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The Virginia advantage

The roadmap for the offshore wind supply chain in Virginia

December 2018

BVG Associates LLC

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- BVG Associates was formed in 2006 at the start of the offshore wind industry.
- We have a global client base, including customers of all sizes in North America, Europe, South America, Asia and Australia.
- Our highly experienced team has an average of over 10 years' experience in renewable energy.
- Most of our work is advising private clients investing in manufacturing, technology and renewable energy projects.
- We've also published many landmark reports on the future of the industry, cost of energy and supply chain.

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• Acknowledgment: "This material is based upon work supported by the U.S. Department of Energy's, Office of Energy Efficiency and Renewable Energy (EERE), under the State Energy Program Award Number DE-EE0007990.0003."

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Executive summary

In 2015, BVG Associates carried out a detailed review of Virginia ports and associated opportunities relating to offshore wind[1].

This study extends that work through the following actions:

- Review of current and projected market development
- Local engagement and development of tools, to help build partnerships between developers and suppliers with regional companies interested in diversifying into offshore wind
- Port review and update
- Review of Virginia's business climate and workforce readiness and
- Evaluation of the strategic fit with the current and future supply chain.

Supply chain opportunity

US offshore wind is accelerating rapidly, challenging the global and regional supply chain with at least 10GW of capacity to be installed by 2030. Approximately 2GW of power purchase agreements (PPAs) are in place in the northern states and an additional 3GW is anticipated in 2019.

Virginia is well positioned to derive economic benefit by establishing a supply chain to serve first-mover projects. Growing the industrial base at this early stage will prepare Virginia to competitively deliver its own 2GW in the coming years.

A timely supply chain entry will equip Virginia with the skills and infrastructure required to participate in a growing pipeline along the East Coast, future activity such as 2GW off the coast of North Carolina and potential wind energy lease areas beyond those currently established.

Comprehensive supply chain concept

This report outlines the benefits of a collaborative multi-state cluster concept, envisaging a "Mid and South Atlantic Coast supply cluster". The Virginia Offshore Wind Team holds the view that regional collaboration will deliver the most effective offshore wind supply chain. A multi-state industrial base, aligned with logistics benefits and workforce synergies in each area, would attract anchor tenants and lead toward a supply diversity delivering the best economic benefit. Manufacturing offshore wind components and offering offshore wind services in Virginia and other neighboring states will, once at scale, enable multiple offshore wind competitors to reach substantial cost savings. Logistics efficiencies, risk mitigation and a diverse supply network will enable comprehensive sourcing strategies, aligning global partners with local capabilities, coastal infrastructure and Jones Act marine logistic solutions.

Recommendations

The Virginia Offshore Wind Team is comprised of a selection of local, state and industry stakeholders. The Team was formed in order to provide local knowledge input into report deliverables as well as serve as a deployment arm for supply-chain tasks and strategies. In coordination with BVG Associates, the Team developed the following recommendations:

1. **Create a "Virginia Office for Offshore Wind" to provide a clearinghouse and facilitator to advance offshore wind**

- Hire or designate an individual to fulfill the role of leading the office in coordinating stakeholder collaboration and to serve as point-of-contact for offshore wind activities
- Engage with the Offshore Wind Business Team and the Offshore Wind Workforce Development Team and Business Team partnerships to leverage resources and share supply chain expertise
- Support both offshore wind prospects and businesses within the regional cluster, focusing on aligning offshore wind needs with regional business capacity
- Provide regular updates covering market and technology development, project schedules, supply chain opportunities and other resources as appropriate, and
- Develop a roadmap to achieve the Commonwealth's 2GW offshore wind commercial development goal by 2028.

2. **Work toward a multi-state regional supply chain cluster, offering the industry a wide network and the best of what each state has to offer**

- Build partnerships in the Mid and South Atlantic region and develop close working relationships with state counterparts
- Address federal issues as a single voice or with a common agenda
- Work with other states on their core strengths and help secure business opportunities for regional state partners

[1] Virginia offshore wind port readiness evaluation, report 1-3, BVG Associates on behalf of DMME, Apr-Jun 2015, available online at https://www.dmme.virginia.gov/de/OffshoreWindPortEvaluation.shtml, last accessed November 2018

- Engage collectively with the offshore wind industry to understand supply needs/preferences to help facilitate a 'best fit' scenario, and
- Promote the Virginia advantage as a logistical hub for major components, particularly for foundations, transition pieces and substations.

3. Solicit and attract "anchor tenant" suppliers, with a focus on major components

- Utilize state economic development resources to actively recruit major suppliers and consider engaging an offshore wind subject matter expert to provide introductions and help secure interest of prospects
- Develop a 'tour package', hosting developers and major suppliers and offering clarity on what Virginia can offer to major employers that choose Virginia, and
- Send a strong “open for business” message, addressing areas of interest and concern and reinforcing through commitment of local and state decision-makers.

4. Enable and grow Virginia’s business opportunity through partnerships and infrastructure

- Keep the Offshore Wind Business Team intact
- Provide clear and timely guidance on eligibility and access to existing resources applicable to offshore wind
- Consider establishing industry specific programs, incentives and resources
- Dedicate assistance to second tier/lower tier suppliers and maintain partnership tools that connect regional cluster businesses with developers and investors, and
- Pursue infrastructure improvements that enable port readiness, consider incentives for private assets and leverage existing programs such as the Virginia Waterway Maintenance Grant Program for dredging.

5. Grow Virginia business opportunity through workforce development

- Keep the Workforce Development Team intact
- Identify and provide clear access to existing training resources applicable to offshore wind
- Establish offshore wind specific programs, training and attraction options for the industry, and
- Work with stakeholders such as the Navy and Department of Defense on ways to complement Navy activities and flatten the workforce fluctuations driven by Navy contracting.

Virginia’s East Coast advantage

This report further evaluates Virginia’s position in key areas that include business climate, workforce, infrastructure and location. Virginia recognizes that it has a number of key competitive advantages specific to the offshore wind supply chain that include:

- Pro-business climate
- Strategic geographic location
- Unmatched port infrastructure
- Congestion-free navigation
- Progressive energy policy stance
- Unrestricted air draft waterways
- High-quality maritime workforce
- Abundant waterfront land and infrastructure, and
- America’s largest shipbuilding industry.

The objective to capture first-mover, as well as long-term supply chain business relies on the ability to overcome the near-term lack of an early commercial scale offshore wind development in the region.

The Virginia advantage is a combination of a diverse regional supply chain network, incentive/workforce packaging and established timelines to build out regional coastal projects to include Virginia and North Carolina will be key in securing the sustainable economic benefits, investments and jobs that a developed regional supply chain cluster will deliver.

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Acronyms and abbreviations

Acronym/abbreviation	Full name
AWS	American Welding Society
CCT	Certified Composites Technician
DMME	Virginia Department of Mines, Minerals and Energy
FTE	Full time employee for one year
GWO	Global Wind Organization
HRPDC	Hampton Roads Planning District Commission
HREDA	Hampton Roads Economic Development Alliance
MLLW	Mean lower low water
OSHA	Standard Occupational Safety and Health Administration
OSW	Offshore wind
PPA	Power purchase agreements
PMWs	Ports, marine terminals and waterfronts
Ro/Ro	Roll on roll off
SOCT	Office of the Secretary of Commerce and Trade
SPMT	Self-propelled modular transporter
STCW	Standards of Training, Certification and Watchkeeping for Seafarers
TP	Transition piece
VEDP	Virginia Economic Development Partnership
VPA	Virginia Port Authority (better known as Port of Virginia)
V3	Virginia Values Veterans Program
WEA	Wind Energy Area
WRDA	Water Resources Development Act

1. Introduction

1.1. Structure of the report

The Virginia Department of Mines, Minerals and Energy (DMME) commissioned BVG Associates (BVGA) and its partners to provide guidance to Virginia as it seeks to position Virginia to leverage maximum benefit from the emerging offshore wind (OSW) supply and maintenance opportunity. Its objective is to advance the development of OSW in Virginia and position the state as an East Coast OSW supply chain and service location of choice. Virginia will achieve this by focusing on key areas of supply, in parallel with working toward a multi-state regional supply chain cluster.

As part of this effort, BVG Associates is leveraging its North American and global partners with extensive OSW industry experience, including Ramboll Group, Timmons Group, Greentree Consulting and the Business Network for Offshore Wind.

Section 2 provides a review of the 2015 study conducted by BVG Associates[2] and changes to the market since this time.

Section 3 provides a global and US East Coast market projection for OSW.

Section 4 provides an overview of the supply chain opportunity serviceable from Virginia, considering its own native project pipeline, as well as the potential wider pipeline, which may be available to a supply chain cluster with neighboring states.

Section 5 provides a high-level overview of some of the related opportunities for smaller companies or established service providers looking to diversify. In addition, it is intended that this section be used to engage with interested local suppliers as this process evolves and interest and investment grows. A summary of the readiness of Virginia's current ports, marine terminals and waterfronts is provided, with indications of the costs and labor required for upgrades.

Section 6 provides a review of the business climate and the incentives available to businesses looking to invest or transition into OSW supply chain. It also discusses actions Virginia could take to support the development of the supply chain.

Section 7 focuses on workforce development. It discusses the required skills and qualifications for OSW and provides a review of relevant training, recruitment assistance and resources currently available within Virginia.

Section 8 provides a summary of Virginia's ports, marine terminals and waterfronts (PMWs). It includes descriptions of existing facilities and the OSW potential if the sites were upgraded.

Appendix A provides background information on floating wind and Appendix B provides the questionnaire used when creating the electric toolkit.

1.2. Methodology and assumptions

Market outlook

Both the overall US and local Virginia market projections were informed using a granular bottom-up approach without statistical correction or aggregation. The following inputs were used:

- The number of executed offtake agreements (mostly in form of a PPA)
- State legislated targets,
- Tax incentives, and
- Direct conversations with developers and Industry stakeholders.

Full time employee (FTE) estimation

The findings are based on the BVGA 2015 study for DMME and confirmed by the recent report for the Sierra Club. One FTE-year is one full time job for one year, where:

- Direct FTE-years are the jobs of those employed by the owners of the wind farm asset and their primary contractors, and
- Indirect FTE-years are the jobs of those employed by suppliers and sub-suppliers to the owners or their primary contractors.

In establishing the requirement for port infrastructure, job creation and skills development, we assumed an output capacity of 100 OSW turbines per year. We based this demand projection on the full build-out of the Virginia, North Carolina, Maryland, Delaware and New Jersey Wind Energy Areas (WEAs) as currently defined by the US Bureau of Ocean Energy Management (BOEM). These WEAs are all within approximately 250 nautical miles of Norfolk, Virginia.

Likelihood of activity

The methodology includes an analysis of the likelihood that activity in a sub-element will create jobs in the US for each

[2] Virginia offshore wind port readiness evaluation, report 1-3, BVG Associates on behalf of DMME, Apr-Jun 2015, available online at https://www.dmme.virginia.gov/de/OffshoreWindPortEvaluation.shtml, last accessed November 2018

market scenario. Jobs were classified as being baseline and additional, whereby:

- Baseline jobs are those that are reasonably expected to take place in the US.
- Additional jobs may be created in the US by investments in new manufacturing and service facilities. These additional jobs were categorized as high, medium or low probability for each scenario.

Electronic tool kit

To maximize coverage of potential suppliers in Virginia, existing OSW industry databases from the following were assembled:

- Business Network for Offshore Wind
- Greentree Consulting
- Virginia Maritime Association, and
- Virginia Ship Repair Association.

Using the combined databases, the team identified companies with OSW capabilities. An OSW questionnaire was developed which captured a supplier's industry specialty and any specific capabilities. Over 250 companies were emailed the electronic survey with over 80 responding as of the completion of this report.

Port, marine terminals and waterfronts analysis

The ports, marine terminals and waterfronts (PMWs) considered in detail were selected by an iterative process between the BVGA team and Virginia DMME, including engagement with facility owners and operators. This allowed the team to understand available areas of land adjacent to quaysides, as well as appetite for diversification opportunities into OSW. The list of PMWs included in this report is not exhaustive but does provide an insight into how Virginia's current facilities meet the needs of the OSW. Through dialog with property owners, site visits and desktop research, we built up a database of characteristics for the 11 PMWs considered. We then assessed the readiness of each port for each OSW activity in turn.

For some OSW activities in the considered PMWs, necessary upgrades are either unfeasible or likely to be uneconomic. In these cases, we did no further evaluation.

2. Review of 2015 study

2.1. Overview of the 2015 study

In 2015, DMME carried out a detailed review and analysis of select Virginia PMWs. The potential utilization of these PMWs for OSW focused on manufacturing and construction staging. The reports made recommendations of high impact investment opportunities and are listed in Table 1.

Table 1 Reports produced as part of the Virginia OSW port readiness evaluation, 2015.

Report	Title
1	An evaluation of 10 ports
2	Port utilization scenarios for manufacturing and wind farm staging
3	High-impact investment opportunities

Selection of ports, marine terminals and waterfronts for the 2015 study

PMWs were selected to be indicative of Virginia's port infrastructure. They were not intended to form an exhaustive list.

The methodology was to assess PMWs readiness requirements for each of eight activities:

1. Blade manufacturing
2. Generator manufacturing
3. Nacelle assembly
4. Tower manufacturing
5. Foundation manufacturing
6. Subsea cable manufacturing and load-out
7. Substation manufacturing
8. Construction staging

PMWs requirements were based on producing and constructing 100 turbines per year, with ratings up to 8MW and rotor diameters up to 170m.

As part of the study, the team evaluated additional facilities identified by DMME, focusing on OSW readiness of private PMWs assets.

Job characterization summary

The 2015 study found that foundation manufacturing yields the most direct job opportunities and the greatest number of high-paying jobs across activities 1 to 8 above.

Nacelle assembly yields many direct jobs, more than half of which are accessible to high school graduates without additional training or certification. In addition, it has been shown that nacelle assembly produces a large number of indirect jobs through the extensive subcomponent and manufacturing that feeds into nacelle assembly. Turbine suppliers typically purchase subcomponents as complete systems. These include structural elements, bearings, gearboxes, drive motors, brakes, transformers and power take-off systems, plus various other ancillary components such as brackets, crane systems, ducting, fiberglass housings, support frames, wiring harnesses, insulation and lighting. The overall job opportunities from nacelle assembly and its supply chain could easily deliver the greatest number of local jobs (direct and indirect) if a robust local supply chain is developed.

All job numbers in this study have been refreshed in response to changes industry changes.

2.2. Market changes since 2015

The rating of turbines being installed in wind farms continues to increase; as developers are actively trying to reduce the cost of energy. Existing platforms have been stretched from 6/7MW up to 9/10MW and new platforms are being developed with ratings of 12MW and greater.

GE Renewable Energy recently announced the development of a 12MW turbine with a 220-meter rotor (GE Haliade-X) and has already advised that this will be 'stretched' even before commercialization. Competitors such as MHI Vestas Offshore Wind and Siemens Gamesa Renewable Energy are also working on larger turbines.

Changes in turbine rating drive the use of larger turbine components, foundations and installation vessels.

Demonstration floating OSW farms are in operation in Europe. Use of floating turbines in deep water will result in the requirement to transport even taller structures, making bridge-free access from construction port to open ocean even more important.

3. Market overview

3.1. The global market

OSW is a mainstream source of electricity in Europe. In the UK and Germany, OSW already contributes a substantial proportion of total generation. By 2020 the UK will be generating 10% of its electricity from OSW. Denmark and the Netherlands have also made significant progress in installing OSW projects. In Asia, the Chinese market is maturing rapidly and the Korean, Japanese and Taiwanese markets are showing significant promise (see Figure 1).

At the end of 2018, a total cumulative capacity of over 23GW will be installed globally. By 2030, this is likely to exceed 120GW. The market share will be split mainly between Europe and Asia until the end of 2019, with North America expected to accelerate in 2020.

Figure 1 provides a central market outlook for each region. It assumes an incremental adoption of technology innovations, such as larger turbine ratings and that current policy and regulation is continued.

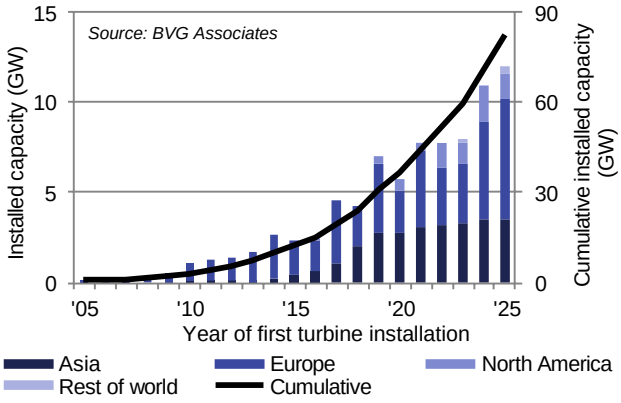


Figure 1 Global installed OSW capacity, cumulative and annually, from 2005 to 2025.

3.2. US East Coast market

The East Coast will likely be the focal point of OSW development in the US up to 2025.

Figure 2, shows the East Coast pipeline. The launch of OSW in the US has to a large extent been driven by the business case in the North East:

- Favorable wind regime with water depths below 30m
- Peaking energy prices
- Proximity to coastal load centers, and
- Avoiding complex, long-distance inter-state transmission.

The East Coast has a wider shallow continental shelf compared to the West Coast. Floating foundation technology, required for the West Coast's deeper water locations, is still in the early stages of development and will not be available for deployment before 2025.

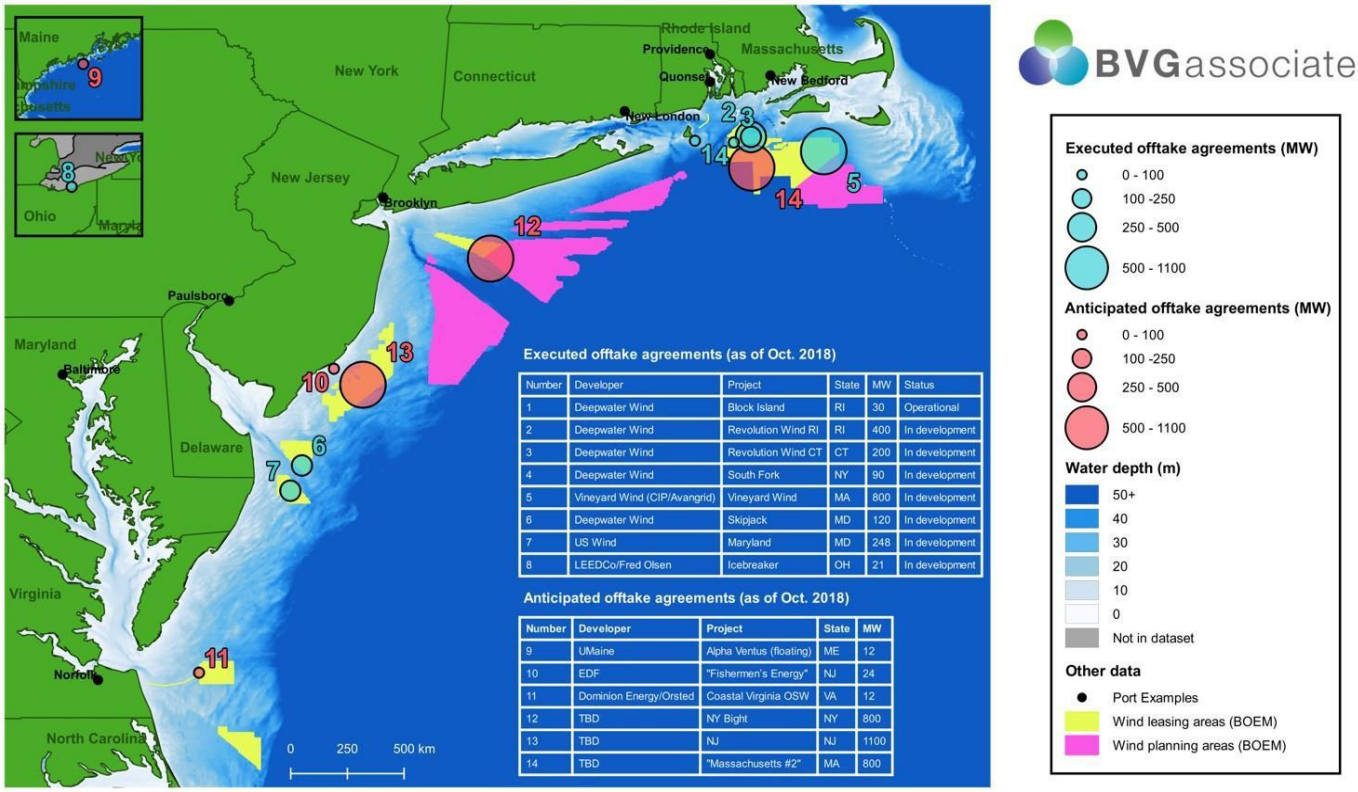


Figure 2 East Coast pipeline of OSW projects with executed and upcoming offtake agreements (status Oct 2018).

Figure 3 shows the market projection for East Coast OSW installation based on developer reports. As of 2018, the only operational OSW farm in the US is the Block Island project (30MW). By the end of 2025, based on the current and anticipated offtake agreements, over 4.6GW of capacity is expected to reach commercial operation along the East Coast. Projects that are likely to contribute the most capacity will be serving Massachusetts, Rhode Island, New York and New Jersey.

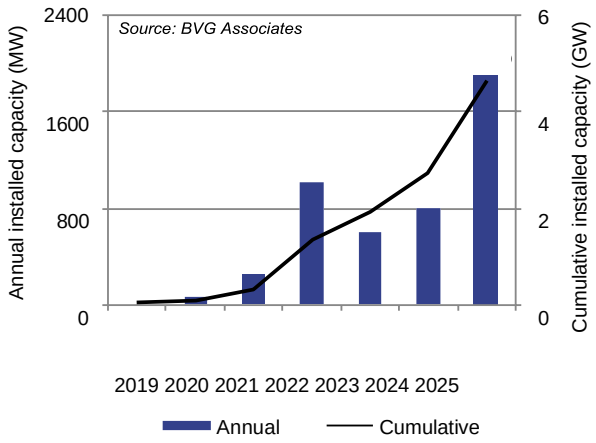
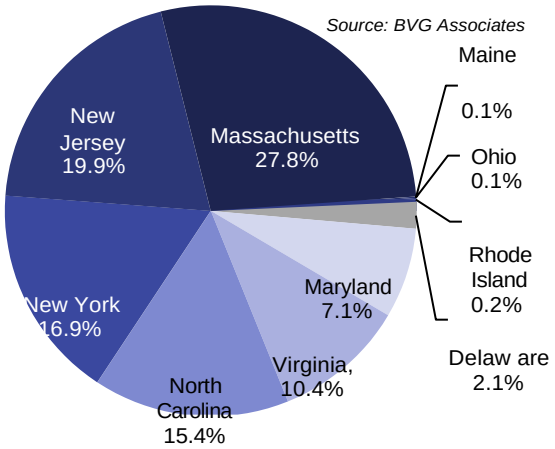


Figure 3 Projected annual and cumulative installed capacity (developer reported) on the US East Coast to 2025.

The two important indicators of future development in the US are the acquisition of federal lease areas and negotiation of offtake agreements, mostly in the form of

(provided by BOEM) is one of the first steps in securing a project. A more advanced wind farm development can obtain an offtake agreement, followed by a challenging phase to secure interconnection, permitting and a competitive supply chain, enabling a construction start within the following three to five years.



Power Purchase Agreements (PPA). A lease area

Figure 4 Projected market share in installed capacity for each East Coast State in the period 2016-2030.

There is considerable optimism about the future of OSW in the US. Significant new investments in the US are expected once it reaches a critical mass in the mid-2020s. In the short term, the main large component opportunities are likely to come from turbine towers, foundations and offshore substations.

Transportation by water of people and merchandise between two points in the US must be by Jones Act

qualified vessels, constructed in the US and owned and operated by US citizens. This limitation prevents the use of European installation vessels for many activities, which opens opportunities for US shipyards, including those in Virginia. It could also provide an opportunity for innovative solutions, allowing a Jones Act compliant combination of US and foreign vessels. Virginia's OSW market is anticipated to accelerate further in 2026, coinciding with the US market as a whole reaching critical mass. At this time, the US can expect investments in all parts of the OSW supply chain and related infrastructure. As shown in Figure 4, Virginia will face competition from other states also developing OSW projects. The Massachusetts Clean Energy Center has positioned the New Bedford Marine Commerce Terminal to support the construction, assembly and deployment of OSW projects. In Maryland, OSW developers have been required to make a $76 million investment in a Maryland steel fabrication plant and $40 million in upgrades in Baltimore ports. Maryland has also mandated that companies use port facilities in the Greater Baltimore region and Ocean City for construction and operations, maintenance and service. Maryland port facilities have to consider bridge restrictions; this is just one example of how a regional multistate supply chain dialogue will benefit the industry, ensuring that scope is distributed between states with air draft restrictions in mind.

Today's state-of-the-art wind turbines have rated capacities of 8-10MW with rotors up to 170 meter in diameter. Larger turbines do not necessarily lead to lower turbine prices per MW for the turbines, but they have profound implications for the number and cost of foundations, cables and their installation and maintenance. For example, a foundation for a 12MW turbine will cost more than a foundation for a 6MW turbine, but not twice as much. Larger turbines mean fewer turbines per MW and so less cabling is needed. A vessel can carry fewer 12MW turbine sets than it can 6MW sets, but it can carry more total megawatts with a 12MW turbine. Furthermore, the maintenance of a 12MW turbine is cheaper than the maintenance of two 6MW turbines.

There are many advantages to larger turbines, consequently wind farms built in the second half of the next decade will be larger still. In an optimistic scenario, the unique logistic, geographic and industrial benefits of Virginia may trigger supply chain investments to serve multiple North East projects. This could enable Virginia to foster a maturing supply chain before its own large-scale OSW projects materialize. Despite this, it is important for Virginia to focus on accelerating the deployment of its own large-scale OSW projects, as this strengthens the state's position as an attractive location for the OSW supply chain.

4. East Coast supply chain opportunity serviceable from Virginia

4.1. Virginia and offshore wind

The Virginia opportunity

With recent legislation (the *Grid Transformation and Security Act of 2018*), Virginia set a goal of developing 5GW of renewable energy by 2028-a goal that would be partially met by developing its current offshore commercial lease area. According to the report *Offshore wind in Virginia-a vision*[3], delivery on this goal would:

- Reduce reliance on out-of-state electricity by 30%
- Generate thousands of local jobs
- Eliminate 3 million tons of CO_2 pollution each year, the equivalent of removing 650,000 cars[4] from the road
- Power more than 500,000 homes with clean, renewable energy, and
- Offer a mix of renewable energy sources each with a unique generation profile to reduce the need to rely on gas "peaker" plants.

Virginia stands to benefit from early action to attract the OSW industry to its shores. There are several states on the US East Coast with plans to develop an OSW industry. This is for good reason, it creates new jobs, attracts private investment into local communities and establishes a reliable, local source of clean renewable electricity. Many states on the Atlantic Coast envision their ports as "the hub" for the OSW industry. A number of states, New York in particular, have already developed OSW master plans. Virginia has great potential and many unique advantages to attract this investment, but it must act now if it is to be a leader in OSW.

The Virginia advantage

Virginia has a number of key competitive advantages:

- Pro-business climate: CNBC ranks Virginia as the fourth top state in the nation and the first on the East Coast for business. Virginia leads the way in education and workforce development in support of its thriving economy.
- Strategic geographic location: with commercial OSW leases located off the coasts of NJ, DE, MD, VA and NC at a travel time of less than 20 hours at a typical navigation speed of 10 knots, Virginia's port assets are strategically located in the Mid-Atlantic with direct open access.
- Unmatched port infrastructure: as the second largest on the East Coast in tonnage and the third largest in container volume, Virginia's PMWs have the ability to handle any type of cargo. Virginia is one of the few offering "plug in and play" facilities to the supply chain.
- Congestion-free navigation: Hampton Roads enjoys open shipping channels and navigational flexibility, eliminating maritime congestion as a concern. The Port of Virginia is the deepest port on the East Coast and recently gained approval for a dredging project that will take the channels to a depth of 55ft and widen them in select areas to allow for two-way traffic of ultra-large containerships.
- Progressive energy policy stance: in a bipartisan fashion, Virginia's legislature passed the Grid Transformation and Security Act in 2018, which deems 5GW of solar and wind generation to be in the public interest.
- Unrestricted air draft waterways: Virginia's PMWs have direct access to sea with no overhead obstacles to impede the shipping of large and upright infrastructure and components-an advantage that differentiates it from every other East Coast state.
- High-quality maritime workforce: Hampton Roads boasts a civilian and military maritime labor force unmatched by any other East Coast state. Its proximity to the largest naval base in the world presents the opportunity to hire retiring military personnel for high-skilled OSW jobs.
- Abundant waterfront land and infrastructure: Virginia's PMWs offer existing dock capacity and ample on-water marshalling areas. The Virginia coastline is geographically rich with waterfront properties and development or redevelopment opportunities.
- America's largest shipbuilding and ship repair industry: Hampton Roads is home to the largest shipbuilding and ship repair market in the United States. This provides numerous advantages as the infrastructure and workforce resources for design, construction and maintenance of vessel and other marine infrastructure are well-developed. It is for this reason that Virginia

[3] *Offshore wind in Virginia – a vision*, BVG Associates on behalf of Sierra Club Virginia Chapter, September 2018, available at https://files.vasierraclub.org/oswvision.pdf . Last accessed November 2018.

[4] Office of Transportation and Air Quality on behalf of the United States Environmental Protection Agency, 2018, https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle, last accessed November 2018

already has the capacity for the construction of new OSW-specialized vessels and modification of existing vessels.

4.2. Assumptions

In October 2017, the Clean Energy States Alliance (CESA) published a report identifying jobs and opportunities for the US East Coast[5]. For the purposes of this study, we are assuming a conservative East Coast market outlook of 8GW to the end of 2030. The total available direct and indirect jobs, based on the current pipeline, created from 2020 to 2030 are shown in Figure 5. In peak years, between 2024 and 2028, 37,000 FTE years are likely to be created annually.

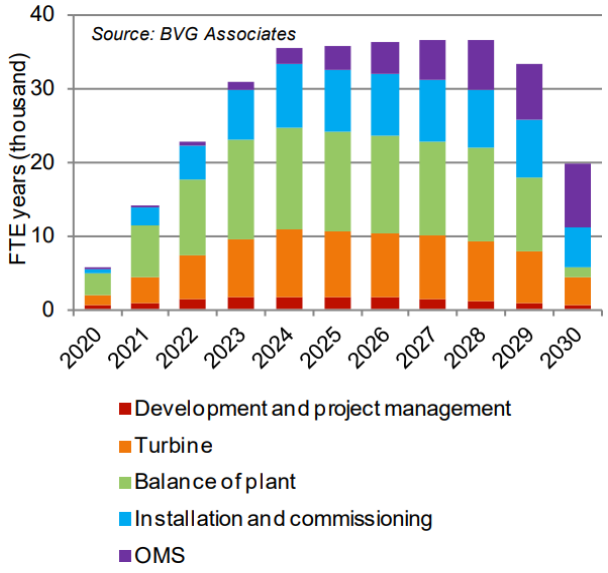


Figure 5 Total available direct and indirect FTE years created annually between 2020 and 2030 by supply chain element (8GW scenario).

Job and supply chain opportunity scenarios

The OSW supply chains in Europe are built on the expectation of an annual market of at least 1GW for a given high-tier supplier. This equates to 80 to 125 units (turbine nacelles, turbine towers, foundations etc.) and a cable production of 200km of cable per year. These volumes achieve the economies of scale (or "tipping point") required for infrastructure investment and skills development and enable the industry to apply lean manufacturing strategies. Manufacturers have to be comfortable that the risk and costs of establishing new facilities are lower than those of transporting the components from existing factories. State driven local content expectations are a further important factor in developing project sourcing strategies.

In the US, the volume required for a factory to reach financial viability may be lower than in more established markets. Firstly, importing components from Europe or Asia will add logistical challenges, not only because of larger distances travelled but also because the added risk of weather-related delays associated with extended distance and duration. Secondly, US factories would mitigate potential exposure to possibly significant import duties on steel and other products. Thus, by mitigating those factors, a US factory could be viable with lower volumes than a comparable European factory

Construction opportunity

The findings below are based on the BVGA 2015 study for DMME, refreshed based on BVGA's report for the Sierra Club[3] and other recent European work. We expect the potential benefit of direct and indirect employment for a manufacturing facility capable of supplying components or assembly of 100 turbines per year for each category to be as shown in the following tables.

[5] US Job Creation in Offshore Wind, BVG Associates on behalf of CESA, October 2017, available online at https://www.northeastwindcenter.org/resources/us-job-creation-in-offshore-wind/ Last accessed November 2018

Table 2 Direct and indirect employment for component manufacture (100 turbine per year facility).

Component	Likelihood of US supply chain	Direct jobs	Indirect jobs
Project management& development	Baseline	200	300
Blade manufacturing	High	600	500
Nacelle assembly	Medium	400	2,500
Tower manufacturing	High	200	300
Jacket manufacturing	High	650	800
Subsea cable manufacturing	High	400	1,000
Substation manufacturing	High	500	800
Construction staging*	Baseline	200	200
Other opportunities	High	Not assessed	

* This is for onshore activity. Further direct and indirect jobs are created offshore during installation and commissioning.

Operation, maintenance and service opportunity

Due to the nature of OMS activity, the OMS base for each specific project is likely to be located at the nearest suitable port. Creation of OMS jobs can be considered as the baseline scenario for all OMS areas. While some specialist skills may be imported at various points in a wind farm's life, the day-to-day operation, maintenance and service cycle will almost certainly be provided locally. Table 3 shows the full-time employment scenario for a single project of 100 turbines over a year. In Europe, some developers have formed hubs in a specific port, where third party suppliers can set up and provide services to multiple projects from a single base. The ability to plan logistics in this manner is driven by the size of pipeline within a suitable transit distance.

These estimates include the annual opportunity for the lifetime of the wind farm, however do not reflect additional significant opportunities such as constructing and operating crew transfer vessels (CTVs) and with increasing wind farm size and distance to shore, service operation vessels (SOVs) with walk to work gangways.

Table 3 Direct employment for OMS (annual employment at a 100-turbine wind farm).

Component	Likelihood of US supply chain	Direct jobs
Wind turbine maintenance and service	Baseline	40
Wind farm management	Baseline	30
Vessel operation	Baseline	20
Balance of plant maintenance and service	Baseline	10

4.3. Virginia local opportunity

Between 2020 and 2025, an estimated 380MW of projects will be serviceable from Virginia ports for installation and operational activities. The identification of these projects is based on a sailing time of 20 hours at 10 knots, which yields a distance of roughly 370 km (or 200 nautical miles). Projects that have been identified are the following: Coastal Virginia Offshore Wind, Skipjack and Maryland. For OMS, shorter distances apply, likely focusing that opportunity to the large-scale Virginia and North Carolina wind farms, expected after 2025. More details of these projects are provided in Table 4.

Table 4 OSW projects serviceable from Virginia to 2030.

Project	State	Commercial operation date	Capacity	Distance to shore (miles)	Status
Coastal Virginia Offshore Wind (Demo)	Virginia	2020	12MW	26	Applied for consent
Maryland US Wind Inc	Maryland	2021	248MW	16	Under development
Skipjack	Maryland	2022	120MW	20	Under development
Virginia phase 1	Virginia	2026	Up to 1GW	26	BOEM leasing area
Virginia phase 2	Virginia	2028	Up to 1GW	33	BOEM leasing area
Kitty Hawk - Avangrid Renewables	North Carolina	TBC	Up to 2GW	35	Early stage development
Wilmington West WEA	North Carolina	TBC	Up to 1GW	14	Early stage development
Wilmington East WEA	North Carolina	TBC	Up to 1GW	30	Early stage development

Virginia recognizes and continues to invest in significant advantages that may allow it to differentiate itself from other locations in order to become a major player in supplying and servicing of East Coast OSW projects. These advantages include:

- Pro-business climate
- Strategic geographic location
- Unmatched port infrastructure
- Congestion-free navigation
- Progressive energy policy stance
- Unrestricted air draft waterways
- High-quality maritime workforce
- Abundant waterfront land and infrastructure, and
- America's largest shipbuilding industry.

Baseline opportunity

The baseline position for Virginia would be the supply chain and maintenance opportunity associated with the build out of at least 2GW of federal lease areas off the coast of Virginia being pursued by Dominion Energy (Virginia phase 1 and 2). The projects listed in Table 4 are serviceable from Virginia up to 2030. Table 4 provides a reasonable business case for larger supply chain manufactures to localize certain components such as foundations or offshore substations.

The localization of nacelles is not anticipated in the near future and cable manufacturing is expected to be located in South Carolina.

Further announcements confirming Virginia's pipeline would provide certainty and give manufacturers the confidence to invest. A forward-looking OSW strategy for Virginia will further encourage investment considerations in the local area.

The 2018 Virginia Energy Plan recommends that the governor set a target for 2GW of OSW projects by 2028. The potential of Virginia's commercial lease area aligns with this target. Establishing a link with the development of OSW on the East Coast may lead to opportunities for Virginia to supply wind turbine components, installation services, OMS as well as vessels. By 2025, Virginia could be one of the leading US markets for OSW, driven by the ability to benefit from the lessons learned from Northeast states, the maturing US supply chain, anticipated major OSW development in the northern part of North Carolina and complemented by Virginia's strong infrastructure, location benefits and deployment of OSW at-scale.

In the scenario shown in Figure 6, we anticipate two major projects of 875MW in 2026 and 2028.

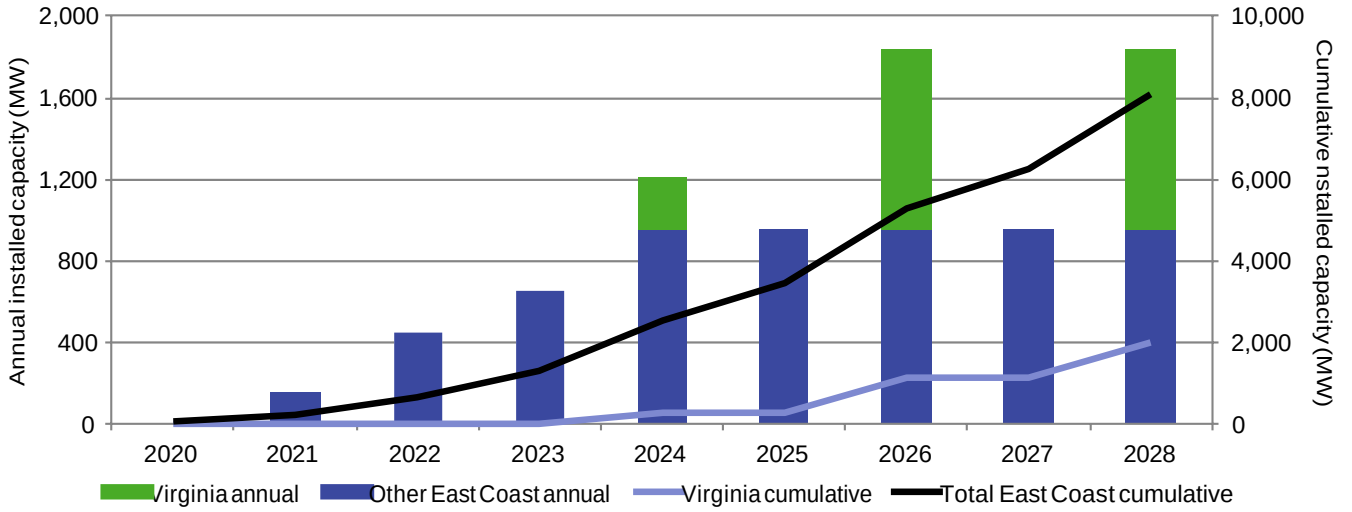


Figure 6 A scenario for OSW in Virginia and the rest of the Atlantic Coast by the end of 2030.

Opportunity to leverage pipeline to attract supply chain interest

The European supply chain tipping point has been established at approximately 1GW per year (80 to 125 units) per major supplier. US supply chain economies of scale could be lower due to shipping distance tolerance (US extends tolerance with the extended distance between planned wind farms along the Atlantic Coast) and added delay risk.

Suppliers to the wind industry, such as turbine, foundation and cable manufacturers, require a sustainable run-rate for installed capacity. This is critical for investment planning and keeping facilities efficient, as manufacturers are looking for project pipelines exceeding 1GW to achieve economies of scale. In the scenario shown in Figure 6, there are two major projects of 875MW in 2026 and 2028. Staging the Virginia OSW development into projects of this magnitude is more likely to lead to investment in Virginia. There are two risks to consider. First, a late start to the domestic pipeline may allow other states to have established their own cost-effective supply chain facilities from which developers choose to source components. Second, if the total East Coast build out is lower than the market outlook, developers and/or wind turbine suppliers may become comfortable with the more expensive but lower risk option of importing some or all components from established supply chains in Europe.

Lower tier components can be moved using inland transport; therefore, factories can be located further from the coast. As those suppliers are more likely to be supplying other sectors too, the correlation with OSW growth is less obvious. Table 5 shows the number of jobs that could be created by specialist facilities for the manufacture, assembly and transport of OSW components. Many jobs are created at lower tiers of the supply chain. The table also shows the likelihood of those jobs being located in the US or Virginia, based on the available local pipeline of projects shown above.

Table 5 High-level overview of potential supply chain value to Virginia (FTEs for 100 turbines per year installation scenario).

Component	Direct jobs	Indirect jobs	Likeli-hood of US location	Likeli-hood of VA location
Project management & development	200	300	High	High
Blade manufacturing	600	500	High	Medium
Nacelle assembly	400	2,500	Medium	Low
Tower manufacturing	200	300	High	Medium
Jacket manufacturing	650	800	High	High
Subsea cable manufacturing	400	1,000	High	Medium
Substation manufacturing	500	800	High	High
Construction staging*	200	200	High	High
Operation, maintenance and service**	100	150	High	High
Other opportunities	Not assessed		High	Medium

* This is for onshore activity. Further direct and indirect jobs are created offshore during installation and commissioning.
** for 500 turbines, equating to average installed capacity during 2020s.

Our assessment of Virginia's current baseline opportunity leads us to conclude that Virginia's reliance on workforce,

business climate and infrastructure will be challenged in fully compensating for the project pipeline disadvantage. Investment in support of large-scale supply chain development and a firm commitment and timeline to build out baseline projects may be required, otherwise the local benefit may be limited in terms of new investment and jobs. An opportunity to contract into a relatively small number of projects will exist, but there will be no strong baseline of expertise or specific skills to leverage into these and the opportunity may be lost to other states where a nascent supply chain has been nurtured off the back of a local build out. East Coast opportunity serviceable from multi-state cluster concept

US based manufacturing

Compared to importing components from overseas, manufacturing OSW components in Virginia and other neighboring states can create significant cost savings for US East Coast OSW farms through the following:

- Avoided cost and weather risk of transporting components
- Avoided cost of handling components in the ports
- Avoided borrowing costs due to longer mobilization and demobilization periods, and
- Avoided cost of additional storage, lay-down areas and other risk mitigation factors.

The industry supply chain will not reach optimal efficiency if the states from the East Coast WEAs (WEAs) seek to compete with, instead of complement each other. Based on the large pipeline of projected US capacity, the industry has made clear what they need most: reliable suppliers coupled with regionally optimized logistics.

Regional cluster

To maximize opportunity, regional partners are moving toward recognizing the value-add proposition of coordinating a more robust, diverse supply chain network and the advantage it offers the industry. Figure 7 reflects a basic cluster that could easily serve the current MD, VA and NC WEAs. Through competitive advantage, this cluster could compete for business as far north as the NY Bight WEA and possibly beyond. The cluster is not meant to be exclusive and should include as many states as possible to support industry needs. In order to provide the OSW industry with the most reliable and cost-competitive supply stream possible, Virginia intends to pursue this multi-state platform that offers the industry a broad network from which to choose. This collaborative multi-state cluster would provide a collective of the best each state could contribute and recognize the cost and logistical advantages each state has to offer. This would position participating states to maximize economic development benefit, likely beyond what would be recognized if pursued as independent ventures.

For Virginia, this would mean a focus on support structures and complex engineering such as foundations and offshore substations. This collaboration would benefit the industry by providing significant risk mitigation and reducing levelized cost of energy (LCOE). This would primarily be accomplished through maximizing economies-of-scale across the major cost-centers associated with OSW deployment. These include establishment of local production supply chains (particularly for major components), natural competition and selection options within the cluster and establishment of logistics and shipping routes that can serve the majority of OSW sites both within the cluster and beyond. The OSW industry will benefit from the ability of states to focus on their core areas of expertise, rather than trying to import skills and training to cover gaps, fulfil local content requirements or similar restrictions.

Figure 7 Basic East Coast OSW cluster.

Each state can focus on its own unique offerings to the industry and specialize according to their traditional resource base and local capabilities. Investments in infrastructure and facilities can be made collaboratively, reducing risk and increasing the likelihood of success by reducing competition for the same opportunity or the risk of over-supply through duplication.

Virginia envisions a regional cluster, likely defined by states from the Mid-Atlantic and Southeast. Development in New England states is advancing rapidly and this region will likely rely on a combination of European supply chain support and establishment of a cluster of smaller ports closer to the New England WEAs. This could also include supply and service from New York or states further south to include Virginia. Virginia has initiated discussions with Maryland, North Carolina and South Carolina and will continue to reach out to others. Virginia seeks to be inclusive regarding participating states, offering the industry the broadest network possible.

Collaborative regional integration

A multistate cluster approach would represent a significant breakthrough in the industry and would enable the following comprehensive benefits:

- Sustainable project pipeline enables a multi-state/multi-project viewpoint
- Regional project sourcing strategy aligned with coastal infrastructure, Jones Act marine logistic solution, workforce availability and global supply & demand cycles
- Operational principles to reach industrialized production, volume aligned investments and synergies with established workforce
- Platform for regional dialogue while preserving opportunity driven decision-making at State level
- Creation of at least one marshalling or staging port within the cluster would allow states to minimize transit distances to projects and simplify logistics by gathering all components at single location
- Best value equation preserved to balance competitive LCOE for ratepayer with long-term localization of supply
- Duplication of investment mitigated to maximize returns
- OSW supply base can reach maturity and cost effectiveness even before commercial wind farms migrate to the cluster region, and
- Regional approach will strengthen operations, attract anchor tenants and accelerate the OSW industry, making it more competitive on a global scale.

A collaborative and co-operative approach to supply chain clustering among regional states will create a much larger collective opportunity. The projected short to mid-term opportunity for supply of initial components and services, including jackets and offshore substations as shown in Table 6.

Table 6 Projects serviceable from collaborative multi-state cluster concept.

Project	State	Commercial operation date	Capacity	Distance to shore (miles)	Status
Coastal Virginia Offshore Wind (Demo)	Virginia	2020	12MW	26	Under development
Fisherman's Energy	New Jersey	2020	24MW	3	Under development
Maryland US Wind Inc	Maryland	2021	248MW	16	Under development
Skipjack	Maryland	2022	120	20	Under development
NY Bight	New York	2024	800	TBC	RFP issued
NJ New Project	New Jersey	2024	1100	TBC	RFP issued
Virginia phase 1	Virginia	2026	Up to 1GW	26	BOEM leasing area
Virginia phase 2	Virginia	2028	Up to 1GW	33	BOEM leasing area
Kitty Hawk - Avangrid Renewables	North Carolina	TBC	Up to 2GW	33	Early stage development
Wilmington West WEA	North Carolina	TBC	Up to 1GW	14	Early stage development
Wilmington East WEA	North Carolina	TBC	Up to 1GW	30	Early stage development
South Carolina Phase 1	South Carolina	TBC	Up to 1GW	TBC	BOEM planning area
South Carolina Phase 2	South Carolina	TBC	Up to 1GW	TBC	BOEM planning area

Table 7 indicates a high-level quantification of the potential supply chain opportunity to the collaborative multi-state cluster concept, with the non-monopile foundation manufacturing and offshore substation manufacturing likely to be a key area of interest for Virginia.

Table 7 High-level summary of supply chain opportunity to collaborative multi-state cluster concept (FTEs for 100 turbines per year installation scenario).

Component	Direct jobs	Indirect jobs	Likeli-hood of US location	Likeli-hood of Cluster location
Project management & development	200	300	High	High
Blade manufacturing	600	500	High	High
Nacelle assembly	400	2,500	Medium	Medium
Tower manufacturing	200	300	High	High
Jacket manufacturing	650	800	High	High
Subsea cable manufacturing	400	1,000	High	High
Substation manufacturing	500	800	High	High
Construction staging*	200	200	High	High
Operation, maintenance and service**	100	150	High	High
Other opportunities	Not assessed		High	High

* This is for onshore activity. Further direct and indirect jobs are created offshore during installation and commissioning.
** for 500 turbines, equating to average installed capacity during 2020s.

By the middle of the next decade, Virginia could be a leading US market for OSW, driven by the ability to benefit from the lessons learned from Northeast states and the maturing US supply chain, complemented by Virginia's strong infrastructure, location benefits and deployment of OSW at-scale.

The expectation, based on current analysis, is that Virginia's primary advantage and the recommended key focus for DMME, should be the delivery of large, complex structures such as foundations, particularly non-monopile foundations and offshore substations. A collaborating cluster state could provide secondary steel to support these activities.

Virginia's offshore wind supply chain to 2030

These activities are supported by Virginia's coastal infrastructure advantage. Unlike turbine nacelle components, they are not dependent on the specialized local supply chain. Investments in these facilities are therefore lower risk.

Table 14 shows the capacity for upgrading existing facilities in Virginia to accommodate the assembly, manufacture and load out of large complex components from key Virginia port facilities. It also explains in further detail what the key strengths of each location is, as well as the enabling works required to unlock this opportunity.

5. Partnership analysis and toolkit

The BVGA Team developed an assessment tool that encapsulates a basic description of the local businesses and suppliers seeking to gain an advantage through diversifying or adapting to service the OSW supply chain. This tool presents the information for each site in a summarized fashion. The intent is to present relevant information such that potential suppliers/investors can quickly assess the opportunity for partnerships, contract agreements, or co-operation scenarios. The tool provides appropriate contact information for acquiring additional information.

5.1. Stakeholders and topics of engagement

The Virginia Offshore Wind Team has taken part in numerous ongoing engagement activities to begin targeting and informing local businesses about the opportunities in OSW. The following activities are those that have proven particularly effective and are recommended to become a regular process:

- Engage with The Virginia Office of Small Business and Supplier Diversity regarding business opportunities and supplier diversity
- Attendance and participation in Local Government/VEDP Workshops
- Coordination with Virginia Port Authority (VPA) regarding overall project objectives alignment, disposition of real estate and status of engineering studies and analysis of VPA facilities
- Coordination with local real estate brokers regarding current trends and market activity, site availability and status
- Coordination with specific locality economic development officials to ensure project objective alignment with economic development opportunities and site readiness reporting
- Coordination with VEDP, and
- Engagement with Reinvent Hampton Roads, HRPDC, Governor of Virginia and HREDA.

5.2. Summary of electronic toolkit

OSW Resource Directory and Outreach Toolkit

The electronic toolkit is an introductory resource for developers who are reviewing the capabilities of local suppliers. The function of the toolkit is to provide summary information for clients based upon the data input by the suppliers. Data collected includes manufacturing specialization, material or services provided, permitting and supplier characteristics. The information provided also includes number of employees, company classification and yearly revenue. The information extracted from this toolkit will provide the characteristics of suppliers and stakeholders within Virginia and the established supply chain cluster.

Every submitted entry requires contact information, with the short-term intention of connecting interested parties and the long-term aim to support the development of a cohesive supply chain. The toolkit has gathered data from parties all over Virginia and is available for any company within the cluster region. At the request of DMME, the toolkit will be publicly accessible and available for download. Users will be able to download a modifiable copy of the document, rather than access the original, to ensure the integrity of the toolkit.

This electronic toolkit will be used to further identify suppliers within the cluster and to build the Virginia OSW Resource Directory.

This resulting OSW Resource Directory will enable developers and major tier 1 contractors to review and identify companies within the cluster interested in supplying this new and emerging industry.

A copy of the questionnaire is included in Appendix B. A summary of toolkit responses is provided in Table 8.

Table 8 Electronic toolkit responses.

Category	Range	Results
State location	VA	57
	MD	9
	OH, MN, PA, MA, MI, NY, SC	9
Number of employees	>200 employees	24
	76-200 employees	4
	25-75 employees	3
	< 25 employees	19
Average yearly income	>$25 million	24
	$11-25 million	5
	$5-10 million	3
	<$5 million	14
Permitting and materials	Provide project equipment	39
	Upfront permitting services	34
	Both	15
Project services	Project management	19
	Project management, maintenance & operations	4
	Project management, maintenance & operations, installation	2
Total companies	Contact information	83

5.3. Summary of existing assets and business potential

The report includes a review of eleven high potential facilities considered in more detail in Section 8, these are:

- Port of VA Newport News Marine Terminal (NNMT)
- Port of VA Portsmouth Marine Terminal (PMT)
- Cape Charles Harbor Holdings LLC facility
- Cape Charles Harbor Floating Dock
- Colonna's Shipyard
- Fairlead Boatworks
- East Coast Repair and Fabrication
- General Dynamics Harper Yard
- General Dynamics Ligon Street Yard
- 1201 Terminal Avenue, and
- Seagate

Interested companies will have access to more specific details of the available opportunities within the OSW supply chain. For example, 19 companies have listed an offering of project management services, a scope listed as baseline for local content in Section 4. Given that project management and design are an early stage service, coaching and preparing these companies to target the future opportunity in OSW should be considered a priority going forward.

5.4. The supply chain

An overview of the OSW supply chain is shown in Figure 8, providing a more granular level to demonstrate to individuals, companies and workers how they can potentially become involved and help fill the needs of an OSW supply chain in Virginia.

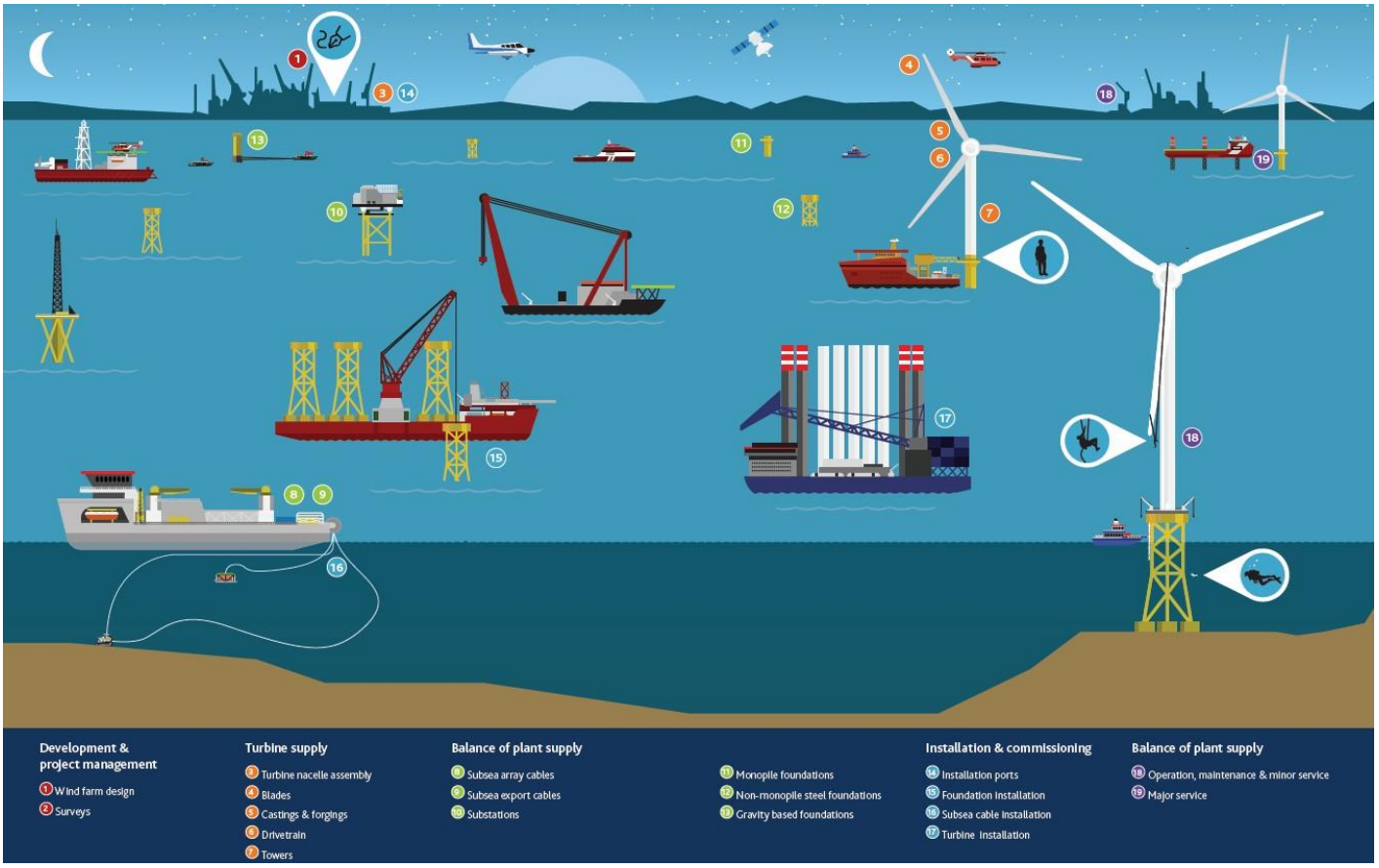


Figure 8 OSW farm supply chain.

Figure 9 illustrates a typical cost breakdown for a UK OSW project. Please note that decommissioning costs are not considered here. The capital expenses (CAPEX) represent approximately 60% of lifetime costs; the remaining 40% are made up of operation, maintenance and service (OMS) costs.

Typical lifetime cost estimate for an OSW farm is $7.3 million per MW, which equates to $3.7 billion for a 500MW wind farm. The expectation, based on current analysis, is that Virginia's primary advantage and the recommended key focus for DMME, should be the manufacture and fabrication of large complex structures such as foundations, particularly non-monopile foundations and offshore substation. Below is an example of classifications of roles and education required for foundation manufacturing (jackets).

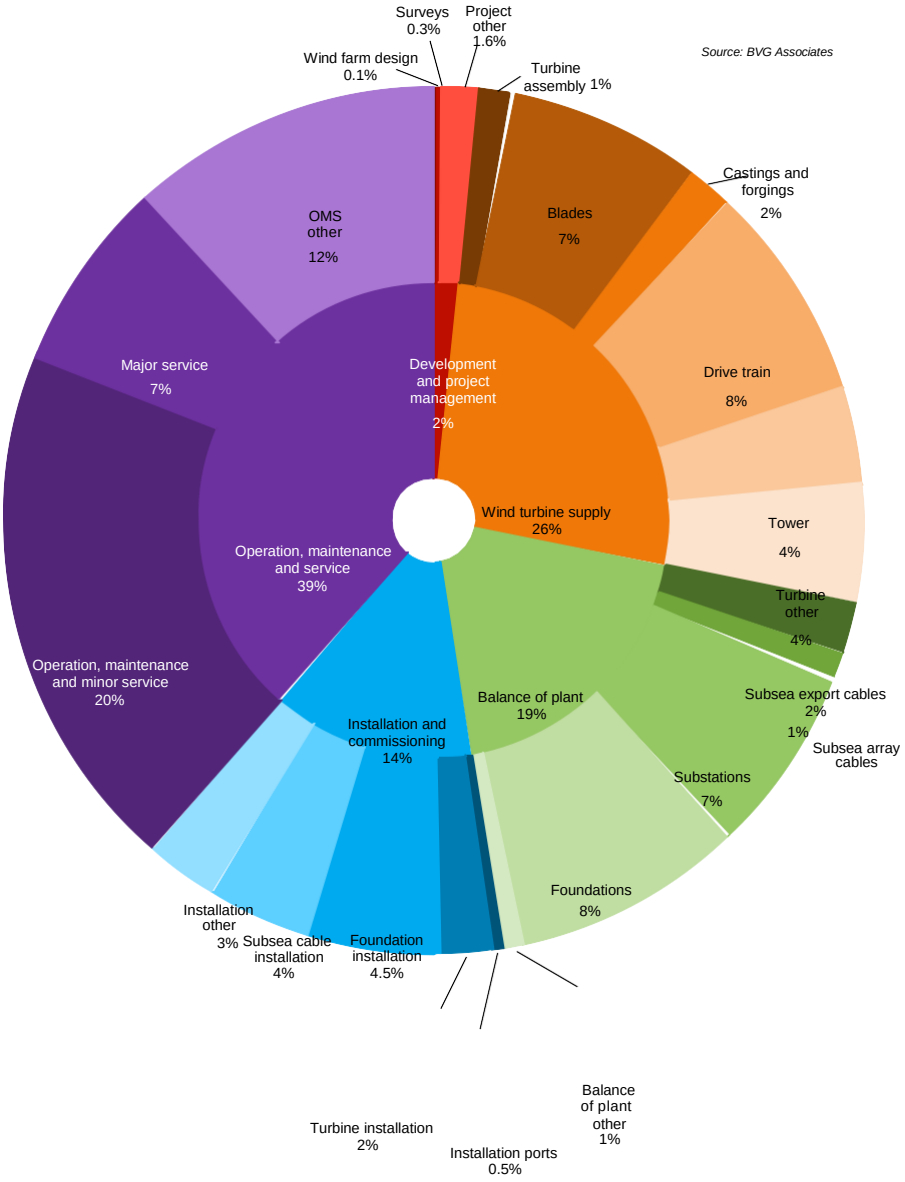


Figure 9 CAPEX and OPEX breakdown of an OSW farm

5.5. Foundation manufacturing

Figure 10 Bladt Industries jacket manufacturing, Denmark.

For the purposes of this report, 'foundation manufacturing' is assumed to mean the production of the main lattice structure and transition piece of a jacket foundation, typically produced at a single facility or adjoining facilities, as in Figure 10.

Job classifications

To manufacture 100 jacket foundations and transition pieces in one year, we estimate that a total staff of about 650 FTEs is needed. Table 9 shows a breakdown of job classifications for these. Of the 600 manufacturing staff, the main lattice production requires 350 FTEs and the transition piece 250 FTEs, equally divided across a three-shift operation. Support staff for both operations is divided across the three shifts as follows: 24 servicing first shift; and 13 each for second and third shift.

Educational requirements

Table 10 shows educational requirements. The majority of production for both the main lattice structure and the transition piece is in welding operations by skilled trade workers requiring post-secondary or trade certification. A minimum high school diploma is required for the carboline coating, galvanize spray, paint operations and ancillary assembly operations.

Skills and certifications

Table 11 shows additional training requirements. For the main lattice and the transition piece production, an American Welding Society (AWS) Welding certification is required for a majority of the skilled trade workers including welders, supervisors and inspectors. AWS requires specific skills plus a combination of qualifying education and work experience. QC inspector certification is required for all quality inspectors and the quality manager.

Table 9 Job classifications for foundation manufacturing.

Classification	Direct jobs (sustained FTEs)
Trade worker	580
Assembly worker	202
Sub-total: manufacturing	600
Manager	25
Engineer	10
Other support staff	15
Sub-total: support staff	50
Total	**650**

Table 10 Educational requirements for foundation manufacturing.

Degree	Number of workers
High school diploma or less	20
Post-secondary or trade certificate	580
Associate degree	25
Bachelor degree	35
Post-bachelor/professional certification	0
Master's or PhD	0

Table 11 Additional training for foundation manufacturing.

Additional training	Number of workers
CNC Machining Certificate (or similar)	0
AWS Welding Certificate	500
Composite Technology Certificate	0
Quality Control Inspector Certificate	50
Six Sigma-minimum Green or Black Belt	10

5.6. Offshore substation manufacturing

Figure 11 Offshore substation being installed at Sheringham shoal OSW farm (UK).

It is assumed that substation manufacture will be performed in a commercial shipyard environment or in partially mobile offshore fabrication yards. It is not anticipated that new, vertically integrated manufacturing facilities will be constructed at this time. Virginia's readiness is evaluated on the assumption that a maximum of two substations would be fabricated per year.

Job classifications

To manufacture two substations a year, we estimate that a total staff of 500 FTEs is needed. Table 12 shows a breakdown of job classifications for these workers.

Table 12 Job classifications for offshore substation manufacturing.

Classification	Direct jobs (sustained FTEs)
Trade worker	200
Assembly worker	240
Sub-total: manufacturing	440
Manager	20
Engineer	15
Other support staff	25
Sub-total: support staff	60
Total	**500**

Overview

OSSs are used to reduce electrical losses before export of power to shore. This is done by increasing the voltage, and in some cases converting from alternating current (AC) to direct current (DC). The substation also contains equipment to manage the reactive power consumption of the electrical system including the capacitive effects of the export cables.

Substations are often delivered as one element of a contract to connect the wind farm generating assets to the onshore transmission grid.

Logistic requirements and fabrication processes both offer a synergetic fit to Virginia conditions: Hampton Roads coastal facilities and unrestricted airdraft waterways offer the necessary space and overhead clearance to fabricate and transport these large components. Installation requires a heavy lift vessel but not jack-up capabilities, as it is possible to choose an adequate weather window with only one or two units requiring offshore installation. Similar to jacket fabrication, substations involve welding, large component handling and assembly comparable to the oil and gas industry as well as the shipbuilding industry.

A HVAC substation topside (everything above the substructure) weighs between 1,000 and 3,000 tons. A 1GW wind farm is likely to have two or three substations.

An HVDC substation topside weighs between 10,000 and 20,000 tons. A 1GW wind farm would only have one HVDC offshore substation but will often be connected to the turbines by several AC convertor stations which would transform the 66kV output from the turbines up to 132kV or higher to feed the HVDC substation.

With the introduction of 66kV subsea cables, near shore wind farms up to 300MW can be built without an offshore substation

A typical HVAC platform is about 25m above the sea and has an area of 800m². Typically, a single substation can support the input of about 500MW. In some circumstances, the greater cost of higher capacity cables can be offset by savings on substation hardware.

Although many substations are not being used primarily as service platforms, they will still have a modestly equipped workshop.

Electrical systems

The electrical system integrates AC power output from individual turbines and transforms voltage from for example 66kV to 275kV for export to onshore substation, else it converts to DC for onward transmission.

HVAC system

An HVAC system converts and transmits the electrical power generated by the wind turbines, at about 66kV AC, to the onshore substation through the export cables at

about 275kV AC. Transformers in the onshore substation may increase the voltage further to about 400kV for connection to the onshore transmission grid.

HVDC system

An HVDC system converts and transmits the electrical power generated by the wind turbines, at 66kV AC, and transformed to about 132kV AC by AC convertor stations, to the onshore substation through the export cables at about 375 kV DC. Equipment in the onshore substation converts the voltage back to about 275kV or 400kV for connection to the onshore transmission grid.

Facilities

Auxiliary systems that support the operation, service and maintenance of the substation and enable wider wind farm maintenance activities.

Structure

The steel structure is complex, with many safety considerations and services incorporated.

A helideck is generally specified to enable helicopter landing.

5.7. Construction staging

The structure of the construction staging workforce is likely to depend on whether it is working on a single, one-off wind farm or an ongoing pipeline of projects. The likely opportunity for Virginia will be in sites planned in Virginia waters, so any growth beyond the 2GW currently identified would increase this potential

For a one-off wind farm, most of the onshore jobs will be short-term contracts. Responsibility for recruiting and training this workforce may rest on either the developer or the wind turbine supplier, depending on the contract structure.

For a pipeline of projects, a more permanent facility and workforce may be possible. In this case, it could be supported either by the wind turbine supplier alongside a manufacturing facility, or by a developer with a strong pipeline of projects in the region.

For the purposes of this analysis, we have assumed that the construction staging facility is operating over a number of years and supporting the construction of 100 turbines per year. Our analysis shows that the facility would employ approximately 220 workers, divided into two main groups:

- Approximately 150 blue-collar and white-collar staff for the assembly of wind turbine components. This involves preparing components for installation and moving them around the construction site. They work a variety of shift patterns depending on their role.
- Approximately 70 blue-collar marine installation and commissioning staff that will support and coordinate the loading of vessels.

There are also many more jobs created during construction that are associated with the vessels and the offshore construction and commissioning work. These workers are much more likely to be working on project-specific contracts, with no fixed base of operation.

5.8. Operation, maintenance and service

Day-to-day personnel and light equipment transfer benefit greatly from short transit times. Wind turbine overhauls or planned major component replacements however, are less distance sensitive but require more substantial load-out and crane capacity. This could result in multi-port strategies with specific activities focused on different locations with the most appropriate facilities.

For a typical duration of five years, wind turbine suppliers guarantee minimum levels of availability on the condition that they have responsibility for day-to-day maintenance activity. More recently, there has been a move to link availability-based contracts with production targets.

Small and Medium Enterprises (SMEs) are particularly well suited to secure opportunities that require a local presence, commercial/technical flexibility or specialist/ innovative solutions.

There are a number of third-party OMS specialist companies establishing themselves within the European OSW sector. These include companies such as 3Sun, Hughes Subsea, ROVOP, Cwind, Briggs Marine and many others. DMME may wish to contact these companies to:

- Better understand companies' interest in a collaborative approach,
- Gain access to industry knowledge and first-hand experience, and
- Discuss how to make the most of any overlaps with current Virginia skills.

Table 13 Example technician requirements for an operating OSW farm.

Scope	Activities
Onshore logistics	Port-side activity, warehousing and on-site office space
Offshore logistics	Planning the resources required to move people and equipment at sea including work boats, offshore bases, helicopter services and jack-up services

Scope	Activities
Back office, administration and operations	Performance monitoring, electricity sales
Turbine maintenance	Inspect and repair the connection of the offshore power plant to the onshore power transmission system, including onshore and offshore electrical substations and export cables
Array cable maintenance	Inspect and repair the subsea cables that connect the turbines to the offshore substation
Foundation maintenance	Inspect and repair the foundations and sub-sea structures

5.9. Opportunity analysis

As part of this analysis, we evaluated 11 commercial facilities for their readiness to accommodate OSW manufacturing and construction activities:

The facilities were assessed against seven main activities and the priorities for pursuit by the owners in co-operation with state bodies and interested investors highlighted and any patterns identified.

- Blade manufacturing
- Nacelle assembly
- Tower manufacturing
- Foundation manufacturing
- Submarine cable manufacturing, and
- Construction staging.

The broad pattern, which has emerged from review of sites, as well as the review of business incentives and skills, is toward facilities which will focus on the construction and fabrication of large complex structures such as non-monopile support structures, as well as offshore substations.

Drawing on intelligence from established OSW industry suppliers and the parameters used in the 2015 study of Virginia's ports, optimal requirements for each OSW activity were developed. The requirements included the waterside infrastructure, the onshore infrastructure for the activities themselves and the access requirements for vessels associated with OSW activities. They excluded the buildings or equipment that would be used for each activity.

The Virginia coastline is geographically rich with waterfront properties for development and redevelopment opportunities. Virginia has a thriving port, shipbuilding and ship repair sector. The facilities were selected by an iterative process between the report team, Virginia DMME and engagement with facility owners and operators to understand available areas of land adjacent to quaysides, as well as appetite for diversification opportunities into OSW. Other ports would likely also be suitable for OSW activities if they became available.

Through dialog with property owners, site visits and desktop research, we built up a database of characteristics for the 11 PMWs. We then assessed the readiness of each port for each OSW activity in turn.

For some activities in some ports, necessary upgrades are either unfeasible or likely to be uneconomic. In these cases, we did no further evaluation.

Although OSW activity is more demanding on port infrastructure than many other commercial port activities, Virginia's ports offer a high level of readiness for the OSW industry. The Virginia Offshore Wind Team has concluded that the 11 Virginia PMWs reviewed for this report show particular promise and realistic potential to be used for one or more OSW activities. These facilities include

- Port of VA Newport News Marine Terminal (NNMT)
- Port of VA Portsmouth Marine Terminal (PMT)
- Cape Charles Harbor Holdings LLC
- Cape Charles Harbor Floating Dock
- Colonna's Shipyard
- Fairlead Boatworks
- East Coast Repair and Fabrication
- General Dynamics Harper Yard
- General Dynamics Ligon Street Yard
- 1201 Terminal Avenue, and
- Seagate

While each of these ports shows great potential for OSW use, the offshore industry requires very specialized facilities with special attributes. Each of the port facilities highlighted herein will require some upgrades or modifications to meet OSW requirements. This report provides details of the required upgrades specific to each activity at each port. These upgrades are summarized in Table 14 and Table 15.

Several of the port facilities reviewed in the 2015 study have been updated and included in this report as these facilities show particular promise for future OSW use. These include the two Cape Charles Harbor facilities, and two of the Virginia's Port Authority properties: the Newport News Marine Terminal (NNMT) and the Portsmouth Marine Terminal (PMT). A high-level summary of these facilities plus the additional facilities evaluated as part of the 2018 update study are presented below. A more detailed overview can be found in section 8.

The Port of Virginia (Virginia Port Authority) Properties at Portsmouth and Newport News

The Port of Virginia is positioned to establish itself as a leader in the emerging US OSW industry. Virginia has a world-class port, an existing maritime-related industry and a ready workforce, this combines to create an unmatched competitive advantage to foster OSW development along the East Coast. In addition, rapid OSW deployment will further be enabled through Virginia's strategic Mid-Atlantic location, with commercial OSW leases in place off the coasts of New Jersey, Delaware, Maryland, Virginia and North Carolina.

NNMT and PMT are both likely terminals the Port of Virginia could adapt for the OSW industry. Numerous locations within the Port of Virginia's complex allow for heavy capacity lifts with ample storage/assembly/staging area and unlimited clearance. With abundant waterfront land and infrastructure, Virginia offers existing terminal

capacity and ample waterfront and on-water capacity for both marshalling and manufacturing.

The Port of Virginia is well underway with a $700 million on-terminal capital investment program to expand annual container capacity by 1 million container units by 2020. This expansion is taking place at Norfolk International Terminals and Virginia International Gateway, which will allow the port to expand its capacity to handle non-containerized cargo (breakbulk) at NNMT and PMT. Many experts point to NNMT and PMT as potential staging and storage sites capable of handling the large components used in the construction of the OSW turbines.

The Port of Virginia is a catalyst for commerce, creating economic investment and jobs throughout the Commonwealth. The Port is well-situated to support the OSW industry supply-chain and potential manufacturing opportunities for existing industries located along the Virginia waterways. Both Virginia Port Authority properties, NNMT and PMT, are US Customs-designated ports of entry and the full range of customs functions is available to customers, including bonded storage areas.

Newport News Marine Terminal (NNMT)

The NNMT facility is currently the Port of Virginia's premier break-bulk and roll-on/roll-off facility, handling thousands of tons of bulk cargo and thousands of vehicles per year. The site covers approximately 165 acres (67ha) on the north bank of the James River, with over 60 acres (24ha) of outside storage and 968,000sqft (89,930sqm) of covered storage space. Within the facility there exists 112 acres (45ha) of uncovered upland area that could be developed for marshalling or manufacturing uses. The coastal frontage of the facility covers 2,600 lineal ft (792m) along the James River. Vessels have access to two piers with four vessel berths, containing 3,480ft (1,060m) of berth space, with draft depth of 40ft (12m) MLLW, accommodating vessels 850ft (260m) in length. The facility also contains 33,900ft of Class I rail provided by CSX. Of particular interest to the OSW industry, the NNMT has extensive roll-on/roll off capacity, delivering heavy-lift components and has traditionally received and shipped power plant equipment via water. The piers at the site can accommodate vessels of up to 850ft (260m) in length. The analysis indicates this facility could be converted without significant modification to become an OMS base, a service port or a secondary steel port. With a moderate investment it could be used as a marshalling and/or manufacturing port for a broad range of OSW components (including an array of foundations).

Portsmouth Marine Terminal (PMT*)*

Is one of the largest of the Port of Virginia (Virginia Port Authority) sites with 287 acres (116ha) of land area and a 4,500ft (1,372m) long quayside. The property is currently operating as one of the chief overflow container facilities in the Port. Container gantry cranes run along rails on the quayside. With no overhead restrictions to the open ocean and marine approach channels 38ft (11m) deep, this site represents an excellent candidate for inclusion into the OSW industry. With little to no investment, the site could readily support OSW in either OMS or Service Port activities. With low to moderate investment the site could support the manufacture or fabrication of blades, towers, nacelles and foundations. Foundations includes transition pieces, monopiles and jackets but also gravity foundations and floating wind platforms. Well placed investments in reinforcing the pier/wharf and upgrading the bearing capacity of the uplands would increase the appeal of the site to the OSW supply chain.

Cape Charles Harbor properties

The Cape Charles Harbor properties represent two old industrial properties on the shores of Cape Charles Harbor. The Cape Charles Harbor Holdings LLC facility (CHH facility), the property on the south side of the harbor, consists of approximately 22 acres (9ha) with a short 200ft (61m) pier. Water depths in the harbor and on approach are relatively shallow for the area at approximately 14-18ft (4.3-5.2m) deep. Several small buildings exist on the site, currently unused. All structures onsite are in various states of disrepair, as is the concrete pier and the small wooden finger piers that extend from the concrete pier. The property is relatively small by itself, however if the adjacent vacant lot were to be appended onto the site the acreage would expand to over 145 acres (59ha). Activities that could be supported in the main property include OMS, service port and secondary steel. If the adjacent property were to be appended, the site would have the acreage to support larger components (with quay improvements), including nacelles, towers, blades and monopiles. The site is not well suited for jackets or substations.

The Cape Charles Harbor Floating Dock (CHF dock) site is small at 6.4-acres/2.6ha. This site is mostly vacant with one warehouse building in poor condition. There is a bulkhead/pier along the harbor edge that is in disrepair and would require upgrades if the site is to be used for OSW activities. The bulkhead has over 800ft (240m) of harbor frontage. Water depths, like at the other Cape Charles Harbor property, is between 14 and 18ft (4.3 and 5.2m). This site is suitable for OMS and secondary steel (with improvements) and could be used for cable and as a service port. The shallow water and small acreage preclude large component transfers at this site.

An immediate opportunity for investment to improve the site for OSW uses is dredging. Dredging of the harbor and the channels leading to the harbor represents improvements that will increase the likelihood that the supply chain will look closely at these two properties.

Colonna's Shipyard

Is a large facility (87 acres/35ha) located on the East Branch of the Elizabeth River. The property has an

irregular coastline and numerous protruding piers, however these could be removed and/or re-purposed for OSW uses. The property has a long (shallow draft) quayside and a dry-dock. Both these features are interesting for OSW, but would need to be upgraded before they could be used for those purposes. Dredging is needed in order to open up the quayside to shipping.

Fairlead Boatworks

Is a very small property (5.3 acres/2.1ha) located on the southern shore of Newport News Point. The property is narrow but has a relatively long quayside (975ft/300m). The berth next to the quayside is narrow (150ft/46m) and shallow (10ft/3m). The main uses for this site are OMS, secondary steel and potentially as a laydown area for overflow components.

East Coast Repair and Fabrication

Is a moderately sized facility (17-acres/7ha) located on the northwest shore of the west branch of the Elizabeth River. The site consists of numerous finger piers and a series of slot-quays that extend into the River. The property has some open land, but the layout of the piers is not conducive for OSW use and would need to be removed before the site could reach its full potential for OSW. However, the site shows potential for several uses, including cable operations, OMS, secondary steel and potentially blade manufacturing. Repairs and upgrades to this facility would be fairly expensive, though its utility could be enhanced to a great extent if upgrades are undertaken.

General Dynamics Harper Yard

This site is a moderately large (56-acres/22ha) facility on the Elizabeth River in Portsmouth, Virginia. The site has been one of the main shipyards in the area for several decades, serving the military and civilian shipping industries. The site contains three long finger piers that allow berthing in the port. Due to the size of this facility, it could be utilized for an array of OSW activities, including OMS, cable load out, nacelle assembly or manufacturing of monopiles, jackets and blades. Conversion of the property to these uses would require some significant modifications to the quayside and the area behind the quay. Abbreviated in **Table** 14 and Table 15 below to GD Harper Yard.

General Dynamics Ligon Street Yard

Is a 33-acre (13ha) site located on the shores of the east branch of the Elizabeth River. The site consists of a number of finger piers and houses a large steel building at the quayside currently used for ship repair. This site could be readily adapted for use for OSW activities that don't require significant land area. These include OMS, secondary steel, cable operations and blade manufacturing. The site could be adapted for operations for the larger components with some significant redevelopment of the quayside and ground improvements. Abbreviated in **Table** 14 and Table 15 below to GD Ligon Street.

1201 Terminal Avenue

This site encompasses approximately 84 acres (34ha) and is adjacent to a large coal distribution yard and an oil terminal. The site has too long finger piers that allow for the berthing of large vessels. Water around the piers is deep and the upland portions of the site are irregularly shaped (narrow and elongated site shape). The waterway includes a 50ft (15m) deep, 800ft (244m) wide channel leading out into Norfolk Harbor and Hampton Rhodes making it well suited to the large transport vessels. Due to its acreage, this site shows promise for a variety of OSW uses, including foundation and nacelle fabrication. Those uses would require a fairly high amount of refurbishment in order to make the site useful.

Seagate

The Seagate facility is an approximately 43 acre (20ha) facility on the Elizabeth River that houses an aggregate transport and storage business. The site has a long quayside (975ft/300m long) and currently has a large rail crane that runs along the quayside for the offloading of aggregate materials. There is one large warehouse building on the site and the remainder of the site is open. This site could be adapted to support manufacturing for all non-foundation components. The site could be used for larger foundation pieces, however significant upgrades to the quayside and the load bearing capacity would be required.

5.10. Summary

Table 14 presents an overview of upgrade cost, the time it would take to deliver and the potential employment opportunity for these facilities. Table 15 provides summary findings from the port evaluation.

Despite the infrastructure requirements, foundation manufacturing and staging, as well as offshore substation and foundation manufacture represent core opportunities for Virginia. Not many facilities along the East Coast are suited for such a significant logistic challenge, requiring unrestricted air draft.

From Virginia's point of view and also from an overall East Coast industry perspective, investments to upgrade the yellow fields in the table to green would be a prudent step. In addition to the logistic match, this large scope also provides significant economic benefit and can draw from natural synergies with current industrial activities.

Table 14 High level overview of upgrade cost and employment opportunity for new facilities assessed.

Activity	NNMT	PMT	CHH facility	CHF dock	Colonna's Shipyard	Fairlead Boatworks	East Coast Repair and Fabrication	GD Harper Yard	GD Ligon Street	1201 Terminal Avenue	SeaGate
Blade manufacturing	$$	$			$$	$$$	$$	$$	$$	$$	$$
Nacelle assembly	$$	$$			$$$	$$$	$$$	$$$	$$$	$$$	$$$
Tower manufacturing	$$	$$			$$$			$$$	$$$	$$$	$$$
Jacket manufacturing	$$	$$			$$$$					$$$$	$$$$
Subsea cable manufacturing	$	$	$$	$$	$$	$$	$$		$$	$$	$$
Construction staging	$$	$$			$$$	$$$			$$$	$$$	$$$
Offshore substation manufacturing	$$	$$			$$$	$$$			$$$		
Operation, maintenance and service	$	$	$$	$$	$	$$	$$	$	$	$$	$

Key for Table 13

$ = up to $5,000,000 upgrade cost
$$ = greater than $5,000,000, up to $20,000,000
$$$ = greater than $20,000,000, up to $50,000,000
$$$$ = greater than $50,000,000

= up to 1 year to complete
= greater than 1 year, up to 2 years
= greater than 2 years, up to 3 years
= greater than 3 years

= up to 100 annual FTE-per year for port upgrade construction jobs
= greater than 100, up to 200 FTE-per year
= greater than 200, up to 400 FTE-per year
= greater than 400 FTE-per year

= unsuitable site for activity

Key for Table 14

S = Suitable with little or no upgrades
Sw = Suitable with upgrades
M = Major improvements required
U = Unsuitable

Table 15 Summary findings from port evaluation.

Activity	NNMT	PMT	Cape Charles Harbor (CHH facility)	Cape Charles Harbor Floating Dock	Colonna's Shipyard	Fairlead Boatworks	East Coast Repair and Fabrication	GD Harper Yard	GD Ligon Street	1201 Terminal Avenue	SeaGate
Blade manufacturing	S	S	U	U	Sw	M	Sw	Sw	Sw	Sw	Sw
Nacelle assembly	Sw	Sw	U	U	M	U	M	M	M	M	Sw
Tower manufacturing	Sw	Sw	U	U	M	U	U	M	U	U	Sw
Jacket manufacturing	Sw	Sw	U	U	M	U	U	U	U	U	U
Subsea cable manufacturing	S	S	M	M	S	S	S	S	S	S	S
Construction staging	Sw	Sw	U	U	M	M	U	U	U	U	U
Offshore substation manufacturing	Sw	Sw	U	U	Sw	Sw	U	U	U	U	U
Operation, maintenance and service	S	Sw	Sw	Sw	Sw	Sw	Sw	Sw	Sw	Sw	Sw

6. Business climate

In this section we examine the existing and new economic development incentives that can be used to attract industry or businesses, as applicable to those that facilitate the deployment of OSW.

6.1. Business incentives and business climate

Virginia's strong business-friendly reputation goes well beyond incentives and strategies aimed at attracting business. Features include offering good career opportunities, quality of life, cost of living, level of education as well as a low crime rate, and history of supporting industry growth in Virginia.

A unique Virginia feature is access to the multiple US major population centers located in the eastern region of the country. Half of the US population lives within a one-day drive (defined as 500 miles). Many rail, long-haul interstate and marine shipping options are available to major suppliers/manufactures of industrial products and construction materials.

Virginia's present economic development incentives resemble those of neighboring states where a wide range of programs and incentives are offered across a number of applications. For example, tax credits, tax exemptions, development fund grants and support for job creation or training. These incentives are sponsored by multiple economic and community development sources. To coordinate these sources of funding it is recommended that the Virginia Offshore Wind Team should stay intact to work in parallel with a Virginia Office for Offshore Wind. This will allow the continued development and deployment of strategies for Virginia to better understand the OSW industry needs. Responding to these needs should become a recurring priority. These activities would include listing of trades and skills that are, or could be, supported in regional offerings through the various training centers/outlets. Training needs would be ranked and prioritized based on level of impact to industry (relative to training capabilities), followed by industry collaboration that considers how offerings could be consolidated, improved, or restructured in order to increase their relation to OSW.

The state VEDP will take a lead role with large manufacturers, service companies and other major investors/employers. Assistance will also be provided by state agencies tasked with administration of the various offerings. A sample of State level incentives and programs that have relevance to the OSW sector include:

- Commonwealth Opportunity Fund
- Major Eligible Employer Grant Program (MEE)
- Virginia Economic Development Incentive Grant (VEDIG)
- Virginia Jobs Investment Program Assistance (VJIP), and
- Small Business Job Grant Fund

Some supportive incentives, such as the Commonwealth Opportunity Fund, have regional leveraging potential based on general, single or double eligibility thresholds, which under the present geographical designation will surely assist the Hampton Roads area. The primary criteria for eligibility and level of assistance typically revolve around the number of new jobs created or retained and capital investment conditions.

The Offshore Wind Office, as an agent for prospects, with support of Offshore Wind Business Team/program sponsor serving as a "sub-agent", would be able to provide services aimed at optimizing the state's effectiveness in attracting, supporting, growing and retaining a strong supply chain.

The present portfolio of incentives has been designed, like other states' programs, to target a wide range of businesses from a variety of industries. As the OSW sector transition gains momentum, significant capital investments for both tangible assets and personnel will be required and the existing Virginia incentive programs may become limited in their ability to drive expansion and growth. One consideration is for the state to develop a new initiative with a holistic long-term view of the business needs in the form of "Virginia Offshore Wind Construction and Supply Chain Program". This approach would make Virginia the first state to make this commitment and it would move the State to the forefront of this growth sector.

Initially, new support initiatives such as this can take the form of 'carve outs' from existing state economic development/job creation/training programs so that the OSW sector could immediately participate and compete with funding requests from other existing industries or business prospects.

Further, not all the programs require immediate development and launch. The rollout of different elements could be staged to match the growing needs of the industry, most likely first addressing port infrastructure and businesses involved in construction and deployment.

The second phase could be targeted toward attracting wind turbine suppliers and second tier suppliers to support manufacturing. The third phase would be the transition to OMS The final phase could target innovation for prolonged growth of the supply chain. Examples of the different forms of support, both financial and non-financial could potentially bolt-on to existing Virginia programs. For examples of similar implementations made by the Europeans as shown:

- Advanced Manufacturing Supply Chain Initiative (AMSCI) designed to improve the global competitiveness of advanced manufacturing supply

chains and encourage major new suppliers to locate to a particular state or region

- Offshore wind manufacturing support fund
- Establish a Center for Offshore Renewable Engineering (CORE)
- Partner with private investors to encourage inward investment
- Offshore wind expert support to-provide tailored coaching and mentoring to individual companies to identify the specific opportunity and how to align with it, and
- Establish an Offshore Wind Investment Organization. Leveraging security or underwriting loans to accelerate private sector investment

Concurrent to the different phases of supporting and incentivizing the development and growth of a Virginia based supply chain there should be a corresponding set of support for work force development to meet the skills required with appropriate and well-matched training or retraining.

Marketing to veterans and integrating into Navy transition services is a mission embraced by the Workforce Team. This is in addition to seeking strategies to help backfill workforce fluctuation caused by start/completion cycles of Navy contracts.

6.2. Existing incentives relevant to offshore wind

Commonwealth's Development Opportunity Fund (COF)

COF is a "deal-closing" fund to be employed at the Governor's discretion to secure a company location or expansion in Virginia. Administered by the VEDP, the COF serves as a final resource for Virginia in the face of serious competition from other states or countries.

Each investment opportunity must meet thresholds for capital investment and job creation. Figure 12 defines whether projects may need to meet General Eligibility Thresholds, Single Distressed or Double Distressed Eligibility Thresholds, depending on location. These thresholds are:

- General Eligibility Thresholds:
  - 50 new jobs and $5 million capital investment, or 25 new jobs and $100 million capital investment
  - The average annual wage for the new jobs must be at least equal to the prevailing average annual wage in the locality, excluding fringe benefits, and
  - If the average annual wage is at least twice the prevailing average annual wage, the Governor may reduce the new jobs threshold to as low as 25.
- Single Distressed Eligibility Thresholds, for locations with an unemployment rate above the average state-wide unemployment rate or with a poverty rate above the state-wide average poverty rate:
  - 25 new jobs and $2.5 million capital investment and
  - Jobs must pay at least 85% of the prevailing average annual wage in the locality, excluding fringe benefits.
- Double Distressed Eligibility Thresholds for locations with an unemployment rate above the average state-wide unemployment rate and with a poverty rate above the state-wide average poverty rate:
  - 15 new jobs and $1.5 million capital investment and
  - Jobs must pay at least 85% of the prevailing average annual wage in the locality, excluding fringe benefits.

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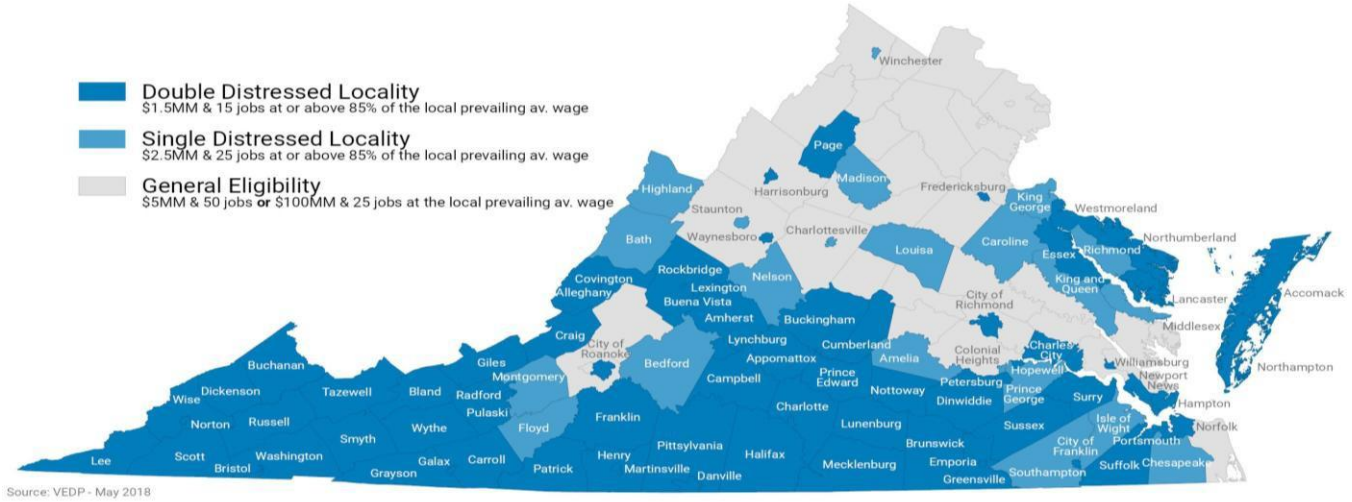

Double Distressed

Accomack	Dinwiddie	Norfolk	Waynesboro
Alleghany	Emporia	Northampton	Westmoreland
Amherst	Essex	Northumberland	Williamsburg
Appomattox	Franklin	Norton	Wise
Bland	Fredericksburg	Nottoway	Wythe
Bristol	Galax	Page	
Brunswick	Giles	Patrick	
Buchanan	Grayson	Petersburg	
Buckingham	Greensville	Pittsylvania	
Buena Vista	Halifax	Portsmouth	
Campbell	Hampton	Prince Edward	
Carroll	Harrisonburg	Pulaski	
Charles City	Henry	Radford	
Charlotte	Hopewell	Rockbridge	
City of Franklin	Lancaster	Russell	
City of Richmond	Lee	Scott	
City of Roanoke	Lexington	Smyth	
Covington	Lunenburg	Suffolk	
Craig	Lynchburg	Surry	
Cumberland	Martinsville	Sussex	
Danville	Mecklenburg	Tazewell	
Dickenson	Newport News	Washington	

Single Distressed

Amelia
Bath
Bedford
Caroline
Charlottesville
Chesapeake
Colonial Heights
Floyd
Highland
Isle of Wight
King and Queen
King George
Louisa
Madison
Middlesex
Montgomery
Nelson
Prince George
Richmond
Southampton
Staunton
Winchester

Figure 12 Map of eligibility for Commonwealth's Development Opportunity Fund support.

Major Eligible Employer Grant Program (MEE)

The program offers cash grants up to $25 million to qualified applicants. Grants are paid in five to seven equal annual installments beginning in the third year after the capital investment and job creation or retention are achieved.

- Minimum capital investment threshold of $100 million.
- Minimum job creation threshold of 1,000 net new jobs (threshold lowered to 400 jobs if the average pay is at least twice the locality's prevailing average wage).

Ports of Virginia Grant (POV)

POV grants are made at the discretion of the Executive Director of the Virginia Port Authority with the expectation that grants awarded will be used to assist a qualified company to locate a new operation or expand an existing operation within the Commonwealth of Virginia.

Subject to appropriation, POV grants are available from January 1, 2014, until June 30, 2020. The maximum grant per qualified company is $500,000 and the maximum total that can be awarded in any given fiscal year is $5 million.

Virginia Economic Development Incentive Grant (VEDIG)

Projects must meet the following eligibility requirements:

- Project must be affiliated with a basic employer, meaning 51% or more of the facility's revenue must be generated outside the Commonwealth.
- There must be an active and realistic competition between Virginia and another state or country for attracting the project.

In addition, a company locating in a Metropolitan Statistical Area (MSA) with a population of 300,000 or more in the most recent decennial census must:

- Create 400 new full-time jobs with average salaries at least 150% of the local prevailing average wage, or create 300 new full-time jobs with average salaries at least 200% of the local prevailing average wage.

- Make a capital investment of at least $5 million or $6,500 per job, whichever is greater.

A company locating elsewhere in Virginia must:

- Create 200 new full-time jobs with average salaries at least 150% of the local prevailing average wage.
- Make a capital investment of at least $6,500 per job.

'Capital investment' means an investment in real property, tangible personal property, or both at the facility within the Commonwealth.

'New job' means employment of an indefinite duration for which the company pays the wages and standard fringe benefits for its employee, requiring a minimum of either (i) 35 hours of the employee's time a week for the entire normal year of the firm's operations, which 'normal year' must consist of at least 48 weeks or (ii) 1,680 hours per year. If there are existing jobs at the firm's facility, it is expected that the performance agreement will state the number of existing jobs and will require that any new jobs be in addition to the existing jobs.

Virginia Investment Performance Grant (VIP)

To obtain, a company must be an existing Virginia manufacturer or offer a research and development service that supports manufacturing and the project must result in capital investment of at least $25 million.

VIP grants are paid in five equal annual installments beginning in the third year after the capital investment and job creation or retention are achieved, or in the second year if the company is locating in a fiscally distressed area of the state.

- Small Business Job Grant Fund
- Major Business Facility Job Tax Credit
- Industrial Development Authority (IDA) Performance Incentives, and
- Gazelle Grant

Virginia Jobs Investment Program Assistance (VJIP)

The Virginia Jobs Investment Program (VJIP) provides services and funding to companies creating new jobs or experiencing technological change to reduce the human resource development costs for new companies, expanding companies and companies retraining their employees.

Funding for each net new full-time job created or full-time employee retrained is based on a customized budget determined by an assessment of the company's recruiting and training activities. Funding is reimbursable 90 days after the trainee is hired (for new jobs programs) or after the retraining activity has occurred (for retraining programs).

In addition to direct funding to offset a company's recruitment and training costs, VEDP offers human resource consultative support at no charge.

6.3. Supply chain growth cycle

Understanding the cycle and sequencing of the various trades, skills and business opportunities in OSW will help maximize success. Supply chain prospects should be categorized not only by what they do, but also by when they are needed. This would be an appropriate assignment for the Virginia Office for Offshore Wind, in partnership with the Business and Workforce Development teams.

For example, 19 companies that responded to questionnaire for the electric toolkit indicated they provide project management services. These are services required at an early stage in the project life cycle. The Virginia Office for Offshore Wind needs to offer support and coaching about OSW project management early on, to ensure local business will be prepared to start engaging within the OSW supply chain.

6.4. Recommendations

Based on dialogue with a wide range of stakeholders, we recommend the following in order to secure local investment and supply chain development in Virginia.

- Solicit and attract 'anchor tenant' suppliers, with a focus on major components
    - Utilize state economic development resources to actively recruit major suppliers and consider engaging an OSW subject matter expert to provide introductions and help secure interest of prospects
    - Develop a 'tour package', hosting developers and major suppliers and offering clarity on what Virginia can offer to major employers that choose Virginia, and
    - Send a strong "open for business" message, addressing areas of interest and concern and reinforcing through access to local and state decision-makers.
- Enable and grow Virginia's business opportunity through partnerships and infrastructure
    - Keep the Offshore Wind Business Team intact
    - Provide clear and timely guidance on eligibility and access to existing resources applicable to OSW
    - Consider establishing industry specific programs, incentives and resources
    - Dedicate assistance to second tier/lower tier suppliers and maintain partnership tools that

connect regional cluster businesses with developers and investors, and

- Pursue infrastructure improvements that enable port readiness, consider incentives for private assets and leverage existing programs such as the Virginia Waterway Maintenance Grant Program for dredging.

Specifically, in delivering the above, we recommend the following initiatives:

Local business coaching

Based on experience working with US companies responding to supply chain OSW bids, we suggest placing business prospects into three categories in order to better direct State resources toward their business needs, as described in Figure 13.

Advanced	Intermediate	Developing
• Sophisticated and credible in business approach; ISO and H&S certifications in place; conducting R&D/technology commercialization; experience with exporting; cash-flow positive. • Support advanced businesses that already have secured opportunities or have decided to enter market & build on their R&D/technology commercialization strengths • Advanced businesses should be given priority points in competing for VIP; POV and MEE to help create a cluster of OSW business in the state. • Additional selected and critical business services could be assisted through leveraging U.S. DOC and other Federal, State, local and private programs.	• Exhibit history and solid performance in domestic market; may or may not have an OSW industry business plan; may have ISO and H&S certifications, little or no R&D and/or export experience, breakeven or cash-flow positive • Engage with intermediate businesses planning to enter the market & help them understand the OSW industry • Intermediate businesses include an array of selected and critical business services including: business counseling/consulting; mentoring; matchmaking and awareness building; promotion strategy and support to supply chain businesses. • DMME should develop 'executive mentoring teams' with experienced staff and companies (European hands-on OSW experience) and provide information on best practices.	• May or may not have an OSW industry business plan in place; newly formed or short history, little or no ISO and H&S certifications, require funding to grow. • Assist developing businesses interested in market entry which presently do not have capacity. • Educational workshops are needed on the OSW industry supply chain. These facilitate knowledge transfer to small businesses and help them identify where they fit in the OSW contracting hierarchy.

Figure 13 Categories for business prospects.

Tier 1 suppliers should also be encouraged to mentor Developing businesses as well as provide knowledge to intermediate businesses that want to expand their operations to new areas.

In the interest of helping Developing businesses catch up, accumulating new research and existing information in an online 'offshore wind industry 101 resource guide' would provide an ongoing education resource on the OSW industry. Subjects could include terminology; components of a wind farm; vessels used; supply chain breakdown; certifications; installation videos and best practices. Finally, by utilizing Small Business Administration and other funding, Developing businesses can be linked with resources that can provide business plans, financial counseling, leadership training, management consulting and credit counseling. These partners could also host workshops for all supply chain businesses.

Anchor tenant outreach

Virginia stakeholders recognized in 2017 informal working sessions that the OSW market is emerging on the US East Coast. Virginia is well positioned to participate with major components, particularly in areas such as jacket foundation manufacturing. This has been part of a recommendation by Renewable Resources International in a 2017 presentation to the Virginia Offshore Wind Development Authority (VOWDA). Renewable Resources International recommended that Virginia quickly secures a partnership

with a leading European foundation fabricator, in order to obtain first-mover advantage.

As a next step, DMME should work closely with VEDP, SOCT and the Governor's Office to formulate a trade mission to meet with reputable foundation suppliers for the current European OSW market.

The intent is that Virginia secures a primary foundation manufacturer (similar to the philosophy of attracting and Amazon or Walmart) and locates them in the Hampton Roads area. This facilitate other OSW supply chain companies moving to the same area to benefit from the close proximity.

Coalesce regional economic development efforts around offshore wind

In discussions with several elected officials and economic development managers, it appears the region is seeking an economic development initiative that could help uplift and coalesce the regional efforts to attract high paying jobs and investments.

Currently Reinvent Hampton Roads (Reinvent), Hampton Roads Planning District Commission (HRPDC) and Hampton Roads Economic Development Alliance (HREDA) are evaluating site readiness for OSW across the Hampton Roads region. BVGA presented the preliminary report results at the HRPDC Annual Meeting on October 18, 2018. The HRPDC recommended passing a resolution in support of the Virginia OSW project at its next monthly meeting. As such, this project can serve as an opportunity to coalesce regional economic development efforts.

If DMME works closely with Hampton Roads local government officials via the HRPDC this will support a focus on regional economic development efforts to capture a significant portion of the Virginia OSW supply chain. This should also involve engaging the local economic development officials as appropriate.

The intent is to increase awareness of Virginia's OSW opportunity with key local government elected officials and their economic development teams. By promoting OSW within local government, the representatives can help educate their electorate and key community leaders to build support for maximizing the benefit of the Virginia OSW opportunity.

The intended outcome is that local government officials and regional economic development organizations provide resolutions of support for the various Hampton Roads Economic Development and Planning Organizations to proactively pursue the Virginia OSW supply chain market. This will be further supported by private organizations such as Virginia Manufacturers Association, Virginia Maritime Association, Virginia Ship Repair Association who will provide letters or resolutions of support for Hampton Roads and Virginia to pursue the OSW supply chain.

Deliver a Virginia offshore wind brand and campaign

Building on the wish to establish an economic development initiative in OSW, it is important to deliver a Virginia OSW branding campaign to highlight the regional and statewide assets, strengths and successes and bring cohesion to a wide program of activities. This initiative could be eligible for GO Virginia funding and could be led by VEDP, HRPDC, HREDA and/or Reinvent Hampton Roads.

The intent is to increase international awareness that Hampton Roads and Virginia is the premier location for key OSW supply chain activities and signal to the market that Virginia is 'Open for Business". The timing of this campaign will be critical to helping Virginia and Hampton Roads establish the region and State as a leader in this market. It is likely to use a wide range of business channels including social media, conventional press releases, targeted marketing collateral and engagement with potential suppliers and their clients.

Leverage funds and incentives to incentivize offshore wind supply chain investment

Currently Virginia has no designated legislative group to focus specifically on incentives for an OSW supply chain. Virginia does have the MEI Project Approval Commission set up for 'Major Employment and Investment' projects which require approval for any incentives in excess of $10 million in value.

A MEI Project is defined as a project that exceeds $250 million in investment and creates over 400 jobs.

A vehicle needs to be in place to negotiate and provide such incentives in order to secure investment from OSW.

It is recommended to engage the MEI Project Approval Commission, or set up a similar a legislative commission to focus solely on incentives to attract the Virginia OSW supply chain, utilizing VOWDA as the potential conduit for distribution of incentives.

Assess public port infrastructure upgrade costs for offshore wind

From the review of the PMW's in section 5 it is clear that the conditions of these facilities vary greatly. To secure funding for development/redevelopment of PMWs it's important to understand the required cost. This understanding will support the OSW supply chain when forming business cases and Virginia in deciding how best to incentivize upgrades of public and private PMWs.

We recommend VPA aggressively pursue the WRDA bill, S. 3021, "America's Water Infrastructure Act" recently enrolled and expected to be signed by the President. It requires a study and report by the Secretary of the Army/Corps of Engineers on three innovative ports for OSW development. This calls for the Army Corps of Engineers to carry out a study of all federally authorized

ports and harbors, including in the Mid-Atlantic, Gulf Coast, West Coast, Great Lakes and New England regions of the United States, to identify:

- Not less than three suitable federally authorized ports and harbors in those regions that could become innovative ports for OSW development
- Barriers to the development of innovative ports for OSW development
- The Federal and State actions, including dredging and construction of supporting infrastructure, needed to facilitate the development of the federally authorized ports and harbors identified, and
- Recommendations on any further research needed to improve federally authorized ports and harbors in the United States for OSW facility development and deployment.

In addition, DMME and/or the Port of Virginia could commission an independent evaluation of the public and private port facilities. This would separately determine the capital costs required to provide the necessary infrastructure and improvements in order to accommodate key OSW suppliers.

The result of this work will be a detailed evidence-based report which DMME and Virginia can utilize to determine which port facilities (public and private) have the best potential return on investment for Virginia taxpayers. It will also be useful in pursuing potential public private partnerships to implement improvements for these facilities.

7. Workforce development

7.1. The need for development

Workforce is a one of the biggest challenges that confronts any major industry or employer looking to open or locate in a new area. Employment in the OSW industry covers a wide array of technical, scientific and trade related skillsets. Preparedness of Virginia's workforce is critical for those seeking to deliver lower costs and higher quality to the industry and in time, to projects deployed in the Virginia WEA.

As the presence of the supply chain grows, training and education of the workforce needs to grow accordingly. The OSW supply chain requires a skilled, efficient and well-compensated workforce. To deliver this, the government, academia and industry need to collaborate to determine the credentials and industry standards necessary, or to adapt established practices to the extent required, then to create the workforce.

Workforce development in Virginia is delivered under four decentralized avenues: law, programs, state agencies and local agencies (see Figure 14). The workforce development programs are designed to support the regional and state economy by creating a robust workforce.

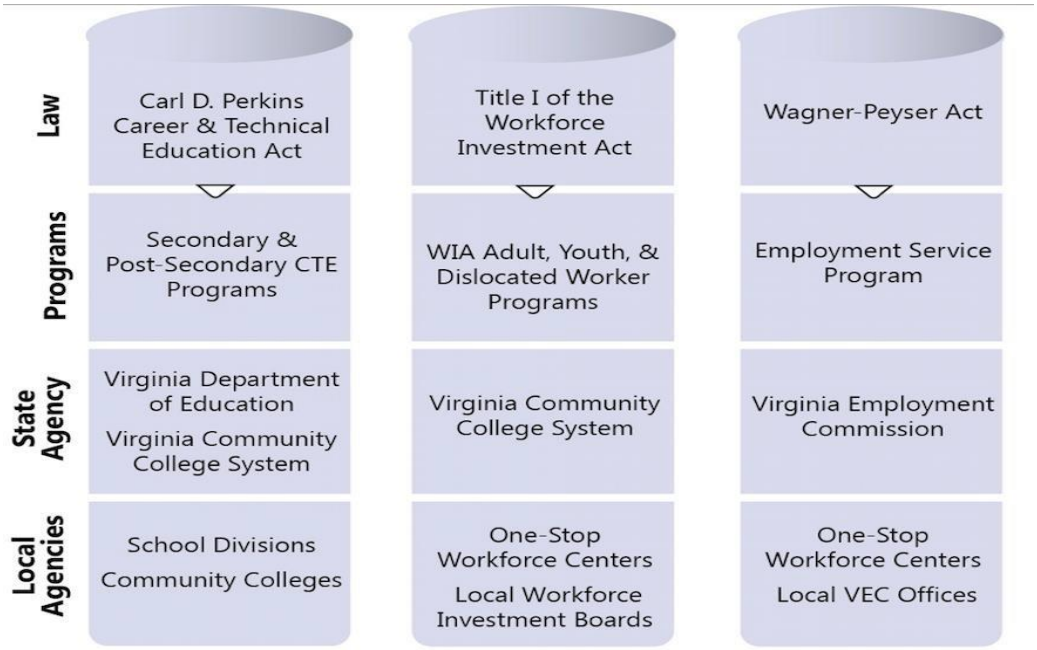

Figure 14 Landscape of work force development in the Commonwealth of Virginia.

Virginia is well positioned with an existing, well-qualified workforce, a rich history in ship building and repair and Hampton Roads, an ideal industrial area for a new OSW supply chain.

Virginia has a solid base of workforce development and community college organizations which could integrate the specific OSW requirements into the current programs.

7.2. Suggested actions

The Offshore Wind Workforce Development Team, identified the following workforce development actions, both existing and with respect to future needs and capabilities to target:

- Virginia has a strong fabrication infrastructure and will be able to adapt it for OSW foundations and wind turbine towers. The welding requirements, however, are different. These requirements will need to be understood and integrated into welding training and certifications.
- Virginia Maritime Academies, Institutes and Community Colleges will need to meet with developers and installation and commissioning contractors to define baseline needs and agree upon an adequate training curriculum.

The team also brainstormed a list of relevant factors to be considered when developing strategies:

- Establish timeline (align the training to complete as jobs become available)
- Understand current training needs and associated capacity (for example welding is already at full capacity)
- Anticipate future needs (integration of certification and skillset requirements)

- Consider welding skillsets needed for certification U.S. versus Europe
- Foster joint community college approach
- As applicable, collaborate with Unions to pull from experienced U.S. workers, and
- Retrain and certify as needed

Creating a labor map that coincides with project development timelines would assist in determining:

- The jobs/certification needs and the timetable in which they are required
- Whether current workers could transition, or if new skills need to be developed
- Strategies that have been successful elsewhere in supporting skills creation in the areas identified as in need, and
- Rank and prioritize the various strategies considered.

By utilizing the 'train the trainer' approach, Virginia can expand the expertise of new and existing industry training providers through peer exchange forums, one-on-one peer exchange with current providers and site visits with associated sub-sector industries. Sequencing the development of training to fit with OSW project lifecycles is recommended, hence covering permitting and resource assessment, manufacturing, construction/installation and then OMS.

7.3. Workforce skills requirements

As Virginia has an established history in workforce development for the maritime industry, with the basis being the US Department of Defense (DOD)/Navy, it will be easier to integrate new OSW training requirements than in locations without such a basis.

Specific OSW requirements for safety, welding, maritime, composites, general manufacturing, CNC machining and six sigma/lean manufacturing needs to be integrated. These requirements have already been reviewed with multiple Virginia workforce development agencies and community colleges. They advise that they could easily adapt their existing programs to meet the training needs of OSW, once they understand the detailed requirements.

Similar to above, Virginia can improve utilization of many additional education and training programs by integrating OSW training modules into program curricula. This could be accomplished by targeting the appropriate program areas in decisions regarding funding and support for community colleges, university workforce development programs and technical institutes.

The core workforce skills required for the direct jobs created by an OSW project are primarily associated with trade workers and assemblers, with skillsets suited for manufacturing, fabrication, assembly, staging, mechanical and electrical fit-out and maintenance. Skilled trade workers and assemblers are anticipated to represent 85% of the required direct FTEs in OSW. A high-level breakdown is provided in Figure 15. This correlates well with the bottom-up estimates presented in Table 16.

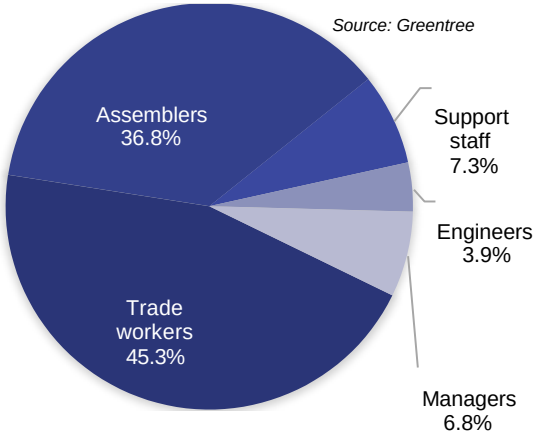

Figure 15 Breakdown of directly employed workers by job type in OSW.

Although many of the trade and assembler positions will require technical or industry certifications, Virginia's coastal workforce is likely well equipped to accommodate the OSW industry needs. In many cases, the skills of Virginia's trade workers and assemblers are directly transferrable to the OSW industry, though some industry-specific training will be required. Much of this training will be product-specific and delivered by the suppliers. There is opportunity for the Virginia to ensure that certification and training requirements are clear and readily available through a combination of educational, technical and labor institutions.

For the purposes of this report, we assume an Atlantic OSW industry that will support installation of 100 turbines offshore per year. In Table 16, direct workforce FTE requirements are estimated for a range of project activities. Indirect jobs are in addition to this, as presented in Table 5.

Table 16 Direct FTE job requirements for a 100 turbines per year installation scenario.

Element	Trade Workers	Assemblers	Managers	Engineers	Support Staff	Total
Project management & development	10	0	60	50	80	**200**
Blade manufacturing	100	430	30	10	30	**600**
Nacelle assembly	35	300	20	25	20	**400**
Tower manufacturing	120	50	10	5	15	**200**
Jacket manufacturing	580	20	25	10	15	**650**
Subsea cable manufacturing	25	320	15	15	25	**400**
Construction staging*	90	90	5	5	10	**200**
Substation manufacturing	200	240	20	15	25	**500**
Operations & maintenance**	400		35	20	45	**500**
Total	**1,560**	**1,450**	**220**	**155**	**265**	**3,650**

* This is for onshore activity. Further direct and indirect jobs are created offshore during installation and commissioning.
** for 500 turbines, equating to average installed capacity during 2020s.

Trade workers will be needed across all elements of the wind farm, except for Project Management. Jacket foundation manufacture, including transition piece (TP), will create the highest number of trade workers, 580, which includes welders, mechanical and electrical fitters, material NDT (non-destructive testing) and quality control inspectors. Jacket and TP production will also yield the greatest number of high-paying jobs.

Assemblers will make up the second largest classification of workforce. Blade manufacturing, nacelle assembly and subsea cable manufacture together will need just over 1,000 assemblers. Assemblers will also be needed for secondary processes for tower production, jacket and TP manufacture, substation platform manufacture and for OMS.

7.4. Available assistance

The ongoing liaison work between Hampton Roads Workforce Council (formerly Opportunity Inc.) and Virginia Offshore Wind Team has highlighted the following incentives which can be made available for on-the-job training, customized training and recruitment assistance:

On-the-job training (OJT)

The Virginia Employment Commission provide up to $5,000/per employee, for a maximum of 5 OJT participants/per employer.[6]

This program is for eligible new hires. OJT provides reimbursement to the employer at a rate of up to 50% of the employee wages during the contract, to a maximum of $5,000 per employee, unless otherwise authorized by the Hampton Roads Workforce Council. Thereafter, additional participants may be authorized.

This program is eligible for new hires and provides up to $5,000 training reimbursement for each authorized new employee. Customized training is provided by a qualified third-party training provider identified and contracted by the employer. The training provided must result in needed workplace skills specific to the employer's business that will result in an industry recognized training credential for the participant upon the successful completion of training. The employer must commit to employing participants who successfully complete training as full-time, non-temporary employees. The Hampton Roads Workforce Council will enter into a contract with an employer for customized training and will provide reimbursement of 50% of the training cost for each authorized participant, not to exceed an overall reimbursement of up to $5,000 per participant. The training duration should be short term, unless otherwise agreed to by Hampton Roads Workforce Council.

Recruitment assistance

General: Hampton Roads Workforce Council will co-host a single-employer 'job fair' geared toward a mass audience; conduct a private hiring event targeted at a narrower skill set audience; and/or, identify and refer potential candidates based on employer job requirements, on an individual basis. The Hampton Roads Workforce Council could provide outreach and recruitment assistance; serve as the entity to accept and organize candidate resumes; pre-screen candidates for basic qualifications; and, handle event registration and facilitation.

[6]Virginia Employment Commission, On-the-Job Training and TAA Programs, 2018 available at: http://www.vec.virginia.gov/employers/incentives/trade-act/on-the-job-training, last accessed November 2018

Military: Hampton Roads Workforce Council can connect any company with exiting military staff in a variety of ways. Over 8,000 active duty military staff transition from service in Hampton Roads annually. The Hampton Roads Workforce Council has a comprehensive veteran outreach and service strategy. It maintains a career developer with a primary focus on transition assistance and veteran recruitment. This provider participates in on-base transition assistance programs; and offers its own 'After TAP' (Transition Assistance Program) Veterans' Workshop. In addition, supply chain businesses can become a V3 (Virginia Values Veterans Program) certified company, allowing access to the V3 Program and the newly enacted Veterans Employment Grant. Qualifying companies may receive up to $10,000 for hiring and retaining each veteran.

7.5. Current training available in Virginia

Technical training, apprenticeships and certifications

For the OSW workforce, there will be certain technical training, apprentice programs and industry certifications that will be required. The key roles are discussed in more detail, along with relevant training providers below.

Safety Training and Certification

Virginia workers will need to be trained to work offshore, which requires additional levels of safety training beyond land-based positions. The largest number of employees, potentially 2000 FTEs, will require Standard Occupational Safety and Health Administration (OSHA) training. Offshore workers will also require Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and, possibly, Global Wind Organization (GWO) safety training depending on developer and tier one contractor requirements.

- **OSHA/ISO certifications** are typically required for manufacturing, installation and OMS. Virginia has a well-established network of OSHA safety training providers. The Mid-Atlantic OSHA Training Institute Education Center (MAOTIEC), with locations in Dulles, Norfolk and Richmond, is a consortium comprised of the Chesapeake Region Safety Council (CRSC) and the Northampton Community College (NCC) which offers a full suite of general industry and construction safety programs, as well as OSAH 5400 and 5410 for the maritime industry. The Hampton Roads Utility and Heavy Contractors Association in Chesapeake provides OSHA training specific to the construction trades. The Virginia Ship Repair Association offers a wide range of marine safety courses including the OSHA 10 and 30-hour maritime course and card certification. A number of safety training courses and certifications are available through MAOTIEC.
- **GWO Safety** training requirements will be determined by project-specific developers and suppliers. The GWO is a non-profit body founded in Europe by leading wind turbine suppliers and project owners in 2012 to create a safer and more productive workforce. In March 2018, it was announced that GWO certified training providers are expanding their operations and investing in new sites around the world, with North America expected to be among the fastest growing global regions as its OSW market expands. Currently GWO certified training programs are available at Siemens in Florida and at ENSA North America in Michigan and Wisconsin. Although there are now five GWO training facilities in the US, there are currently no US GWO training programs that provide the sea survival module required for OSW. Virginia should therefore work to ensure this training becomes locally accessible.
- **STCW** (Standards of Training, Certification and Watchkeeping for Seafarers) safety training is required for all seagoing personnel and is readily available in the Virginia Hampton Roads area through the Chesapeake Marine Training Institute, Hayes and the Mid-Atlantic Maritime Academy, Norfolk.

  STWC sets minimum qualification standards for masters, officers and watch personnel on seagoing merchant ships and large yachts. From 2014, seafarers entering the industry for the first time have been required to complete Proficiency in Security Awareness, making them aware of security related issues on the high seas. The basic modules within the STCW Basic Safety Training course are:

  - Personal Safety and Social Responsibilities (PSSR)
  - Fire Prevention and Fire Fighting (FF&FP)
  - Elementary First Aid (EFA)
  - Personal Survival Techniques (PST), and
  - Proficiency in Security Awareness (PSA).
- The **Mid-Atlantic Maritime Academy in Norfolk** offers intensive maritime training courses, from deck to engine room, STCW-approved safety, license preparation, fire-safety, navigation and resource management. Training programs include:

  - Basic Safety Training (BST)
  - Able Bodied Seaman (AB)
  - Designated Duty Engineer (DDE)
  - Vessel Personnel with Designated Security Duties (VPDSD)
  - Vessel Security Officer (VSO), and
  - Qualified Member of the Engineering Department (QMED).

Courses are certified under the guidelines of the International Maritime Organization (IMO) and are regulated in the USA by the USCG's National Maritime Center.

- The Chesapeake Marine Training Institute in Hayes offers over 50 US Coast Guard approved courses, including the Master's course for 25 to 100 gross tons captain's license (and an upgrade course to 200 gross tons). In addition, there are STCW courses:
    - Basic training (including refresher and revalidation)
    - Advanced firefighting (including refresher and revalidation)
    - ARPA (Advanced Research Projects Agency), and
    - ECDIS (Electronic Chart Display and Information System).

Welding certification

The Advanced Technology Institute (ATI) indicates that in May 2017, Virginia was home to over 7,300 professional welders. The need for trained welders is especially high in the Hampton Roads vicinity with the ship building and repair industry requiring many of the same skilled trades required for foundation manufacture. The Hampton area is home to many businesses that rely on welders, cutters, solderers and brazers to produce goods and equipment for multiple industries.

At the ATI Hampton Roads campus, the welding program offers a diploma in maritime welding. The program offers training in the practical aspects of construction and repair of equipment and structures built with steel.

Virginia has a well-developed network of technical training schools, high school trades programs and community college programs that provide weld training and certification. These organizations should be well positioned to work with OSW component manufacturers to enhance their current weld training programs.

CNC Machining

CNC machinists will be needed primarily for the wind turbine blade and tower production and also for the foundation production. CNC machining is required on the root end of the blade for attachment and interface to the hub. Towers require CNC machined forged rings that provide for the attachment of the tower sections. A similar flange is required on the foundation.

With the large presence of the shipping industry, Virginia community colleges and technical institutes have well-established machining training and certification centers which are open to working with other partners to serve new sectors, such as OSW. One example is the Machining Skills Certification Program[7] which is training, designed in collaboration with the Commonwealth Center for Advanced Manufacturing. Southern Virginia Higher Education Center and Southside Virginia Community College prepares students with the skills needed in 18 weeks, as opposed to the more traditional two-year timeline. At Southside Virginia Community College, the Machining Skills Certification program includes:

- 7 weeks interactive online learning (with 4 prescheduled assessments)
- 11 weeks of project base labs in a new training center in Emporia (5 days a week, 7 to 8 hours per day)

Students earn several certifications through the program:

- Southside Virginia Community College Certificate of Completion
- OSHA 10 Safety Certification
- 4 National Institute Metalworking Skills (NIMS)
- Machining Level 1-Measurement, materials and safety
- Machining Level 1-Job Planning, bench work, and layout
- Machining Level 1-CNC milling: Operations

Composite technology

For blade manufacturing, 75% of the 600 direct FTE blade production workforce will require CCT (Certified Composites Technician) training. CTT is the industry standard for composites training and certification offered through the American Composites Manufacturing Association. CCT training and certification is designed to strengthen industry standards, elevate production performance, upgrade individual levels of knowledge and skill in composites. This certification will apply to all assemblers and most trade workers in a blade facility.

The American Composites Manufacturers Association located in Arlington, offers Certified Composites Technician (CCT) training and has certificate programs specific to blade manufacturing.

Quality Control

In general, QC inspector certification will be needed for all quality inspectors and the quality managers. The largest number of quality control inspectors will be needed in tower and jacket foundation manufacture. For these operations, quality control inspectors will need to be certified

[7] Southside Virginia Community College, (Virginia 2018), http://southside.edu/machining-skills-certification-program last accessed November 2018

specifically in weld inspection. A QC inspector certificate (ISO 9001) is offered through the AWS.

OSW activity should provide an opportunity for Virginia community colleges and technical schools to expand programs related to assembly production, such as lean manufacturing and Six Sigma, which can play a key role in improving efficiencies in manufacturing and assembly.

Although the American Quality Society is the principal certifying agency for Six Sigma Green and Black Belt, there are various educational and professional organizations that also provide training in Six Sigma disciplines. The International Association for Six Sigma Certification is a professional association that exclusively facilitates and delivers centralized universal Lean Six Sigma Certification Standards testing and Lean Six Sigma training program accreditations. Six Sigma training is readily available throughout Virginia.

Maritime and shipmaster

Staff that are involved in OSW construction, installation and OMS, will require some form of maritime training, be that for deck hands, operators, or ship masters. Military Sealift Command has compiled a nationwide list of US Coast Guard approved maritime training schools. In Virginia, the Military Sealift Command has four registered providers:

- Chesapeake Marine Training Institute in Hayes
- Tidewater Community College in Virginia Beach
- Trident Group in Virginia Beach and
- Mid-Atlantic Maritime Academy in Norfolk

Collectively they offer a variety of courses including:

- Unlicensed Deck
- Firefighting & STCW
- Licensed Deck
- Unlimited Tonnage
- Leadership
- Maritime Security, and
- Marine Safety.

Apprenticeships

The construction and commissioning phase of an OSW project will require trade workers with trade or technical certification and a large number of apprentice certifications will be required. These apprentice trade certifications will be for mechanical and electrical apprenticeships. These may be for onshore or offshore activities. They could be from local unions in partnership with wind turbine supplier's vessel contractors and other large OSW players.

The Virginia Registered Apprenticeship program is an employment training model that produces highly skilled workers to meet the demands of employers competing in the global economy, through a combination of on-the-job training and related technical instruction. The process of apprenticeship program registration with Federal and State government agencies is designed to ensure that working apprentices, program sponsors and the general public can gain a clear understanding of the training content and the measures that are in place to ensure ongoing quality. The Virginia Registered Apprenticeship program currently has approximately 2,000 Virginia sponsors (employers) who use custom-designed programs to train their workforce. Employers provide on-the-job training for their employees in a variety of occupations, ranging from high tech to highly skilled trades.

Veterans Programs

The US Department of Veterans Affairs has several programs that support veteran skills training, education and transition to full time employment. The Yellow Ribbon Program is a provision of the Post-9/11 GI Bill that can help students attend expensive private schools at little or no cost to themselves. Normally, Post-9/11 GI Bill payments at private schools are limited to a national maximum amount by law, although that amount changes every year, it seldom covers the full tuition and fees that private schools charge for enrolment. Currently the maximum amount is about $23,000. Virginia has several participating schools in the Yellow Ribbon Program. Further research of these schools and universities is recommended to verify educational degrees and training specifically relevant to the needs of OSW.

7.6. Virginia workforce training resources

During the course of this project, input was collected from several community colleges, universities and workforce development agencies. They participated in benchmark reviews and discussions on education, training and certifications that will be required for the OSW industry. The following are further examples of workforce programs available in Virginia that can support the OSW industry:

Rappahannock Community College (RCC), Glenns

- Safety: RCC's Workforce Center offers OSHA 10 and OSHA 30-hour online training
- Welding-RCC's Workforce Center offers AWS qualification testing in SMAW, GMAW, FCAW, GTAW
- Maritime: RCC offers American Boating and Yachting Council Standards coursework and certification
- Composites: RCC offers American Boating and Yachting Council Standards coursework and certification in composites

- General Manufacturing: RCC offers National Institute for Metalworking Skills in hydraulics, pneumatics, Electrical control systems and process control, and
- CNC Machining: RCC will be launching a CNC program in Fall 2019

Eastern Shore Community College (ESCC), Melfa

- Safety: ESCC routinely offers SAF 130 for several trades' certificates or career studies certificates. The instructor is OSHA Certified and students earn the OSHA 10 Hour Card. In addition to credit instruction, custom contract training is available in the form of Continuing Education Units through the Workforce Development Division.
- Welding: ESCC offers both a Certificate and Career Studies Certificate in Welding. Competences are aligned with American Society of Mechanical Engineers and AWS Standards.
- Six Sigma: Concepts of quality control are embedded in all trade's credentials. It is anticipated that ESCC will offer an Associate of Applied Science degree in Technical Studies beginning in Fall 2019. The program is structured with a specific class dedicated to quality assurance.

Tidewater Community College (TCC)

- Safety: TCC offers six courses in safety; SAF 120 Safety and Health Standards: Regulations and Codes, SAF 126 Principles of Industrial Safety, SAF 130 Industrial Safety - OSHA 10, SAF 135 Safety Program Organization and Administration, SAF 205 Human Factors and Safety Psychology and SAF 246 Hazardous Chemicals, Materials and Waste in the Workplace.
- Welding: TCC offers three certificates in welding, two are focused on industrial and manufacturing and the third is Maritime welding which prepares welders for the shipbuilding and ship repair industry. TCC is an AWS Standards testing site and teaches welding to NAVSEA standards for the shipbuilding industry. Training is offered at both the Portsmouth campus and at a Workforce Solutions Training Center in Portsmouth designed to deliver training for construction trades.
- Maritime: TCC offers an extensive variety of maritime degrees and certificates. It offers programs that focus in the operation and navigation to coast guard standards for above deck and under way operations. TCC offers individual training in the construction, maintenance and repair of large and small vessels, below decks training in marine electrical, marine mechanical, pipe fitting, welding and inside machinist.
- General manufacturing: TCC delivers various industrial training programs along with the Mechatronics program, which trains students in industrial maintenance practices. Courses include electricity, electronics, pneumatics, hydraulics, programmable logic controllers (PLC), instrumentation and process control. Mechatronics is one of the areas that the wind industry is drawing workers from. TCC also has a renewable energy certificate in the Electrical Technology program where solar PV and thermal, geothermal and small-scale wind is covered in 19 credits of instruction.
- CNC: TCC offers two certificates in CNC machining, Basic Metal and Plastic Machine Operator, Computer Numerical Controls (CNC) Operator. Instruction teaches basic and advanced G and M code programming and basic CAD/CAM. Hands-on instruction is conducted in the machining lab on the Chesapeake campus. Students set for the National Institute of Metal Working Skills (NIMS) exams.
- Other: TCC offers painting and coating training through its Work Force Solution Division.

Avoler Group LLC, Norfolk

- Safety: VSRA and in-house safety training, plus medical clearance for respirator, globally harmonized system of classification and labeling of chemicals fall protection.
- Welding: structural and pipe.

Hampton Roads Workforce Council (formerly Opportunity Inc)

- The Hampton Roads Workforce Council serves as the regional leader of workforce development. The council is committed to the convening and implementation of a system that will equip the OSW industry with the hiring and training needs for our region.

7.7. Recommendations to expand relevant workforce development

Based on dialogue with a wide range of stakeholders, we recommend the following in order to develop the Virginia workforce for OSW:

- Keep the Workforce Development Team intact
- Identify and provide clear access to existing training resources applicable to OSW
- In collaboration with industry and academia, design and establish OSW specific programs, training and attraction options for the industry in specific areas of manufacturing, quality and maritime safety and capability to meet OSW requirements
- Work with stakeholders such as Navy and DoD on ways to complement Navy activities and flatten the workforce fluctuations driven by Navy contracting, and
- Virginia supports the expansion of these programs by providing new grants and funding for community

colleges, university workforce development programs and technical institutes that are specific to addressing the workforce needs for OSW.

8. Review of Virginia's ports

8.1. The Port of Virginia's Newport News Marine Terminal (NNMT)

Existing conditions

The Newport News Marine Terminal (NNMT) is located at 25th Street and Warwick Boulevard in Newport News Virginia and is one of the properties within the Port of Virginia's portfolio. The property occupies approximately 165 acres (67ha) on the north bank of the James River, offering 60 acres (24ha) of outside storage and 968,000sqft (89,930sqm) of covered storage space. Within the facility there exists 112 acres (45ha) of uncovered upland area that could be developed for marshalling or manufacturing uses. The coastal frontage of the facility stretches for over 2,600 lineal ft (792m) along the James River. Vessels have access to two piers with four vessel berths, containing 3,480ft (1,060m) of berth space, with draft depth as deep as 40ft (12m) MLLW, accommodating vessels 850ft (260m) in length. The facility also contains 33,900ft of Class I rail provided by CSX. In addition, NNMT has a roll-on/roll off (Ro/Ro) ramp on Pier C South to deliver heavy-lift components and has traditionally received and shipped power plant equipment via water. The piers at the site can accommodate vessels of up to 850ft (260m) in length. The facility is located within Foreign Trade Zone #20 and there exists significant tax and fee incentive programs when shipping through the Terminal. The property sits on the southern peninsula of Newport News near the northern entrance to the Hampton Roads Beltway (Bridge-Tunnel).

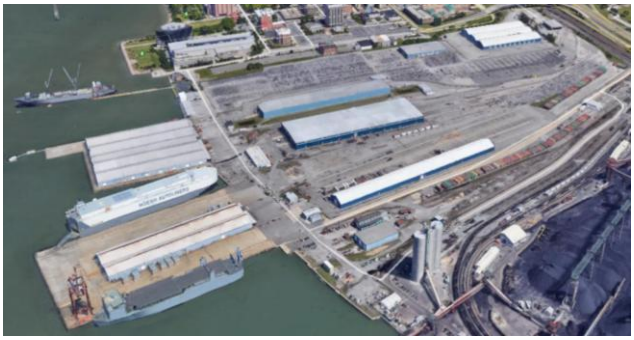

Figure 16 Aerial image of Newport News Marine Terminal.

Overview

The facility is currently the Port of Virginia's premier break-bulk and Ro/Ro facility, handling thousands of tons of bulk cargo and thousands of vehicles per year, servicing the military, maritime, private and public sectors. The facility was once a large container port as well and a large box cargo container crane on a rail system that runs the length of the quay exists on the large southern pier on the facilities waterfront. Today the facility mostly concentrates on Ro/Ro cargo; including vehicles, machine parts, power components and military hardware. Bulk and break-bulk is also handled at the quayside and offloaded into warehouse buildings both on the piers and on the upland portions of the site.

NNMT has direct on-dock rail service provided by CSX Rail, which has connections throughout the southern rail corridor and the ability to perform transfers to the Norfolk Southern Line in Richmond. The port facility has a permanent Ro/Ro rail car transfer system which allows transfers of rail cars to rail barges. This connection was once used to transfer rail cars to the Cape Charles rail Ro/Ro facility (see description of Cape Charles Harbor Floating Dock property below).

The site houses two large piers, each is constructed with solid-fill core with pile-supported deck and the piers are covered with reinforced concrete decking placed on concrete pile caps on steel piles.

- The Northern Pier covers an area of approximately 8.23 acres (3.33ha) and contains 3 quayside berthing areas, one on the north side of the pier, one on the end of the pier and one on the south side of the pier. The quayside lengths of the berth on the north side of the pier is 800ft (244m), the berth on the south side of this pier measures 575ft (175m) in length and the end of the pier can accommodate berthing for up to 400ft (122m). Water depths in the berths at the pier range from 35ft to 40ft (10.7m to 12.2m) MLLW. Much of this pier is covered by a large high-bay warehouse building that is built out on the pier that measures 296,000sqft (27,500sqm).

- The Southern Pier encompasses approximately 12 acres (4.9ha) and has three berthing areas, a berth to the north of the pier, one to the south of the pier and one on the end of the pier. The quayside lengths on the north and south sides of the pier extend approximately 920 lineal ft (280m) and the quayside on the end of the pier extends for 540ft (165m). Water depths in the berths at the pier range from 35ft to 40ft (10.7m to 12.2m) MLLW.

- Vessel berthing at the two piers can occur within four berth slips (one on either side of the piers) and on the ends of the piers. Within the slips surrounding the piers there exists 3,480ft (1,060m) of berth space.

The site is unique in that its operating capacity includes significant Ro/Ro capability and has several heavy-lift reinforced quay areas. The north pier can accommodate vehicle Ro/Ro imports and exports and a rail line that runs the length of the north pier to the bulkhead allows for direct Ro/Ro of rail cars onto (and off of) rail barges, allowing for direct shipping of rail-to-water-to-rail cars and containers.

The southern pier also has rail lines along its southern berth that allow for direct loading/offloading of vessels onto/into and from rail cars using ships cranes or conveyor systems. The southern pier also contains a rail-mounted container gantry crane which can run the length of the 920ft (280m) quayside adjacent to the southern berth. This pier can accommodate Ro/Ro as well as crane load-on/load-out. A heavy component ramp on Pier C South allows for the direct vessel-to-shore and shore-to-vessel loading/unloading of heavy components and has been used to ship heavy-lift components such as power plant equipment.

Over 18 buildings exist on the site in various sizes and configurations totaling over 968,000sqft (89,930sqm) under roof. The buildings range from small brick office buildings to very large steel warehouses:

- Small buildings onsite: includes two small brick multi-story office, administration and shop buildings on the northern portion of the site; a block and steel security and, a vehicle control building located at the truck scale and the entrance to the site; and three small steel multi-purpose buildings near the rail connections at the southern pier.
- Medium-sized buildings include a steel and concrete block warehouse and shop building on the northern edge of the site; a steel high-bay building near the river edge of the property and a pair of steel and wood buildings associated with the rail interface with the piers at the southern end of the site.
- Large buildings include:
    - A large (295ft by 145ft) (90m by 45m) steel warehouse and storage building located in the middle of the shipped vehicle parking yard;
    - A large (475ft by 335ft) (145m by 100m) sprung-structure and steel warehouse building located at the northern edge of the shipped vehicle parking area;
    - A large lineal (835ft by 120ft) (255m by 36m) steel high-bay warehouse building located in the middle of the site;
    - A very large (800ft by 260ft) (245m by 80m) steel high-bay warehouse and storage building centrally located on the site adjacent to the truck staging area;
    - A long, narrow steel building (1,000ft by 100ft) (305m by 30.5m) located on the southern portion of the site in front of the southern pier and adjacent to the road and rail lines that enter the southern side of the site;
    - On the northern pier, a large (570ft by 460ft) (173m by 140m) steel warehouse and storage building exists on the pier adjacent to the berths around that pier.
    - On the southern pier, a (695ft by 200ft) (211m by 60m) steel warehouse building located centrally on the pier.

The property is in a heavy marine industrial area; residential housing exists approximately 0.3 miles (0.45 km) to the east of the facility. Road transportation is close by, with the on-ramp/off-ramps for I-664 and State Routes 143 and 167 located within 400ft (122m) from the north-east corner of the site. A main branch of CSX Rail crosses the eastern edge of the site and sidings of the rail line extend tout to the end of both piers at the facility. The property abuts the large Dunbar Coal Transfer facility and the CSX Rail line the serves the site is an off-shoot of the main CSX Rail line that includes tracks that branch off to the east for the transfer of coal to and from vessels berthed at the Dunbar facility.

Water approaches to the site are from the James River via the Newport News Channel. The waterway includes a 50ft (15m) deep, 800ft (244m) wide channel leading out into Norfolk Harbor and Hampton Rhodes. Approaches to the Newport News Channel include passage through the Norfolk Harbor Reach, which is a 50ft (15m) deep, 1,000ft (305m) wide passage. The facility is well suited for the berthing of very large transport vessels, which call on the port regularly. The facility is a US Customs-designated port of entry and the full range of customs functions is available to customers, including bonded storage areas.

Limitations

There are no overhead restrictions between the facility and the open ocean, though there are three bridge-tunnels between the facility and the open ocean: the Monitor-Merrimac Memorial (I-664) Bridge-Tunnel, the Hampton Roads (I-64) Bridge-Tunnel and the Chesapeake Bay Bridge-Tunnel. The Monitor-Merrimac Memorial (I-664) Bridge-Tunnel is located slightly down-river of the facility and represents the first navigation point for vessels sailing from the facility. The Hampton Roads (I-64) Bridge-Tunnel is located approximately 5.8 nautical miles (10 km) to the east of the facility along the Newport News Channel. There are no overhead restrictions for passage through the bridge-tunnel openings and the channel clearance width is 800ft (244m) where it passes over the tunnel (between the bridge abutment structures). The Chesapeake Bay Bridge-Tunnel is located approximately 17 nautical miles (32 km) to the east of the site and spans the Chesapeake Bay. This bridge-tunnel has a 4,500ft (1370m) large opening between the bridge abutments where the roadway submerges below the Bay and the channel depth in this area is 50ft (15m).

The closest commercial airport to Newport News Marine Terminal is Newport News/Williamsburg International Airport (PHF), located approximately 16-miles (25km) from

the facility. Norfolk International Airport (ORD) is also nearby, located approximately 22-miles (35km) to the southeast. A large radio tower exists nearby next to a neighboring boatyard property, and it is anticipated that FAA ceiling restrictions will be coincident with the height of the radio tower (400ft/123m) in the vicinity of the site.

Table 17 Summary of NNMT key statistics.

Parameter	US units	Metric units	Notes
Property size	165 acres	67 ha	The property is located on the James River in a marine industrial area on Newport News Point.
Waterfront bulkhead/quayside	5,850ft	1,783m	A reinforced concrete deck on solid core plus steel pile bulkhead platform exists along the quayside and within the two pier structures.
Pier 1 (Northern Pier)	600ft x 540ft	182mx 164m	Heavy-duty pier. Used for Ro/Ro and train to barge.
Pier 2 (Southern Pier)	980ft x 550ft	300mx 168m	Heavy-duty pier. Ro/Ro and Gantry crane loadout.
Berth depth at quayside	35-40ft MLLW	10.6-12m MLLW	4 large berths: • 2 on either side southern pier: 920ft by 300ft (280mby 91m). • 1 on the southern side of the north pier: 575ft by 250ft (175mby 76m). • 1 on the north side of the north pier: 790ft by 300ft) (240mby 91m).
Main channel depth to site	50ft	15m	Newport News Channel, MLLW.
Buildings	968,000sqft	89,930sqm	18 buildings various size plus several temporary structures.
Load bearing capacity*	2,000-4,000psf	9,760-19,530kgpsm	Load bearing capacity on the piers and approaches to the piers expected to be at the higher end of range. Ground bearing capacity in the parking lots and vehicle storage portions of the site are expected to be at the lower end of the range.
Cranes	1 Cargo Box Gantry Crane	1 Crane	Crane runs on rails along southern quay of southern pier.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential offshore wind uses

The facilities large acreage (over 100 acres, 40ha) and two piers make the site well adapted for OSW manufacturing of a wide range of components. The existing land area is also sufficient for marshalling. The prevalence of Ro/Ro shipping options coupled with the ability to install cranes at the site makes it a good candidate for the heavy components including monopile, jacket and gravity-based foundations, transition pieces, towers, blades and nacelles. The site is also well suited for use as a lay down site or for use as an OMS facility for wind farm maintenance and also as a repair service port.

Foundation and tubular components

The site could be adopted to handle monopile, transition piece and tower section components, including manufacturing and fabrication. The property's relatively large size and configuration of the existing quayside make it a good location for foundation manufacturing. The site is also well suited for the fabrication/staging of a floating wind platform. Installation of crane pads and cranes would be needed for some of the larger components in order to attain the high level of ground bearing capacity needed.

Nacelles, blades, rotors, generators:

These components could be manufactured or finished at this facility. As with the foundations, the shape and layout of the property imparts some challenges to local on-site transport of these components. Large crawler cranes are a potential, however upland soil load-bearing capacity would need to be improved over portions of the site in order for the efficiency of this operation to meet serial production standards. Load-out by crane would require installation of a crane pad or pads. Bulkhead geometry may require modification for optimal utility for some of the super-large components (jacket foundation). Ro/Ro transport to barge or transport ship is a potential for these components from the pier and bulkhead areas.

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS operations from a layout perspective, however the site is distant from much of the WEAs. The site shows good potential as a Service Port, as service vessels could berth at the facility and the warehousing and upland lay down areas on the site are good. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be easily adapted at this site. The site is well suited for cable storage, as a cable service port and as a cable manufacturing facility with minimal modification needed.

Upgrades and improvements opportunity for full utility

There are a number of OSW uses this site could be utilized for that would require little to no modification (OMS, blades, nacelles, secondary steel, laydown). In order for the property to meet the needs of OSW production for the super-large components (jackets, substations, monopile), particularly the serial production of these components for a pipeline of projects, certain site modifications are likely to be needed. These would include: connection of portions of the upland areas with high density surface treatment to allow for ease of component transfer movement; addition of production buildings (for manufacturing/fabrication scenarios); inspection and repair of the piers; maintenance dredging of the area adjacent of the site; installation of crane pads where extreme heavy lift operations might occur; installation of high-mast lighting, security, upgrade of electrical, water, sewer connection-particularly at the bulkheads.

Opportunities for investment

Upgrades for site utility could range from low-cost (<$5 million) for OMS or secondary steel applications, to moderate-cost ($15-$50 million) for upgrades to allow for tubular or foundation and tower pieces to support the top-side configurations of nacelle, blade and tower manufacturing/fabrication.

Opportunity Strategy for Investment

While there are a number of OSW activities that could occur at this site with little or no modification (such as OMS and secondary steel, transition piece, blade and nacelle), full utility of the site for OSW uses would require some upgrades and improvements. These site modifications range from bulkhead repair/improvement to ground improvement improve the mobility of cranes and other OSW-specific equipment such as the Self-Propelled Modular Transports (SPMTs) to the potential strengthening of the bulkhead and dredging. Of these activities, the opportunity for public investment and support include:

- Minor dredging is needed to improve vessel access to strengthened piers.
- Improvements to the quayside, including strengthening of the piers and installation of crane pads.
- Funding, design and regulatory approvals/permitting support for the improvements need to the bulkhead and quayside if crane load-out is to be considered for the site. Additionally, similar support could be provided for the reconfiguration of finger piers at the site to adapt for specialty OSW use.
- Economic and regulatory approvals/permitting support for the improvements needed at the site to increase the heavy-lift capacity at the bulkhead (i.e. installation of a heavy-duty crane and improvements to site bearing capacity surrounding the bulkhead and travel lanes).

Table 18 Summary of OSW utility at NNMT.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.2. The Port of Virginia's Portsmouth Marine Terminal (PMT)

Existing conditions

The Portsmouth Marine Terminal (PMT) is located at the intersection of Cleveland Street and Lee Avenue in Portsmouth, VA and is one of the largest facilities within the Port of Virginia complex, occupying 287 acres (116ha) of land on the west bank of the Elizabeth River. The terminal has 4,500ft (1,372m) of wharf, three berths and is able to handle containers, break-bulk and Ro/Ro. The facility is served by CSX directly and Norfolk Southern via the Norfolk Portsmouth Beltline Railway.

The site currently operates as a major container port. The shipping of breakbulk and bulk commodities also occurs at the site to a lesser degree. A component of the property, a laydown area for empty containers, represents a potential large 44-acre (18ha) area with an adjacent 45-acre (18.2ha) vacant area parcel that could be readily used by the OSW industry. The site has a large quay, having a primary berth at the quayside that exceeds 3,540ft (1,080m) and an extended berth area that elongates the total berth area to 4,500ft (1,372m). An additional 680ft (208m) rip-rap coastline area could also be developed into a berth at the site through the installation of a wharf.

The quayside at the site can accommodate multiple vessels of up to 850ft (260m) to 1,000ft (305m) in length. The facility is located within Foreign Trade Zone #20 and there exists significant tax and fee incentive programs when shipping through the Terminal. The property sits on the west bank of the Elizabeth River in the heart of the marine industrial area in Portsmouth, Virginia and sits over the entrance to the Midtown Tunnel on the Portsmouth side.

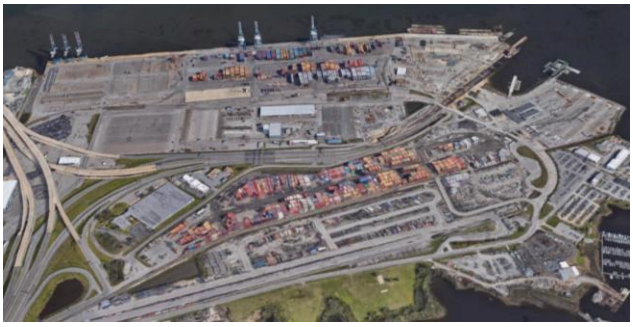

Figure 17 Aerial image of Portsmouth Marine Terminal.

Overview

The facility is currently the Port of Virginia's principal backup container facility, with a capacity of over 250,000 containers and a TEU capacity of over 437,500 TEU's. Large Container box gantry cranes run along the length of the primary quayside allowing for the berthing and unloading of multiple vessels at one time. The facility has been a shipping port for decades, allowing for the import and export of all manner of goods. Today the facility mostly concentrates on containers, but continues to support roll-on/roll-off Ro/Ro cargo as needed. Bulk and break-bulk cargo can also be handled at the quayside and offloaded into warehouse buildings on the upland portions of the site. The facility is a US Customs-designated port of entry and the full range of customs functions is available to customers, including bonded storage areas.

At 287 acres (116ha) the property represents one of the largest facilities that could be utilized by the OSW industry in VA. With no overhead restrictions and an over 4,500ft (1,372m) quayside available for berthing, this site is one of the closest port facilities in the US that is similar to the large OSW port facilities in Denmark or Germany. The berth at the quayside can accommodate very large vessels, with a berth depth of 40ft (12m) MLLW for the western 3,500ft (1,000m) of the main quayside. The remaining developed 1,000ft (305m) quayside has a berth depth of 38ft (11.5m).

The PMT does not have direct on-dock rail service, however, the site shares a boundary with rail lines on the east of the site. This is where the CSX line runs and the Norfolk Portsmouth Belt Line crosses the site and connects to the Norfolk Southern line, making connections throughout the southern rail corridor and the ability to perform transfers to the Norfolk Southern Line in Richmond. The site has excellent highway access, with the entrance to Routes 164 and 58 located adjacent to the site. The site is bisected by Route 58 where it enters into the Midtown Tunnel.

The site consists of one primary quayside wharf area that runs the length of the Elizabeth River frontage of the site. The quay represents a relieving platform of reinforced concrete on piles. The quayside ties into a large open upland area of moderate Load bearing capacity (see table below). Along the wharf, 6 container gantry rail cranes (capable of offloading super-post-panamax vessels) operate along a rail system that runs the length of the 3,500ft (1,000m) primary quay. An additional medium-lift hook-crane runs on the rails along this portion of the port as well.

The primary quayside area could be augmented if the rip-rap waterfront area located to the south of the main quayside is upgraded to a useable wharf. That quayside runs for 680ft (208m) and could create a secondary quay and berthing area if the proper wharf is installed. The installation of any wharf in that area however would need to undergo significant planning, investigation and engineering, as the area lies on top of the undersea tunnel known as the Midtown Tunnel. Dredging would also be restricted in this area and therefore the dredge depth may be fixed primarily at the current depth.

Between the main quay area and the rip-rap secondary waterfront area, a slot-quay berth area exists. The berth area is bordered by beach or rip-rap shoreline on the east and south and by a steel sheet bulkhead on the northwest. At 20-24ft (6-7.3m) MLLW, this slot berth is shallower than the other berths and would require dredging if it is to be used for the OSW industry. The berth currently contains a narrow-fixed finger pier extending from the northern edge approximately 200ft (62m) into the river and a floating Ro/Ro wharf that extends 300ft (94m) into the slot quay.

Water depths at the berth along the main quayside varies from 38-40ft (11.5-12m). Water depths in the slot quay range from 20-24ft (6 - 7.3m) and the water depths along the rip-rap waterfront area range from 20-24ft (6 - 7.3m). Similar to the rip-rap area, the slot quay area overlies the Midtown Tunnel and dredging or other subsurface soil disturbance is prohibited near the tunnel.

Water approaches to the site is via the Elizabeth River Channel. The Norfolk Harbor Reach is 50ft (15.2m) deep MLLW and over 800ft (243.8m) wide. Starting at the Lambert Bend Reach and continuing to the Pinner Point to Town Point Reach the channel narrows to 750ft (228.6m) and the depth deceases to 40ft (12m) MLLW. The piers along the northeast edge of the property can accommodate several large vessels.

Limitations

There are no bridges between facility and the open ocean. The closest airport is the Norfolk International Airport located approximately 7.5-miles (12km) to the east of the facility. The Naval Medical Center at Portsmouth is located approximately 1,500ft (457m) south of the facility and has a helipad. It is anticipated that FAA ceiling restrictions may apply to the site.

Table 19 Summary of PMT key statistics.

Parameter	US units	Metric units	Notes
Property size	287 acres	116 ha	The property is located on the Elizabeth River in an industrial and shipbuilding section of Portsmouth.
Wharf/quayside	3,540ft	1,078m	A concrete platform on piles bulkhead exists along the quayside of the facility.
Additional quayside	1,000ft	300m	An extension of the main quay allows for additional berthing.
Berth depth at quayside	38-40ft MLLW	6–7.3m MLLW	Multiple large berths exist end-to-end adjacent to the long main pier area.
Main channel depth to site	40-50ft	12-15m	Pinner Point to Town Point Reach.
Buildings	various	various	Approx. 10 buildings onsite (~65,000 total sqft/6,040sqm). Buildings range from brick building multi-story office and shop to large steel high-bay storage and warehouse buildings.
Load bearing capacity*	1,000-3,000psf (estimated)	4,880-14,640kgpsm	Load bearing capacity at the quayside is not well understood and at present is difficult to determine. Ground bearing in the parking lots site are expected to be at the low end of the range.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

Due to the large acreage at this site and the long quayside that already exists at the site, it is expected that this site is well adapted for OSW manufacturing and marshalling of multiple OSW components. The site is also well suited for use as a lay down site or for use as an OMS facility for wind farm maintenance and repair service port.

Foundation and tubular components

The site could be adopted for the production, fabrication and/or staging of monopile, transition piece, jacket and tower section components. The large size of the property,

the length of the quayside and the lack of overhead obstructions lends itself to foundation manufacturing for all foundation types, including jacket, gravity-base and floating wind platform manufacture/fabrication/staging. Due to the bearing capacity of the quayside not being well known, investigations would need to be conducted to ensure stability and upgrades conducted if needed.

Nacelles, blades, rotors, generators

These components could be manufactured or finished at this facility. Large crawler cranes are a potential; however, quayside and upland soil load-bearing capacity would need to be tested and possibly improved over portions of the site in order for the efficiency of this operation to meet serial production standards. Load-out by crane would likely require installation of a crane pad or pads. Ro/Ro transport to barge or transport ship is a potential for these components from the bulkhead area of from the slot-quay area or the rip-rap adjacent area (assuming dredging is not necessary due to the proximity of the cross-river tunnel).

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS operations from a layout perspective, however the site is distant from much of the WEAs. The site shows good potential as a Service Port, as service vessels could berth at the facility and the warehousing and upland lay down areas on the site are good. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be easily adapted at this site. The site is well suited for cable storage, as a cable service port and as a cable manufacturing facility with minimal modification needed.

Upgrades and improvements opportunity for full utility

In order for the property to meet the needs of OSW production, particularly the serial production of components for the pipeline of projects expected, certain site improvements would be required. These would include: improvement of the quayside to allow for repetitive heavy lifts; increase bearing capacity of upland portions to allow for transit of crawler crane; addition of production buildings (for manufacturing/fabrication scenarios); installation of a bulkhead along the rip-rap area south of the quayside and potentially dredging of that area; augmentation to existing high-mast lighting, security, upgrade of electrical, water, sewer connection-particularly at the bulkheads.

Opportunities for investment

Upgrades for site utility could range from low-cost (<$5 million) for OMS or secondary steel applications, to moderate-cost ($15-$50 million) for upgrades to allow for tubular or foundation and tower piece manufacturing/fabrication. Special attention should be focused on the bulkhead, pier and rip-rap water frontage areas.

Opportunity Strategy for Investment

While there are some OSW activities that could occur at this site with little or no modification (such as OMS and secondary steel), full utility of the site for OSW uses would require some upgrades and improvements. These site modifications range from bulkhead repair/improvement to ground improvement improve the mobility of cranes and other OSW-specific equipment (such as the Self-Propelled Modular Transports (SPMTs)) to potential conversion of rip-rap river frontage to bulkhead (with subsequent dredging). Of these activities, the opportunity for public investment and support include:

- Conducting the dredging needed to improve vessel access to the bulkhead.
- Funding, design and regulatory approvals/permitting support for the improvements needed for the bulkhead and quayside if crane load-out is to be considered for the site.
- Economic and regulatory approvals/permitting support for the improvements needed at the site to increase the heavy-lift capacity at the bulkhead (i.e. installation of a heavy-duty crane and improvements to site bearing capacity surrounding the bulkhead and travel lanes).
- Reinforcing of the quayside may be required, particularly if the facility is used for foundation or nacelle manufacture or fabrication and this activity would represent a good investment opportunity.

Table 20 Summary of OSW utility at PMT.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.3. Cape Charles Harbor Cape Harbor Holdings facility

In the 2015 *Virginia offshore wind port readiness evaluation* report, the Cape Charles properties consisted of two parcels amalgamated into one property, with a total land area of over 145 acres (59ha). The provenance and the interest of the water-front parcel property owner remains high in 2018 (as it was in 2015), however the inland large property, which consist mostly of undeveloped wooded land with drainage canals, is not as well-known and therefore is not considered part of the main (Cape Harbor Holdings LLC facility) parcel under evaluation for this 2018 report. The 2018 evaluation constitutes approximately 22 acres (9ha) of the 145 acres (59ha) evaluated as part of the 2015 report. The 2018 analysis concludes that the site will be useful for a more restricted set of OSW uses, unless the provenance and owner interest of the undeveloped land can be determined and the property appended to the main Cape Harbor Holdings facility.

Existing Conditions

The Cape Harbor Holdings facility is located at 1267 Bayshore Road, Cape Charles Virginia. The property encompasses approximately 22.2 acres (9.0ha) on the southern shore of Cape Charles Harbor. The property has over 1,000ft of harbor frontage which includes one 200 by 55ft (61m by 17m) concrete pier/dock facility that extends into the harbor and has two timber finger piers extending to the east and the west of the concrete pier. Three buildings and one former building foundation exist on the site near the waterfront in the vicinity of the concrete pier. To the south of the dock area, the remainder of the property is wooded land. A drainage canal which discharges to Cape Charles bisects the eastern portion of the property from south to north. The facility is currently unused. Historically its uses included maintenance and repair activities and light manufacturing. Water depths in the channels leading up to and adjacent to the pier onsite range from about 14ft (4.3m) to 17ft (5m) in depth (MLLW).

Property Overview

The waterfront portion of the property is characterized by a flat soil surface and with three (existing) buildings and two concrete paved lay down areas. A former building concrete foundation also exists on the waterfront portion of the property. The buildings range in size and construction and include:

- A small single-story metal building of roughly 30ft by 20ft (9m by 6m) on the pier at the quayside. This building appears to have been used previously for storage;
- A medium-sized single-story metal and brick building, which is 80ft by 30ft (25m by 9m) in size, currently unused; and
- A larger one-story block and metal building 240ft by 100ft (72m by 31m) in size, currently unused.

Figure 18 Aerial image of Cape Charles Cape Harbor Holdings facility.

The former building concrete foundation is located on the western end of the site near the waterfront and covers an area that is approximately 165ft (50m) by 80ft (25m).

The waterfront portion of the property consists of a 195ft (59m) long wooden bulkhead with timber pile fendering on the west; a concrete deck pier on timber pilings 200ft (61m) by 55ft (17m) in size and jutting out into the Harbor on the central portion of the property, a 300ft (94m) long rip-rap slope on the eastern-central portion of the property and a small 150ft (45.7m) long sandy beach on the far eastern portion of the waterfront. The concrete pier at the and a portion of the southern edge of the structure will require improvement to use. From the concrete pier, two wooden docks (on timber piles) extend to the west and east. The piers will require improvement to use. The western dock extends 65ft (20m) from the concrete pier and the eastern dock extends 220ft (67m) from the concrete pier.

A road entering the site from the east provides access to the buildings and the quayside. The southern portion of the property is covered by a stand of trees and an approximately 25ft (9m) wide drainage ditch/creek crosses from south to north across the eastern 1/3 of the property and empties into Cape Charles Harbor.

The property is in an industrial area with commercial and recreational (marina) uses. Cape Charles Harbor is a small Port area approximately 56 acres (23ha) in size.

From the water, the site is approached from the east from Chesapeake Bay, the Cherrystone Inlet Canal, into the city harbor. Water depths on approach to the facility range from 45-70ft (14-21m) deep in the Chesapeake Bay approach to the site, to 11.4-18ft (3.5-5.5m) deep in the Cherrystone Inlet Channel up to the berth at the concrete pier (depths are form NOAA charts and are given in MLLW). The Cherrystone Inlet Channel is approximately 500ft (152m) wide and 2.8miles (4.5km) long.

Limitations

There is one bridge-tunnel structure (the Chesapeake Bay Bridge-Tunnel) between the site and the open ocean. The Chesapeake Bay Bridge Tunnel is an approximately 15-mile (24km) long structure that consists of a bridge abutting the east and west shores of Chesapeake Bay that converts to a tunnel under the Bay where it crosses the Chesapeake Bay Channel. The tunnel section of the crossing spans 4,500ft (1,370m) of the Bay, providing a passage that wide and greater than 50ft (15m) deep. As such, the bridge-tunnel does not pose any overhead restriction and there are no overhead restrictions between the site and the open ocean. The closest airports are small civilian airfields, with the closest being approximately 1.8 miles (2.9km) to the northeast of the site. It is anticipated that FAA ceiling restrictions will impose height restrictions of approximately 200 to 300ft (60-90m) in the vicinity of the site.

Table 21 Summary of Cape Charles Cape Harbor Holdings facility key statistics.

Parameter	US units	Metric units	Notes
Property size	22.2 acres	9.0 ha	Irregularly shaped property on the south shore of Cape Charles Harbor.
Pier Size	200ft x 55ft	61m x 17m	Concrete deck on timber piles; will require improvement to use.
Wooden Finger Docks	285ft	87m	Finger docks (in two segments) extend to east and west of concrete pier will require improvement to use.
Berth depth at concrete pier (estimated)	14ft	4.3m	Vessels can dock beyond the concrete pier length (for a length of approximately 500ft (150m)).
Main channel depth to site	14ft	4.3m	Cherrystone Inlet Channel has authorized depth of 18ft (5.5m) MLLW, however siltation has shallowed effective depth to 14ft (4.3m) MLLW.
Buildings (3 Onsite)	~25,800sqft	~2,400sqm	3 buildings ranging from small to large. Steel or block and steel construction; all in poor condition.
Pier Loading Capacity	N/A	N/A	Pier; will require improvement to use.
Load bearing capacity (land)*	<1,000psf	<4,880kgpsm	Load bearing capacity increased at crane pad on western edge site, area around dry -docks expect to have higher bearing capacities.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

NOTE: The property sits adjacent to over 120 acres (~49ha) of vacant land that may be available. The land is currently undeveloped, covered by trees and drainage canals. If the site does become available, the vacant land could add significantly to the utility of the main site.

Potential OSW uses

With its relatively small acreage and small pier configuration, this site would require significant modifications and upgrades to be adapted for OSW manufacturing. Additionally, the shallow channel to the site would limit vessels visiting the site. Significant dredging would be required in order to open the channels for OSW marshalling or manufacturing use. The use of the site for manufacturing could be enhanced if the adjacent large vacant property were available. Due to this site being one of the closest sites in Virginia to the open ocean and the potential OSW lease areas, it is thought that it could be used as an OMS Port or a Service Port. The site could also function as a lay-down yard for components being brought in by barge. In all cases, the quayside would need to be reconditioned or replaced and crane pads installed if heavy components were to be shipped to the site. Additionally, it is expected that the channel entrance to the site would need to be dredged to allow access for OSW Vessels (including OMS vessels).

Foundation and large tubular components

The site is too small to handle monopile, transition piece, or tower section manufacturing and fabrication unless the adjacent large vacant parcel was connected to the site. The property could be utilized for lay down/storage of these components if they were to be delivered by barge and the adjacent Ro/Ro facility may be able to play a role in that scenario.

Nacelles, blades, rotors, generators

As with the foundation components, the site would only be useful for the manufacture of these components if the adjacent vacant land were to be incorporated and the channels leading to the facility were to be dredged.

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS from a layout perspective. Site infrastructure would need to be replaced to support this use and the pier and the buildings on the site will require improvement to use. This site is the closest to the WEA in Virginia. The site also has potential as a service port, as service vessels could berth at the facility and warehousing and lay down could be accommodated. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be adapted at this site. The site is well suited for cable storage and as a cable service port, if pier and site upgrades and dredging are conducted.

Upgrades and improvements opportunity for full utility

In order for the property to meet the needs of OSW production, particularly the serial production of components for the pipeline of projects expected, significant site improvements would be required. These would include: connection of the adjacent upland vacant property and the installation of production buildings (for manufacturing/fabrication scenarios). With less investment, the property could be adapted for use as an OMS, and or secondary steel facility. Lay down for components manufactured at other locations could also be accommodated if the components could be delivered by shallow draft barge.

Opportunities for investment

Upgrades for site utility could range from moderate ($5-$20 million) for OMS or secondary steel applications, to high (>$50 million) for upgrades to allow for tubular or foundation and tower piece finishing or nacelle, blade and tower manufacturing/fabrication. For full OSW use, the pier at the site would need to be replaced, dredging conducted and buildings removed and replaced.

Table 22 Summary of OSW utility at Cape Charles Cape Harbor Holdings facility.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.4. Cape Charles Harbor Floating Dock

In the 2015 report, *Virginia offshore wind port readiness evaluation,* the Cape Charles Floating Dock Property was not assessed. This property has been added to the 2018 Report in response to interest from the community. Adjacent to this property is a Railroad Ro/Ro facility that connects a large train barge directly to the Norfolk Southern Railroad. The train barge has the potential to carry a train to a destination that the barge can mate to Ro/Ro opportunities, within the immediate area. This increases the utility of the site for OSW.

Existing Conditions

The Cape Charles Harbor Floating Dock property is located at 96 Mason Avenue, Cape Charles Virginia The property covers 6.4 acres (2.6ha) on the northern shore of Cape Charles Harbor (across the harbor form the Cape Charles Cape Harbor Holdings facility). The site has approximately 850ft (260m) of harbor frontage, all of which has a bulkhead. One building exists at the site; it is a one-story warehouse- building of concrete block and steel construction. The building would require improvement prior to reuse. The remainder of the property is a green field site, a concrete path provides access for vehicles to the site.

Water depths in the channels leading up to and adjacent to the pier onsite range from about 14ft (4.3m) to 17ft (5m) in depth (MLLW). The berth depth at the facility quayside is approximately 17ft (5m) MLLW for about 2/3 the length of the quay and intertidal for the other 1/3. The property is located adjacent to a sandy beach and residential homes exist across Mason Street and Bay Avenue from the Site.

Overview

The site exists as a grass yard abutting the north side of Cape Charles Harbor. The site is adjacent to the actual floating pier facility, which is the terminus for the Bay Coast Railroad, which connects Port Cape Charles with the Norfolk Southern Railway (across the Bay). The floating pier is a railroad Ro/Ro barge that allows for the overwater transport of rail cars. One building exists on the site, an approximately 80ft by 65ft (24.5m by 19.5m) concrete block and steel former warehouse building, it would require improvement before use. The quayside itself is composed of a concrete wharf, concrete bulkhead and concrete apron set on timber piles. The wharf runs the full length of the water side of the property, with the deeper water quayside running along approximately 560ft (160m) of the eastern portion of the quayside. The wharf requires refurbishment. A dirt road provides access to the onsite building from Mason Street.

The property is in an industrial area with commercial and recreational (marina) uses. Cape Charles Harbor is a small Port area approximately 56 acres (23ha) in size. From the water, the site is approached from the east from Chesapeake Bay, the Cherrystone Inlet Canal, into City Harbor. Water depths on approach to the facility range from 45-70ft (14-21m) deep in the Chesapeake Bay approach to the site, to 11.4-18ft (3.5-5.5m) deep in the Cherrystone Inlet Channel up to the berth at the concrete pier (depths are form NOAA charts and are given in MLLW). The Cherrystone Inlet Channel is approximately 500ft (152m) wide and 2.8miles (4.5km) long.

Limitations

There is one bridge-tunnel structure (the Chesapeake Bay Bridge-Tunnel) between the site and the open ocean. The Chesapeake Bay Bridge Tunnel is an approximately 15-mile (24km) long structure that consists of a bridge abutting the east and west shores of Chesapeake Bay that converts to a tunnel under the Bay where it crosses the Chesapeake Bay Channel. The tunnel section of the crossing spans 4,500ft (1,370m) of the Bay, providing a passage of50ft (15m) deep. As such, the bridge-tunnel does not pose any overhead restriction and there are no overhead restrictions between the site and the open ocean. The closest airports are small civilian airfields, with the closest being approximately 1.8 miles (2.9km) to the northeast of the site. It is anticipated that FAA ceiling restrictions will impose height restrictions of approximately 200 to 300ft in the vicinity of the site. Potential users of the site should contact the FAA to determine what equipment height restrictions (if any) there would be for this property.

Table 23 Summary of Cape Charles Harbor Floating Dock key statistics.

Parameter	US units	Metric units	Notes
Property size	6.4 acres	2.6 ha	Rectangularly shaped property on the north shore of Cape Charles Harbor.
Quayside size	560ft	160m	Concrete deck with timber piles; concrete in poor conditions and collapsed in places.
Berth depth at concrete pier (estimated)	14ft-18ft	5.5m	Quayside has bollards for large vessel tie-up.
Main channel depth to site	14ft	4.3m	Cherrystone Inlet Channel has authorized depth of 18ft (5.5m) MLLW, however siltation has shallow effective depth to 14ft (4.3m) MLLW.
Buildings (1 Onsite)	290sqft	27sqm	1 building onsite. Block and steel construction; will require rehabilitation to use.
Pier Loading Capacity	N/A	N/A	Pier; will require improvement to use.
Load bearing capacity (land)*	<1,000psf	<4,880kgpsm	Load bearing capacity estimate based on unimproved soil stability.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

NOTE: The property sits adjacent to a Ro/Ro rail barge facility. This feature may be useful for barge shipment of components.

Potential OSW uses

This site is of relatively small acreage but has a relatively large quayside area. The quayside would require significant modifications and upgrades to be adapted for OSW manufacturing. The site is small at 6.4 acres (2.6ha) for manufacturing. Additionally, the shallow channel to the site would limit vessels visiting the site. Significant dredging would be required in order to open the channels for OSW marshalling or manufacturing use. However, because of the proximity of this site to the Cape Charles Holdings site (see description above), it could be utilized as a lay down yard in tandem with the Cape Charles Holdings site (particularly if that site were to be enhanced with the vacant acreage adjacent to it).

Due to this site being one of the closest sites in Virginia to the open ocean and the potential OSW lease areas, it is thought that it could be used as an OMS port. In all cases, the quayside would need to be reconditioned or replaced and crane pads installed if heavy components were to be shipped to the site. Additionally, it is expected that the channel entrance to the site would need to be dredged to allow access for OSW Vessels (including OMS vessels).

Foundation and large tubular components

The site is not suited to handle monopile, transition piece, or tower section manufacturing and fabrication. The property could be utilized for lay down/storage of these components if they were to be delivered by barge and if the adjacent vacant land were to be incorporated into the site (for lay down area).

Nacelles, blades, rotors, generators

As with the foundation components, the site would only be useful as a lay down yard for these components as the acreage of the site is small. The channels leading to the facility would need to be dredged for this scenario.

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS operations from a layout perspective. Site infrastructure would need to be replaced to support this use and the wharf and the building on the site require improvement. This site is the closest to the WEA in Virginia. The site also has potential as a service port, as service vessels could berth at the facility and warehousing and lay down could be accommodated.

Manufacture of secondary steel components (ladders, platforms, railings, racks) could be adapted at this site. The site is well suited for cable storage and as a cable service port if pier and site upgrades and dredging are conducted.

Upgrades and improvements opportunity for full utility

In order for the property to meet the needs of OSW production, particularly the serial production of components for the pipeline of projects expected, significant site improvements would be required. These would include: significant repair or replacement of the quayside and dredging. The small acreage available at the site prohibits the manufacture of large components; however, the site could be used in concert with other nearby sites for lay down and storage if the components could be delivered by shallow draft barge. With less investment, the property could be adapted for use as an OMS, service and or secondary steel facility.

Opportunities for investment

Upgrades for site utility could range from moderate ($5-$20 million) for OMS or secondary steel applications, to extensive ($20M-$50 million) for upgrades to allow for tubular or foundation and tower piece storage or finish work or nacelle, blade and tower storage. For full OSW use, the wharf at the site would need to be replaced, dredging conducted and buildings removed and replaced

Table 24 Summary of OSW utility at Cape Charles Harbor Floating Dock.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.5. Colonna's Shipyard

Existing conditions

The Colonna's Shipyard facility is located at 400 East Indian River Road in Norfolk, Virginia The property encompasses approximately 87.1 acres (35.2ha) on the southern shore of the Eastern Branch of the Elizabeth River between Berkely Bridge (Routes I-464/I-264) and the CSX Railroad bridge crossing of the River. The property has over 5,400ft of river frontage and includes eight pier/dock facilities that extend into the river. The facility's current uses are shipbuilding, ship repair, maintenance and dry docks. The property includes two bulkhead areas where cranes conduct vessel loading and off-loading operations. The westernmost bulkhead area consists of three connected bulkhead segments [approximately 50ft (15.2m) long, 150ft (45.7m) long and 100ft (30.5m) long components] at oblique angles to each other. A second bulkhead exists on the central portion of the property, which is approximately 340ft (100m) long and supports two docks that extend into the river 310ft (94m) and 200ft (61m) respectively.

Overview

A large track-mounted crawler crane operates along this quayside component for the load-in and load-out of bulk materials and heavy components. A 600ft (183m) long and 250ft (76m) long set of dry docks exists at the site with capacity to handle vessels between 100ft (30.5m) and 600ft (183m) in length. Fourteen buildings of various sizes exist on the site currently. The largest building is a high-bay warehouse/shop space that encompasses approximately 62,500sqft (5,800m^2). The facility has been used for decades as a ship repair and vessel maintenance facility and has over the years serviced vessels of all shapes and sizes.

Figure 19 Aerial image of Colonna's Shipyard.

The property is in an industrial area, however residential properties abut a portion of the southern edge of the site. Road transportation is close by, with the on-ramp/off-ramp for Routes I-464/I-264 located approximately 1,500ft (477m) from the south-western edge of the site. A Norfolk Southern Rail Line cuts across the eastern edge of the site, with expansion capacity for potential future service to the site.

Water approaches to the site include the East Branch of the Elizabeth River and the Town Point Reach Channel, with a controlling depth of 36.4ft (11m) MLLW in the main channel. Water depth along the shoreline abutting the facility ranges from 1ft (0.3m) MLLW on the western edge of the site to 29ft (9m) MLLW on the eastern portion of the site around the dry docks. Water depths surrounding the bulkhead on the eastern portion of the site are very shallow (3-15ft/1-5m); load-in/load-out using the crane in that area is currently restricted to shallow draft barges. Water depths surrounding the dry docks and finger piers on the eastern portion of the site creates berths of 29ft (8.8m) around the piers, which can accommodate vessels up to 600ft (182m) in length with up to 110ft (34m) beam.

Limitations

There is one bridge between the Colonna's Shipyard port facility and the open ocean: the Berkley Bridge, a bascule bridge (lifts open) with no overhead restriction and a horizontal clearance width of 150ft (46m). The closest airport is a military facility located approximately 6.8-miles (11km) to the north of the facility. It is anticipated that Federal Aviation Administration (FAA) ceiling restrictions will impose height restrictions of approximately 300ft in the vicinity of the site. With the current configuration, the dry docks at the site are not well connected to the upland portion of the site, limiting the size of the crane or travel-lift that could negotiate the dry-dock piers.

Table 25 Summary of Colonna's Shipyard key statistics.

Parameter	US units	Metric units	Notes
Property size	87.1 acres	37.2 ha	Irregularly shaped property adjacent to the East Branch of the Elizabeth River.
Eastern bulkhead length	300ft	91m	In 3 bulkhead segments adjacent to shallow embayment. Large crawler crane present.
Western bulkhead length	340ft	100m	Supports two finger piers and the dry-docks.
Finger piers	240-780ft	72-40m	8 Finger Piers of various lengths.
Berth depth at eastern bulkhead	29ft	8.8m	Good vessel access to the western finger piers and the dry docks.
Berth depth at western bulkhead	3-15ft	1-5m	Currently accessible only by shallow draft barge. Deeper vessels would require dredging. Crawler crane located at eastern bulkhead area.
Main channel depth to site	36.4ft	11m	Main channel.
Bridge horizontal opening	150ft	46m	Bascule Bridge-opens to allow passage.
Buildings			14 buildings of various sizes.
Dry docks	600/110ft	182/34m	Dry docks not well connected to uplands.
Load bearing capacity*	1,000-4,000psf	4,880-19,530kgpsm	Load bearing capacity increased at crane pad on western edge site, area around dry -docks expect to have higher bearing capacities.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

With its relatively large acreage and its multiple pier configurations, this site could be well adapted for OSW manufacturing, for certain components. Due to the sites irregular shape and spread-out shoreline, the site is not well suited for marshalling, though it could be used for laying down of component parts that are awaiting transport to a marshalling yard. The site could also house OMS facilities and would make a good location for a service port for wind farm maintenance and repair. The 150ft-wide bridge opening between the facility and the open ocean impedes the use of (currently sized) jack-up installation vessels. Potential access of rail could be an important factor for this site.

Foundation and tubular components

The site could be adapted with moderate upgrade to handle monopile, transition piece and tower section components, including manufacturing and fabrication. The property configuration (irregular shape) does not represent an ideal layout, however it is expected that the site could be adapted to work. The site is ideal for cable service, staging and manufacture. The site is not well suited for jacket foundation manufacture/staging, concrete foundation fabrication/staging, floating wind platform fabrication/staging. A manufacturing train could make use of dry docks, particularly if travel-lift type vehicles are used with barges.

Nacelles, blades, rotors, generators

These components could be manufactured or finished at this facility. As with the foundations, the shape and layout of the property imparts some challenges to local on-site transport of these components. Large crawler cranes are a potential, however upland soil load-bearing capacity would need to be improved over portions of the site in order for the efficiency of this operation to meet serial production

standards. Load-out by crane would require dredging along the eastern bulkhead and repair of that bulkhead area. Bulkhead geometry would require modification for optimal utility. Ro/Ro transport to barge or transport ship is a potential for these components from the dry docks and finger piers on the western portions of the site with some modification.

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS operations from a layout perspective; however, the site is distant from much of the WEA. The site shows good potential as a service port, as service vessels could berth at the facility and the warehousing and upland lay down areas on the site are good. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be easily adapted at this site. The site is well suited for cable storage, as a cable service port and as a cable manufacturing facility with minimal modification needed.

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Upgrades and Improvements Opportunity for Full Utility

In order for the property to meet the needs of OSW production, particularly the serial production of components for the pipeline of projects expected, certain site improvements would be required. These would include: connection of upland areas with high density surface treatment to allow for ease of component transfer movement; addition of production buildings (for manufacturing/fabrication scenarios); better connection of the dry-dock areas with the upland (installing connecting land); repair of the piers; repair and upgrade of the western bulkhead; dredging of the area adjacent of the western bulkhead; installation of crane pads where extreme heavy lift operations might occur; installation of high-mast lighting, security, upgrade of electrical, water, sewer connection, particularly at the bulkheads.

Opportunities for Investment

Upgrades for site utility could range from low-cost (<$5 million) for OMS or secondary steel applications, to moderate-cost ($15-$50 million) for upgrades to allow for tubular or foundation and tower piece finishing; to high (>&50M) for upgrades to support the top-side configurations of nacelle, blade and tower manufacturing/fabrication. Special attention should be focused on the bulkhead, pier, wharf and dry dock areas.

Table 26 Summary of OSW utility at Colonna's Shipyard.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.6. Fairlead Boatworks

Existing Conditions

The Fairlead Boatworks, Inc. (aka, Fairlead Marine) facility is located at 99 Jefferson Avenue in Newport News, Virginia. The property encompasses approximately 5.3 acres (2.1ha) on the southern shore of the Newport News Point, adjacent to the Route I-664 approach to the Hampton Roads Beltway Bridge-Tunnel and at the intersection of the Newport News Creek and the Newport News Channel. The property has over 1,025ft (312m) of Creek frontage and includes 975ft (297m) of total quayside. The facility current uses include ship maintenance and repair activities for the fishing and yachting industry and for the government. The boatworks at the facility is known for vessel component machining, fabrication and advanced mobility solutions. The property includes one 975ft (297m) bulkhead with an 800ft (244m) working quay (along the Newport News Creek), where vessels can tie up and transient cranes can be utilized to conduct loading and off-loading operations. A 100ft (30.5m) by 38ft (11.5m) "slot berth" also exists near the northern edge of property, which is serviced by a large travel lift. The main property (approximately 4.9 acres (1.9ha) extends along the Newport News Creek between the waterway and Jefferson Avenue. A second small triangular-shaped parcel exists (across Jefferson Avenue from the main site) adjacent to Norfolk Harbor, with a size of 0.4 acres (.16ha). This parcel is currently used as a parking lot.

Overview

The facility has a decades-long history as a ship repair and vessel maintenance facility, servicing small to medium size vessels for the fishing industry, the recreational boating industry and the military. Machining and fabrication of vessel parts and components is a key element of the services currently provided at the facility. The facility specializes in welding and metal-works, with (one-off) fabrication as well as serial and mass production of complex components and has fabrication capabilities ranging from sheet metal to large complex weldments. The facility has a history of designing and fabricating large structures and enclosures and houses equipment that enables high tolerance manufacturing. As a military supplier, the facility produces container solutions that integrate sensitive equipment in ruggedized vessels that operate in the harshest conditions, as well as conducts ship repair. The facility also conducts coating operations and large component blasting and powder coating and painting operations are conducted at the site.

A large marine travel lift crane operates along the quayside of the facility, launching and pulling vessels through the slot berth on the Creek. The travel lift has large vessel and component lifting capabilities for vessels and structures up to 135ft by 35ft (41m by 10.6m) and up to 250-ton and there exists 5 acres (2ha) of yard space and vessel block area immediately adjacent to the quayside.

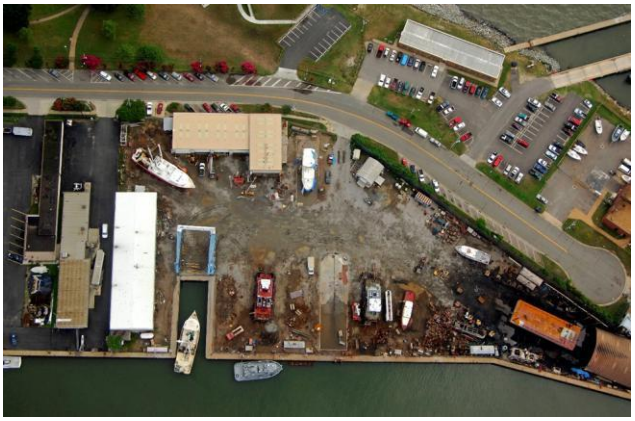


Figure 20 Aerial image of Fairlead Boatworks facility.

Four buildings currently exist at the site:

- A 175ft by 52ft (54m by 16m) single story workshop with offices steel building;
- An L-shaped 140ft by 50ft (43m by 15.5m) single story steel building;
- A 31ft by 25.5ft (9.5m by 7.8m) steel sprung-structure building; and
- A large 150ft by 66ft (45.5m by 20m) high-bay fabrication and coating building.

The property sits on the southern peninsula of Newport News near the northern entrance to the Hampton Roads Beltway (Bridge-Tunnel). The property is bordered by the Newport News Creek on the west and Jefferson Avenue on the east. It is located in an area characterized by industrial and port facility operations and commercial operations, including vessel docking facilities. Abutting the site to the south is a local radio station (WGH-FM Newport News) transmitting tower facility. Road transportation is close by, with the on-ramp/off-ramp for Route I-664, the Hampton Roads Beltway located approximately 1.1-miles (1.8 km) north of the site. Rail connections are not available at the site directly but are present nearby where a large coal distribution facility is located approximately 0.6-miles (1 km) to the northeast of the facility.

The site has over 800ft (244m) useable quayside fronting on the Newport News Creek, which has a limiting depth (NOAA Chart 12245-Hampton Rhodes) of approximately 10ft (3m) and a width of 150ft (45.7m). The site is located near the mouth of the creek where it empties into the Newport News Channel, which is a 50ft deep (15m), 800ft (244m) wide channel leading out into Norfolk Harbor and Hampton Roads. Water approaches to the site include passage through the Norfolk Harbor Reach, which is a 50ft (15m) deep, 1,000ft (305m) wide passage.

Limitations

The facility is located on the Newport News Creek with a confining depth of 10ft (3m). The site is utilized for heavy component and vessel welding, machining and coating, but is comprised of 5 useable acres of land.

There are no overhead restrictions between the facility and the open ocean, though there are two bridge-tunnels between the Fairlead Boatyard facility and the open ocean, the Highway 60 (I-64) Bridge-Tunnel and the Chesapeake Bay Bridge-Tunnel. The Highway 60 (I-64) Bridge-Tunnel is located approximately 5 nautical miles (9.5km) to the east of the Fairlead Boatworks facility along the Newport News Channel. This bridge-tunnel consists of a bridge that spans a portion of the distance into the Bay and then submerges beneath the Channel in an under-bay tunnel. There is no overhead restriction for passage through the bridge-tunnel opening and the channel clearance width is 800ft (244m) where it passes over the tunnel (between the bridge abutment structures). The Chesapeake Bay Bridge-Tunnel is located approximately 17 nautical miles (32km) to the east of the site and spans the Chesapeake Bay. This bridge-tunnel has a 4,500ft (1370m) large opening between the bridge abutments where the roadway submerges below the Bay and the channel depth in this area is 50ft (15m).

The closest airport is Aberdeen Field, located approximately 10 miles (16km) from the facility. Norfolk International Airport (ORD) is also nearby, located approximately 13 miles (21km) to the southeast. A large radio tower exists abutting the boatyard property and it is anticipated that FAA ceiling restrictions will be coincident with the height of the radio tower (400ft/123m) in the vicinity of the site.

Table 27 Summary of Fairlead Boatworks key statistics.

Parameter	US units	Metric units	Notes
Property size	5.3 acres	2.1 ha	Narrow property adjacent to the Newport News Creek.
Bulkhead length	800ft	244m	In one bulkhead segment adjacent to Creek. Bulkhead steel and concrete construction.
Total quayside length	975ft	297m	Includes several long bulkhead and short bulkhead segments.
“Slot” berth	100ft by 35ft	31m by 11m	One “slot berth” exists cut into the bulkhead at the quayside for the pulling and launching of vessels using a heavy-lift travel lift.
Berth depth at Bulkhead	10-15ft	3 - 5m	NOAA chart depth indicates 10ft-shallow due to debris and sediment build-up in parts of the Creek.
Channel depth in creek	10-15ft	3 - 5m	Site abuts 150ft wide creek.
Main channel depth to site (along two reaches)	50ft	15m	Main channels: Newport News Channel and Norfolk Harbor Reach).
Bridge-tunnel horizontal clearance	800ft and 1,000ft	244m and 305m	Bridges do not impart overhead restrictions as they submerge beneath the Bay in the areas where marine channels exist to facilitate tall vessel passage.
Buildings	~30,440-sqft total area	~2,824-sq-m total area	4 buildings of various sizes. One building is a high-bay building.
Load bearing capacity*	1,000-3,000psf	4,880-14,647kgpsm	Load bearing estimated based on current site uses. Actual Load bearing capacity may vary.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

While this site has relatively small acreage, it has a good bulkhead and quayside. and a large high-bay building. The "slot" berth and heavy-lift (250 ton) travel lift increase the utility of this site for certain components and vessels. The site is not suitable for large component manufacturing (such as foundations or nacelles), however with its history of medium-sized ship repair and marine component fabrication, it could be utilized in concert with other local facilities for numerous secondary-purpose uses by the OSW industry, including finish work and secondary component fabrication and coating. This site could also be configured for OMS purposes relatively easily and could be utilized as a service port for multiple components for wind farm maintenance and repair. The lack of overhead restriction and broad and deep main channel configurations are important factors for this site. The shallow depth (10–15ft or 3–5m) and narrow (150ft or 45m) nature of the Newport News Creek, which abuts the bulkheads for the facility, represents a challenge for some of the service vessels for OSW.

Foundation and tubular components

The site is expected to be too small to support the manufacture or fabrication of monopile, transition piece and/or tower section components. Due to the presence of the slot berth and travel lift capacity at the quayside and the presence of a high-bay building where welding and coating could be conducted, it is conceivable that the facility could be used as a transient steel finishing and coating yard, working in tandem with other port facilities in the area, with components moving to and from the facility by barge. The site is not well suited for Jacket Foundation manufacture/staging, Concrete Foundation fabrication/staging, or floating wind platform fabrication/staging because of the limited waterway size and depth and the small size of the site. Secondary manufacturing or fabrication trains at the site could make use of the slot berth, particularly if travel-lift type vehicles are used with barges.

Nacelles, blades, rotors, generators

Similar to foundation components, the pieces typically need larger acreage, deeper water and wider channel access than is possible at this site. The site is suited for use as a service port where storage of one of each of these components as spares could be conducted. Upland soil load-bearing capacity would need to be improved over portions of the site in order for the efficiency of this operation to meet standards. Load-out by crane would require dredging along the eastern bulkhead the placement of a crane pad. Channel geometry leading to the site restricts optimal utility. Barge trans shipping of components is possible using the slot berth and a heavy-lift travel lift.

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS operations from a layout perspective, however the site is distant from much of the WEA. The site shows good potential as a service port, as service vessels could berth at the facility and the warehousing and upland lay down areas on the site, while small, are in reasonably good condition. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be adapted at this site and the potential for coating is a positive attribute. The site could be utilized for cable storage, however cable baskets and spools would need to be shipped via barge, as cable lay vessels would create a challenge for other vessels using the Newport News Creek due to the narrow channel berth at the quayside.

Upgrades and improvements opportunity for full utility

Dredging of the Newport News Creek adjacent to the facility and down-stream to the mouth of the creek would be required in order make this property useful for any manufacturing or fabrication of components for the OSW industry. For the property to meet the needs of OSW component finish-work or production, quayside improvements and installation of crane pads where heavy lift operations might occur would be needed.

Opportunities for investment

Upgrades for site utility could range from low-cost (<$5 million) for OMS or secondary steel applications, to moderate-cost ($15-$30 million) for upgrades to allow tubular component finishing and/or coating.

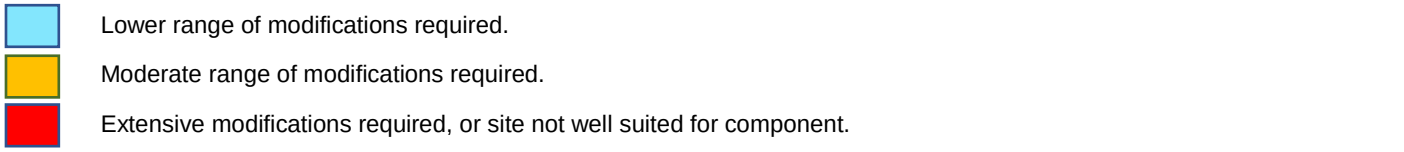
Opportunity strategy for investment

While there are some OSW activities that could occur at this site with little or no modification (such as OMS and secondary steel), full utility of the site for OSW uses would require upgrades and improvements. These site modifications range from dredging and bulkhead repair/improvement to ground improvement improve the mobility of cranes and other OSW-specific equipment (such as the Self-Propelled Modular Transports (SPMTs)). Of these activities, the opportunity for public investment and support include:

- Conducting the dredging needed to improve vessel access to the bulkhead and slot berth.
- Funding, design and regulatory approvals/permitting support for the improvements need to the bulkhead and quayside if crane load-out is to be considered for the site.
- Economic and regulatory approvals/permitting support for the improvements needed at the site to increase the heavy-lift capacity at the slot berth (i.e., purchase of a heavy-duty travel lift and improvements to site bearing capacity surrounding.

Table 28 Summary of OSW utility at Fairlead Boatworks.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel, Coating	OMS and Service Facility



Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.7. East Coast Repair and Fabrication

Existing conditions

The East Coast Repair and Fabrication, Inc. (ECRF) facility is located at 3400 Shipwright Street in Portsmouth, Virginia The property encompasses approximately 17.3 acres (7ha) on the southern shore of the Lake Kingman Promontory and sits on the northern portion of the Western Branch of the Elizabeth River near Route 164 (The Western Freeway). The property area includes a portion of the water area adjacent to the site, leaving approximately 10-acres (4ha) of upland area available for operations. The property has nearly 1,000ft of river frontage and includes 9 pier/dock facilities that extend into the river. The facility current operations include ship maintenance and repair activities and shipbuilding and specialty marine manufacturing and fabrication. ECRF specializes in ship repair and construction and has an extensive mobile capability (floating work-dock) that can facilitate large-scale off-site reconstruction, reconfiguration or new construction projects. The facility focuses on military, government and commercial large vessel reconfiguration, upgrades and repair. ECRF conducts custom fabrication and precision metal fabrication services, including cutting, bending, rolling, welding, shaping and trimming on a various metal structures including piping of all types, aluminum, steel, copper, fiberglass and wood projects. Component production ranges from small handheld components to the entire replacement of US Navy warships bow to stern. ECRF is also a marine industrial coating specialist, with a QP-1 certification for painting and blasting. The facility has many coatings projects on a multitude of systems and platforms, from small individual components up to US Nuclear Powered Aircraft Carriers.

Overview

The property waterfront is dominated by 9 finger piers that extend into the Elizabeth River. The pier lengths range from 93ft (28m) to 440ft (136m). The pier widths range from 7ft (2.1m) to 25ft (7.6m). Of the finger piers, seven are of timber construction on timber piles and are narrow (between 7ft (2.1m) and 10ft (3m). The remaining two piers are wider, approximately 25ft (7.8m) wide and appear to be concrete decking on timber or timber and steel pilings. One of the wider pier systems is of newer construction, is 215ft (65.5m) long and 25ft (7.6m) wide and is located on the central portion of the facility waterfront. The other wide piers are located on the easternmost portion of the site and is approximately 450ft (137m) long and 20ft (5.8m) wide, though a portion of the end of the pier is in poor condition and is un-useable, leaving approximately 180ft (55m) of useable pier.

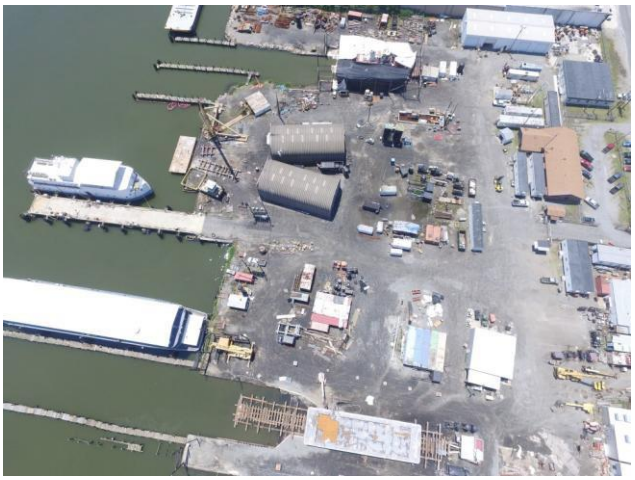


Figure 21 Aerial image of East Coast Repair and Fabrication shipyard.

The facility also has two marine railway systems nestled between sets of finger piers onsite. The railway systems facilitate the hauling and launching of very large vessels through the use of under-keel support platforms/cradles that are used to pull the ships or barges that require repair (or launching) onto the upland portion of the quayside. Both railway systems are located on the eastern portion so the site in between the sets of long narrow finger piers located there. A medium sized mobile crane with outriggers exists at the site and can move about the site to facilitate load-on/load-off from multiple piers, including assisting with operations around the marine railway features. A 170ft (52m) long steel sheet-pile bulkhead exists on the western portion of the site between a narrow timber finger pier and the larger concrete decked pier. A larger fixed ringer/outrigger crane is also located at the quayside adjacent to the newer concrete decked pier. A “slot berth” exists on the eastern portion of the site-this feature is bordered by rip-rap on either side.

Summary of waterfront pier/bulkhead components at the site (from west to east):

- Bulkhead: 170ft (52m); located on the western portion of the site.
- Pier 1: (timber) - 100ft long; 8ft wide (31m long; 2.4m wide)
- Pier 2: (timber) - 93ft x 7ft (28m x 2.1m)
- Pier 3: (timber) - 154ft x 7ft (47m x 2.1m)
- Pier 4: (timber) - 108ft x 7ft (33m x 2.1m)
- Pier 5: (concrete) - 215ft x 25ft (65.5m x 7.6m)
- Pier 6: (timber) - 285ft x 7ft (87m x 2.1m)
- Pier 7: (timber) - 288ft x 7ft (88m x 2.1m)
- Pier 8: (timber) - 288ft x 7ft (88m x 2.1m)
- Pier 9: (wood and concrete; the end 270ft [83 m] of pier in disrepair) total length - 450ft x 20ft (137m x 6m)

Upland Area*:* The site encompasses approximately 17 acres (7ha), with approximately 10 acres (4ha) of upland open space. 9 buildings of various size exist at the site, with a total of approximately 61,600sqft (5,723m^2) under roof. A 200ft by 60ft (62m by 20m) steel hi-bay warehouse and fabrication/shop building exists on the far western edge of the site. Adjacent to this building and inland of the first two piers on the western edge of the site is a second steel warehouse/shop building of approximately 220ft by 60ft (67m by 20m). A third (120ft by 53ft (37m by 16m) warehouse/shop building exists on the western portion of the site. Two Quonset-style fabrication and repair buildings (approximately 90ft by 45ft; 27m by 14m) are located behind the main bulkhead quayside on the center portion of the site. A multi-story concrete block and brick building located near the entrance to the facility serves as office and shop space. Several other building (mostly steel) exist at various locations on the upland on the eastern portion of the site.

The facility has been used for decades as a ship repair, fabrication and vessel maintenance facility and has over the years serviced vessels of all shapes and sizes. The facility has services the marine military market for decades, facilitating the reconstruction and repair of small cruisers to large aircraft carriers (offsite). As such, the facility has the capacity to shape and weld all manner of metal components of many sizes and shapes. The property is in an industrial area, with the nearest residential properties located approximately 600ft (183m) to the north. Highway road transportation is close by, with the on-ramp/off-ramp for Route 164 located approximately 1,500ft (477m) to the north of the site. There is not a rail connection on the site, however, a Norfolk Southern Rail Line that services a nearby fuel offloading facility is located approximately 600ft (183m) to the north of the site.

Water approaches to the site include the Western Branch of the Elizabeth River (the site is on the north side of the River), which is accessed through the Main Branch of the Elizabeth River (Lambert Bend and Pinner Point Channel), past the Norfolk Marine Terminals and Hampton Flats from Chesapeake Bay.

Summary of approach channels to the ECRF Site*:*

- Channel approaching site: 16ft deep (with one obstruction), 150ft wide (4.8m deep and 46m wide).
- Channel entering Lambert Bend to Pinner Point Channel: 17ft deep, 200-300ft wide (5m deep and 61-91m wide).
- Lambert Bend: 40ft deep, 750ft wide (12m deep and 229m wide).
- Craney Island Reach: 50ft deep, 800ft wide (15m deep and 244m wide)

Limitations

The facility is located on the western branch of the Elizabeth River with a local confining depth of 16ft (4.8m). The site is utilized for heavy component and vessel welding, machining and coating and is comprised of 15 useable acres of land area with several finger piers and a 170ft (52m) bulkhead quayside.

There are no overhead restrictions between the facility and the open ocean, though there are two bridge-tunnels between the ECRF facility and the open ocean: The Highway 60 (I-64) Bridge-Tunnel and the Chesapeake Bay Bridge-Tunnel. Both bridge-tunnels consists of a bridge that spans a portion of the distance into the Bay and then submerges beneath the Channel in an under-bay tunnel. There is no overhead restriction for passage through the bridge-tunnel opening. Furthermore, the channel clearance width of the Highway 60 Bridge-Tunnel is 800ft (244m) where it passes over the tunnel (between the bridge abutment structures) and the Chesapeake Bay Bridge-Tunnel has a 4,500ft (1370m) large opening between the bridge abutments where the roadway submerges below the Bay and the channel depth in this area is 50ft (15m).

The closest airport is the Hampton Roads Executive Airport located approximately 7.6miles (12km) to the west of the ECRF facility. The Chambers Field-NAS Norfolk Airport is located approximately 6miles (9.6km) to the north of the Site. It is anticipated that FAA ceiling restrictions will impose height restrictions of approximately 300ft in the vicinity of the site (confirmation with FAA should be conducted prior to use).

With the current configuration, a large number of the timber finger piers at the site are not well suited for OSW use. Connections to the main bulkhead at the site and lay down areas that exist upland of the finger piers on the eastern end of the site could be made but would require the removal or relocation of several buildings and possibly the removal of several finger piers.

Table 29 Summary of East Coast Repair and Fabrication key statistics.

Parameter	US units	Metric units	Notes
Property size	17.3 acres	7 ha	Irregularly shaped property adjacent to the Western Branch of the Elizabeth River. Portion of the property area is in the water, approximately 10 acres (4ha) of land area useable.
Bulkhead length	170ft	52m	Located between finger piers on the central portion of the waterfront at the site. Small ringer crane present.
Finger piers	93ft to 440ft	28-134m	9 Finger Piers of various length and width.
Berth depth at Bulkhead	14ft (reported)	4.2m	Vessel access to Bulkhead is between the western finger piers. Depth reported is due to obstruction and functional depth may be deeper.
Channel depth to site	17ft	5m	Western Branch Elizabeth River Channel.
Bridge horizontal opening	800ft (narrowest) (bridge-tunnel)	244m	2 bridge-tunnels between site and open ocean. No overhead restrictions.
Buildings	61,600sqft (total under roof)	5,723sqm (total under roof)	9 buildings of various sizes.
Load bearing capacity*	1,000-2,000psf	4,880-9,760kgpsm	Load bearing capacity expected to be higher that reported at ringer crane on western edge site.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

While this site has relatively small acreage, it has a bulkhead and quayside and several high-bay buildings. The site is not suitable for large component manufacturing (such as foundations or nacelles), however with its history of medium-sized ship repair and marine component fabrication, it could be utilized in concert with other local facilities for numerous secondary-purpose uses by the OSW industry, including finish work and secondary component fabrication and coating. This site could also be configured for OMS purposes relatively easily and could be utilized as a service port for multiple components for wind farm maintenance and repair. The lack of overhead restrictions and close proximity to a channel to the open ocean are important factors for this site. The shallow depth (16-20ft or 5-6m) and numerous narrow timber-construction finger piers represent a challenge for many of the service vessels for OSW.

Foundation and tubular components

The site is expected to be too small to support the manufacture or fabrication of monopile, transition piece and/or tower section components. The presence of a high-bay building where welding and coating could be conducted could potentially be utilized for OSW secondary foundation component steel finishing and coating, working in tandem with other port facilities in the area, with components moving to and from the facility by barge. The site is not well suited for jacket foundation manufacture/staging, concrete foundation fabrication/staging, or floating wind platform fabrication/staging because of the limited waterway size and depth and the small size of the site.

Nacelles, blades, rotors, generators

Similar to foundation components, these pieces typically need larger acreage, deeper water and wider channel access than is possible at this site. The site could be used as a service port where storage of one of each of these components as spares could be conducted. Upland soil load-bearing capacity would need to be improved over portions of the site in order for the efficiency of this operation to meet standards. Load-out by crane would require dredging along the site bulkhead and the placement of a crane pad.

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS operations from a layout perspective; however, the site is distant from much of the WEA. The site shows good potential as a service port, as service vessels could berth at the facility and the warehousing and upland lay down areas on the site, while small, are of reasonable utility. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be readily adapted at this site and the potential for coating is a positive attribute. The site's history as a fabricator of large components for the navy is seen as a great attribute. The site could be utilized for cable storage, however cable baskets and spools would need to be shipped via barge, as access for cable lay vessels would be challenged due to the shallow channel depth and berth at the quayside.

Upgrades and improvements opportunity for full utility

Dredging of the berth at the bulkhead and quayside and the Elizabeth River Channel adjacent to the facility (and down-stream to the mouth of the river) would be required make this property useful for any manufacturing or fabrication of components for the OSW industry. In order for the property to meet the needs of OSW component finish-work or production, quayside improvements and installation of crane pads where heavy lift operations might occur would be needed.

Opportunities for investment

Upgrades for site utility could range from low-cost (<$5 million) for OMS or secondary steel applications, to moderate-cost ($15-$50 million) for upgrades to allow tubular component finishing and/or coating.

Opportunity Strategy for Investment*:* While there are some OSW activities that could occur at this site with little or no modification (such as OMS and secondary steel), full use of the site for OSW would require upgrades and improvements. These site modifications range from dredging and bulkhead repair/improvement to ground improvement to improve the mobility of cranes and other OSW-specific equipment (such as the self-propelled modular transports (SPMTs)). Of these activities, the opportunity for public investment and support include:

- Conducting the dredging needed to improve vessel access to the bulkhead and finger piers.
- Funding, design and regulatory approvals/permitting support for the improvements need to the bulkhead and quayside if crane load-out is to be considered for the site. Additionally, similar support could be provided for the removal/reconfiguration of finger piers at the site.
- Economic and regulatory approvals/permitting support for the improvements needed at the site to increase the heavy-lift capacity at the bulkhead (i.e. installation of a heavy-duty crane and improvements to site bearing capacity surrounding the bulkhead and travel lanes.

Table 30 Summary of OSW utility at East Coast Repair and Fabrication.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.8. General Dynamics Harper Yard

Existing Conditions

The General Dynamics Harper Yard facility is located at 2 Harper Road in Portsmouth, Virginia The property encompasses approximately 55.6 acres (22.5ha) at Pinners Point next to the Portsmouth Marine Terminal on the Elizabeth River. The facility is currently a full-service shipyard with two concrete and steel piers. The facility has been in the business of ship repair and maintenance for several decades.

Overview

The property is in an industrial area. Road transportation is close by, with the on-ramp/off-ramp for Route 58 located approximately 1,000ft (304.8m) from the western edge of the site. Rail is not present on the property but is present on the adjacent property to the west.

The property has significant water frontage on the Elizabeth River, with two long finger piers that jut out into the Elizabeth River. Approximately half (the southern half) of the main upland portion of the site currently houses parking for vehicles. The northern portion of the upland at the site houses nine buildings of various size and construction totaling approximately 63,400sqft (4,960m^2). The buildings house office, warehouse and fabrication shop activities. The largest building, the main fabrication hall, measures approximately 345ft by 82ft (105m by 25m) and is a high-bay building with oversized door on the water-facing end.

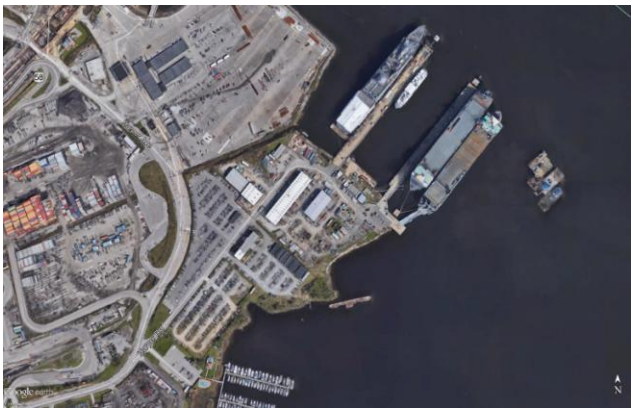


Figure 22 Aerial image of General Dynamics Harpers Yard.

Pier 1 is 799ft (244m) long and 55ft (16.8m) wide and is used for ship repair and modernization. A dolphin rated for 200 tons (181t) is located 53ft (16.2m) off the pier head. Pier 2 is east of pier 1 and is 785ft (239.3m) long and 55ft (16.8m) wide lay berth pier. The berth west of pier 1 is 35ft (10.7m) MLLW and the berth on the east side is 34ft (10.4m) MLLW. The berth east of pier 2 is 31ft (9.5m) MLLW.

The facility current operations include ship maintenance and repair activities, shipbuilding and specialty marine manufacturing and fabrication. The facility specializes in ship repair and construction and has an extensive capability. The facility focuses on military and government large vessel reconfiguration, upgrades and repair. NASSCO-Norfolk's Harper Avenue Yard is a full-service shipyard outfitted with one ship repair/modernization pier, one lay berth pier and over 60,000sqft of covered environmentally controlled shops and inside shop storage area. The shipyard's steel and concrete Pier #1 has been approved by the US Navy for mooring combatant, auxiliary and amphibious ships up to and including LPD-17 class vessels. Pier #2 serves as a MARAD lay berth facility.

Water approaches to the site is via the Elizabeth River Channel. The Norfolk Harbor Reach is 50ft (15.2m) deep MLLW and over 800ft (243.8m) wide. Starting at the Lambert Bend Reach and continuing to the Pinner Point to Town Point Reach the channel narrows to 750ft (228.6m) and the depth deceases to 40ft (12.2m) MLLW. The piers along the northeast edge of the property can accommodate several large vessels. The water depth along the southeast edge of the property is 1 to 3ft (0.3 to 0.9m) and there are submerged obstructions making navigation difficult.

Limitations

There are no bridges between the facility and the open ocean. The closest airport is the Norfolk International Airport located approximately 7.5-miles (12km) to the east of the facility. The Naval Medical Center at Portsmouth is located approximately 1,500ft (457m) south of the facility and has a helipad. It is anticipated that FAA ceiling restrictions may apply to the site.

Table 31 Summary of General Dynamics Harper Yard key statistics.

Parameter	US units	Metric units	Notes
Property size	55.6 acres	22.5 ha	The property is located on the Elizabeth River in an industrial and shipbuilding section of Portsmouth.
Bulkhead/quayside	200ft	61m	A concrete on steel pile bulkhead platform exists between the two pier structures.
Pier 1	799ft x 55ft	244m x 17m	Heavy-duty finger pier with 200-ton dolphin.
Pier 2	785ft x 55ft	239m x 17m	Heavy-duty pier; MARAD lay berth facility.
Berth depth at quayside	30-35ft MLLW	10m MLLW	2 large berths (260ft [79m] wide and 200ft [61m] wide) about the onsite piers.
Main channel depth to site	40ft	12m	Pinner Point to Town Point Reach.
Buildings			Approx. 9 buildings (~63,400 total sqft).
Load bearing capacity*	1,000-4,000psf	4,880-19,530kgpsm	Load bearing capacity on the piers and approaches to the piers expected to be at the higher end of range. Ground bearing, the parking lots and the vehicle storage portions of the site are expected to be at the low end of the range.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

The facilities moderate acreage and two piers make the site well adapted for OSW manufacturing of some components. The existing structures could support manufacturing, but the size and configuration of buildings on the site makes using it as a marshalling port unlikely. The site could be well suited for use as a lay down site or for use as an OMS facility for wind farm maintenance and repair service port.

Foundation and tubular components

The site could be adopted to handle monopile, transition piece and tower section components, including manufacturing and fabrication. The property's moderate size and configuration of existing structures are not ideal for foundation manufacturing, however could be modified to work. Due to its size and quayside configuration, the site is not well suited for jacket foundation manufacture/staging, concrete foundation fabrication/staging, floating wind platform fabrication/staging.

Nacelles, blades, rotors, generators

These components could be manufactured or finished at this facility. As with the foundations, the shape and layout of the property imparts some challenges to local on-site transport of these components. Large crawler cranes are a potential, however upland soil load-bearing capacity would need to be improved over portions of the site in order for the efficiency of this operation to meet serial production standards. Load-out by crane would require installation of a crane pad or pads. Bulkhead geometry would require modification for optimal utility. Ro/Ro transport to barge or transport ship is a potential for these components from the bulkhead area between the finger piers on the riverfront portions of the site with some modification

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS from a layout perspective, however the site is distant from much of the WEA. The site shows good potential as a Service Port, as service vessels could berth at the facility and the warehousing and upland lay down areas on the site are good. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be easily adapted at this site. The site is well suited for cable storage, as a cable service port and as a cable manufacturing facility with minimal modification needed.

Upgrades and improvements opportunity for full utility

In order for the property to meet the needs of OSW production, particularly the serial production of components for the pipeline of projects expected, certain site improvements would be required. These would include: connection of upland areas with high density surface treatment to allow for ease of component transfer movement; addition of production buildings (for manufacturing/fabrication scenarios; repair of the piers; repair and upgrade of the western bulkhead; dredging of the area adjacent of the western bulkhead; installation of crane pads where extreme heavy lift operations might occur; installation of high-mast lighting, security, upgrade of electrical, water, sewer connection-particularly at the bulkheads.

Opportunities for investment

Upgrades for site utility could range from low-cost (<$5 million) for OMS or secondary steel applications, to moderate-cost ($15-$50 million) for upgrades to allow for tubular or foundation and tower piece finishing; to high (>&50M) for upgrades to support the top-side configurations of nacelle, blade and tower manufacturing/fabrication. Special attention should be focused on the bulkhead, pier and rip-rap water frontage areas.

Opportunity Strategy for Investment

While there are some OSW activities that could occur at this site with little or no modification (such as OMS and secondary steel), full use of the site for OSW would require upgrades and improvements. These site modifications range from bulkhead repair/improvement to ground improvement to improve the mobility of cranes and other OSW-specific equipment (such as the Self-Propelled Modular Transports (SPMTs)) to potential conversion of rip-rap river frontage to bulkhead (with subsequent dredging). Of these activities, the opportunity for public investment and support include:

- Conducting the dredging needed to improve vessel access to an enlarged bulkhead.
- Funding, design and regulatory approvals/permitting support for the improvements need to the bulkhead and quayside if crane load-out is to be considered for the site. Additionally, similar support could be provided for the reconfiguration of finger piers at the site to adapt for specialty OSW use.
- Economic and regulatory approvals/permitting support for the improvements needed at the site to increase the heavy-lift capacity at the bulkhead (i.e. installation of a heavy-duty crane and improvements to site bearing capacity surrounding the bulkhead and travel lanes).

Table 32 Summary of OSW Utility at the General Dynamics Harper Yard.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.9. General Dynamics Ligon Street Yard Facility

Existing Conditions

The General Dynamics Ligon Street Yard facility is located at 200 Ligon Street, Norfolk, Virginia The property encompasses approximately 32.8 acres (13.3ha) at the confluence of the Southern and Eastern Branches of the Elizabeth River. The city of Norfolk is directly across the river and the Berkley Bridge is just to the east. The facility is currently a shipyard with three concrete and steel pontoon piers and a steel pontoon dry-dock. Pier 1 western berth is 787ft (240m) long and 40ft (12m) wide and has a depth of 35ft (10.7m) MLLW. Pier 1 eastern berth is 365ft (111m) long and 40ft (12m) wide with a depth of 30ft (9m) MLLW. Pier 2 western birth is 620ft (189m) long and 40ft (12m) wide with a depth of 35ft (10.7m) MLLW. Pier 2 eastern birth is 1117ft (340.5m) long and 40ft (12m) wide with a depth of 35ft (10.7m) MLLW. Pier 3 eastern birth is 847ft (258m) long and 41ft (12.5m) wide with a depth of 35ft (10.7m) MLLW. The dry-dock is 750ft (228m) long with a clear width of 126.5ft (38.6m) and a lift capacity of 40,000 long tons (40,642t). The property is a full-service shipyard with approximately 10 buildings totaling over 100,000sqft (30,480m). Five tower cranes each provide 22 ton (20t) of lift capacity at 96ft (29m) and 7.6 ton (6.9t) at 246ft (75m).

Overview

The property is bordered to the south by two major roads, interstate 464 and interstate 264. Ramp access to these roadways is approximately 1,000ft (304.8m) from the southern edge of the site. No rail access is provided on the property but a rail spur does connect to the property to the southwest of the site. The area is highly industrialized with other port and marine facilities in the surrounding area.

Water approaches to the site is via the Elizabeth River Channel. The Norfolk Harbor Reach is 50ft (15.2m) deep MLLW and over 800ft (243.8m) wide. Starting at the Lambert Bend Reach and continuing to the Pinner Point to Town Point Reach the channel narrows to 750ft (228.6m) and the depth deceases to 40ft (12.2m) MLLW. The piers along the northeast edge of the property can accommodate several large vessels, up to 900ft (275m) in length. The property immediately to the west has a non-functional area blocking water access to the western side of the property. An approach from the eastern side of the property is constrained by the Berkley Bridge.

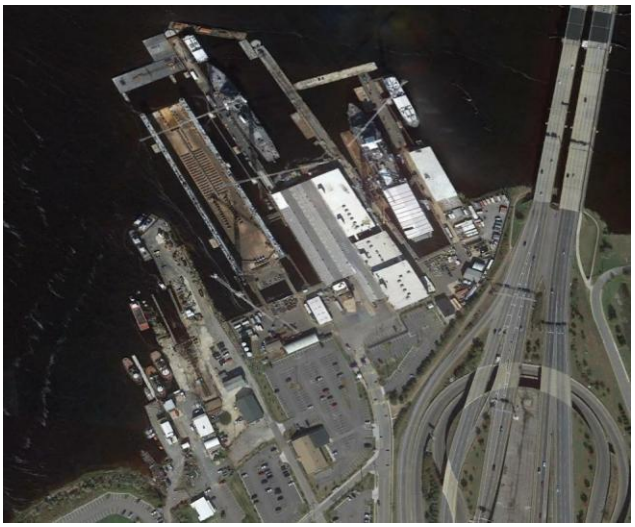


Figure 23 Aerial image of General Dynamics Ligon Yard.

Limitations

There are no bridges between facility and the open ocean. The closest airport is the Norfolk International Airport located approximately 5.25-miles (12km) to the northeast of the facility. The Naval Medical Center at Portsmouth's helipad is approximately 7,500ft (457m) west of the facility. FAA ceiling restrictions may apply to the site.

Table 33 Summary of General Dynamics Ligon Street Yard key statistics.

Parameter	US units	Metric units	Notes
Property size	32.8 acres	13.3 ha	
Quayside			Three piers steel and concrete pontoon.
Pier 1	787ft x 40ft (west) 365ft x 40ft (east)	240m x 12m (west) 111m x 12m (east)	
Pier 2	620ft x 40ft (west) 1117ft x 40ft (east)	189m x 12m (west) 340.5m x 12m (east)	
Pier 3	847ft x 41ft (east)	258m x 12.5m (east)	
Dry-dock	750ft x 126.5ft	228m x 38.6m	lift capacity of 40,000 long tons (40,642t).
Berth depth at quayside	30-35ft MLLW	10m MLLW	
Main channel depth to site	40ft	12m	Pinner Point to Town Point Reach.
Buildings			Approx. 10 buildings (~101,100 total sqft).
Load bearing capacity*	1,000-4,000psf	4,880-19,530kgpsm	

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

The facilities moderate acreage, dry-dock and two piers make the site well adapted for OSW manufacturing of components. The existing structures could support manufacturing, but the size and configuration of buildings on the site makes using it as a marshalling port unlikely. The site could be well suited for use as a lay down site or for use as an OMS facility for wind farm maintenance and repair.

Foundation and tubular components

The site could be adopted to handle monopile, transition piece and tower section components, including manufacturing and fabrication. The property's moderate size and configuration of existing structures are not ideal for foundation manufacturing but could be modified to work. The site is ideal for cable service, staging and manufacture. The site is not well suited for Jacket foundation manufacture/staging, concrete foundation fabrication/staging, floating wind platform fabrication/staging.

Nacelles, blades, rotors, generators

These components could be manufactured or finished at this facility. As with the foundations, the shape and layout of the property imparts some challenges to local on-site transport of these components. Large crawler cranes are a potential, however upland soil load-bearing capacity would need to be improved over portions of the site in order for the efficiency of this operation to meet serial production standards. Load-out by crane would require dredging along the eastern bulkhead and repair of that bulkhead area. Bulkhead geometry would require modification for optimal utility. Ro/Ro transport to barge or transport ship is a potential for these components from the dry-docks and

finger piers on the western portions of the site with some modification

Operations, maintenance and service, cables, secondary steel

The site is well suited for OMS from a layout perspective; however, the site is distant from much of the WEA. The site shows good potential as a service port, as service vessels could berth at the facility and the warehousing and upland lay down areas on the site are good. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be easily adapted at this site. The site is well suited for cable storage, as a cable service port and as a cable manufacturing facility with minimal modification needed.

Upgrades and improvements opportunity for full utility

In order for the property to meet the needs of OSW production, particularly the serial production of components for the pipeline of projects expected, certain site improvements would be required. These would include: connection of upland areas with high density surface treatment to allow for ease of component transfer movement; addition of production buildings (for manufacturing/fabrication scenarios; repair of the piers; repair and upgrade of the western bulkhead; dredging of the area adjacent of the western bulkhead; installation of crane pads where extreme heavy lift operations might occur; installation of high-mast lighting, security, upgrade of electrical, water, sewer connection-particularly at the bulkheads.

Opportunities for investment

Upgrades for site could range from low-cost (<$5 million) for OMS or secondary steel applications, to moderate-cost ($15-$50 million) for upgrades to allow for tubular or foundation and tower piece finishing; to high (>&50 million) for upgrades to support the top-side configurations of nacelle, blade and tower manufacturing/fabrication. Special attention should be focused on the bulkhead, pier, wharf and dry dock areas.

Opportunity strategy for investment

While there are some OSW activities that could occur at this site with little or no modification (such as OMS, service port and secondary steel), full use of the site for OSW would require upgrades and improvements. These site modifications range from bulkhead repair/improvement to ground improvement to improve the mobility of cranes and other OSW-specific equipment (such as the Self-Propelled Modular Transports (SPMTs). Of these activities, the opportunity for public investment and support include:

- Conducting the dredging needed to improve vessel access to an enlarged bulkhead.
- Funding, design and regulatory approvals/permitting support for the improvements need to the bulkhead and quayside if crane load-out is to be considered for the site. Additionally, similar support could be provided for the reconfiguration of finger piers at the site to adapt for specialty OSW use.
- Economic and regulatory approvals/permitting support for the improvements needed at the site to increase the heavy-lift capacity at the bulkhead (i.e. installation of a heavy-duty crane and improvements to site bearing capacity surrounding the bulkhead and travel lanes).

Table 34 Summary of OSW utility at General Dynamics Ligon Street Yard.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.10.1201 Terminal Avenue

Existing Conditions

The Site is located at 1201 Terminal Avenue (a.k.a., Jerry O. Talton Piers 14 & 15; a.k.a. Talton Marine Terminal, 450 Harbor Road) in Newport News, Virginia on the north shore of the James River. The property extends for approximately 84.4 acres (34ha) on the southern coast of Newport News Point, adjacent to the Route I-664 (Hampton Roads Beltway) approach to the Hampton Roads Beltway Bridge-Tunnel. This site is located across the Newport News Creek and highway from the Fairlead Marine Site (also reviewed elsewhere in this report). The property has 1235ft (376m) of river frontage and has a quayside dominated by a pair of long piers.

The property operates as a Break-Bulk facility for receipt and shipment of containerized cargo and military equipment by vessel and for the mooring of transient vessels. The large finger piers at the facility are used for the tie up of Ro/Ro vessels and the quayside is used for the on-loading and off-loading of heavy weight civilian and military components. The land area of the site is tear-drop shaped, with a long narrow segment of the property stretching for nearly 2,800ft (860m) between Terminal Avenue and the abutting Dunbar Coal loading facility to the west and south (see Figure 24 below). This area is mostly not useable for operations as it is quite narrow (on average only about 170ft [54m] wide). Additionally, the recorded property acreage includes about 36 acres (14.6ha) of land underwater around the piers. The useable portion of the property encompasses approximately 35-acres (14.2ha), covering approximately the southern 2/3 of the upland area. The larger more open area adjacent to the quayside houses several older buildings and a large parking lot and is the portion of the site that is currently utilized for Ro/Ro and shipping. Moveable product transfer bridges exist at the site to facilitate loading and unloading of vessels. As many as 7 large transport vessels can berth at the site (when rafter together) for loading and discharging, two on each side of each of the two piers

Overview

The facility has a decades-long history as a vessel loading and unloading facility and as a warehousing and provisioning facility. The facility has also provided transient dockage for large and medium-sized civilian and military vessel. Historically, the facility has conducted light repair work, including light welding and metal-works. The facility has been a family owned and operated business for over 70-years, serving the maritime industry and the military with shipping and transport of large bulk and break-bulk cargo. The Talton Marine Terminal is a full-service maritime lay berth facility and is one of the only facilities on the East Coast capable of accepting the largest vessels in the Military Sealift Command and MARAD fleets. The quayside at the facility includes two long narrow finger piers that extend into the James River:

- Pier 14 (off of the western side of the property): is approximately 1,100ft (333m) long and 66ft (20m) wide;
- Pier 15 (off of the eastern side of the property): is approximately 1,000ft (305m) long and 75ft (23m) wide

Figure 24 Aerial image of 1201 Terminal Avenue.

The finger piers are of concrete platform on timber piles construction. Pier 14 is constructed of concrete decking on piles. Pier 15 is constructed of concrete decking on piles with a strip of timber decking on timber piles along its western edge. The concrete portion of the piers are in fair condition and the wooden wharf portion of Pier 15 is in fair-poor condition, with segments of the pier (near the outer end) collapsed. Water depth in the vicinity of the piers at the facility ranges from 37ft (11.3m) MLLW on the west side of Pier 14; to 35ft (10.7m) MLLW between Pier 14 and Pier 15; to 32ft (9.8m) to the east of Pier 15 MLLW (shallowing to 22ft [6.7m] at the northern end of that berth). Vessels up to 980ft (300m) in length and 230ft (70m) in beam, with a draft of up to 33ft (10m) can safely berth at the western-most slip at the facility. Similar sized vessels can berth at the other piers at the site-with the most restrictive berth being the eastern-most slip (to the east of Pier 15), which has experienced siltation at its northern edge and deeper draft vessels must tie-up further from the bulkhead. Ro/Ro ramps, both mobile land type and vessel equipped, allow for loading and off-loading of vessels at the quayside. A marine bulkhead stretches along the water's edge at the site between the property boundary and the piers and between the piers. Approximately 1,065ft (325m) of steel sheet-pile bulkhead exists between the piers and the property edges. Vessels tie up to the finger piers stern-

to the bulkhead. Ro/Ro activities take place across the transfer bridges using both street-class vehicles and special purpose trucks and transport vehicles. The upland property area adjacent to the pier is used for the parking of transport vehicles and laydown for cargo. Most of the site is unpaved, with the exception of the area adjacent to the quayside.

Two warehouse/storage buildings exist on the site, augmented by 2 office trailers and a guard hut. The buildings consist of:

- A block and steel building approximately 82ft (25m) by 37ft (11m) in size and positioned near the quayside;
- A steel warehouse building approximately 125ft (38m) by 55ft (17m) in size located on the southern portion of the facility near the quayside.

Two office trailers are located between the two onsite buildings. A small guard-house is located near the loading area of the quayside for control of access. The buildings are generally in fair condition but are in need of repair and upgrades if they are to be used by the OSW industry. A parking area exists at the site landward of the buildings. The remainder of the upland portion of the site is undeveloped land and is characterized by stands of trees and brush crossed by several paved and unpaved roads.

The property sits on the southern peninsula of Newport News near the northern entrance to the Hampton Roads Beltway (Bridge-Tunnel). The property is abutted by the large Dunbar Coal Transfer facility on the west and a fuel off-loading depot on the east. It is located in an area characterized by heavy industrial and port facility operations and commercial operations, including vessel docking facilities and bulk commodities transport facilities. The nearest residential neighborhoods are located over 1,200ft (365m) to the north. Rail is not present on the site; however, it is present on the adjacent coal transfer facility and could be extended to the site if needed.

The site has berth capacity to up to 7 vessels of over 900ft (275m) in length. The site is located near the mouth of the Newport News Creek where it empties into the James River at the Newport News Channel. The waterway includes a 50ft (15m) deep, 800ft (244m) wide channel leading out into Norfolk Harbor and Hampton Rhodes. Water approaches to the site include passage through the Norfolk Harbor Reach, which is a 50ft (15m) deep, 1,000ft (305m) wide passage. The facility is well suited for the berthing of very large transport vessels, which call on the port regularly. Limitations

There is one bridge-tunnel structure (the Chesapeake Bay Bridge-Tunnel) between the site and the open ocean. The Chesapeake Bay Bridge Tunnel is an approximately 15-mile (24km) long structure that consists of a bridge abutting the east and west shores of Chesapeake Bay that converts to a tunnel under the Bay where it crosses the Chesapeake Bay Channel. The tunnel section of the crossing spans 4,500ft (1,370m) of the Bay, providing a passage that wide and greater than 50ft (15m) deep. As such, the bridge-tunnel does not pose any overhead restriction and there are no overhead restrictions between the site and the open ocean. The closest airports are small civilian airfields, with the closest being approximately 1.8miles (2.9km) to the northeast of the site. It is anticipated that FAA ceiling restrictions will impose height restrictions of approximately 200 to 300ft (60 to 90m) in the vicinity of the site. Potential users of the site should contact the FAA to determine what equipment height restrictions (if any) there would be for this property.

Limitations

There are no overhead restrictions between the facility and the open ocean, though there are three bridge-tunnels between the facility and the open ocean: the Hampton Roads Beltway (I-664) Bridge-Tunnel, the Highway 60 (I-64) Bridge-Tunnel and the Chesapeake Bay Bridge-Tunnel. The Hampton Roads Beltway (I-664) Bridge-Tunnel is located almost adjacent to the facility and represents the first navigation point for vessels sailing from the facility. The Highway 60 (I-64) Bridge-Tunnel is located approximately 5 nautical miles (9.5km) to the east of the facility along the Newport News Channel. There is no overhead restriction for passage through the bridge-tunnel opening and the channel clearance width is 800ft (244m) where it passes over the tunnel (between the bridge abutment structures). The Chesapeake Bay Bridge-Tunnel is located approximately 17 nautical miles (32km) to the east of the site and spans the Chesapeake Bay. This bridge-tunnel has a 4,500ft (1370m) large opening between the bridge abutments where the roadway submerges below the Bay and the channel depth in this area is 50ft (15m).

The closest airport is Aberdeen Field, located approximately 10-miles (16km) from the facility. Norfolk International Airport (ORD) is also nearby, located approximately 13-miles (21km) to the southeast. A large radio tower exists abutting the boatyard property and it is anticipated that FAA ceiling restrictions will be coincident with the height of the radio tower (400ft/123m) in the vicinity of the site.

Table 35 Summary of 1201 Terminal Avenue key statistics.

Parameter	US units	Metric units	Notes
Property size	84.4 acres (35 acres useable)	34ha (14.2ha useable)	A portion of the northern end of the property is too narrow to be efficiently used. A portion of the recorded acreage includes land underwater. Remaining acreage (35 acres/14.2ha) is quayside area and undeveloped land.
Bulkhead length	1,065ft (total)	325m (total)	In multiple bulkhead segments between the finger piers. Bulkhead is sheet steel construction.
Total quayside length	1,230ft	375m	Property edge to property edge.
Finger Piers (2)	1,100ft by 66ft 1,000ft by 75ft	333m by 20m 305m by 23m	Two finger piers perpendicular to bulkhead. Can accommodate very large vessels.
Berth depth at Bulkhead	37ft (west) 35ft (central) 32ft (east)	11.2m (west) 10.7m (central) 9.7m (east)	NOAA Chart indicates far eastern berth shallows to 22ft (6.7m) at very northern end of eastern berth (east of Pier 15).
Main channel depth to site (along two reaches)	50ft	15m	Main channels: Newport News Channel and Norfolk Harbor Reach).
Bridge-tunnel horizontal clearance	800ft and 1,000ft	244m and 305m	Bridges do not impart overhead restrictions as they submerge beneath the Bay in the areas where marine channels exist to facilitate tall vessel passage.
Buildings	~31,000-sqft total area	~929-sq-m total area	2 older single-story buildings onsite. One building high-bay warehouse style.
Load bearing capacity* (at/near quayside)	2,000-4,000psf	9,765-19,530kgpsm	Load bearing estimated based on current site uses. Actual Load bearing capacity may vary.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

This site shows good potential for OSW use. It has moderate acreage (at 35 acres/14.2ha), large enough for a small manufacturing or assembly facility. The site also has good water depths and a quayside with finger piers that could be used for Ro/Ro transportation. It is expected the site is suitable for the dockage of the Ro/Ro vessels now being employed for the transport of nacelles components in Europe. Barge transport of large components could also be accommodated at the facility using travel-lift cranes. The addition of crane pads or rail crane components would allow for the fabrication of larger components such as jacket, tower, or monopile/transition piece components.

Foundation and Tubular Components

While this site is somewhat small to support the serial manufacture of monopile, transition piece and/or jacket section components, it could accommodate aspects of these activities in concert with other sites in the area. The site can support jacket foundation manufacture/staging, concrete foundation fabrication/staging, or floating wind platform manufacturing because of its deep-water berths if the piers can be repositioned.

Nacelles, Blades, Rotors, Generators

The Site is thought to be useful for the nacelle and related products manufacture and staging, as the quayside and berths can accommodate Ro/Ro shipping, which these components lend themselves to. Upland soil load-bearing capacity would need to be improved over portions of the

site in order for the efficiency of this operation to meet standards. Load-out by crane would require the placement of crane pads and possible the removal of one of the piers. Barge trans-shipping of components is also possible.

Operations, maintenance and service, cables, secondary steel I

The site is well suited for Operation & Maintenance operations from a layout perspective, however the site is distant from much of the WEAs. The site shows good potential as a service port, as service vessels could berth at the facility and there is good laydown area and room for warehousing on the upland portions of the site. Manufacture of secondary steel components (ladders, platforms, railings, racks) could be adapted at this site and the potential for installing a coating facility is a positive attribute. The site could be utilized for cable storage and cable spooling could be accommodated via the berths and finger piers onsite.

Upgrades and Improvements Opportunity for Full Utility

This site represents a good Roll-on/Roll-off option for the OSW industry. Components could be manufactured, fabricated, or staged at the property and loaded on and off the site via Ro/Ro shipping. Upgrades and repairs to the finger piers and the site bulkhead would be required in order for the facility to meet the needs of OSW component finish-work or production. For elements that require crane load-out, quayside improvements and installation of crane pads where heavy lift operations might occur would be needed. With a small amount of quayside modification, this Site could be adapted for the fabrication of floating wind components.

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Opportunities for Investment

Upgrades for site utility could range from low-cost (<$5 million) for OMS or Ro/Ro applications, to moderate-cost ($15-$30 million) for upgrades to allow for crane load-out of super-large and heavy-weight components.

Opportunity Strategy for Investment

There are a number of OSW activities that could occur at this site with slight modification (such as OMS, secondary steel manufacture and Ro/Ro operations for large component manufacturing/fabrication such as nacelles and generators). Full utility of the site for OSW uses would require upgrades and improvements. These site modifications range from bulkhead repair/replacement to finger pier removal or reconstruction, to ground improvement to improve the mobility of cranes and other OSW-specific equipment (such as the Self-Propelled Modular Transports (SPMTs)). Of these activities, the opportunity for public investment and support include:

- Improving the bulkhead capacity by reinforcing the quayside and installing crane pads.
- Funding, design and regulatory approvals/permitting support for the improvements need to the bulkhead and quayside if crane load-out is to be considered for the site.
- Economic and regulatory approvals/permitting support for the improvements needed at the site to increase the heavy-lift capacity at the slot berth (for example purchase of a heavy-duty travel lift and improvements to site bearing capacity surrounding

Table 36 Summary of OSW utility at 1201 Terminal Avenue.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel, Coating	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

8.11.SeaGate Terminals

In the 2015 report, the SeaGate Terminals Property was not assessed. This property has been added to the 2018 Report in response to interest from the community. A second storage building and 5 acres (2ha) concrete storage pads have been added to the property since 2015.

Existing Conditions

The SeaGate Terminals property is located at 1310 Priority Lane, Chesapeake, Virginia The property covers 43 acres (17.6ha) on the Elizabeth River. The site has approximately 600ft (183m) of concrete pier frontage. Two large warehouse buildings each approximately 90,000sqft along with several smaller structures are present. Concrete storage pads totaling 5 acres were constructed on either side of the rail spurs along the northern section of the property.

Water depths in the channels leading up to site range from about 40ft (12m) to 50ft (15m) in depth (MLLW). The berth depth at the facility quay side is approximately 40ft (12m). The property is surrounded by industrial properties to the north and south and rail and highways to the east.

Property Overview

The site is a bulk terminal located on the east bank of the South Branch of Elizabeth River. Existing facilities include 2 large warehouses building and a 1000 TPH ship loader. The larger warehouse is 160ft (49m) by 600ft (183m) and the second warehouse is 200ft (61m) by 400 ft (121m). The quayside itself is composed of a concrete bulkhead. The property is can be access off of Priority lane.

The property is in an industrial area and border by commercial properties to the north and south. SeaGate Terminal is relatively small at approximately 43 acres (17ha) in size. From the Water, the Site is approached vie the Elizabeth River navigation channel. From Craney Island reach to Lambert bend the channel decreases in depth from 50ft (15m) to 40ft (12m). Water depths on approach to the facility to the berth are 40ft (14m) (depths are form NOAA charts and are given in MLLW).

Figure 25 Aerial image of Seagate Terminals.

Limitations

The Hampton Roads Bridge-Tunnel and the Chesapeake Bay Bridge-Tunnel are between the site and the open ocean. The Chesapeake Bay Bridge Tunnel is an approximately 15-mile (24km) long structure that consists of a bridge abutting the east and west shores of Chesapeake Bay that converts to a tunnel under the Bay where it crosses the Chesapeake Bay Channel. The tunnel section of the crossing spans 4,500ft (1,370m) of the Bay, providing a passage that is greater than 50ft (15m) deep. Similarly, the Hampton Roads Bridge- Tunnel has a horizontal clearance of 6,300ft and no vertical restrictions. As such, the bridge-tunnels do not pose any overhead restriction and there are no overhead restrictions between the site and the open ocean. The closest airport to the site is Norfolk International Airport at 6.3 miles (10.1km). It is anticipated that FAA ceiling restrictions will impose height restrictions of approximately 200 to 300ft (60 to 90m) in the vicinity of the site. Potential users of the site should contact the FAA to determine what equipment height restrictions (if any) there would be for this property.

Table 37 Summary of SeaGate Terminals key statistics.

Parameter	US units	Metric units	Notes
Property size	43 acres	17.4ha	Rectangular shaped property along the eastern bank of the southern branch of the Elisabeth River.
Quayside size	800ft	244m	Concrete pier.
Berth depth (estimated)	40ft	12m	
Main channel depth to site	40ft	12m	
Buildings (2)	180,000sqft	16723sqm	2 large warehouse buildings.
Quayside loading capacity	N/A	N/A	
Load bearing capacity (land)*	<1,000psf	<4,880kgpsm	Load bearing capacity estimate based on unimproved soil stability.

*No direct investigations conducted-estimates based on visual observation only. All capacities are approximate.

Potential OSW uses

This site's moderate size and relatively long quayside makes it of potential use for OSW. Manufacturing of components could be supported at the site. The depth of the channel and berth would not require dredging for most applications. Good rail and road access are attractive features of the site. The bearing capacity of the quayside is unknown and may require improvement to support large component manufacturing.

Foundation and large tubular components

The site's acreage and quayside make it potentially suitable to handle monopile, transition piece, or tower section manufacturing and fabrication. The property could also potentially be utilized for lay down/storage of these components. The bearing capacity of the quayside is unknown and could limit the utility of the site for large components.

Nacelles, blades, rotors, generators

The site could support manufacturing and lay down for these components.

Operations, maintenance and service, cables, secondary steel

The site could support manufacturing of components but due to the distance from the lease areas may not be a good location for an OMS facility.

Upgrades and improvements opportunity for full utility

Quayside improvements may be required at the site to facilitate manufacturing and lay down of large component but the relative size and depth quayside could support several OSW uses.

Opportunities for Investment

Upgrades for site utility could range from moderate ($5 million $20M) to moderate-high ($20M-$50 million) depending required quayside improvements allow for component manufacturing and storage.

Table 38 Summary of OSW utility at SeaGate Terminals.

Monopile Foundation/ Transition Piece/Tower	Gravity/Jacket Foundations	Nacelle/Rotor	Blades	Cables	Secondary Steel	OMS and Service Facility

Lower range of modifications required.

Moderate range of modifications required.

Extensive modifications required, or site not well suited for component.

Appendix A: Overview of opportunity from floating offshore wind

Benefits to Virginia

The availability of shallow water resource means the US East Coast market is unlikely to focus on floating technology in the near future apart from some demonstrators and upcoming lease auctions in the northern areas. A larger distance to shore may provide certain permitting benefits, while adding new challenges for transmission and installation. The US West Coast and Hawaii have large deep-water resources but commercial scale deployment will be dependent on reducing the LCOE and improved capability for integrating variable generation into the electricity network.

In time, the same advantages which make Virginia an ideal base for the manufacture of complex components such as jacket foundations and offshore substations, means that a further opportunity may also be available in floating offshore wind. Virginia's Research Lease area only strengthens those advantages. Additionally, advancements in floating foundation technology may help drive a call for BOEM WEA leases beyond the continental shelf of the US East Coast, presenting VA with a future potential first-mover opportunity.

Technology

As presented in Figure 26, there are three technology concepts currently being developed:

- Spar-buoy
- Semi-submersible and
- Tension leg platforms (TLP).

To deploy spar-buoy type floating foundations there are technical restrictions which require deep water channels (100m+). Tension leg platforms pose the most complex installation challenges and are better suited to water over 100m deep. Developers are likely to focus any efforts on semi-submersible foundations, as these are the most commercially advanced and have the widest range of applicability.

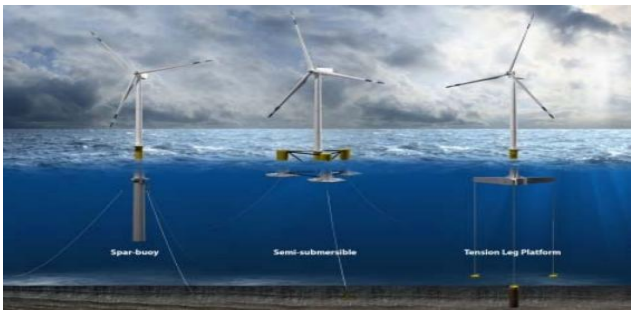

Figure 26 Different types of floating foundations.

US floating projects status

New England Aqua Ventus 1 is currently the only active East Coast floating project. At 12MW, it is project led by University of Maine and enabled with DOE demonstration project grant. The Foundation is semi-submersible and deployment is expected in 2021.

Several project developers are advancing floating solutions on the West Coast, such as Principle Power, in collaboration with EDPR, Trident Wind in collaboration with EnBW and Magellan Wind in collaboration with Copenhagen Infrastructure Partners.

Floating trajectory and attractiveness on US East Coast

In Wind Europe's October 2018 floating OSW report they conclude that the cost of floating OSW will substantially reduce in the next ten years[8],The gap is expected to close significantly, however, well before 2030. Floating projects that can access higher wind speeds will effectively be cost competitive by the late 2020s.

Each national market will vary considerably and this will affect the relative competitiveness of floating technology. For example, in some locations floating technology can be deployed in areas of higher wind resource that would be inaccessible to bottom-fixed projects.

Due to the immaturity of floating offshore wind technology, there is still uncertainty about the technology in terms of cost and performance. This includes the fabrication costs for the structures (whether or not the designs can be standardized), the impact of metocean conditions on the mooring systems (particularly for TLPs) and the long-term impact of any wave-induced movement on the turbine

[8] Floating offshore wind energy, a policy blueprint for Europe, Wind Europe, October 2018, available online at: https://windeurope.org/policy/position-papers/floating-offshore-wind-energy-a-policy-blueprint-for-europe/, last accessed November 2018

Appendix B: Supply chain questionnaire

With more than 31 tables, 35 relationships, 263 layouts, 65 value lists, 127 scripts and 120 offshore wind supply chain categories, the current database provides a strong head start for Virginia based companies looking for partners or global companies looking for local partners.

The team will export data collected under this contract based on DMME specified criteria. Data will be exported to a searchable table for posting on DMME's website.

Questionnaire background

Virginia Department of Mines, Minerals and Energy (DMME) is supporting the project contractor BVG Associates and team of subcontract partners Timmons, Ramboll, Business Network for Offshore Wind and Greentree Consulting to execute the project entitled: "Plan to Position Virginia as the East Coast Offshore Wind Supply Chain and Service Industry Location of Choice." The team will develop a final report that provides an analysis of Virginia's current maritime infrastructure and assets, identifies how to leverage Virginia's advantages and provides recommendations on alleviating barriers, including executive actions, regulatory changes and statutory changes. The final documents will serve as a partnership tool to connect industry prospects with Virginia's robust maritime industry located in Hampton Roads; provide a summary of Virginia's unique advantages; communicate OSW-related workforce development requirements.

One of the goals of the project is to identify current Virginia suppliers (service providers and manufactures) with core maritime- and manufacturing-related expertise. A Virginia Offshore Wind Supply Chain Resource Network Directory will be prepared to provide a platform to connect offshore wind developers, wind turbine suppliers and other prime contractors with Virginia professional services, manufacturers, equipment and material suppliers and other general service providers relative to all phases of an offshore wind project.

Please enter your company's information as accurately as possible so the Directory reflects your company's capabilities appropriately.

Questionnaire questions

1. Company info
    a. Company Name:
    b. Street Address:
    c. Suite #:
    d. City:
    e. State:
    f. Zip:
    g. Website:

2. Prime company contact for offshore wind opportunities
    a. First Name:
    b. Last Name:
    c. Title:
    d. Email Address:
    e. Contact Phone Number
    f. Office:
    g. Cell:

Offshore Wind Supply Chain Company Questions. Please check all that apply.

3. Do you provide any of the following upfront engineering or permitting services?
    a. Coastal & Marine Spatial Planning
    b. Ocean Soil and Core testing
    c. Meteorological testing
    d. Avian & Bat Studies
    e. Environmental Studies
    f. Ports and Harbors Infrastructure Analyses
    g. Other Engineering or Permitting Services [text entry box]

4. Do you supply any of the following equipment?
    a. Heavy lift cranes, crawler cranes, & modular transport - Provide lift capacity range [text entry box]
    b. Forklifts and trucks - Provide lift capacity range [text entry box]
    c. Lifting appliances, rigging and slings
    d. Vessels, barges and tugs for crew and product transport
    e. Diving services
    f. Underwater construction
    g. ROV and Subsea equipment
    h. Site development/excavation
    i. Onsite fabrication and welding services
    j. Aggregate/concrete
    k. Generators, Compressors, Portable Welders, Pumps and motors
    l. Other Equipment [text entry box]

5. Can you provide any of the following services?
    a. Project Management
    b. Installation and Commissioning services for offshore wind turbine units
    c. O&M (Operation & Maintenance) Services for offshore wind turbines

6. What contractor or labor services can your company provide?
    a. General
    b. Electrical
    c. Mechanical
    d. Civil
    e. Mariner or Diving
    f. Onsite fabrication and welding
    g. Material testing and inspection
    h. Skilled labor
    i. Utility services
    j. Other contract or labor services [text entry box]

7. What materials can your company provide to this project?
    a. Steel plate, pipe, or bar
    b. Concrete or Aggregate
    c. Welding Supplies
    d. Plastic Pipe and Fitters
    e. Fasteners
    f. Marine Horns & Lighting
    g. Fabricated Steel Decks
    h. Ladders & Rails
    i. SCADA Systems
    j. Electrical Wiring or Controls
    k. Other material [text entry box]

8. Are you a manufacturer specializing in any of these areas?
    a. Fabrication
    b. Rolled steel plate
    c. Machining
    d. Electrical/Electronics
    e. Other manufacturing sector [text entry box]

9. If your company product or service was not listed in the above questions, please describe your offerings here: [Text entry box]

10. Optional: Please indicate your number of employees

    a. <25
    b. 25-75
    c. 76-200
    d. >200

11. Optional: Please indicate your company's revenue range per year

    a. <$5 million
    b. $5-10 million
    c. $11-25 million
    d. >$25 million

12. Optional: Please indicate if your company qualifies for any of the following classifications

    a. MBE
    b. FBE
    c. DBE
    d. SBE
    e. VOB