of a lot of collaboration with the US Navy. Other adjacent industries such as onshore wind tower fabrication has typically been established around the Gulf Coast and Great Lakes.

- Market volume resilience – Offshore wind towers are bespoke to the OSW turbines and are significantly larger than onshore WTG towers. The long-term success of an OSW towers facility would be entirely reliant on the OSW project pipeline.

- Advantage for local supply – Local supply of towers would reduce logistical challenges associated with marshalling of components.

- Opportunity for export supply – A tower fabrication facility can serve a wide geographical market. With the expected volume of projects along the East Coast, there may be appetite for an VA supplier, however the planned tower manufacturing facility at the Port of Albany will provide competitive supply to the region.

- Relative project spend on supply area – This portion of the project spend typically accounts for around 1.5% of total project costs.

- Investment case – A high level of investment and long-term confidence in obtaining suitable market share of the future project pipeline would be required to establish a tower fabrication facility assembly in VA.

#### 7.2.3.2 Discussion

Towers for offshore WTGs are welded rolled steel cans. They are typically blasted, and surface finished (painted or coated) inside and out. Beyond manufacturing of the tower structures there are also opportunities for the supply of tower internal components where there is need for secondary steel items such as ladders, platforms, handrails, cable trays and electrical equipment including cables, lighting and heating, ventilation and air conditioning systems. This represents an opportunity for the firms identifying as having capabilities in the manufacturing and fabrication sector.

## 7.3 Balance of Plant Supply

Balance of plant covers the non-turbine related wind farm infrastructure, such as cables, substations and foundations.

12.9% of firms identified in the research phase of this study are operating in the balance of plant supply phase.

### 7.3.1 Export Cables

#### 7.3.1.1 Assessment

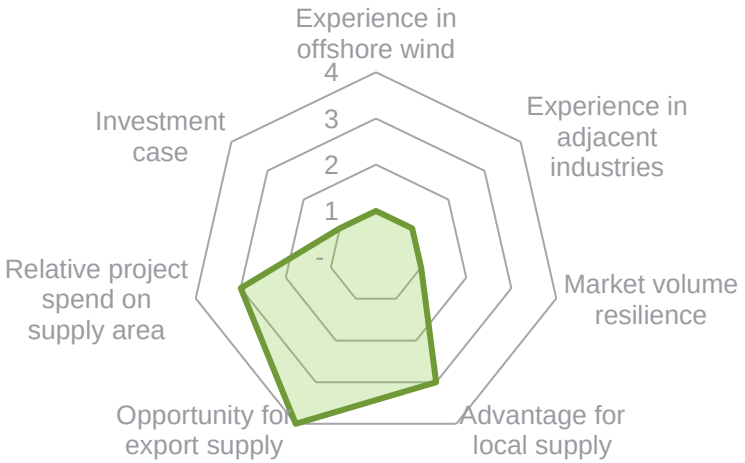


*Figure 22 Assessment of Hampton Roads' export cable supply opportunity*

- Experience in OSW – VA companies have no experience in delivering high voltage cables for the OSW industry nor have the facilities currently to serve future demand.
- Experience in adjacent industries – There do not appear to be companies in adjacent industries with strong capability to transfer to supply this area.
- Market volume resilience – There is limited demand for high voltage submarine cables in local adjacent sectors.
- Advantage for local supply – Local supply of cables would significantly reduce logistical costs and challenges associated with expense of specialist vessels equipped for cable handling.
- Opportunity for export supply – An export cable facility would serve a wide geographical market.
- Relative project spend on supply area – This portion of the project spend typically accounts for around 3% of total project costs.
- Investment case – A high level of investment and market confidence in OSW would be required to establish an export cable manufacturing facility in VA.

#### 7.3.1.2 Discussion

Given the volume of projects in the north east there could be appetite for a facility to be located in VA with ability to export to the wider US industry. However, competition for this market will come from other states. Typical export cable suppliers include Nexans, Prysmian, LS Cable, NKT and JDR Cables. Some of these suppliers have established facilities in the US elsewhere (Nexans in South Carolina for example) and while the size of the opportunity is significant the investment in a new fabrication facility will be high.

### 7.3.2 Array Cables

#### 7.3.2.1 Assessment

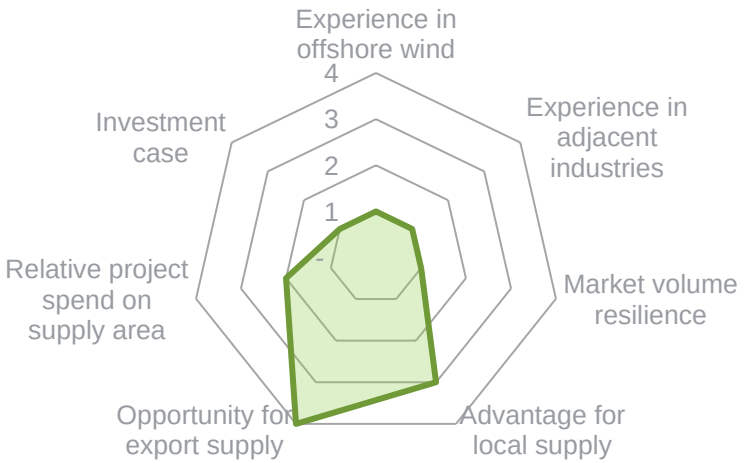


*Figure 23 Assessment of Hampton Roads' array cable supply opportunity*

- Experience in OSW – VA companies have no experience in delivering high voltage cables for the OSW industry nor have the facilities currently to serve future demand.
- Experience in adjacent industries – There do not appear to be companies in adjacent industries with strong capability to transfer to supply this area.
- Market volume resilience – There is limited demand for high voltage submarine cables in local adjacent sectors.
- Advantage for local supply – Local supply of cables would significantly reduce logistical costs and challenges associated with expense of specialist vessels equipped for cable handling.
- Opportunity for export supply – An array cable facility would serve a wide geographical market.

- Relative project spend on supply area – This portion of the project spend typically accounts for around 1% of total project costs.

- Investment case – A high level of investment and market confidence in OSW would be required to establish an export cable manufacturing facility in VA.

#### 7.3.2.2 Discussion

Given the volume of projects in the north east there could be appetite for a facility to be located in VA with ability to export to the wider US industry. However, competition for this market will come from other states. Typical export cable suppliers include Nexans, Prysmian, LS Cable, NKT and JDR Cables. Some of these suppliers have established facilities in the US elsewhere (Nexans in South Carolina for example) and while the size of the opportunity is significant the investment in a new fabrication facility will be high.

### 7.3.3 Foundations

#### 7.3.3.1 Assessment

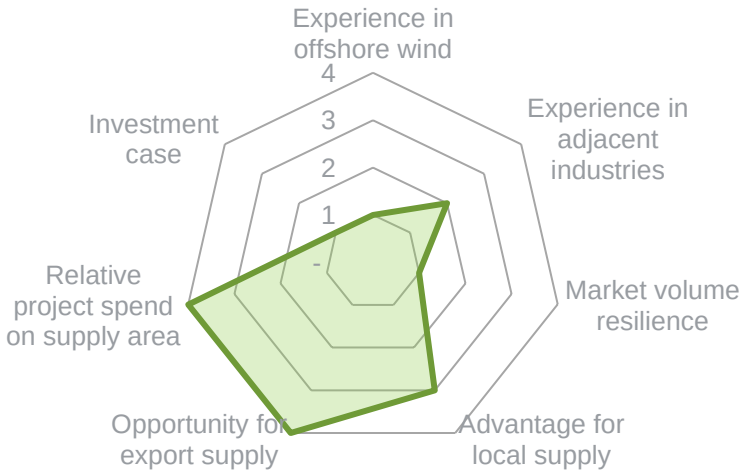


*Figure 24 Assessment of Hampton Roads' foundations supply opportunity*

- Experience in OSW – Major offshore foundation fabrication yards (for jackets, monopiles or transition pieces) are not currently present in VA.

- Experience in adjacent industries – While sub-supply opportunities will exist, particularly further down the supply chain (Tier 2 or 3) to support secondary steel manufacturing and fabrication needs. The heavy steel manufacturing industry in the Hampton Roads area shows a group of companies from adjacent industries as a result of a lot of collaboration with the US Navy.

- Market volume resilience – Offshore wind foundations are bespoke to the offshore environment and synergies and support are normally sought from oversees or the oil and gas industry. Company success in this sector would be entirely reliant on the OSW industry.

- Advantage for local supply – Local supply of foundation would significantly reduce logistical challenges associated with marshalling of components.

- Opportunity for export supply – A foundation fabrication facility would serve a wide geographical market. Given the volume of projects along the East Coast there should appetite for a facility to be located in VA with ability to export to the entire US industry.

- Relative project spend on supply area – This portion of the project spend typically accounts for around 6-8% of total project costs.

- Investment case – A high level of investment would be required to locate and establish a foundation fabrication facility in VA.

#### 7.3.3.2 Discussion

If VA could attract a major foundation fabrication facility, this could support growth of a secondary supply chain. Suitable land adjacent to a deep-water port without air draft restriction is at a premium and would likely require significant refurbishment and modifications.

Supply of secondary components to such a facility would present a significant opportunity for VA based companies. Supply of steel sub-components could include machined and fabricated items such as railings, barriers, platform, J-tubes, boat interface steelwork, brackets, plating, handrails, flooring and ladders. The survey phase of this project showed that there is an increased and wide-ranging set of skills that could be utilized for these purposes. VA companies could be in a position to transport these items to neighboring state facilities as they are largely rail and road transportable.

Although competition would be high between local suppliers the primary foundation contract is likely to be more open to widening subcontracting opportunities to local suppliers of components and services in an effort to increase local project spend.

## 7.3.4 Offshore Substation

### 7.3.4.1 Assessment

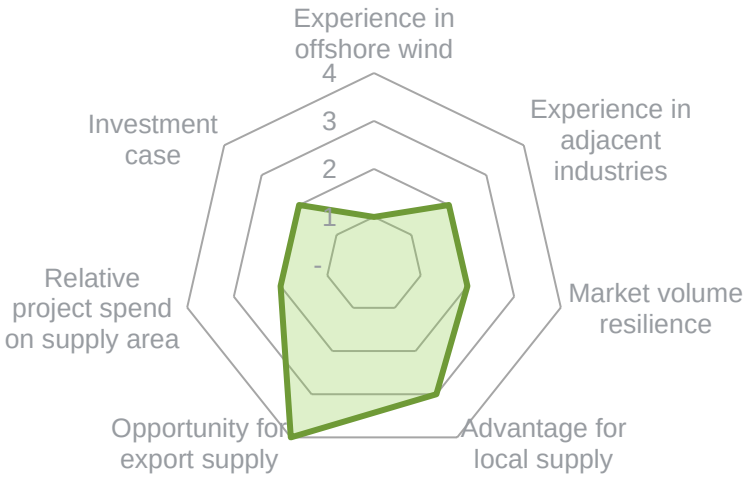


*Figure 25 Assessment of Hampton Roads' offshore substation supply opportunity*

- Experience in OSW – Substation electrical infrastructure providers have a presence in VA but currently no manufacturing facilities.
- Experience in adjacent industries – Related experience for this supply chain sector can be found in steel fabrication and welding, which are critical parts of the pre-assembly process for the foundations of offshore substations, however fabrication yards in the Gulf of Mexico are prepped and primed for delivery on these scopes. This leaves ample opportunity for a select few firms that have exhibited related capability for the delivery of electrical infrastructure, most if not all of which has occurred onshore to date.
- Market volume resilience – Companies manufacturing electrical infrastructure would look to supply other industries in addition to OSW.
- Advantage for local supply – Supply of offshore substation electrical infrastructure is likely in part to still come from Europe so local capability would reduce logistics costs. For offshore substation foundations there is less competitive advantage for a local supplier when structures can be produced in fabrication yards around the Gulf of Mexico.
- Opportunity for export supply – Electrical infrastructure manufacturing capability would serve a wide geographical market. There is less logic for export of substation foundations where these can be supplied from US fabrication yards around the Gulf of Mexico.

- Relative project spend on supply area – - This portion of the project spend typically accounts for 3% of total project costs, with around 1.5% on the substation topside equipment and 1.5% for the foundation substructure.

- Investment case – Establishing a facility to manufacture complex electrical infrastructure for offshore substations would require a sizeable long-term project pipeline.

#### 7.3.4.2 Discussion

While there are some synergies for the electrical infrastructure and electrical aspects of onshore substations, the existence of specialist expertise in the manufacturing of complex components with tight tolerances and supplying global markets means there may not be strong business case for new facilities. Despite strong US OSW capacity targets in place relatively few substations are required.

The offshore substation foundations (likely a large jacket structure) are analogous with those required in the oil and gas sector. Fabrication of offshore substation foundations is thus likely to be suited to established yards (such as Gulf Fabrications and Kiewit) in the Gulf of Mexico. There is less logic to VA based companies supplying secondary components as with turbine foundations where strong competition exists near the established fabrication yards, but some secondary steel structures can be fabricated away from the site of the main substructure and integrated at a staging facility prior to installation.

### 7.3.5 Onshore Substation

#### 7.3.5.1 Assessment

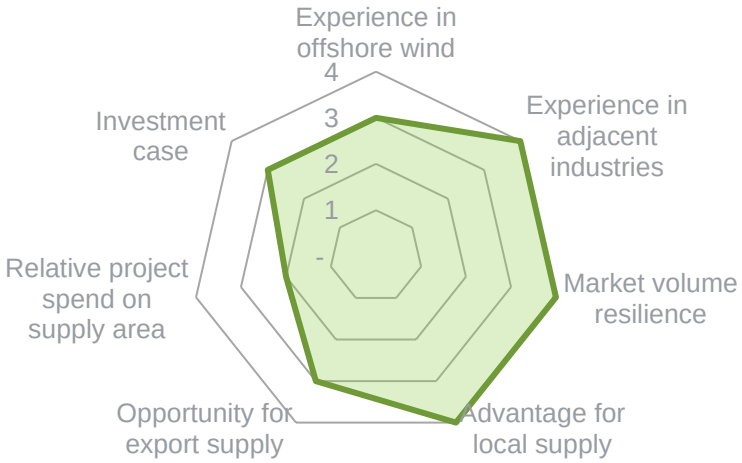


*Figure 26 Assessment of Hampton Roads' onshore substation supply opportunity*

- Experience in OSW – The experience that has been exhibited in VA has been related to the CVOW Pilot Project for which a company from the Hampton Roads area supplied the full onshore electrical design and construction scope with additional local sub-suppliers.
- Experience in adjacent industries – There appears to be a fair amount of experience in the supply of onshore electrical infrastructure in-state. Companies that currently supply onshore grid transmission projects are well positioned to support the OSW industry.
- Market volume resilience – Companies supporting the supply of onshore substations will be largely established prior to the emergence of the US OSW industry and will support sectors beyond OSW.
- Advantage for local supply – Local supply of electrical components would reduce logistical challenges associated with delivery of components, although components would likely be easily transportable by rail or road.
- Opportunity for export supply – As components are transportable, a supply chain supporting the electrical component supply of an onshore substation has the potential to serve a wide geographic market.
- Relative project spend on supply area – This portion of the project spend typically accounts for around 1% of total project costs.
- Investment case – A low level of investment would be required to establish electrical component supply in VA.

#### 7.3.5.2 Discussion

There may be opportunity to establish a supply chain for onshore electrical infrastructure, however, the requirements for supply to OSW projects are not unique nor needed in high volume and so it is likely that this will come from established suppliers elsewhere.

There are likely companies situated in VA, supporting adjacent industries, that have capability to support. However, only a few been identified to date. L. E. Myers Company supported the onshore substation works for the CVOW Pilot Project.

## 7.4 Installation & Commissioning

The installation and commissioning category includes the services contracted to construct an OSW project. These elements can be Tier 1 or Tier 2 packages, with the exception of ports contracts which are typically Tier 2 or Tier 3.

27.4% of firms identified in the research phase of this study are operating in the installation phase.

### 7.4.1 Turbine Installation

#### 7.4.1.1 Assessment

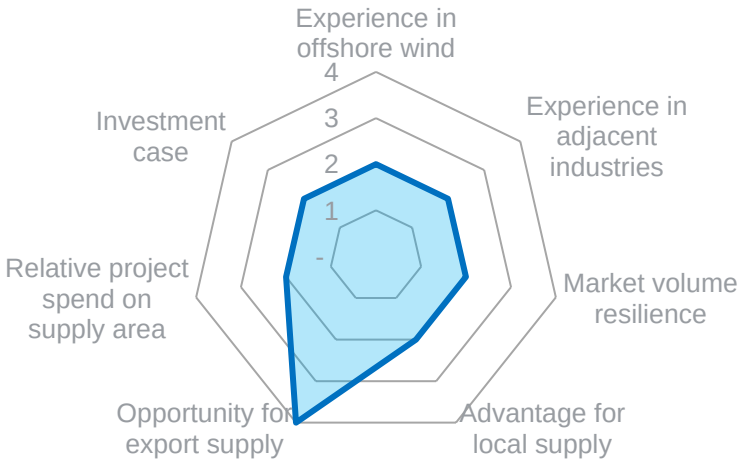


*Figure 27 Assessment of Hampton Roads' turbine installation opportunity*

- Experience in OSW – While there is currently very limited experience as it relates to the installation of turbines from companies located within the Hampton Roads area, there is a critically important vessel that is being constructed by Dominion Energy, which will be Jones Act compliant and have the potential to service much of the turbine installation work for projects on the East Coast of the United States.

- Experience in adjacent industries – Some aspects of the onshore construction sector could be used to support the installation of OSW WTGs such as onshore staging and marshalling including supply of lifting frames and rigging. Due to the requirements of the Jones Act, the market is still currently looking to establish the 'norm' for WTG installation. Due to the absence of a Jones Act compliant jack-up vessel for WTG installation, a feeder barge method is currently the preferred solution. This presents an opportunity for the supporting marine industry to play a limited role. A Jones Act compliant vessel constructed by Dominion Energy is expected to be completed by the end of 2023.

- Market volume resilience – While turbine installation heavy lift vessels can support offshore and quayside lifting operations in other sectors, the market trend has been to design vessels geared towards supporting the OSW market.

- Advantage for local supply – WTG T&I companies are multi-national and support projects around the globe. There is no particular advantage for them to be located in VA. Locality can be advantage to partnering with local barge supplier or marshalling yards.

- Opportunity for export supply – Conversely, WTG T&I vessels can support projects globally.

- Relative project spend on supply area – This portion of the project spend typically accounts for around 1% of total project costs.

- Investment case – Long-term confidence in the US OSW market has been required to commission a Jones Act compliant turbine installation vessel.

#### 7.4.1.2 Discussion

The opportunity for VA in this particular sector appears low, however there is the vessel that is being constructed by Dominion Energy, which will be Jones Act compliant and have the potential to service much of the turbine installation work for projects on the East Coast of the United States; this vessel is expected to be completed by the end of 2023. There should also be a focus on developing word-class ports and maritime logistics to support the WTG installation. This availability of supporting infrastructure will allow for multi-national T&I companies to use VA to support their contracts on the East Coast.

There will likely be many opportunities for local suppliers to provide added value through project management and vessel mobilization capability. For VA and neighboring state projects there will also be a need for ports, CTVs and technicians to support turbine commissioning. Companies from the Hampton Roads area such as Cape Henry Launch Service have experience in providing CTV services for the CVOW Pilot Project in addition to entities such as Hampton Roads Port Services which organized the logistics around having the CTVs in port.

## 7.4.2 Foundation Installation

### 7.4.2.1 Assessment

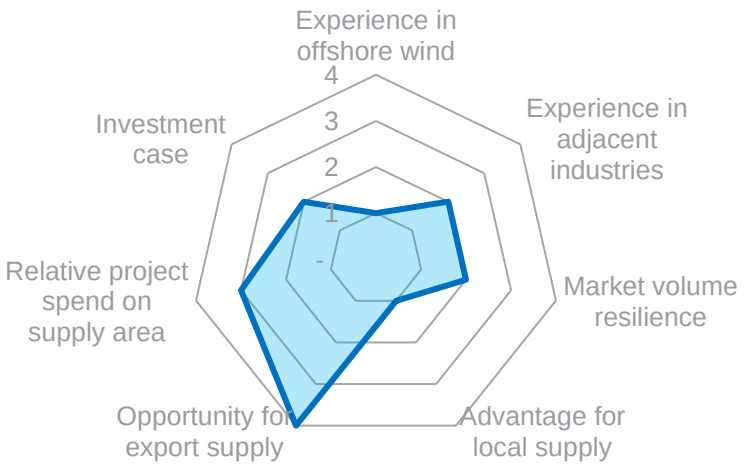


*Figure 28 Assessment of Hampton Roads' foundation installation opportunity*

- Experience in OSW – To date there has been little to no experience in the installation of OSW turbine/substation foundations from companies in the Hampton Roads area.
- Experience in adjacent industries – Due to the requirements of the Jones Act, the market is still currently looking to establish the 'norm' for turbine foundation installation. Due to the absence of a Jones Act compliant jack-up vessel for foundation installation, a feeder barge method is currently the preferred solution. This presents an opportunity for the supporting marine industry to play a limited role.
- Market volume resilience – While offshore heavy lift vessels supporting the installation of foundations can support offshore and quayside lifting operations in other sectors, the requirement from the OSW sector is likely to be the primary driver for the construction of any new Jones Act compliant vessel.
- Advantage for local supply – Foundation T&I companies are multi-national and support project around the globe. There is no particular advantage for them to be located in VA. Locality can be advantage to partnering with local barge suppliers or marshalling yards.
- Opportunity for export supply – Conversely, T&I vessels can support projects globally.

- Relative project spend on supply area – This portion of the project spend typically accounts for around 2.5% of total project costs.

- Investment case – Long-term confidence in the US OSW market would be required for a VA based company to commission a Jones Act compliant foundation installation vessel.

#### 7.4.2.2 Discussion

The opportunity for VA in this particular sector is low. Focus should be on developing word-class ports and maritime logistics to support the foundation installation. Availability of supporting infrastructure will ensure multi-national T&I companies use VA to set up base to support their contracts along the East Coast.

### 7.4.3 Subsea Cable Installation

#### 7.4.3.1 Assessment

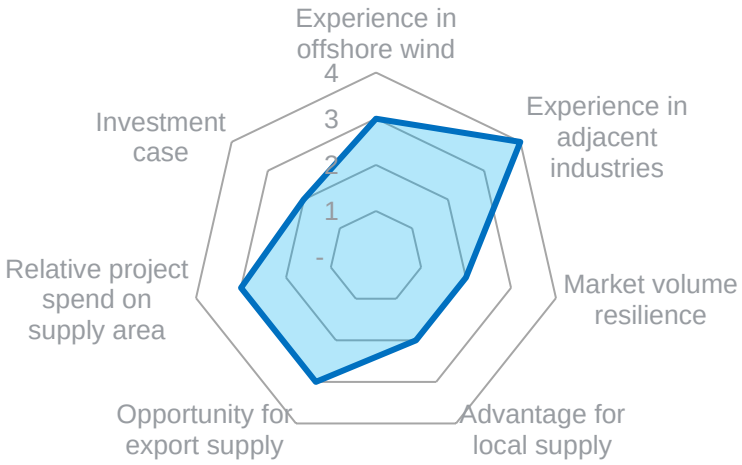


*Figure 29 Assessment of Hampton Roads' subsea cable installation opportunity*

- Experience in OSW – Two companies from the Hampton Roads area supported the installation of cables for the CVOW Pilot Project and other projects globally. Fugro has a wealth of experience in the installation of subsea cables, while James Fisher Renewables performed controlled flow excavation for the cables in the CVOW Project and will be supplying similar services for upcoming projects in the US.

- Experience in adjacent industries – The presence of companies such as Fugro and James Fisher Renewables in the Hampton Roads area indicates a strong representation and breadth of experience in sectors similar to OSW related

cable installation. Other lower tier companies in the area also have goods and services that bolster this section of the supply chain.

- Market volume resilience – There is need for installation of submarine cables in other sectors, but the requirement in OSW is likely to be significant.
- Advantage for local supply – There is no strong logistical benefit to local supply of cable installation. Due the costs associated with cable handling it is typically the case that subsea cables are installed directly from the manufacturing facility.
- Opportunity for export supply – Cable installation vessels can supply projects globally.
- Relative project spend on supply area – This portion of the project spend typically accounts for around 3-5% of total project costs.
- Investment case – Confidence in the US OSW market would be required for a VA based company to commission a Jones Act compliant cable installation vessel.

#### 7.4.3.2 Discussion

The opportunity for VA in this particular sector is greater than many other areas in the US. A few companies listed in the database such as Fugro and James Fisher Renewables have exhibited the capability to support subsea cable installation.

## 7.4.4 Offshore Substation Installation

### 7.4.4.1 Assessment

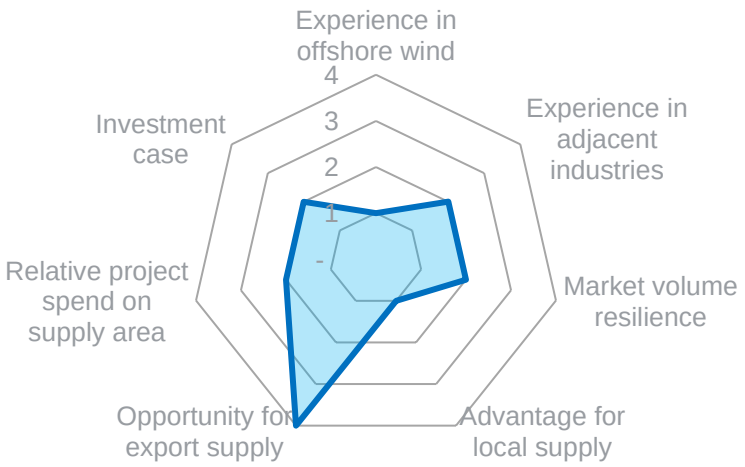


*Figure 30 Assessment of Hampton Roads' offshore substation installation opportunity*

- Experience in OSW – There is very little experience in the installation of offshore substations from firms based in the Hampton Roads area.
- Experience in adjacent industries – Vessels used to provide single heavy lifts of large topside modules or jacket installation come from the oil and gas industry or support turbine foundation installation in OSW. Electrical testing and commissioning services may come from adjacent sectors.
- Market volume resilience – Offshore heavy lift vessels supporting the installation of substation foundations can support offshore and quayside lifting operations in other sectors.
- Advantage for local supply – Heavy lift vessel operators are multi-national and support project around the globe. There is no particular advantage for them to be located in VA.
- Opportunity for export supply – Heavy lift vessels can support projects globally.
- Relative project spend on supply area – This portion of the project spend typically accounts for around 1% of total project costs.

- Investment case – It is unlikely new a new vessel will be commissioned to support offshore substation installation where this capability can be met from existing supply. Long-term confidence in the US OSW market would be required for a VA based company to commission a Jones Act compliant foundation installation vessel.

#### 7.4.4.2 Discussion

The opportunity for VA in this particular sector is low. Focus should be on developing word-class ports and maritime logistics to support the foundation installation. Availability of supporting infrastructure will ensure multi-national T&I companies use VA to set up base to support their contracts along the East Coast.

### 7.4.5 Onshore Construction

#### 7.4.5.1 Assessment

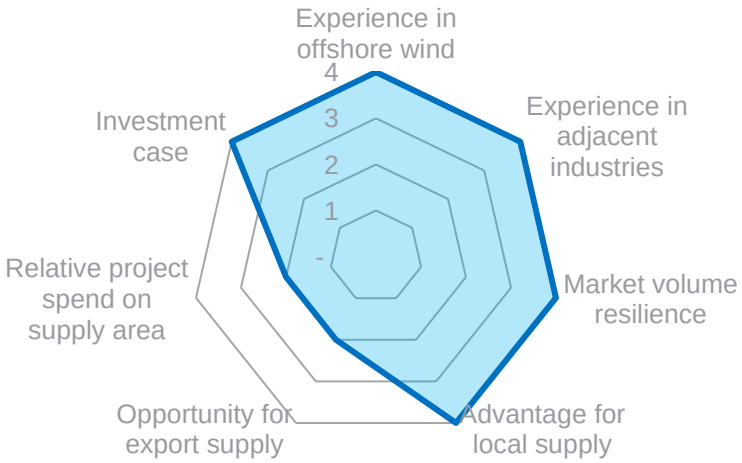


*Figure 31 Assessment of Hampton Roads' onshore construction opportunity*

- Experience in OSW – There is limited experience in the OSW sector among VA onshore construction contractors, however in this area lack of specific OSW project experience is not a barrier to supplying future projects.
- Experience in adjacent industries – Onshore civil infrastructure construction firms based in VA should be well positioned to support the onshore construction requirements of an OSW farm.
- Market volume resilience – Companies supporting onshore construction for an OSW project will support a wide range of other infrastructure projects.

- Advantage for local supply – Local civil construction companies are likely to be contracted.
- Opportunity for export supply – Local civil construction companies are likely to be contracted.
- Relative project spend on supply area – This portion of the project spend typically accounts for less than 1% of total project costs.
- Investment case – Companies in VA are already fully capable of providing support so no additional investment to supply is necessary.

#### 7.4.5.2 Discussion

Onshore construction is likely to be an area where VA suppliers emerge with strong capability to support, although the skill sets used are not specific to OSW. With lease areas supporting multi-phased developments, VA firms are well placed to capture further construction work for future phases. The buildout of the different phases of the CVOW Project will likely lead to ample opportunities in this sector of the supply chain.

### 7.4.6 Ports & Logistics

#### 7.4.6.1 Assessment

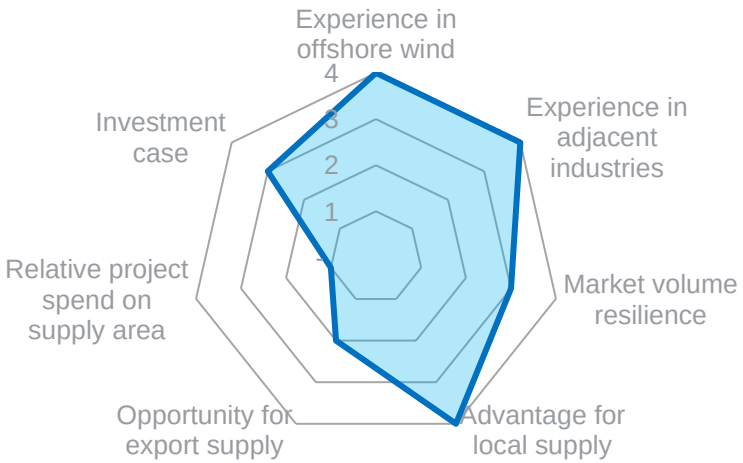


*Figure 32 Assessment of Hampton Roads' ports and logistics opportunity*

- Experience in OSW – Port usage and the logistics associated with it are a major strength of the Hampton Roads area. To date only the CVOW Pilot Project has been constructed using Hampton Roads based ports but the

capabilities that are inherent in that are also related to the port usage and logistics surrounding the presence of the US Navy and major containership operations in the area.

- Experience in adjacent industries – There are several companies in the adjacent marine industry supply chain that have capability to support the OSW industry.
- Market volume resilience – Expanded port infrastructure could be used to support other industries but few have the same requirement as commercial scale OSW projects.
- Advantage for local supply – Local supply provides increased logistical benefit due to shorter transiting times to the OSW project location. However, some components may be installed directly from manufacturing facilities.
- Opportunity for export supply – Installation and staging ports with strong capability can be used to support projects across a wide geographical area, although there will be logistical benefit to local supply where available.
- Relative project spend on supply area – This portion of the project spend typically accounts for less than 1% of total project costs.
- Investment case – Project developers have typically been willing to provide some investment and share risk in developing installation ports, as has been seen with the development of port infrastructure in support of the commercial scale CVOW project.

#### 7.4.6.2 Discussion

In addition to the VA port infrastructure to support OSW projects, there comes significant opportunity for local companies to provide port and logistics services including security, utilities, fuel bunkering, stevedoring, cranes, handling, forklifts, SPMTs, trailers, vessel maintenance, ships agent, towage, and waste removal. Provision of these services is not limited to the project installation phase, where smaller ports in the Hampton Roads area of VA may aid in these logistical services to support the development surveys and wind farm O&M stages.

## 7.5 Operations & Maintenance

The operations and maintenance (O&M) category includes the products and services required to optimize and sustain the performance of OSW projects over their lifetimes. Wind farm O&M is typically led by one of the project developers in the lead operator role from an operations base close to the project.

43.5% of firms identified in the research phase of this study are operating in the operations and maintenance phase.

## 7.5.1 Operations

### 7.5.1.1 Assessment

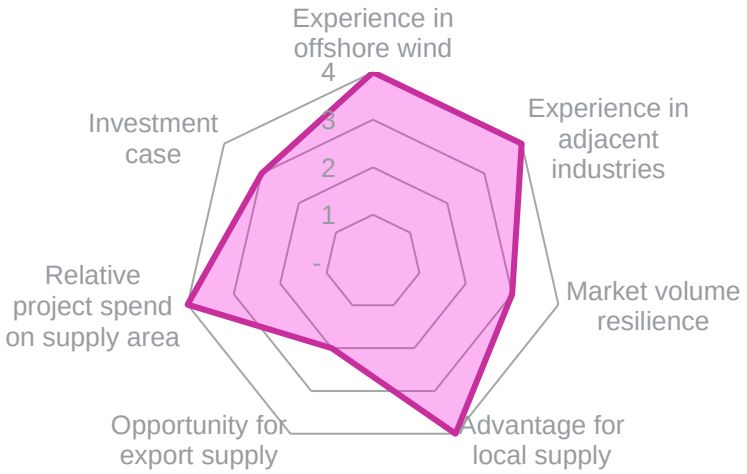


*Figure 33 Assessment of Hampton Roads' wind farm operations opportunity*

- Experience in OSW – Dominion Energy has presence in VA.
- Experience in adjacent industries – Many VA companies working in adjacent marine and logistics sectors will be able to support OSW projects without additional investment. Suppliers looking to expand capability to offer bespoke OSW training or software services will need to understand specific sector needs.
- Market volume resilience – There is overlap in the services provided to project operators with the marine operations and onshore wind sectors.
- Advantage for local supply – For provision of operations software tools there is no competitive advantage to locality, but operations typically occur at a local base where locality of support services is advantageous.
- Opportunity for export supply – Provision of software and digital services to support wind farm operations are not tied to location, and local training of technicians can be of benefit to non-local projects.
- Relative project spend on supply area – O&M represents a long-term opportunity for supply chain. This portion of the project spend typically accounts for around 10-15% of total project costs.
- Investment case – Investment required to develop capability in operations services is relatively low.

#### 7.5.1.2 Discussion

While day-to-day and long-term operations planning and execution is carried out by the project lead operator, there are opportunities for companies from the Hampton Roads area to support operations via provision of control room software for management of tasks and real time monitoring and analysis of performance data, training and certification of technicians, and onshore and offshore logistics support.

With little installed OSW capacity in the US and operations stage contracting typically not occurring until late in the project development process there have been few opportunities to date for VA companies to engage with the sector and demonstrate capability. As more projects become operational (particularly local projects) it can be anticipated that a greater number of suppliers will be identified to support OSW farm O&M.

### 7.5.2 Turbine Inspection & Maintenance

#### 7.5.2.1 Assessment

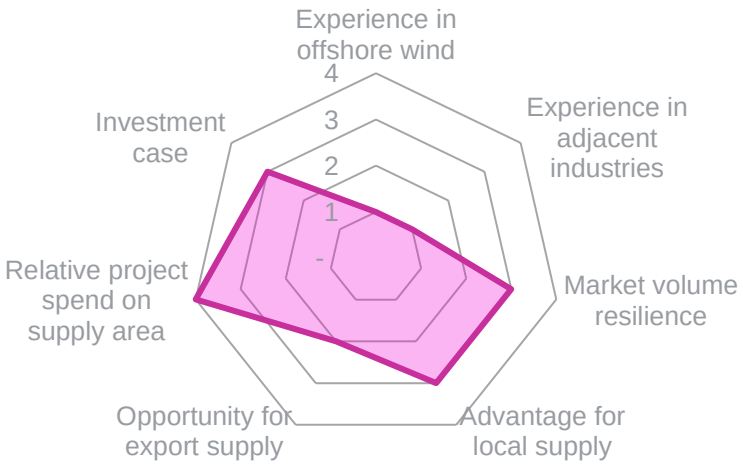


*Figure 34 Assessment of Hampton Roads' turbine maintenance opportunity*

- Experience in OSW – Major Turbine OEMs, who typically provide turbine inspection, repair and maintenance during warranty period (~5-10 years) currently do not have a presence in VA.

- Experience in adjacent industries – Engineering and inspection companies may see provision of turbine technicians and inspection and repair services as an opportunity for diversification, where investment in training and certification will be required. Companies with turbine inspection capability to serve the onshore wind sector can also transition to working offshore with appropriate training and certification.

- Market volume resilience – Companies moving to support OSW O&M will anticipate being able to provide services long-term.
- Advantage for local supply – There is a significant logistics benefit to local supply where mobilization costs can be minimized and the ability to attend to repairs quickly reduces generation downtime.
- Opportunity for export supply – Specialist O&M provision can be mobilized from further afield.
- Relative project spend on supply area – O&M represents a long-term opportunity for supply chain. This portion of the project spend typically accounts for 15-20% of total project costs.
- Investment case – Companies investing in their own capability to provide O&M will take confidence from the long-term opportunity.

#### 7.5.2.2 Discussion

While responsibility for turbine inspection, repair and maintenance will sit with the turbine OEM for at least the first five years of the operational lifetime, subcontracting opportunities will arise for inspection and repair of turbine mechanical, electrical and auxiliary components, as well as blade inspection that may be undertaken via rope access or by drones. The turbine O&M is critical to keep asset downtime as low as possible.

With little installed OSW capacity in the US and operations stage sub-contracting for turbine maintenance typically not occurring until the project is already operational there have been few opportunities to date for VA companies to engage with the sector and demonstrate capability. As projects become operational (particularly local projects) it can be anticipated that a greater number of suppliers will be identified to support OSW farm O&M.

## 7.5.3 Balance of Plant Inspection & Maintenance

### 7.5.3.1 Assessment

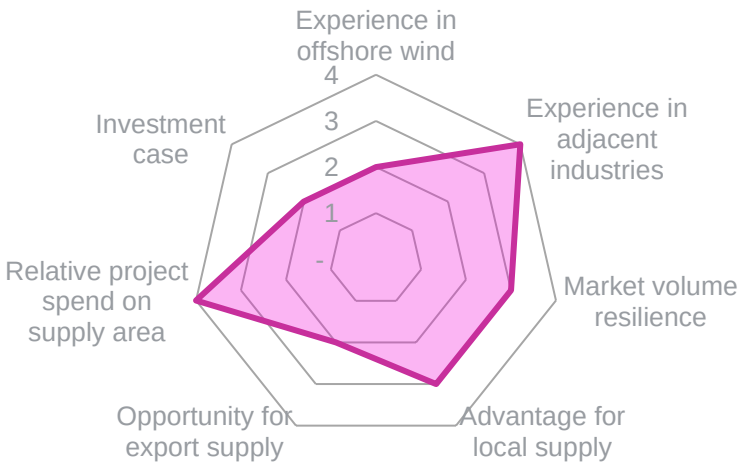


*Figure 35 Assessment of Hampton Roads' balance of plant maintenance opportunity*

- Experience in OSW – Companies that are listed to have the capabilities to provide services related to the balance of plant inspection and maintenance have won and delivered upon projects out of the Hampton Roads area, however none of the scopes that were delivered upon were related to this area of the supply chain.
- Experience in adjacent industries – The marine and subsea engineering services industry is well placed to support this function.
- Market volume resilience – Companies moving to support OSW O&M will anticipate being able to provide services long-term.
- Advantage for local supply – There is a significant logistics benefit to local supply where mobilization costs can be minimized and the ability to attend to repairs quickly reduces generation downtime.
- Opportunity for export supply – Specialist O&M provision can be mobilized from further afield.
- Relative project spend on supply area – O&M represents a long-term opportunity for supply chain. This portion of the project spend typically accounts for 10-15% of total project costs.

- Investment case – Companies investing in their own capability to provide O&M will take confidence from long-term opportunity.

#### 7.5.3.2 Discussion

Balance of plant inspection, repair and maintenance covers a diverse range of onshore and offshore (subsurface and topside) structural, mechanical and electrical needs, as well as support to access the wind farm and provision of tools and equipment.

With little installed OSW capacity in the US and operations stage contracting for balance of plant maintenance typically not occurring until the project is already operational there have been few opportunities to date for VA companies to engage with the sector and demonstrate capability. As projects become operational (particularly local projects) it can be anticipated that a greater number of suppliers will be identified to support OSW farm O&M

## 7.6 Decommissioning

### 7.6.1 Decommissioning

#### 7.6.1.1 Assessment

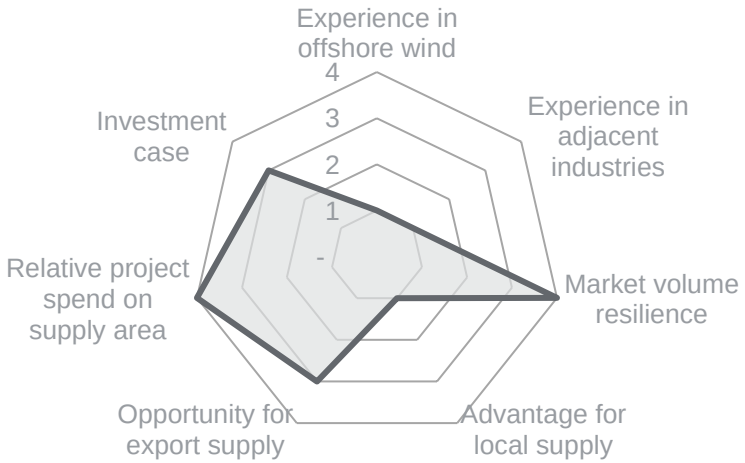


*Figure 36 Assessment of Hampton Roads' decommissioning opportunity*

- Experience in OSW – The lack of experience in OSW decommissioning is expected with services not likely to be required for 25+ years.
- Experience in adjacent industries – Some experience likely to come from adjacent marine industry, however a minimal number of companies in the Hampton Roads area indicated that they had capabilities in this sector.
- Market volume resilience – Scrap and salvage not exclusive to OSW.
- Advantage for local supply – Likely no significant competitive advantage to local supply.
- Opportunity for export supply – Where capability does emerge it is likely to service multiple east coast projects.
- Relative project spend on supply area – Expenditure on decommissioning has only been estimated to date as no commercial scale projects have required this. Estimated spend range at around 3-8% of total costs.
- Investment case – It is likely that most decommissioning activities will be carried out by existing suppliers, although technical solutions to the recycling of turbine blades still require investment.

#### 7.6.1.2 Discussion

Few OSW projects globally have been decommissioned to date and supporting services are not anticipated to be required for 25+ years. There was a single respondent to the BW survey who had indicated that they may be capable of supporting this function in the future.

## 7.7 Summary Matrix

A summary of the complete supply chain opportunity analysis scoring for each supply area is given in Table 22

*Table 22 Summary Supply Chain Opportunity Analysis*

| | Experience in OSW | Exp. in adjacent industries | Market volume resilience | Advantage for local supply | Opportunity for export supply | Relative project spend | Investment case |
|---|---|---|---|---|---|---|---|
| Development and permitting | 3 | 4 | 4 | 2 | 3 | 1 | 4 |
| Surveys | 3 | 4 | 3 | 3 | 2 | 1 | 4 |
| Engineering & design | 2 | 3 | 4 | 1 | 3 | 1 | 4 |
| Project management | 4 | 4 | 4 | 2 | 3 | 1 | 4 |
| Rotor | 1 | 2 | 2 | 3 | 4 | 3 | 2 |
| Nacelle | 1 | 2 | 1 | 3 | 4 | 4 | 1 |
| Tower | 1 | 4 | 1 | 3 | 3 | 3 | 2 |
| Export cables | 1 | 1 | 1 | 3 | 4 | 3 | 1 |
| Array cables | 1 | 1 | 1 | 3 | 4 | 2 | 1 |
| Foundations | 1 | 2 | 1 | 3 | 4 | 4 | 1 |
| Offshore substation | 1 | 2 | 2 | 3 | 4 | 2 | 2 |
| Onshore substation | 3 | 4 | 4 | 4 | 3 | 2 | 3 |
| Turbine installation | 2 | 2 | 2 | 2 | 4 | 2 | 2 |
| Foundation installation | 1 | 2 | 2 | 1 | 4 | 3 | 2 |
| Subsea cable installation | 3 | 4 | 2 | 2 | 3 | 3 | 2 |
| Offshore substation installation | 1 | 2 | 2 | 1 | 4 | 2 | 2 |
| Onshore construction | 4 | 4 | 4 | 4 | 2 | 2 | 4 |
| Ports and logistics | 4 | 4 | 3 | 4 | 2 | 1 | 3 |
| Operations | 4 | 4 | 3 | 4 | 2 | 4 | 3 |
| Turbine inspection and maintenance | 1 | 1 | 3 | 3 | 2 | 4 | 3 |
| BoP inspection and maintenance | 2 | 4 | 3 | 3 | 2 | 4 | 2 |
| Decommissioning | 1 | 1 | 4 | 1 | 3 | 4 | 3 |

# Appendix A DEVELOPER AND OEM/TIER 1 QUESTIONNAIRE

## Developer Questionnaire

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | PROJECT | OSW Supply Chain Assessment | | | |
| | CLIENT | Hampton Roads Alliance | | | |
| | SUBJECT | Interview Contacts | | | |
| | JOB NUMBER | **B400011-S00** | | | |
| | REVISION | R02 | | | |
| | | | | | |
| | | | | | |
| | Company | | | | |
| | Project | | | | |
| | Contact | | | | |
| | Attendees | | | | |
| | Question 1/Subject Area | How do you define your major packages (WTGS, Foundation etc.)? | | | |
| | What are the packages as defined by your organization? How consistent are these packages across all your projects? Do packages change based upon PPA size and/or location (or other project characteristic)? Do you favor an EPCI or multi-contract based approach (or a mix of both)? Is the package breakdown driven at a project level or a corporate level? | | | | |
| | Question 2/Subject Area | How do you influence Tier 2/3 supply chain procurement? | | | |
| | Do you identify locations for the Tier 1 suppliers? Do you identify supply chain partners and arrange introductions? Do you push local content requirements to the suppliers? What influence do you have in the selection of Tier 2/3 suppliers? | | | | |

| | | |
|---|---|---|
| | Question 3/Subject Area | What is your internal criteria for evaluating suppliers? |
| | How would you describe your process for evaluating Tier 1 suppliers? Is part of the process looking at their supply chain network? | |
| | Question 4/Subject Area | Key challenges you perceive to achieving high local content on projects |
| | Where do you expect local content to come from on your project? Are the local content requirements made clear to the Tier 1s? Is there typically flexibility in how local content is defined? How is it validated by the state? If you are working on two projects in different states but the same lease area how does this effect your local content discussions? | |
| | Question 5/Subject Area | Understanding impact of PLAs on supply chain and local content metrics/KPIs |
| | How are project labor agreements impacting the contracting of tier 1 packages? Is the local supply chains understanding of skilled labor and unions a key influence in contracting success factors? Are you negotiating PLAs on behalf of the project? Are Tiers 1s involved in the negotiations of PLAs? | |
| | Question 6/Subject Area | Strengths of Local Supply Chain |
| | Rate each of the following in terms of strength of the Virginia and specifically Hampton Roads supply chain (1 - Poor, 5 - Excellent):<br>1. Available skilled labor<br>2. Engineering and Environmental Services<br>3. Operations and Maintenance<br>4. Offshore Construction<br>5. Ports<br>6. Raw material supply (secondary steel)<br>7. Research and development<br>8. WTG and WTG component supply (inclusive of WTG towers)<br>9. Electrical infrastructure supply (onshore and offshore substation)<br>10. Cables (Export cables and Inter Array Cables, including ancillaries.)<br><br>How would you rate the strength of the existing OSW supply chain eco-system in Hampton Roads?<br><br>(1 - Poor, 5 - Excellent) Why?<br><br>Where do you believe Virginia and specifically Hampton Roads ranks in comparison to neighboring states in regard to strength and depth of the OSW supply chain?<br>1. MD<br><br>2. NJ<br>3. NY | |

| | |
|---|---|
| | 4. MA<br>5. RI<br><br>How does your rating of these change if considering the wider Virginia area supply chain? |

| | | |
|---|---|---|
| | Question 7/Subject Area | Where should Hampton Roads be focusing effort/investment etc. |
| | Rate in order of importance<br>1. Supply Chain Development - Ensuring supply chain are technically competent.<br>2. Local Incentives (i.e. tax relief, grants etc.)<br>3. Physical Asset and Improvement Plans (i.e. port infrastructure, jones act compliant vessels)<br>4. Workforce Training and Education (GWO certification for example)<br>5. Communicating the Available Supply Chain<br>6. Other (Suggestions) | |
| | Question 8/Subject Area | $/MWh additional on PPA to enhance local content |
| | Would additional revenue, conditional on enhanced local content, incentivize contracting with local supply chain? If so, what approximate level of additional revenue support would be required? | |

## OEM/Tier 1 Questionnaire

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | PROJECT | OSW Supply Chain Assessment | | | |
| | CLIENT | Hampton Roads Alliance | | | |
| | SUBJECT | Interview Contacts | | | |
| | JOB NUMBER | **B400011-S00** | | | |
| | REVISION | R02 | | | |
| | | | | | |
| | | | | | |
| | Company | | | | |
| | Project | | | | |
| | Contact | | | | |
| | Attendees | | | | |

| Subject Area 1 | How do you define your Tier 2 packages? |
|---|---|
| What is (or could be) the scope of your OSW supply? What are the Tier 2 packages as defined by your organization for each of these scopes? How tied are you to the specific project? If you have multiple projects, how does this change effect your scope? | |
| Subject Area 2 | How do you influence Tier 2/3 supply chain procurement? |
| How do you make Tier 2/3 suppliers aware of your requirements? What influence do you have in the selection of Tier 3 suppliers? Do you identify locations for the Tier 2/3 suppliers? Do you get support from developers in identifying capable local companies? | |
| Subject Area 3 | Internal Criteria for Evaluating Suppliers |

| | |
|---|---|
| How would you describe your process for evaluating Tier 2 suppliers? Is part of the process looking at their supply chain network? How do you look to overcome the risks associated with sub-contracting new suppliers? How important is proximity to a project? | |
| Subject Area 4 | Key challenges to obtaining high local content |
| Where do you expect local content to come from on your contracts? What are the barriers to you delivering supply locally? Are the local content requirements made clear to the Tier 2s? As you look to multiple projects, how does this change? | |
| Subject Area 5 | Supplier Engagement |
| What is your timeline for engagement with Tier 2 suppliers as part of bidding for contacts and award of sub-contracts? What is your process for engagement? How do you work to develop relationships with new suppliers? | |
| Subject Area 6 | Understanding impact of PLAs on supply chain and local content metrics/KPIs |
| How are project labor agreements impacting the contracting of Tier 2 packages? Is the local supply chains understanding of skilled labor and unions a key influence in contracting success factors? Are you involved in the negotiations of PLAs? | |
| Subject Area 7 | Strengths of Local Supply Chain |

Rate each of the following in terms of strength of the Hampton Roads supply chain

(1 - Poor, 5 - Excellent):

1. Available skilled labor
2. Engineering and Environmental Services
3. Operations and Maintenance
4. Offshore Construction
5. Ports
6. Raw material supply (secondary steel)
7. Research and development
8. WTG and WTG component supply (inclusive of WTG towers)
9. Electrical infrastructure supply (onshore and offshore substation)
10. Cables (Export cables and Inter Array Cables, including ancillaries.)

How would you rate the strength of the existing OSW supply chain eco-system in Virginia and specifically Hampton Roads? (1 - Poor, 5 - Excellent) Why?

Where do you believe Hampton Roads ranks in comparison to neighboring states in regard to strength and depth of the OSW supply chain?
1. MD
2. NJ
3. NY
4. CT
5. RI

6. MA

How does your rating of these change if considering the wider Virginia supply chain?

| Subject Area 8 | Where should Virginia be focusing effort/investment etc. |
|---|---|

Rate in order of importance
1. Supply Chain Development - Ensuring supply chain are technically competent.
2. Local Incentives (i.e tax relief, grants etc.)
3. Physical Asset and Improvement Plans (i.e port infrastructure, jones act compliant vessels)
4. Workforce Training and Education (GWO certification for example)
5. Communicating the Available Supply Chain
6. Other (Suggestions)

# Appendix B SUPPLY ELEMENT MAPPING

## Project Development

The project development category includes the services contracted prior to the Developer reaching final investment decision (FID). This includes surveys and studies required to inform wind farm project and component design, as well as to obtain necessary planning consents. The BNOW Supply Chain Connect Directory competencies, with some applicability to each of the elements within the project development category, are given in Table 23.

*Table 23 Project Development Competency Tracker*

| Area | Element | Industry Sector | Competency |
|---|---|---|---|
| Project Development | Development and Permitting | Marine Services | Land for O&M |
| | | | Land for Prospective Manufacturers |
| | | Consultant / Service Provider | Site and Permit Consulting |
| | | | Environmental Consulting |
| | | | Marine Acoustic Analysis / Permitting |
| | | | Permit Processing |
| | | | Land for O&M |
| | | | Land for Prospective Manufacturers |
| | Surveys | Consultant / Service Provider | Surveying - Environmental |
| | | | Marine Acoustic Analysis / Permitting |
| | | | Ocean Soil / Core Testing |
| | | | Surveying - Ornithology & Marine Mammals |
| | | | Meteorological Testing |
| | | | Surveying - Subsea |
| | | | Geological / Geotechnical |
| | | Manufacturer | Photographic Services |
| | Engineering & Design | Consultant / Service Provider | Marine Engineering |
| | | | Engineering - Environmental |
| | | | Engineering - Civil |
| | | | Computer / IT / Telecom / Security Consulting |
| | | | Engineering - Foundation |
| | | | GIS Support |
| | | | Health & Safety Consulting |
| | | Construction | Engineering - Civil |
| | | Undefined | Engineering - Foundation |
| | Project Management | Marine Services | Project Management |
| | | | Insurance |

| | | | |
|---|---|---|---|
| | | Consultant / Service Provider | Project Management |
| | | | Evaluation & Optimizing of Energy Systems |
| | | | Computer / IT / Telecom / Security Consulting |
| | | | Risk Evaluation / Management |
| | | | Event Organizer / Media |
| | | | Public Relations / Advertising / Market Research |
| | | | Information / Public Relations Materials / Equipment Management - Construction |
| | | | Transportation Consulting |
| | | | Insurance |
| | | Manufacturer | Project Management |
| | | | Stakeholder Engagement |
| | | | Event Organizer / Media |
| | | | Public Relations / Advertising / Market Research |
| | | | Welding by Certified Personnel |
| | | Construction | Project Management |
| | | Undefined | Insurance |
| | | | Project Management |
| | | Insurance | Insurance |

## Wind Turbine Supply

The wind turbine supply category includes general components of the WTG supply contract. The assembly of the WTG is carried out by the WTG OEM with the rotor, nacelle, and electrical systems elements broad terms for a number of Tier 2 supply packages. The BNOW Supply Chain Connect Directory competencies applicable to each of the elements within the wind turbine supply category are given in Table 24.

Supply areas not covered in the directory relevant to wind turbine supply includes bearings and gearboxes (and components). While supply of specialist sub-elements such as pitch systems, yaw systems, power take-off systems, and control systems may be classified as mechanical and electrical components, companies supplying in these areas may lack the specialist knowledge required to manufacture components for OSW turbines.

*Table 24 Wind Turbine Supply Competency Tracker*

| Area | Element | Industry Sector | Competency |
|---|---|---|---|
| Wind Turbine Supply | Rotor | Manufacturer | Forges, Rolled Ring, Machined & Hardened |
| | | | Steel Manufacturer |
| | | | Machining (Lathe / Milling / Drilling) |
| | Nacelle | Marine Services | Lubricants / Seals |
| | | | Welding by Certified Personnel |
| | | | Weld Inspection |
| | | | Lubricants / Seals |

| | | | |
|---|---|---|---|
| | | Consultant / Service Provider | Welding by Certified Personnel |
| | | | Weld Inspection |
| | | | Various Iron / Metal Services |
| | | | Welding by Certified Personnel |
| | | | Steel Fabrication / Inspection |
| | | | Lubricants / Seals |
| | | | Installation / Maintenance of Fire Fighting Equipment & Systems |
| | | | Fire / Gas Detection / Protection Systems |
| | | | Low-Voltage Motors & Accessories |
| | | | Firefighting |
| | Tower | Marine Services | Welding by Certified Personnel |
| | | | Weld Inspection |
| | | Consultant / Service Provider | Various Iron / Metal Services |
| | | | Welding by Certified Personnel |
| | | | Steel Fabrication / Inspection |
| | | | Installation / Maintenance of Fire Fighting Equipment & Systems |
| | | | Fire / Gas Detection / Protection Systems |
| | | | Firefighting |
| | | Manufacturer | Welding by Certified Personnel |
| | | | Forges, Rolled Ring, Machined & Hardened |
| | | | Steel Manufacturer |
| | | | Steel / Metal Pipes / Accessories |
| | | | Primers / Coatings / Paints |
| | | | Towers and Accessories |
| | | | Large SG Iron or Fabricated Steel Structure |
| | | | Hatches & Accessories |
| | | | Machining (Lathe / Milling / Drilling) |
| | | Installation / Logistics | Welding Equipment / Consumables |
| | | Construction | Towers and Accessories |
| | | Undefined | Weld Inspection |
| | | | Welding by Certified Personnel |

## Balance of Plant Supply

The balance of plant supply category includes the remaining components of an OSW project beyond the supply of the WTG. These elements are typically Tier 1 packages. The BNOW Supply Chain Connect Directory competencies applicable to each of the elements within the balance of plant supply category are given in Table 25.

Supply areas not covered in the directory relevant to balance of plant supply includes scour protection and davit cranes. While supply of specialist sub-elements such as switchgear, converters and power compensators may be classified as electrical components, companies supplying in these areas may lack the specialist knowledge required to manufacture components for OSW substations.

*Table 25 Balance of Plant Supply Competency Tracker*

| Area | Element | Industry Sector | Competency |
|---|---|---|---|
| Balance of Plant Supply | Export Cables | Consulting / Service Provider | Marine & Underground Cable Systems |
| | | | Cable Protection |
| | | | Cable / Line Joints / Fittings (High & Low Voltage) |
| | | | Subsea Cables (High & Low Voltage) |
| | | | Underground Cables (High & Low Voltage) |
| | | | Laying / Maintenance of Underground Cables & Accessories |
| | | | Laying / Maintenance of Subsea Cables & Accessories |
| | | | Laying & Maintenance of Telecommunication Cables & Accessories |
| | | | Marine & Underground Cable Systems |
| | Array Cables | Consulting / Service Provider | Marine & Underground Cable Systems |
| | | | Cable Protection |
| | | | Cable / Line Joints / Fittings (High & Low Voltage) |
| | | | Subsea Cables (High & Low Voltage) |
| | | | Laying / Maintenance of Subsea Cables & Accessories |
| | | | Laying & Maintenance of Telecommunication Cables & Accessories |
| | | | Marine & Underground Cable Systems |
| | Offshore Substation | Marine Services | Welding by Certified Personnel |
| | | | Weld Inspection |
| | | Consultant / Service Provider | Various Iron / Metal Services |
| | | | Welding by Certified Personnel |
| | | | Steel Fabrication / Inspection |
| | | | Installation / Maintenance of Fire Fighting Equipment & Systems |
| | | | Fire / Gas Detection / Protection Systems |
| | | | Cable / Line Joints / Fittings (High & Low Voltage) |
| | | | Firefighting |
| | | Manufacturer | Welding by Certified Personnel |
| | | | Forges, Rolled Ring, Machined & Hardened |
| | | | Steel Manufacturer |
| | | | Steel / Metal Pipes / Accessories |
| | | | Primers / Coatings / Paints |
| | | | Large SG Iron or Fabricated Steel Structure |
| | | | Hatches & Accessories |
| | | | Steel Work for Offshore Substation |
| | | | Obstruction Light Control / Obstruction LED Solutions |

| | | | |
|---|---|---|---|
| | | | Safety Valves / Relief Valves / Bursting Discs & Accessories |
| | | | Signal Cables / Computer & Communication Cables |
| | | | Machining (Lathe / Milling / Drilling) |
| | | | Axial Compressors & Accessories |
| | | | Pumps & Accessories |
| | | Installation / Logistics | Welding Equipment / Consumables |
| | | | Valves & Accessories |
| | | | Compressors & Accessories |
| | | Construction | Gaskets / Pipe Insulation Materials |
| | | | Primers / Coatings / Paints |
| | | | Powder Coating |
| | | | Anti-Corrosion Products |
| | | Operations & Maintenance | Synchronoscopes |
| | | Undefined | Weld Inspection |
| | | | Welding by Certified Personnel |
| | | | Hoses & Accessories |
| | | | Gaskets / Pipe Insulation Materials |
| | | | Other Pipes / Hoses / Filters / Gaskets & Accessories |
| | | | Filters / Strainers & Accessories |
| | | | Hangers / Fastenings for Pipes / Hoses |
| | | | Non-Metal Flanges & Other Non-Metal Pipe Accessories |
| | | | Steel / Metal Flanges / other Non-Metal Pipes |
| | | | Steel Work for Offshore Substation |
| | Onshore Substation | Manufacturer | Cement / Concrete |
| | | Installation / Logistics | Cement / Concrete |
| | | Construction | Cement / Concrete |
| | | | Underground Cables (High & Low Voltage) |
| | | | Power Transformers & Accessories |
| | | | Upland Cable & Substation |
| | | Operations & Maintenance | Synchronoscopes |
| | | Undefined | Heavy, Dense Magnetite Concrete for Ballast or Offshore Base Structures |
| | Foundations | Marine Services | Towing - Barge / Foundation |
| | | | Welding by Certified Personnel |
| | | | Weld Inspection |
| | | Consultant / Service Provider | Engineering - Foundation |
| | | | Foundations |
| | | | Various Iron / Metal Services |
| | | | Welding by Certified Personnel |

| | | | |
|---|---|---|---|
| | | | Installation - Foundation |
| | | | Steel Fabrication / Inspection |
| | | Manufacturer | Welding by Certified Personnel |
| | | | Forges, Rolled Ring, Machined & Hardened |
| | | | Steel Manufacturer |
| | | | Steel / Metal Pipes / Accessories |
| | | | Primers / Coatings / Paints |
| | | | Cement / Concrete |
| | | | Large SG Iron or Fabricated Steel Structure |
| | | | Foundations |
| | | | Transition Pieces |
| | | | Hatches & Accessories |
| | | | Obstruction Light Control / Obstruction LED Solutions |
| | | | Machining (Lathe / Milling / Drilling) |
| | | | Pumps & Accessories |
| | | Installation / Logistics | Welding Equipment / Consumables |
| | | | Cement / Concrete |
| | | Construction | Cement / Concrete |
| | | | Primers / Coatings / Paints |
| | | | Powder Coating |
| | | | Anti-Corrosion Products |
| | | Operations & Maintenance | Vibration Meters |
| | | Labor / Staffing | Foundations |
| | | Undefined | Engineering - Foundation |
| | | | Foundations |
| | | | Heavy, Dense Magnetite Concrete for Ballast or Offshore Base Structures |
| | | | Weld Inspection |
| | | | Welding by Certified Personnel |
| | | | Steel / Metal Flanges / other Non-Metal Pipes |

## Installation & Commissioning

The installation and commissioning category includes the services contracted to construct an OSW project. These elements can be Tier 1 or Tier 2 packages, with the exception of ports contracts which are typically Tier 2 or Tier 3. The BNOW Supply Chain Connect Directory competencies applicable to each of the elements within the installation and commissioning category are given in Table 26.

*Table 26 Installation & Commissioning Competency Tracker*

| Area | Element | Industry Sector | Competency |
|---|---|---|---|
| Installation & Commissioning | Turbine Installation | Marine Services | Power and Fuels |
| | | Consultant / Service Provider | Power and Fuels |
| | | Manufacturer | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Lifevests / Flotation Devices |
| | | | Working Clothes / Gloves / Safety Boots |
| | | | Installation / Maintenance of Rotating Electrical Machines |
| | | | Power and Fuels |
| | | Installation / Logistics | Tackles / Winches / Lifting |
| | | Labor / Staffing | Installation / Maintenance of Electrical Systems |
| | Foundation Installation | Consultant / Service Provider | Installation - Foundation |
| | | Manufacturer | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Lifevests / Flotation Devices |
| | | | Working Clothes / Gloves / Safety Boots |
| | | Installation / Logistics | Tackles / Winches / Lifting |
| | | Undefined | Towing - Barge / Foundation |
| | Subsea Cable Installation | Consultant / Service Provider | Laying / Maintenance of Subsea Cables & Accessories |
| | | | Marine & Underground Cable Systems |
| | | | Cables & Pipeline Trenches Construction Works<br>Cable Protection<br>Laying / Maintenance of Subsea Cables & Accessories |
| | | | Laying & Maintenance of Telecommunication Cables & Accessories |
| | | Manufacturer | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Lifevests / Flotation Devices |
| | | | Working Clothes / Gloves / Safety Boots |
| | | Installation / Logistics | Tackles / Winches / Lifting |

| | | | |
|---|---|---|---|
| | Offshore Substation Installation | Manufacturer | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Lifevests / Flotation Devices |
| | | | Working Clothes / Gloves / Safety Boots |
| | | | Installation of Power Transformers & Accessories |
| | | Installation / Logistics | Tackles / Winches / Lifting |
| | | Labor / Staffing | Installation / Maintenance of Electrical Systems |
| | Onshore Construction | Marine Services | Cranes / Lifts / Marine Cranes |
| | | | Land for O&M |
| | | Consultant / Service Provider | Land for O&M |
| | | | General Building / Offices |
| | | | Other Building and Construction Works |
| | | | Management - Construction |
| | | | Laying / Maintenance of Underground Cables & Accessories |
| | | | Marine & Underground Cable Systems |
| | | | Cables & Pipeline Trenches Construction Works |
| | | Installation / Logistics | Cranes / Lifts / Marine Cranes |
| | | Construction | Underground Cables (High & Low Voltage) |
| | | | Fuel Handling Systems & Accessories |
| | | | Street Lighting Equipment |
| | | | Installation Cables / Conductors |
| | | | Upland Cable & Substation |
| | | Undefined | Other Building and Construction Maintenance |
| | | | Rental of Cranes / Special Vehicles |
| | | | Road Works/ Maintenance / Snow Clearing |
| | | | Rock Drilling / Blasting |
| | Ports and Logistics | Marine Services | Coastal & Marine Spatial Planning |
| | | | Ports and Harbors Infrastructure Analysis |
| | | | Cranes / Lifts / Marine Cranes |
| | | | Marine Cargo Services |
| | | | Sea Transport |
| | | | Lay Down / Marshalling Area |
| | | | Power and Fuels |
| | | | Ship Repair |
| | | | O&M Vessel Operation |
| | | | Marine Support / Logistics |
| | | | Freight Forwarding / Custom Clearence / Logistics |
| | | | Supply Chain Logistics |

| | | |
|---|---|---|
| | | Port Agent |
| | | Air Transport |
| | | Containers / Carriages / Trailers |
| | | Vessels / Barges / Boats / Tugs |
| | | Other Transport & Material Handling Equipment |
| | | Towing - Barge / Foundation |
| | | Wires / Ropes / Chains / Straps & Associated Lifting Gear |
| | | Marine Construction |
| | Consultant / Service Provider | Ports and Harbors Infrastructure Analysis |
| | | Harbor Dredging |
| | | Lay Down / Marshalling Area |
| | | Supply Chain Logistics |
| | | Freight Forwarding / Custom Clearence / Logistics |
| | | Sea Transport |
| | | Air Transport |
| | | Road / Railroad Transport |
| | | Marine Cargo Services |
| | | Ship Repair |
| | | Marine Support / Logistics |
| | | Vessels / Barges / Boats / Tugs |
| | | Vessel Inspection |
| | | Power and Fuels |
| | | Rental of Cranes / Special Vehicles |
| | | Diesel Fuel / Supplies / Gasoline |
| | Manufacturer | Jack Up Barge Fabrication |
| | | Ship Repair |
| | | Marine Construction |
| | | Power and Fuels |
| | Installation / Logistics | Transport & Material Handling Equipment |
| | | Rental of Cranes / Special Vehicles |
| | | Cranes / Lifts / Marine Cranes |
| | | Tackles / Winches / Lifting |
| | Vessel Builder / Owner / Operator | Vessels / Barges / Boats / Tugs |
| | | O&M Vessel Operation |
| | | Vessel Inspection |
| | Transportation | Supply Chain Logistics |
| | | Sea Transport |
| | Other Association | Ports and Harbors Infrastructure Analysis |
| | Tier 1 Supplier | Vessels / Barges / Boats / Tugs |
| | Undefined | Towing - Barge / Foundation |
| | | Rental of Cranes / Special Vehicles |
| | | Ship Repair |

## Operations & Maintenance

The operation and maintenance category includes the services contracted to support the continuing operation of an OSW project. Turbine inspection and maintenance is typically carried out by the WTG OEM for at least the first five years of operation with services sub-contracted by them. Other operations, inspections and maintenance services are typically contracted by the project owner. The BNOW Supply Chain Connect Directory competencies applicable to each of the elements within the operation and maintenance category are given in Table 27.

*Table 27 Operations & Maintenance Competency Tracker*

| Area | Element | Industry Sector | Competency |
|---|---|---|---|
| Operations & Maintenance | Operations | Marine Services | Ports and Harbors Infrastructure Analysis |
| | | | Marine Cargo Services |
| | | | Sea Transport |
| | | | Lay Down / Marshalling Area |
| | | | O&M Vessel Operation |
| | | | Marine Support / Logistics |
| | | | Freight Forwarding / Custom Clearence / Logistics |
| | | | Port Agent |
| | | | Containers / Carriages / Trailers |
| | | | Vessels / Barges / Boats / Tugs |
| | | | Other Transport & Material Handling Equipment |
| | | Consultant / Service Provider | Ports and Harbors Infrastructure Analysis |
| | | | Evaluation & Optimizing of Energy Systems |
| | | | Lay Down / Marshalling Area |
| | | | Vessels / Barges / Boats / Tugs |
| | | | Rental of Cranes / Special Vehicles |
| | | Vessel Builder/Owner/Operator | Vessels / Barges / Boats / Tugs |
| | | | O&M Vessel Operation |
| | | | Vessel Inspection |
| | | Other Association | Ports and Harbors Infrastructure Analysis |
| | | Tier 1 Supplier | Vessels / Barges / Boats / Tugs |
| | Turbine Inspection and Maintenance | Manufacturer | Installation / Maintenance of Rotating Electrical Machines |
| | | | Installation / Maintenance of Generators & Accessories |
| | | Installation / Logistics | Equipment Rental |
| | | Operations & Maintenance | Multimeters / Service Instruments |
| | | | Metering / Instrumentation Equipment |
| | | Labor / Staffing | Installation / Maintenance of Electrical Systems |
| | | Marine Services | Pumps & Accessories |
| | | | Welding by Certified Personnel |

| | | | |
|---|---|---|---|
| | BoP Inspection and Maintenance | | Weld Inspection |
| | | Consultant / Service Provider | Maintenance of Security Equipment & Systems |
| | | | Laying / Maintenance of Underground Cables & Accessories |
| | | | Laying / Maintenance of Subsea Cables & Accessories |
| | | | Welding by Certified Personnel |
| | | | Steel Fabrication / Inspection |
| | | | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Life vests / Flotation Devices |
| | | | Installation / Maintenance of Pumps & Compressors |
| | | | Installation / Maintenance of Fire Fighting Equipment & Systems |
| | | Manufacturer | Photographic Services |
| | | | Welding by Certified Personnel |
| | | | Diving |
| | | | Personal Safety Equipment / Survival Suits / Personal Locator Beacon / Life vests / Flotation Devices |
| | | | Working Clothes / Gloves / Safety Boots |
| | | | Ear Defenders / Safety Eyewear |
| | | | Installation / Maintenance of Generators & Accessories |
| | | Installation / Logistics | Equipment Rental |
| | | | Welding Equipment / Consumables |
| | | Operations & Maintenance | Multimeters / Service Instruments |
| | | | Metering / Instrumentation Equipment |
| | | Labor / Staffing | Installation / Maintenance of Electrical Systems |
| | | Undefined | Diving |
| | | | Weld Inspection |
| | | | Welding by Certified Personnel |
| | | | Other Building and Construction Maintenance |

## Decommissioning

The decommissioning category would include the services contracted to remove, make safe or dispose of wind farm components at the end of project lifetime. The BNOW Supply Chain Connect Directory indicates that there are no companies in the Hampton Roads area with capabilities that would align with this sector. As outreach and marketing campaigns continue to attract new companies to list themselves within the database, this will likely change.

## Sector Support

The sector support category includes services that will benefit the development of the supply chain but that may not be contracted directly as the result of an OSW project. The BNOW Supply Chain Connect Directory competencies applicable to each of the elements within the sector support category are given in Table 28.

*Table 28 Sector Support Competency Tracker*

| Area | Element | Industry Sector | Competency |
|---|---|---|---|
| Sector Support | Educational Institution/ Training Provider | Marine Services | Education & Training |
| | | Consultant / Service Provider | Education & Training |
| | | Other Association | Education & Training |
| | | R&D / University / Institute | R&D / University / Institute |
| | | Labor / Staffing | Installation / Maintenance of Electrical Systems |
| | Government Agencies | Regulator/Policy Maker | Workforce Development |
| | | Marine Services | Coastal & Marine Spatial Planning |
| | | Consultant / Service Provider | Coastal & Marine Spatial Planning |
| | Trades, Labor and Workforce Organizations | Regulator/Policy Maker | Workforce Development |
| | | Consultant / Service Provider | Manpower Supply / Temporary Staff Hiring - Technical |
| | | | Manpower Supply / Temporary Staff Hiring - Administration |
| | | Labor / Staffing | Surface Treatment / Sandblasting |
| | | | Industrial Cleaning |
| | | | Other Installation / Mechanical / Maintenance Service |
| | | Undefined | Engineering - Foundation |
| | | | Foundations |
| | | | Manpower Supply / Temporary Staff Hiring - Technical |
| | | | Manpower Supply / Temporary Staff Hiring - Administration |

# Appendix C JOB ROLES IN OSW

## Project development job roles

*Table 29 Job Roles in Project Development Supply Chain Elements*

| Supply element | Job roles in supply of element | Job role category |
|---|---|---|
| Development and permitting | Environmental consultant | Scientist |
| | GIS analyst | Scientist |
| | Project manager | Manager |
| | Purchasing manager | Manager |
| | Contracts manager | Manager |
| | Finance manager | Manager |
| | HSE manager | Manager |
| Surveys | Marine ecologist | Scientist |
| | Ornithologist | Scientist |
| | Protected species observer (PSO) | Scientist |
| | Passive Acoustic Monitor (PAM) | Scientist |
| | Ecologist | Scientist |
| | Geologist | Scientist |
| | Environmental scientist | Scientist |
| | Field scientist | Scientist |
| | Data scientist | Scientist |
| | Aerial survey operator (pilot) | Skilled trade - Specialist |
| | Aerial survey technician | Skilled trade – Standard |
| | Data analyst | Skilled trade – Standard |
| | Master (Captain) | Skilled trade - Specialist |
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| | Site supervisor | Manager |
| | Production Manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Specialist |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |

| | | |
|---|---|---|
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Calibration technician | Skilled trade - Specialist |
| | Master (Captain) | Skilled trade - Specialist |
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| | Geotechnical engineer | Engineer |
| | Geophysicist | Scientist |
| | Hydrographer | Scientist |
| | Oceanographer | Scientist |
| | Environmental scientist | Scientist |
| | Data scientist | Scientist |
| | Data analyst | Skilled trade – Standard |
| | Master (Captain) | Skilled trade - Specialist |
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| Engineering and Design | Mechanical engineer | Engineer |
| | Electrical engineer | Engineer |
| | Process engineer | Engineer |
| | Structural engineer | Engineer |
| | Control engineer | Engineer |
| | Architect | University Degree |
| | Drafter (CAD technician) | Skilled trade - Standard |
| | Operations engineer | Engineer |
| | HSE manager | Manager |
| | Wind analyst | Scientist |
| | Reliability engineer | Engineer |
| Project Management | Project manager | Manager |
| | IT | Support staff |
| | HR | Support staff |
| | Document control | Support staff |
| | Sales and marketing | Support staff |
| | Administration | Support staff |
| | Recruitment | Support staff |

## Turbine supply job roles

*Table 30 Job Roles in Turbine Supply Chain Elements*

| Supply element | Job roles in supply of element | Job role category |
|---|---|---|
| Nacelle | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Skilled trade - Standard |
| | Production operative | Skilled trade - Standard |
| | Calibration technician | Skilled trade - Specialist |
| | Industrial electrician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Process Engineer | Engineer |
| | Controls Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |
| Rotor | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |

| | | |
|---|---|---|
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Production operative | Skilled trade – Standard |
| | Calibration technician | Skilled trade - Specialist |
| | Industrial electrician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Process Engineer | Engineer |
| | Controls Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |
| Tower | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Production operative | Skilled trade – Standard |
| | Structural Engineer | Engineer |
| | Process Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |

## Balance of plant supply job roles

*Table 31 Job Roles in Balance of Plant Supply Chain Elements*

| Supply element | Job roles in supply of element | Job role category |
|---|---|---|
| Foundation | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Production operative | Skilled trade – Standard |
| | Structural Engineer | Engineer |
| | Process Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |
| | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |

| | | |
|---|---|---|
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Production operative | Skilled trade – Standard |
| | Structural Engineer | Engineer |
| | Process Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |
| Offshore substation | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Production operative | Skilled trade – Standard |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Civil Engineer | Engineer |
| | Process Engineer | Engineer |
| | Controls Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |
| | HVAC technician | Skilled trade – Standard |
| | Elevator technician | Skilled trade – Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Plumber | Skilled trade - Standard |
| Onshore substation | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |

| | | |
|---|---|---|
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Protective coating technician | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Production operative | Skilled trade – Standard |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Civil Engineer | Engineer |
| | Process Engineer | Engineer |
| | Controls Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |
| | HVAC technician | Skilled trade – Standard |
| | Elevator technician | Skilled trade – Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Plumber | Skilled trade - Standard |
| Export cables | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Machine operator | Engineer |
| | Cable jointer | Skilled trade - Standard |
| | Cable test and termination engineer | Engineer |
| | Carousel and tensioner operator | Skilled trade – Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Protective coating technician | Skilled trade – Standard |

| | | |
|---|---|---|
| | Hoist and winch operator | Skilled trade - Standard |
| | Fibre optics technician | Skilled trade – Standard |
| | Electrical Engineer | Engineer |
| | Process Engineer | Engineer |
| | Controls Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |
| | Lineman | Skilled trade - Standard |
| Array cables | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Machine operator | Skilled trade - Standard |
| | Cable jointer | Skilled trade - Standard |
| | Cable test and termination engineer | Engineer |
| | Carousel and tensioner operator | Skilled trade – Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Protective coating technician | Skilled trade – Standard |
| | Hoist and winch operator | Skilled trade - Standard |
| | Drafter (CAD technician) | Skilled trade - Standard |
| | Fibre optics technician | Skilled trade – Standard |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Civil Engineer | Engineer |
| | Process Engineer | Engineer |
| Export cables | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | NDT technician | Skilled trade - Standard |
| | Machine operator | Skilled trade - Standard |
| | Cable jointer | Skilled trade - Standard |
| | Cable test and termination engineer | Engineer |

| | | |
|---|---|---|
| | Carousel and tensioner operator | Skilled trade – Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Protective coating technician | Skilled trade – Standard |
| | Hoist and winch operator | Skilled trade - Standard |
| | Fibre optics technician | Skilled trade – Standard |
| | Electrical Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Civil Engineer | Engineer |
| | Process Engineer | Engineer |
| | Controls Engineer | Engineer |
| | Drafter (CAD technician) | Skilled trade - Standard |

## Installation job roles

*Table 32 Job Roles in Installation and Commissioning Supply Chain Elements*

| Supply element | Job roles in supply of element | Job role category |
|---|---|---|
| Foundation installation | Master (Captain) | Skilled trade - Specialist |
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| | Cook | Skilled trade - Standard |
| | Sanitation services provider | Non-skilled labor |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | HSE supervisor | Skilled trade - Standard |
| | Elevator technician | Skilled trade – Standard |
| | Plumber | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Certification Engineer | Engineer |
| | ROV operator | Skilled trade - Specialist |
| | ROV technician | Skilled trade - Standard |
| | ROV vessel crew | Skilled trade - Standard |
| Offshore substation installation | Master (Captain) | Skilled trade - Specialist |

| | | |
|---|---|---|
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| | Cook | Skilled trade - Standard |
| | Sanitation services provider | Non-skilled labor |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | HSE supervisor | Skilled trade - Standard |
| | Hoist and winch operator | Skilled trade - Standard |
| | Elevator technician | Skilled trade – Standard |
| | Plumber | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Civil Engineer | Engineer |
| | Controls Engineer | Skilled trade - Standard |
| | Certification Engineer | Skilled trade - Standard |
| | Calibration technician | Skilled trade - Specialist |
| | ROV operator | Skilled trade - Specialist |
| | ROV technician | Skilled trade - Standard |
| | ROV vessel crew | Skilled trade - Standard |
| | HVAC technician | Skilled trade – Standard |
| Subsea cable installation | Master (Captain) | Skilled trade - Specialist |
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| | Cook | Skilled trade - Standard |
| | Sanitation services provider | Non-skilled labor |
| | Crane operator | Skilled trade - Standard |
| | HSE supervisor | Manager |
| | Elevator technician | Skilled trade – Standard |
| | Plumber | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Certification Engineer | Skilled trade - Standard |
| | Calibration technician | Skilled trade - Specialist |
| | ROV operator | Skilled trade - Specialist |
| | ROV technician | Skilled trade - Standard |

| | | |
|---|---|---|
| | ROV vessel crew | Skilled trade - Standard |
| | Machine operator | Skilled trade - Standard |
| | Cable jointer | Skilled trade – Standard |
| | Cable test and termination engineer | Engineer |
| | Carousel and tensioner operator | Skilled trade – Standard |
| | Fibre optics technician | Skilled trade – Standard |
| Turbine installation | Master (Captain) | Skilled trade - Specialist |
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| | Cook | Skilled trade - Standard |
| | Sanitation services provider | Non-skilled labor |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | HSE supervisor | Manager |
| | Hoist and winch operator | Skilled trade - Standard |
| | Elevator technician | Skilled trade - Standard |
| | Plumber | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Civil Engineer | Engineer |
| | Process Engineer | Skilled trade - Standard |
| | Controls Engineer | Skilled trade - Standard |
| | Certification Engineer | Skilled trade - Specialist |
| | Wind turbine technician | Skilled trade - Specialist |
| Ports and logistics | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | Port engineer | Skilled trade - Standard |
| | Captain of the port | Skilled trade - Specialist |
| | Stevedore/longshoreman | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Warehouse manager | Skilled trade - Specialist |
| | Fuel bunkering | Skilled trade – Standard |
| | Operations Manager | Manager |

| | | |
|---|---|---|
| | Security Guard | Non-skilled labor |
| | Painter | Non-skilled labor |
| | Sandblaster | Non-skilled labor |
| | Welder | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Construction manager | Manager |
| | Laborer | Non-skilled labor |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | Marine warranty surveyor | University Degree |
| | Master (Captain) | Skilled trade - Specialist |
| | Deck Officer | Skilled trade - Standard |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Specialist |
| | Cook | Skilled trade - Specialist |
| | Sanitation services provider | Non-skilled labor |
| | Diver | Skilled trade - Specialist |
| | ROV operator | Skilled trade - Specialist |
| | ROV technician | Skilled trade - Standard |
| | ROV vessel crew | Skilled trade - Standard |
| | Protected species observer (PSO) | Scientist |
| | Passive Acoustic Monitor (PAM) | Scientist |
| | AUV Operator | Skilled trade - Specialist |
| | Data analsyt | Skilled trade – Standard |
| | Embedded systems engineer | Engineer |
| | Software engineer | Engineer |
| | Meterologist | Scientist |
| Onshore construction | Site supervisor | Manager |
| | Construction manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Manager |
| | Crane operator | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Operations Manager | Manager |
| | Laborer | Non-skilled labor |
| | Sanitation services provider | Non-skilled labor |
| | Architect | University Degree |

| | | |
|---|---|---|
| | Civil engineer | Engineer |
| | Structural engineer | Engineer |
| | Electrical engineer | Engineer |
| | Mechanical engineer | Engineer |
| | Plumber | Skilled trade - Standard |

## Operations and maintenance job roles

*Table 33 Job Roles in Operations and Maintenance Supply Chain Elements*

| Supply element | Job roles in supply of element | Job role category |
|---|---|---|
| Operations | Software engineer | Engineer |
| | Embedded systems engineer | Engineer |
| | IT technician | Skilled trade – Standard |
| | Data analyst | Skilled trade – Standard |
| | Operations Manager | Manager |
| | HSE supervisor | Manager |
| | Training instructor | Skilled trade - Standard |
| | HSE supervisor | Manager |
| | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | Marine warranty surveyor | University Degree |
| | Port engineer | Skilled trade - Standard |
| | Captain of the port | Skilled trade - Specialist |
| | Stevedore/longshoreman | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Warehouse manager | Manager |
| | Fuel bunkering | Skilled trade – Standard |
| | Operations Manager | Manager |
| | Security Guard | Non-skilled labor |
| | Painter | Non-skilled labor |
| | Sandblaster | Non-skilled labor |
| | Welder | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |

| | | |
|---|---|---|
| | Construction manager | Manager |
| | Laborer | Non-skilled labor |
| | Sanitation services provider | Non-skilled labor |
| | Pilot | Skilled trade - Specialist |
| | Helicopter repair technician | Skilled trade - Specialist |
| | Fueling service | Non-skilled labor |
| | Ground control | Skilled trade – Standard |
| | Emergency response personnel | Skilled trade – Standard |
| Turbine maintenance and service | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | Master (Captain) | Skilled trade - Standard |
| | Deck Officer | Skilled trade - Specialist |
| | Deck Cadet | Skilled trade - Standard |
| | Marine Engineer | Skilled trade - Standard |
| | Cook | Skilled trade - Specialist |
| | Sanitation services provider | Non-skilled labor |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Hoist and winch operator | Skilled trade - Standard |
| | Elevator technician | Skilled trade - Standard |
| | Plumber | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | HVAC technician | Skilled trade – Standard |
| | Calibration technician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Controls Engineer | Engineer |
| | Certification Engineer | Engineer |
| | NDT technician | Skilled trade - Standard |
| | Protective coating technician | Skilled trade – Standard |
| | Rope access technician | Skilled trade - Specialist |
| | Wind turbine technician | Skilled trade - Specialist |
| Balance of plant maintenance and service | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Skilled trade - Specialist |
| | HVAC technician | Skilled trade - Standard |
| | Elevator technician | Skilled trade – Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Plumber | Skilled trade - Standard |

| | | |
|---|---|---|
| | Calibration technician | Skilled trade - Specialist |
| | Mechanical Engineer | Engineer |
| | Structural Engineer | Engineer |
| | Electrical Engineer | Engineer |
| | Geotechnical Engineer | Engineer |
| | Civil Engineer | Engineer |
| | Process Engineer | Engineer |
| | Controls Engineer | Engineer |
| | NDT technician | Skilled trade - Standard |
| | Plater | Skilled trade - Standard |
| | Welder | Skilled trade - Standard |
| | Ironworker | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Rigger | Skilled trade - Standard |
| | Scaffolder | Skilled trade - Standard |
| | Laborer | Non-skilled labor |
| | Protective coating technician | Skilled trade – Standard |
| | Cable jointer | Skilled trade - Standard |
| | Cable test and termination engineer | Engineer |
| | Carousel and tensioner operator | Skilled trade – Standard |
| | Fibre optics technician | Skilled trade – Standard |
| | Diver | Skilled trade - Specialist |
| | ROV operator | Skilled trade - Specialist |
| | ROV technician | Skilled trade - Standard |
| | ROV vessel crew | Skilled trade - Standard |

## Port development job roles

*Table 34 Job Roles in Port Development Supply Chain Element*

| Supply element | Job roles in supply of element | Job role category |
|---|---|---|
| Port development | Site supervisor | Manager |
| | Production manager | Manager |
| | HSE supervisor | Manager |
| | Logistics coordinator | Manager |
| | Purchasing manager | Manager |
| | QC inspector | Manager |
| | Port engineer | Skilled trade - Specialist |

| | | |
|---|---|---|
| | Captain of the port | Skilled trade - Specialist |
| | Stevedore/longshoreman | Skilled trade - Standard |
| | Crane operator | Skilled trade - Standard |
| | Heavy equipment operator | Skilled trade - Standard |
| | Industrial electrician | Skilled trade - Specialist |
| | Warehouse manager | Skilled trade - Standard |
| | Fuel bunkering | Skilled trade – Standard |
| | Operations Manager | Manager |
| | Security Guard | Non-skilled labor |
| | Painter | Non-skilled labor |
| | Sandblaster | Non-skilled labor |
| | Welder | Skilled trade - Standard |
| | Machinist | Skilled trade - Standard |
| | Millwright | Skilled trade - Standard |
| | Construction manager | Manager |
| | Laborer | Non-skilled labor |
| | Sanitation services provider | Non-skilled labor |
| | Architect | University Degree |
| | Naval architect | University Degree |
| | Civil engineer | Engineer |
| | Structural engineer | Engineer |
| | Electrical engineer | Engineer |
| | Mechanical engineer | Engineer |
| | HVAC technician | Skilled trade – Standard |
| | Plumber | Skilled trade - Standard |

## Indirect and induced industries

*Table 35 Sectors Represented in Indirect and Induced Job Roles*

| Supply element | Sectors in supply of element | Job role category |
|---|---|---|
| Indirect and induced job roles | Accommodation | Support staff |
| | Real Estate | Support staff |
| | Laundry Services | Support staff |
| | Restaurant | Support staff |
| | Catering | Support staff |
| | Transportation | Support staff |
| | Recruitment Services | Support staff |
| | Vehicle Rental Agency | Support staff |
| | Health and emergency services | Support staff |

# Appendix D COMPANIES WITHIN EACH TAXONOMY SECTOR

*Development & Consenting*

McNeilan & Associates

Waterway Surveys & Engineering, Ltd.

Ecology and Environment, Inc.

Virginia Beach Economic Development

Stantec

Moffatt & Nichol

Cardno, Inc.

PER Properties

Seagate Terminals, LLC

City of Newport News

City of Norfolk, Department of Economic Development

Nansemond International

ABS Group, Inc.

Froehling & Robertson, Inc.

Accurate Marine Environmental LLC

Burns & McDonnell

*Surveys*

Fugro Marine GeoServices, Inc.

Waterway Surveys & Engineering, Ltd.

Ecology and Environment, Inc.

McNeilan & Associates

Cardno, Inc.

Stantec

O'Brien et al. Advertising

Froehling & Robertson, Inc.

Advanced Aircraft Company

*Engineering & Design*

Waterway Surveys & Engineering, Ltd.

McNeilan & Associates

Cardno, Inc.

Fugro Marine GeoServices, Inc.

G2 Ops, Inc.

Angels Instrumentation a Transcat Company

Kyanite Mining Corp.

ECS Mid-Atlantic, LLC

DLBA Naval Architects - Division of Gibbs & Cox

MBM Consultancy

Froehling & Robertson, Inc.

MI Technical Solutions, Inc.

ABS Group, Inc.

Blue Water Shipping

Bryant Structures, Inc.

Burns & McDonnell

Crofton Industries

Honor Builders

*Rotor*

Threat System Solutions

Fairlead Integrated, LLC

Collins Machine Works

Anchor Sandblasting and Coatings

Artcraft Fabricators, Inc. T/A Collins Machine Works

Bay Metals & Fabrication, LLC

Dishman Fabrications & Powder Coating, LLC

HyVal Industries, Inc.

Marcom Services, LLC

Marine Hydraulics International, LLC

Stanley Black & Decker

Wilson Pipe & Fabrication llc

*Project Management*

Western Branch Diesel, Inc.

Clark Nexsen

General Dynamics NASSCO-Norfolk

Kinder Morgan  Bulk Terminals, Inc.

Seaward Marine Corporation

On Point, LLC

Hiller Systems

American Bureau of Shipping (ABS)

McNeilan & Associates

Moffatt & Nichol

Ecology and Environment, Inc.

Cardno, Inc.

Stantec

Lyon Shipyard

BAE Systems Ship Repair

Q.E.D. Systems Inc

Colonna's Shipyard dba Weld America

Compass Insurance Solutions/Compass Marine Group

Expeditors International of Washington, Inc.

London & Norfolk Ltd

G2 Ops, Inc.

Angels Instrumentation a Transcat Company

Rubin Communications Group

Goldman & Associates Public Relations

Livingston International

O'Brien et al. Advertising

Clancy & Theys Construction Company

MI Technical Solutions, Inc.

ABS Group, Inc.

Hampton Roads Alliance

City of Newport News

City of Norfolk, Department of Economic Development

Vandeventer Black LLP

Atlantic Union Bank

Axcel

BB&T now Truist

Bryant Structures, Inc.

Crofton Industries

Drucker and Falk

Great Lakes Dredge & Dock

Hamilton Consulting Solutions Corp (HCSC)

L3Harris

Local Initiative Support Corporation (LISC) Hampton Roads

MI Technical Solutions

SimIS Inc.

The Urban League of Hampton Roads

Training Modernization Group, Inc.

TS3 Architects PC

VHB

Honor Builders

*Nacelle*

Anders Williams Ship Agency / Marine Oil Service

Marine Oil Service, Inc.

Auxiliary Systems, Inc.

Western Branch Diesel, Inc.

Bay Container Services, Inc.

McDonough Marine Service

Weld America

Craft Machine Works

Collins Machine Works

Threat System Solutions

Colonna's Shipyard dba Weld America

Hiller Systems

Hiller Systems (Fire)

Jo-Kell Inc

Steel America

Volvo Penta

Bay Diesel and Generator Corporation

Fairlead Integrated, LLC

Atlantic Lift Systems

MID-ATLANTIC ABV, INC

Froehling & Robertson, Inc.

Vansant Gusler

Anchor Sandblasting and Coatings

Artcraft Fabricators, Inc. T/A Collins Machine Works

Bay Metals & Fabrication, LLC

Dishman Fabrications & Powder Coating, LLC

HyVal Industries, Inc.

Marcom Services, LLC

Marine Hydraulics International, LLC

Stanley Black & Decker

Wilson Pipe & Fabrication llc

*Electrical & Auxilary Systems*

Jo-Kell Inc

Total Quality Assembly

Bay Metals & Fabrication, LLC

Marine Hydraulics International, LLC

L.E. Myers Company

*Tower*

Hiller Systems

Threat System Solutions

B&B Hose and Rubber Co.

Thermal Spray Solutions, Inc.

Marine Specialty Painting INC

Steel America

Hudgins Contracting Corporation, LLC

Fairlead Integrated, LLC

Collins Machine Works

Atlantic Lift Systems

Bay Container Services, Inc.

McDonough Marine Service

Auxiliary Systems, Inc.

Weld America

Craft Machine Works

Froehling & Robertson, Inc.

Vansant Gusler

TST Fabrications LLC

Anchor Sandblasting and Coatings

Artcraft Fabricators, Inc. T/A Collins Machine Works

Bay Metals & Fabrication, LLC

Dishman Fabrications & Powder Coating, LLC

HyVal Industries, Inc.

Marcom Services, LLC

Marine Hydraulics International, LLC

Stanley Black & Decker

Wilson Pipe & Fabrication llc

| *Export Cables* | *Array Cables* |
| --- | --- |
| Fugro Marine GeoServices, Inc. | Fugro Marine GeoServices, Inc. |
| Angels Instrumentation a Transcat Company | Angels Instrumentation a Transcat Company |
| Jo-Kell Inc | Jo-Kell Inc |
| Hudgins Contracting Corporation, LLC | James Fisher Renewables |
| James Fisher Renewables | |

*Offshore Substation*

Weld America

Hiller Systems

Hiller Systems (Fire)

Jo-Kell Inc

Threat System Solutions

Thermal Spray Solutions, Inc.

Marine Specialty Painting INC

Steel America

ITL Solutions

Total Quality Assembly

Fairlead Integrated, LLC

Atlantic Lift Systems

Seager Mechanical Systems, LLC

Hudgins Contracting Corporation, LLC

MID-ATLANTIC ABV, INC

Tidewater Staffing

B&B Hose and Rubber Co.

HYTORC Virginia

Bay Container Services, Inc.

McDonough Marine Service

Auxiliary Systems, Inc.

Craft Machine Works

Collins Machine Works

Colonna's Shipyard dba Weld America

Froehling & Robertson, Inc.

Vansant Gusler

TST Fabrications LLC

Terma North America Inc.

Anchor Sandblasting and Coatings

Artcraft Fabricators, Inc. T/A Collins Machine Works

Bay Metals & Fabrication, LLC

Dishman Fabrications & Powder Coating, LLC

HyVal Industries, Inc.

Marcom Services, LLC

Marine Hydraulics International, LLC

Standard Calibrations Inc.

Stanley Black & Decker

Wilson Pipe & Fabrication llc

| *Onshore Substation* | *Turbine Installation* |
|---|---|
| Argos-US | Anders Williams Ship Agency / Marine Oil Service |
| Atlantic Lift Systems | Marine Oil Service, Inc. |
| ECS Mid-Atlantic, LLC | Domestic Fuels and Lubes, Inc |
| Kyanite Mining Corp. | Volvo Penta |
| Hudgins Contracting Corporation, LLC | ITL Solutions |
| MID-ATLANTIC ABV, INC | Atlantic Lift Systems |
| Bay Metals & Fabrication, LLC | Tidewater Staffing |
| Marine Hydraulics International, LLC | |
| Standard Calibrations Inc. | |
| L.E. Myers Company | |

*Foundations*

Norfolk Tug Company

Chesapeake Management Group, LLC

Bay Container Services, Inc.

McDonough Marine Service

Auxiliary Systems, Inc.

Weld America

Craft Machine Works

Collins Machine Works

Threat System Solutions

Colonna's Shipyard dba Weld America

Fugro Marine GeoServices, Inc.

Kyanite Mining Corp.

Steel America

B&B Hose and Rubber Co.

Thermal Spray Solutions, Inc.

Marine Specialty Painting INC

Argos-US

Atlantic Lift Systems

ECS Mid-Atlantic, LLC

ITL Solutions

Fairlead Integrated, LLC

MID-ATLANTIC ABV, INC

Froehling & Robertson, Inc.

ABS Group, Inc.

Blue Water Shipping

TST Fabrications LLC

Terma North America Inc.

Anchor Sandblasting and Coatings

Artcraft Fabricators, Inc. T/A Collins Machine Works

Bay Metals & Fabrication, LLC

Dishman Fabrications & Powder Coating, LLC

HyVal Industries, Inc.

Marcom Services, LLC

Marine Hydraulics International, LLC

Stanley Black & Decker

Wilson Pipe & Fabrication llc

| *Foundation Installation* | *Subsea Cable Installation* |
|---|---|
| Fugro Marine GeoServices, Inc. | Fugro Marine GeoServices, Inc. |
| ITL Solutions | Angels Instrumentation a Transcat Company |
| Atlantic Lift Systems | ITL Solutions |
| Bryant Structures, Inc. | Atlantic Lift Systems |
| Crofton Industries | Crofton Industries |
| | James Fisher Renewables |

*Offshore Substation Installation*

ITL Solutions

Volvo Penta

Hudgins Contracting Corporation, LLC

Atlantic Lift Systems

Tidewater Staffing

Crofton Industries

*Onshore Construction*

Seaward Marine Corporation

General Dynamics NASSCO-Norfolk

Port of Virginia

Capes Shipping Agencies

Cape Henry Launch Service

Kinder Morgan  Bulk Terminals, Inc.

Atlantic Lift Systems

Surf Club LLC, dba Fisherman's Wharf Marina

Hampton Roads Development llc

Virginia Beach Economic Development

SB Ballard Construction Company

Andre + Marquez Architects, Inc.

American Bureau of Shipping (ABS)

Fugro Marine GeoServices, Inc.

Hudgins Contracting Corporation, LLC

Chesapeake Management Group, LLC

Marine Specialty Painting INC

PER Properties

Seagate Terminals, LLC

Clancy & Theys Construction Company

W. M. Jordan Company

TST Fabrications LLC

Bryant Structures, Inc.

Crofton Industries

Scaffolding Solutions, LLC

Virginia Weldcore Inc.

L.E. Myers Company

*Ports & Logistics*

Clark Nexsen

McNeilan & Associates

Moffatt & Nichol

Ecology and Environment, Inc.

Cardno, Inc.

Stantec

American Bureau of Shipping (ABS)

Waterway Surveys & Engineering, Ltd.

On Course Solutions LLC

Virginia Beach Economic Development

Virginia Ship Repair Association

Seaward Marine Corporation

General Dynamics NASSCO-Norfolk

Port of Virginia

Capes Shipping Agencies

Cape Henry Launch Service

Kinder Morgan  Bulk Terminals, Inc.

Atlantic Lift Systems

NATIONAL CARGO BUREAU, Inc.

CP&O, LLC

CV International, Inc.

Ceres Marine Terminals, Inc.

Expeditors International of Washington, Inc.

Squyres Marine Services Inc.

Rover Marine, Inc

Norfolk Tug Company

Livingston International

Norfolk Southern Corporation

Bay Container Services, Inc.

Surf Club LLC, dba Fisherman's Wharf Marina

Cushman and Wakefield | Thalhimer

Anders Williams Ship Agency / Marine Oil Service

Marine Oil Service, Inc.

Domestic Fuels and Lubes, Inc

Volvo Penta

Precon Marine, Inc.

East Coast Repair & Fabrication

Auxiliary Systems, Inc.

Weld America

Angels Instrumentation a Transcat Company

Steel America

BAE Systems Ship Repair

Fairlead Integrated, LLC

Collins Machine Works

Tidewater Staffing

MHI Ship Repair & Services

Marine Specialty Painting INC

CITA LOGISTICS LLC

McDonough Marine Service

Weeks Marine, Inc.

Machinery Mounting Solutions, Inc.

Chesapeake Management Group, LLC

Crofton Industries

Craft Machine Works

Hampton Roads Port Services

PER Properties

Seagate Terminals, LLC

Nansemond International

Tecnico Corporation

Blue Water Shipping

Intracoastal Marine Inc

ABS Group, Inc.

Marine Chemist Service Inc

Beach Consulting Services

Bryant Structures, Inc.

Crofton Industries

Fisherman’s Wharf Marina

GI Industrial-Marine, LLC

Gregory Poole

Jamestown Metal Marine Sales, Inc.

John S. Connor Global Logistics

KRT INC

NASSCO-Norfolk

Netarus, LLC

R&P Technologies

Virginia Weldcore Inc.

*Operations*

Clark Nexsen

American Bureau of Shipping (ABS)

McNeilan & Associates

Moffatt & Nichol

Waterway Surveys & Engineering, Ltd.

Cardno, Inc.

On Course Solutions LLC

Virginia Beach Economic Development

Stantec

Virginia Ship Repair Association

NATIONAL CARGO BUREAU, Inc.

CP&O, LLC

CV International, Inc.

Capes Shipping Agencies

Ceres Marine Terminals, Inc.

Cape Henry Launch Service

Expeditors International of Washington, Inc.

Squyres Marine Services Inc.

Rover Marine, Inc

Norfolk Tug Company

Livingston International

Norfolk Southern Corporation

Bay Container Services, Inc.

Surf Club LLC, dba Fisherman's Wharf Marina

Cushman and Wakefield | Thalhimer

MHI Ship Repair & Services

Precon Marine, Inc.

CITA LOGISTICS LLC

Angels Instrumentation a Transcat Company

McDonough Marine Service

Weeks Marine, Inc.

Machinery Mounting Solutions, Inc.

G2 Ops, Inc.

Domestic Fuels and Lubes, Inc

Atlantic Lift Systems

Chesapeake Management Group, LLC

PER Properties

Seagate Terminals, LLC

Nansemond International

Intracoastal Marine Inc

ABS Group, Inc.

Beach Consulting Services

Fisherman's Wharf Marina

GI Industrial-Marine, LLC

Gregory Poole

John S. Connor Global Logistics

KRT INC

NASSCO-Norfolk

Netarus, LLC

R&P Technologies

| *Turbine Inspection & Maintenance* | *Decommissioning* |
| --- | --- |
| Volvo Penta | Accurate Marine Environmental LLC |
| Bay Diesel and Generator Corporation | |
| Atlantic Lift Systems | |
| MID-ATLANTIC ABV, INC | |
| Tidewater Staffing | |
| Advanced Aircraft Company | |

*BoP Inspection & Maintenance*

Auxiliary Systems, Inc.

Western Branch Diesel, Inc.

Collins Machine Works

Bay Container Services, Inc.

McDonough Marine Service

Weld America

Craft Machine Works

Threat System Solutions

Colonna's Shipyard dba Weld America

G2 Ops, Inc.

Fugro Marine GeoServices, Inc.

Angels Instrumentation a Transcat Company

ITL Solutions

Domestic Fuels and Lubes, Inc

Seager Mechanical Systems, LLC

Hiller Systems

Hiller Systems (Fire)

O'Brien et al. Advertising

Trademen International

Chesapeake Bay Diving Inc

Volvo Penta

Bay Diesel and Generator Corporation

Atlantic Lift Systems

MID-ATLANTIC ABV, INC

Tidewater Staffing

Froehling & Robertson, Inc.

Vansant Gusler

Advanced Aircraft Company

Crofton Industries

Hampton Rubber Co.

Packaging Tech LLC

Parker Safety Inc.

*Educational Institution / Training Provider*

Mid Atlantic Maritime Academy

Avoler Group, LLC

Reinvent Hampton Roads

Hampton Roads Workforce Council

Virginia Maritime Association

ViGYAN, Inc.

Tidewater Community College

Tidewater Staffing

MI Technical Solutions, Inc.

City of Newport News

City of Norfolk, Department of Economic Development

Hampton Roads Alliance

Virginia Technical Academy Inc

Centura College

CIVIC Leadership Institute

Norfolk State University

Old Dominion University

TCC

The Dove of Peace Ministry

*Government Agencies*

Southeast Maritime and Transportation Center (SMART) at Tidewater Community College

Reinvent Hampton Roads

Hampton Roads Workforce Council

Hampton Roads Chamber

VAHCDO

Valkyrie Enterprises Inc.

*Trades Labor & Workforce Organizations*

Southeast Maritime and Transportation Center (SMART) at Tidewater Community College

Avoler Group, LLC

Trademen International

Tidewater Staffing

Hampton Roads Alliance

Ameri-Force Craft Services, Inc.

Aerotek

Greater Peninsula Workforce Board

HKA Enterprises

Nationwide Skilled Trades

SBDC of Hampton Roads, Inc

Venture Dynamics

Workrise Staffing Solutions