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Building North Carolina's Offshore Wind Supply Chain

The roadmap for leveraging manufacturing and infrastructure advantages

March 2021

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North Carolina Offshore Wind Supply Chain Registry

North Carolina Department of Commerce encourages companies (both inside and outside North Carolina) to join its publicly available supply chain registry by completing a 10-minute survey:

https://www.nccommerce.com/business/key-industries-north-carolina/energy/offshore-wind-industry.

Executive summary

North Carolina leadership

"*Offshore wind development combined with our strong solar capacity will bring more high paying, clean energy jobs to North Carolina while we continue to ramp up our fight against climate change*," said North Carolina Governor Roy Cooper. "*This bipartisan [SMART-POWER] agreement with neighboring states allows us to leverage our combined economic power and ideas to achieve cost effective success*."[1]

As part of a coordinated approach by North Carolina (NC) state economic, energy and environmental leadership,[2] the North Carolina Department of Commerce (NCDOC) commissioned this strategic study to maximize the economic benefit in NC from offshore wind. The study:

- Characterizes the offshore wind opportunity for North Carolinians
- Assesses the North Carolina advantages in existing assets and business potential
- Provides engagement and development tools to help build partnerships between developers and suppliers with regional companies interested in diversifying into offshore wind
- Reviews existing, and identifies gaps in, business incentives and policies to enhance the already good business climate and further develop the workforce, and
- Reviews the Morehead City and Wilmington ports plus other key state infrastructure, including the Carolina Connector Intermodal Facility being built in Rocky Mount.

Strategic positioning for offshore wind

North Carolina's strategic position in offshore wind should be to:

1. **Strengthen anchor companies** – build upon the strong base of major manufacturing companies already established in North Carolina, and attract additional ones, to grow and anchor the industrial base and enable an acceleration effect on the wider supply chain.
2. **Leverage existing manufacturing strength** – build upon North Carolina's manufacturing strengths and nation-leading economic conditions for component manufacturing to supply the offshore wind market along the East Coast and beyond.
3. **Build momentum for a strong pipeline of windfarms** – accelerate the offshore wind opportunity by driving North Carolina's offshore wind targets and new windfarm developments to match the significant electricity consumption of the Southeast and mid-Atlantic states, to maximize economic, decarbonization and environmental benefit.

Offshore wind is delivering globally

- Offshore wind levelized cost of energy (LCOE) reduction continues apace. Auction prices have more than halved from projects installed in 2018 to those due to be installed in 2023. A further 30% reduction is expected between projects installed in 2023 and those in 2030
- The global market has grown on average by 24% each year since 2013[3]
- Over 5 GW was installed globally in 2020, bringing the total installations to over 32 GW[3]
- Over 8 GW is forecast to be installed globally in 2021, rising to over 30 GW per year by 2030,[3] and
- Growth is occurring across multiple regions and countries, and over 300 GW is forecast to be installed by the end of 2030.[3]

The scale of the US offshore wind opportunity

State-driven offshore wind targets have exceeded 28 GW[4] to date and are expected to result in 41 GW of cumulative installed capacity by end of 2035. Already 9 GW of projects are well on track with offtake agreements, with ongoing solicitations enabling an additional 6 GW to follow by end 2021.

The larger this market becomes, the more the supply chain will be established on the East Coast.

The rapidly developing economic opportunity will well exceed $100 billion for windfarm development and construction alone (CAPEX), not even accounting for the

[1] Memorandum of Understanding Among Maryland, North Carolina and Virginia to create the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER) https://files.nc.gov/governor/documents/files/SMART-POWER-MOU_FINAL.pdf, last accessed February 2021.

[2] Office of the Governor, Department of Commerce (NCDOC), Department of Environmental Quality (NCDEQ).

[3] BVGA analysis.

[4] A watt (W) is a measure of power (energy per second), and there are 1 billion watts in 1 GW. The capacity of large power plants or of many power plants are typically measured in GWs.

30 years of operations and maintenance local economic benefit (OPEX).

Of the states that have made commitments for offshore wind capacity, Rhode Island's 1.03 GW is proportionately the biggest and enough to generate about 68% of its 2019 electricity consumption. New York's 9 GW is the largest in absolute terms and is enough to generate about 30% of its 2019 electricity consumption.

By way of comparison, the UK has a 40 GW offshore wind target by end of 2030; this will generate the equivalent of 65% of its 2019 electricity consumption.[5]

Manufacturing is North Carolina's edge

North Carolina wishes to use its existing strength in quality manufacturing and its enduring manufacturing-friendly environment that exceeds that of any east coast state to supply the physical supply chain and project-specific marine activities:

- Supply of major components, lower-level components, and materials to the whole of the east coast market, including for turbines, and
- Supply of port-based and operations and maintenance services to wind farms off North Carolina, Maryland, Virginia, South Carolina and potentially other states.

The strengths of North Carolina include:

- Ranking 1st among east coast states and 5th in the nation in the value of its manufacturing sector's Gross Domestic Product (GDP).[6] The nearest east coast state is New York, ranked 9th, with a level that is 30% lower than North Carolina's; the remaining east coast states have levels that are at least 40% lower.
- Out of all industrial sectors, manufacturing leads the state in GDP contribution at 17.2%. The nearest east coast state is South Carolina, with 16.3%
- The largest manufacturing industries, by employees, are food, chemicals, fabricated metal products, transportation equipment and machinery.
- Manufacturing employs over 470,000 workers in the state in 10,250 manufacturing companies.[7]
- The weekly wages in manufacturing place it 7th among the state's 19 industrial sectors. Manufacturing wages are higher on average than healthcare and social assistance, transportation and construction, and
- The governors of Maryland, North Carolina, and Virginia forming, in 2020, the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER).[8] This recognizes that working together, these three states can make the region the natural choice for the offshore wind supply chain.

North Carolina's infrastructure and policies support offshore wind

This report further evaluates North Carolina's position in key areas that include business climate, workforce, infrastructure and location. North Carolina 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
- Relatively large electricity consumption (9% of east coast states' electricity) and growing demand for renewable energy
- Relatively low CO_2 electricity footprint
- The North Carolina Clean Energy Plan goal of 70% reduction in power sector greenhouse gas emissions by 2030 and a carbon-neutral power sector by 2050[9]
- The major electricity provider to most of North Carolina, Duke Energy, has set a near-term carbon reduction goal of at least 50% by 2030 and long-term goal of net-zero by 2050[10]
- Good transport links for components including for smaller components by inland waterways, rail and road
- Congestion-free navigation waterways

[5] Energy Trends, Table 5.2 Supply and consumption of electricity https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/946760/ET_5.2_DEC_20.xls last accessed February 2021.

[6] Based on 2019 data from the US Bureau of Economic Analysis.

[7] North Carolina Manufacturing Extension Partnership (NCMEP), 2019 data.

[8] Memorandum of Understanding Among Maryland, North Carolina, and Virginia To Create the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER), https://files.nc.gov/governor/documents/files/SMART-POWER-MOU_FINAL.pdf, last accessed February 2021.

[9] North Carolina Clean Energy Plan, https://deq.nc.gov/energy-climate/climate-change/nc-climate-change-interagency-council/climate-change-clean-energy-16, last accessed February 2021.

[10] Duke Energy presents options to further accelerate carbon reduction in Carolinas, Duke Energy, https://news.duke-energy.com/releases/duke-energy-presents-options-to-further-accelerate-carbon-reduction-in-carolinas, last accessed February 2021.

- Unrestricted air draft waterways
- High-quality maritime workforce
- Existing waterfront and infrastructure with further potential to expand, and
- Relatively low-cost land.

Local offshore windfarms would provide a boost to local industry

- Together, Maryland, North Carolina, and Virginia have over a third of the electrical consumption of the coastal states from Maine to Georgia. This reflects the sizeable role of manufacturing in these states, not just population. Manufacturing companies need to be certain of future generation capacity but also along with the wider business community, need to be confident that the future generating capacity enables them to meet customers' expectations for lower carbon emissions.
- North Carolina boasts the second highest net technical energy potential for offshore wind on the East Coast, after Massachusetts, at over 600TWh/year.[11]
- In 2018, North Carolina DEQ endorsed and expressed interest in BOEM's *Proposed Path Forward for Future Offshore Renewable Energy* noting that to 'achieve Governor Roy Cooper's goal of transitioning our State to a clean energy economy, it is critical that North Carolina seize the opportunity that lies in offshore wind'.[12] NCDEQ continues to deploy initiatives and engage actively with BOEM.[13]

Recommendations

Based on the assessments in this report, working knowledge of policies, programs, and practices in other states and nations, and in consultation with North Carolina's state economic, energy, and environmental leadership, the BVG Associates-led team developed the following 48 recommendations [R#], categorized under six areas and each having more specific steps according to whether they help North Carolina to **Prepare**, **Facilitate**, or **Accelerate** offshore wind industry activity within its borders:

1. Solicit and attract "anchor company" suppliers to North Carolina, with a focus on major components

Prepare

- Continue to understand who the major, experienced supply chain companies are and their location decisions and their timescales. [R1]
- Engage with major suppliers and consider using the support from an offshore wind specialist to provide introductions and help secure their interest. [R2]

Facilitate

- Actively support connectivity and industry information sharing across the whole OSW supply chain. [R3]
- Actively support existing high-tier North Carolina based companies to pivot to the domestic OSW market, especially where they already have relevant skills and experience, or supply to the domestic onshore wind market. [R4]

Accelerate

- Actively support existing companies in the transition to OSW supply from North Carolina. [R5]

2. Define and accelerate North Carolina OSW project development strategy

North Carolina needs 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.

Prepare

- Designate a formal offshore wind point person in NCDEQ. [R6]
- Study wholesale market reform options and ensure that implications for OSW are considered. [R7]

Facilitate

- Accelerate leasing of existing WEAs in the Carolinas and pursue additional area designations. Continue to work with BOEM and other stakeholders, to establish new lease areas off North Carolina to accommodate at a much larger scale anticipated for the future supply needed to meet its large electricity consumption and the needs for continuing the timely transition to a clean energy economy including the significant growth in electricity consumption needed to decarbonize sectors like transport. [R8]

[11] NREL, 2016 Offshore Wind Energy Resource Assessment for the United States, Figure ES-4 https://www.nrel.gov/docs/fy16osti/66599.pdf, last accessed February 2021.

[12] Michael Regan, Secretary NCDEQ, June 20, 2018 https://www.regulations.gov/document?D=BOEM-2018-0018-0090, last accessed February 2021.

[13] Jennifer Mundt, Governor's Appointee, BOEM NCVA Task Force, NCDEQ, Offshore Wind: Initiatives and Updates - North Carolina, https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NC/State-Initiatives-Update-North-Carolina.pdf, last accessed January 2021.

- Remove barriers to investment in grid infrastructure. [R9]
- Identify permitting steps for onshoring transmission and land-based infrastructure. [R10]

Accelerate

- Set an OSW deployment target for the State. [R11]
- Create a specific OSW procurement mechanism. [R12]
- Create more opportunity for OSW capacity expansion through decarbonization efforts. [R13]

3. Support the multi-state regional supply chain cluster, making it the easiest place for developers and suppliers to do OSW business in the southeast and mid-Atlantic regions

Prepare

- Promote regional collaboration in policy development and supply chain development, working with counterparts in Virginia and Maryland to align offshore wind needs with regional business capacity, to help secure business opportunities for regional state partners. [R14]
- In support of the SMART-POWER MOU, the state should work with its counterparts in Virginia and Maryland on industry-focused research and other relevant opportunities.

4. Enable and grow North Carolina's business opportunity

Prepare

- Actively support existing companies in the transition to OSW supply from North Carolina. [R15]
- Continue to promote and develop the NC Offshore Wind Supply Chain Registry. [R16]
- Designate a North Carolina OSW Director for Economic Development. [R17]
- Create an OSW economic development team. [R18]
- Organize and facilitate a North Carolina OSW Industry Task Force. [R19]
- Establish year-round schedule of regular outreach events – virtual or in person. [R20]

Facilitate

- Include "local benefit" considerations in future windfarm procurement mechanism, as some other states have done, to ensure that work will be delivered from North Carolina. [R21]
- Consider further integrating information about North Carolina companies with wider US and global offshore wind databases, while keeping the platform accessible via the NCDOC website. [R22]
- Evaluate establishing or participating in a more advanced database, possibly in collaboration with Virginia and Maryland. [R23]
- Organize "fact finding" visits to wind installations for local and state policymakers and business leaders. [R24]
- Support research including public/private partnership development for OSW deployment. [R25]
- Support public/private research collaboration for OSW advanced manufacturing and supply chain logistics. [R26]
- Provide tailored coaching and mentoring to individual companies regarding OSW. [R27]
- Work with utilities to enable large energy users to directly access OSW resources. [R28]

Accelerate

- Assist existing and new anchor companies with access to market including securing appropriate sites, transport and port access. [R29]
- Create and fund a North Carolina Green Bank that can provide investment to support OSW firms. [R30]
- Provide targeted incentive support to OSW-related firms. [R31]
- Provide targeted incentive support for OSW innovation. [R32]
- Reinstate and expand the Renewable Energy Equipment Manufacturer Tax Credit. [R33]

5. Enable and sustain North Carolina's business opportunity through workforce development

Prepare

- Conduct a job skills analysis. [R34]
- Develop an inventory of industry-relevant training already available. [R35]
- Promote the training opportunity to North Carolina. [R36]
- Promote the training opportunity to the OSW Industry. [R37]

Facilitate

- Establish a wind energy technician training program. [R38]
- Establish training partnership with the Mid-Atlantic Wind Training Alliance. [R39]

Accelerate

- Provide funding for new infrastructure, equipment and curriculum. [R40]

6. Strengthen Existing Port Assets and Key Strategic Properties

Prepare

- Assess the competitiveness of an installation port along the southern North Carolina coast, as one input to the location of future lease areas off the coast. [R41]
- Assess further potential locations for OMS ports along the coast of North Carolina, as inputs the location of future lease areas. [R42]
- Evaluate developing Southport/North Carolina International Terminal Property: a 600-acre, North Carolina State Ports Authority (NCSPA) owned property that is one of the only potential “mega-port” facility locations on the US East Coast. [R43]
- Further explore using manufacturing sites next to CSX Carolina Connector at Rocky Mount for the manufacture of smaller components. [R44]
- Further explore using the Port of Wilmington and Port of Morehead City facilities with NCSPA, allowing North Carolina earlier access to supply OSW projects. [R45]
- Educate and promote operations and maintenance facility opportunities. Work with owners and operators of such facilities to develop their offerings. [R46]

Facilitate

- Further explore developing Radio Island, adjacent to the Port of Morehead City, for manufacturing and staging of Tier-1 and lower tier sub-components. [R47]
- Further explore developing the North property and the Wilmington Business Park/Vertex property for manufacturing and staging of Tier-1 components and for use as a construction base port. [R48]

BVG Associates LLC

BVG Associates is an independent renewable energy consultancy focusing on wind, wave and tidal and energy systems. Our clients choose us when they want to do new things, think in new ways and solve tough problems. Our expertise covers the business, economics and technology of renewable energy generation systems. We're dedicated to helping our clients establish renewable energy generation as a major, responsible and cost-effective part of a sustainable global energy mix. Our knowledge, hands-on experience and industry understanding enables us to deliver you excellence in guiding your business and technologies to meet market needs.

- 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.

NCSU Economic Development Partnership

As a land-grant university, NC State is dedicated to excellent teaching, the creation and application of knowledge, and engagement with public and private partners. The NCSU Economic Development Partnership works across the state to attract new businesses and industries to North Carolina. Working closely with the N.C. Department of Commerce, the Economic Development Partnership of North Carolina (EDPNC), and local and regional economic development organizations, the office is instrumental in helping recruit companies to the state while providing real-world opportunities for students and faculty. Under this office's leadership, NC State actively participates in outreach and engagement projects with local communities across the state to support economic development.

N.C. Clean Energy Technology Center at NCSU

The N.C. Clean Energy Technology Center, founded in December 1987 as the North Carolina Solar Center, works closely with partners in government, industry, academia, and the non-profit community and is one of the premier clean energy centers of knowledge in the United States. The Center, part of the College of Engineering at NCSU, provides services to the businesses and citizens of North Carolina and beyond relating to the development and adoption of clean energy technologies. Through its programs and activities, the Center seeks to promote the development and use of clean energy in ways that stimulate a sustainable economy while reducing dependence on foreign sources of energy and mitigating the environmental impacts of fossil fuel use.

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LR and our US-based Subject Matter Experts (SMEs) have a strong foundation in the US Southeast, Mid-Atlantic and New England OSW markets stretching back to permitting, designing and constructing the New Bedford Marine Commerce Terminal. The LR team has decades of experience in evaluating the infrastructure needs of the OSW Supply Chain and evaluating, permitting, designing and overseeing the construction of highly-specializes OSW port facilities. The US-based LR OSW team is connected to the full range of LR experience globally, blending into one client-focused project delivery team the capability of the larger LR capacity from our deep European OSW experience, our oil and gas expertise in the Gulf of Mexico, our extensive and historically grounded marine and offshore facility inspection capacity active in virtually every major port facility in the US, our global vessel and offshore structure classification business. The US team brings the local knowledge of the political, technical, manufacturing, site conditions, and local supply chain conditions on the ground to our projects; and marrying that knowledge with the extensive experience of LR in the European OSW space as a market leader in global OSW services, technology and research.

Timmons Group

Timmons Group is a Nationally recognized and award-winning Engineering and Technology Firm with over 700 employees nationwide and 170 professionals and 4 offices located throughout North Carolina. Recognized as an ENR Top 500 Design Firm for over 27 years, Timmons Group has been a leader in the Economic Development and Alternative Energy practice areas implementing cutting edge projects throughout the United States. As recognized experts in site and infrastructure assessments and development, Timmons Group assisted the team with the ports and infrastructure assessment for this study.

Timmons Group is a known and trusted entity for North Carolina DOC and a recognized expert in site and infrastructure development with strong relationships with EDPNC, North Carolina East and North Carolina Southeast Regional Economic Development Organizations and the North Carolina Ports. Timmons has a long history of providing high quality services in North Carolina and has successfully delivered on multiple projects that could be impacted by the North Carolina Offshore Wind project.

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Acronyms and abbreviations

Acronym/abbreviation	Full name
AWS	American Welding Society
BOEM	Bureau of Ocean Energy Management – manages development of US Outer Continental Shelf energy and mineral resources
CAPEX	Capital expenditure, it will be incurred during the manufacturing and installation of a windfarm
CCT	Certified Composites Technician
DOD	US Department of Defense
EDPNC	Economic Development Partnership of North Carolina
EMC	(North Carolina) Environmental Management Commission
DECEX	Decommissioning expenditure, it will be incurred during the decommissioning of a windfarm
DEVEX	Development expenditure, it will be incurred during the development phase of a windfarm
NCDOC	North Carolina Department of Commerce
NCDOT	North Carolina Department of Transportation
NCDEQ	North Carolina Department of Environmental Quality
NCEMC	North Carolina Electric Membership Cooperatives
NCMIPA	North Carolina Marine Industrial Park Authority
NCSPA	North Carolina State Ports Authority
FTE	Full time employee for one year
GWO	Global Wind Organization
LCOE	Levelized cost of energy
MLLW	Mean lower low water
nm	Nautical mile
O&M	Operations and maintenance
OMS	Operations, maintenance and service (O&Ms is a subset of this wider activity)
OPEX	Operational expenditure, it will be incurred during the operational lifetime of a windfarm
OSHA	Occupational Safety and Health Administration

Acronym/abbreviation	Full name
OSW	Offshore wind
POW	Port of Wilmington
PMC	Port of Morehead City
PPA	Power purchase agreement
PMWs	Ports, marine terminals, and waterfronts
RoRo	Roll on roll off
SAM	Serviceable addressable market
SOM	Serviceable obtainable market
SOCT	Office of the Secretary of Commerce and Trade
SMART-POWER	Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources
SPMT	Self-propelled modular transporter
STCW	Standards of Training, Certification and Watchkeeping for Seafarers
TAM	Total addressable market
TP	Transition piece
WEA	Wind Energy Area
WRDA	Water Resources Development Act

1 Introduction

1.1 Structure of the report

North Carolina Department of Commerce (NCDOC) commissioned BVG Associates (BVGA) and its partners to provide guidance to North Carolina as it seeks to position North Carolina to leverage maximum benefit from the emerging offshore wind (OSW) supply and maintenance opportunity.

The objective is to position the state as an east coast OSW supply chain and service location of choice.

North Carolina 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 worked with its North American and global partners with extensive OSW industry experience, Lloyds Register, Timmons Group and NC State University (Economic Development Partnership and N.C. Clean Energy Technology Center).

This final report is structured as follows:

- Section 2 provides a forecast of the market for installed capacity and expenditure.
- Section 3 provides an overview of the supply chain opportunity serviceable from North Carolina, considering its own native project pipeline plus projects being developed on the East Coast.
- Section 4 provides an overview of the project-specific opportunities, such as installation, and operations and maintenance, serviceable from North Carolina.
- Section 5 provides an assessment of the North Carolina supply chain offerings. The main companies are described, and the North Carolina supply chain directory described and how to access it explained.
- Section 6 provides a summary of transportation infrastructure including rail, road, and ports, marine terminals and waterfronts (PMWs). It includes descriptions of existing facilities and their OSW potential.
- Section 7 provides a review of the currently friendly business climate and the incentives available to businesses looking to invest or transition into the OSW supply chain. It discusses actions North Carolina could take to further support the development of the supply chain related to manufacturing and its clean energy market. It also discusses the required skills and qualifications for OSW and provides a review of relevant training, recruitment assistance and resources currently available within North Carolina.
- Appendix A provides the questionnaire used when creating the electric toolkit.
- Appendix B contains the detailed assessment of the Morehead City and Wilmington port area facilities/properties discussed in Section 6.
- Appendix C contains a summary list of all the recommendations.

1.2 Recommendations format: Prepare, Facilitate, Accelerate

North Carolina has many options to support the growth and development of offshore wind. The recommendations identified are categorized into three categories of increasing level of state activity: Prepare, Facilitate, and Accelerate.

- “Prepare” policies focus on information-gathering and formation of policy frameworks.
- “Facilitate” policies aim to create conditions conducive to the expansion of offshore wind through removal of policy barriers and development of favorable infrastructure.
- “Accelerate” policies directly support deployment of offshore wind through incentives and state/utility procurements.

These three categories are not mutually exclusive and North Carolina may adopt policies from multiple levels in the different areas of recommendations at any one time.

1.3 Methodology and assumptions

1.3.1 Market outlook

Both the overall US and local North Carolina 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 power purchase agreement (PPA))
- State legislated targets, and
- Direct conversations with developers and Industry stakeholders.

1.3.2 Timing of projects

To distinguish between the timing of projects we refer to 3 waves:

- First wave [2023-2026]: well progressed projects with an offtake agreement (~6 GW)
- Second wave [2026-2028]: Projects currently in the process to secure an offtake agreement (~11 GW) – that includes Equinor's 2.5 GW awarded 2021 in NY, Dominions’ 2.6GW and Avangrid's 2.4 GW Kitty Hawk, and

- Third wave [2028-2035]: Future projects based on existing or new lease areas [2028-2035].

1.3.3 Electronic tool kit

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

- Business Network for Offshore Wind
- EDPNC, and
- Southeastern Wind Coalition.

Using the combined databases, and existing knowledge, the study team identified companies with OSW capabilities for dialogue. An OSW questionnaire was developed that captured a supplier's industry specialty and any specific capabilities that forms the basis of the North Carolina Offshore Wind Supply Chain Registry.

1.3.4 Port, marine terminals and waterfronts analysis

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

For some OSW activities in the considered PMWs, necessary upgrades are either unfeasible or likely to be uneconomic. In these cases, we did no additional evaluation. Further, although several privately-owned properties were present and discussed as examples as how these facilities could pivot into OSW use, they were not carried fully through the analysis stages of this project and upgrade-improvements to such properties would not be under the purview of the State.

2 The US east coast offshore wind market

2.1 Forecast of installed capacity

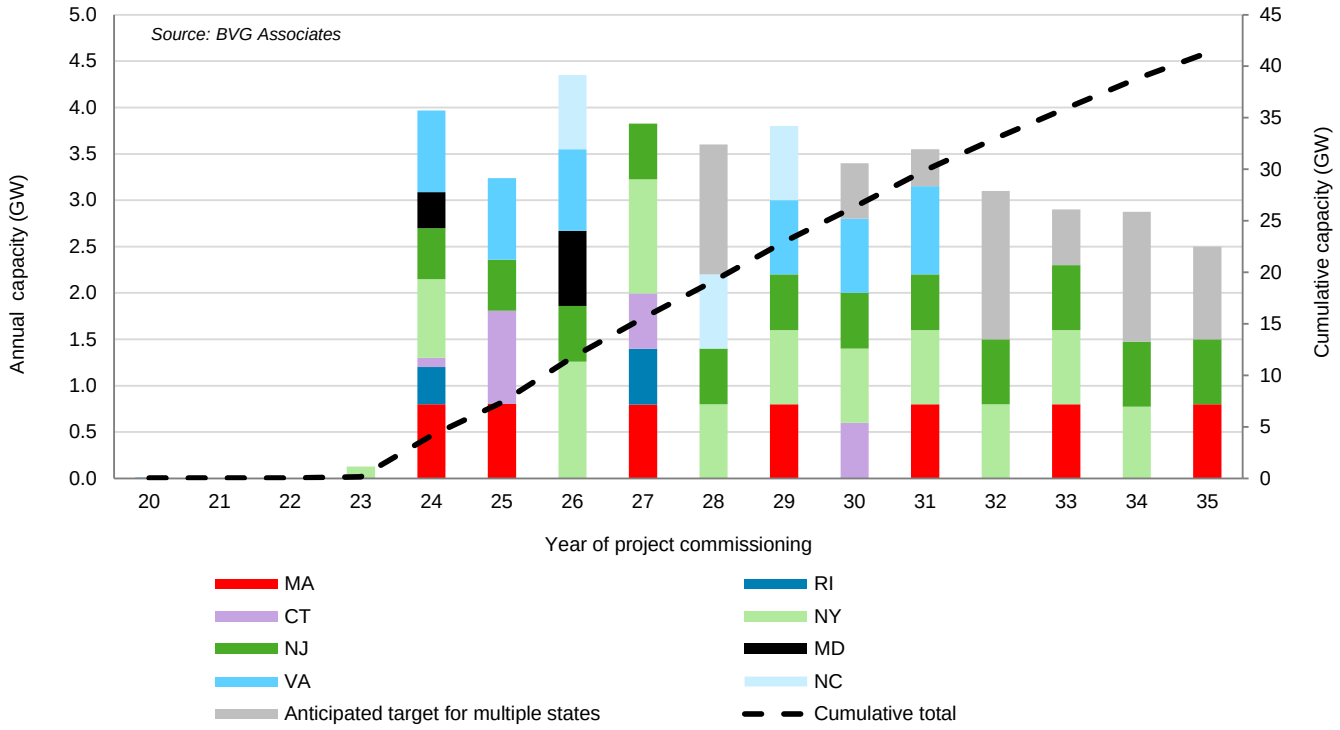


Figure 1 Developers' and states' targeted annual and cumulative US installed capacity to 2035, by state.

Developers' and states' targeted installed capacity for the US OSW market, see Figure 1, is expected to reach between three and four GW per year of new installed capacity by 2025 and continue for at least a decade at around this level, based on known and anticipated information. The two critically 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 Power Purchase Agreements (PPA). A lease area (provided by BOEM) is one of the first steps in securing a project. A more advanced windfarm development can obtain an offtake agreement. This will be followed by a challenging phase to secure interconnection, permitting and a competitive supply chain, enabling a final investment decision and construction start.

The most significant driver for the rapid OSW industry growth and related long-term investments in the US has been the leadership of the east coast states. From 2017 to 2020, seven east coast states added 26.5 GW to their targets, currently validating more than 28 GW of OSW by 2035. We expect state-driven OSW commitments to grow further in the next year or two, and are likely to reach 41 GW of installed capacity by 2035. The increasing targets are expected to result from revised current objectives of States already active in OSW and are also driven by States we anticipate to formally commit to OSW for the first time, such as Maine, New Hampshire, Delaware, North Carolina[14] and South Carolina. These anticipated revised and new State commitments are reflected Figure 1, in grey color.

These anticipated additional commitments will further validate the transition from potential pipeline to sustainable volume, enabling long-term infrastructure investment and the development of scaled up supply chain, leading towards a predictable, mature and cost-effective industry.

Launching an industry of the foreseen scale and complexity is challenging. In recognition of this, BVGA expects some early targeted construction may shift into the following year(s). Such a shift, however, would not reduce the overall business opportunity; it just reflects the time for the supply chain to build momentum and if anything increases US supply opportunities. A suitably adjusted construction profile is shown in Figure 2 as the "Conservative annual forecast". At 41 GW by 2035, the developers' and states'

[14] No formal state target has been communicated for NC; we have assumed a state target of 2.4 GW, equal to the capacity of the Kitty Hawk project.

targeted cumulative total is the same as our "conservative" cumulative forecast.

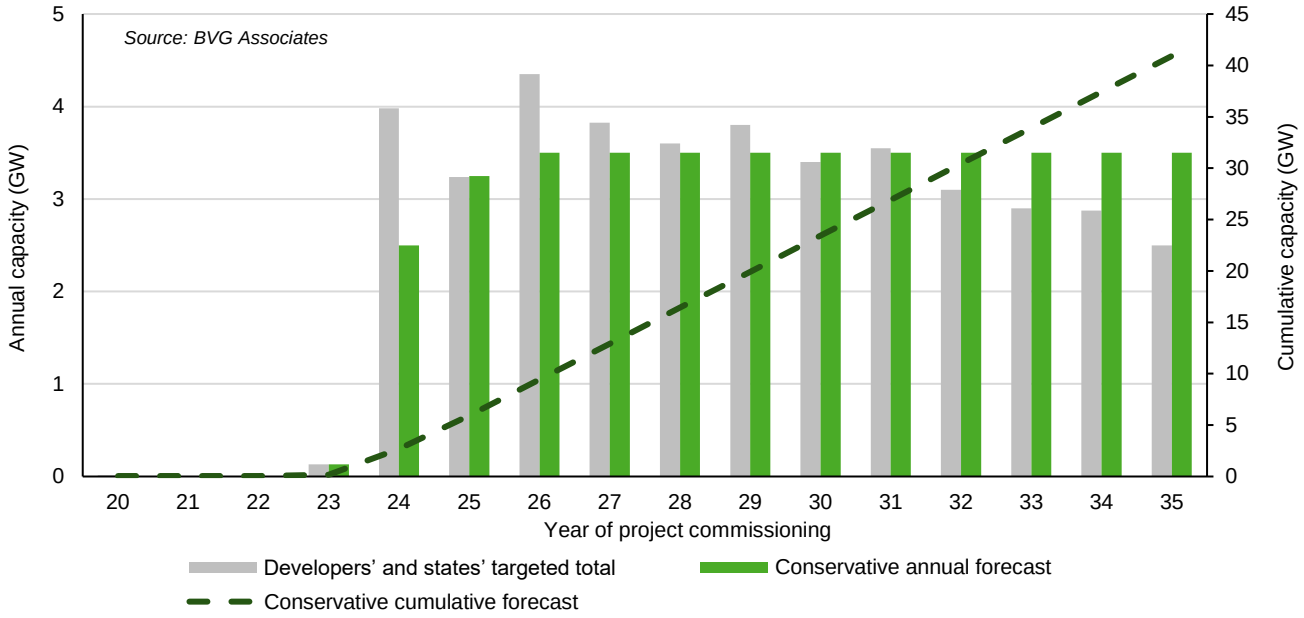


Figure 2 Conservative forecast of US East Coast installed capacity.

The US forecast should be seen in the context of BVGA's forecast for OSW, globally, that it will grow at more than 20% per year across the next 5 years. Commercial-scale projects are already operational in more than 10 countries in Europe and East Asia and are under development in a further 10. That growth is forecast because offshore wind is a low-carbon source of energy that is: proven, cost-effective, scalable and has a capacity factor of around 50%. Much of the US East Coast shares similar wind speeds, water depths and seabed conditions with those found in the North Sea, which provided the ideal ingredients for the growth of this industry.

To see if the 40 GW by 2035 is realistic, it was sense-checked in the three following ways:

2.1.1 Comparison of the US East Coast with the UK[15]

The UK has a population of 68 million, slightly lower than the US east coast states with 85 million[16], and its electricity use per capita is also lower. Nevertheless, it has recently raised its target for OSW energy from 30 to 40 GW of installed capacity by 2030. The Committee for Climate Change has said there is potential for 75 GW of OSW in the UK to be operating by 2050[17]. While BVGA expects that the 40 GW target will be missed in 2030, due in part to the lead time on interconnection and transmission, it will be reached soon after.

The UK is busy accommodating not just OSW, but also increasing quantities of onshore wind and solar onto its grid, see Figure 3. It is managing to maintain supply through a combination of demand management, interconnectors to other European countries to smooth out peaks of supply and demand and peaking plant. Hydro-electric power and pumped storage are only a small part of the electricity mix. The UK's electricity system operator recently said, "By 2025, our ambition is to be able to operate the system entirely with zero-carbon sources of electricity", which is a scenario it expects.[18] Across the whole of 2019 the UK generated 22.7 % of its electricity from offshore and onshore wind, and during December

[15] National Grid data: http://grid.iamkate.com/, last accessed February 2021.

[16] UK, source: https://en.wikipedia.org/wiki/United_Kingdom. US East Coast from Maine to Georgia, inclusive, source: https://en.wikipedia.org/wiki/List_of_states_and_territories_of_the_United_States_by_population, last accessed February 2021.

[17] Report on CCC's Progress Report to Parliament: https://www.offshorewind.biz/2020/06/26/uk-offshore-wind-big-in-cccs-progress-report-to-parliament/, last accessed February 2021.

[18] UK national grid ESO news article: https://www.nationalgrideso.com/news/how-our-new-spin-grid-stability-boost-renewable-generation, last accessed February 2021.

2020 wind generation reached a record output of 17.3 GW, or 43% of total demand[19].

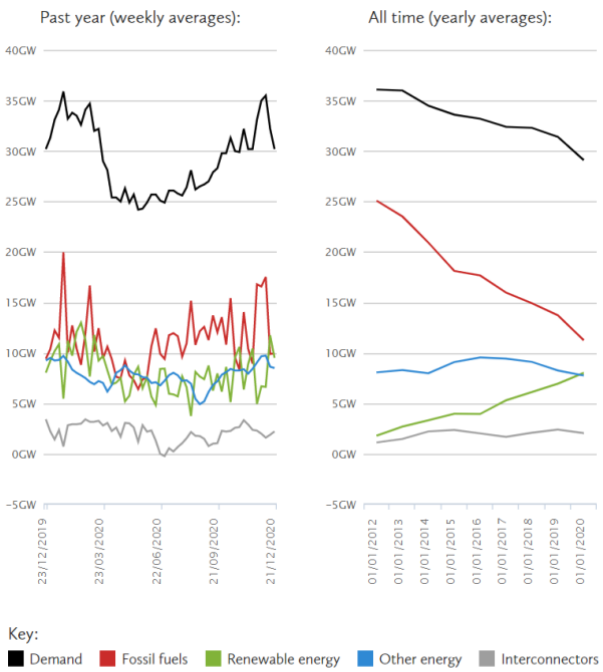


Figure 3 The UK electricity generation mix.

2.1.2 Comparison between US east coast states[20]

New York and New Jersey have set the highest OSW targets amongst US east coast states, in capacity terms, with state targets declared to date of 9.0 and 7.5 GW by 2035 respectively. The annual amount of electricity used in these states, as measured by electricity sales, is 146 and 74 TWh respectively to November 2020. If their target of 16.5 GW of OSW farms generates with a net capacity factor of 50%, a realistic value compared with Europe, it would provide 33% of the electricity mix for these two states at 2019 consumption rates.

Now consider that the annual use of electricity in 2019 for the east coast states from Maine to Georgia inclusive is 875 TWh. If all of these states choose OSW to generate 33% of their electricity usage, this would require 67 GW of installed capacity generating with a net capacity factor of 50%. Further, consider that electricity use is not constant but is predicted to rise due to the progressive electrification of many industries over coming decades, for example electric cars, and that more electricity needs to be generated than gets used because of grid losses. This means that 66 GW of OSW will make up less than 33% of current electricity use and even less of future use.

To decarbonize heat and transport, the UK expects its electricity consumption to grow by 2.5% a year, so the proportion generated from offshore will be smaller potentially about 50%.[21] If 50% of the US east coast states' 2019 consumption were to come from offshore wind the capacity for the coastal states from Maine to Georgia would need to be about 100 GW. If the electricity consumption was to grow by 2.5% a year until 2035, then 50% of the electricity need would require 145GW of offshore wind.

2.1.3 Comparison of energy sources available to US east coast states[22]

OSW is not the right answer everywhere. It requires the right fundamental drivers to be in place and for there not to be other cheaper forms of electricity available:

- Much of the US East Coast shares similar conditions to those found in the North Sea, which have been ideal for the growth of OSW. These include annual mean wind speeds (9.0 – 10.0 m/s), water depths for bottom-fixed foundations from 10-60 m, seabed geology that allows economic piling, short transmission connections to coastal centers of electricity use and industries capable of cost-effective supply of equipment and services.
- The US East Coast has relatively few options for electricity generation that are cost effective and low carbon:
- Hydro-electric power has largely been built out, where it is available. There may be the potential to import more from Canada to the northern states, but this will be limited by transmission costs
- PV is used, but its ultimate level of use is limited by the space it needs and its relatively low capacity factor of approximately 20% maximum
- Onshore wind has not been widely adopted as onshore wind speeds are generally low, with less than 3GW installed and almost all of this in higher wind speed areas in NY and ME

[19] UK national grid ESO Tweet: https://twitter.com/ng_eso/status/1340217793694855168, last accessed February 2021.

[20] Comparison between US east coast states, U.S. Energy Industry Association statistics: https://www.eia.gov/electricity/state/, last accessed February 2021.

[21] Energy white paper: Powering our net zero future, https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future, last accessed January 2021.

[22] Comparison of energy sources available to US east coast states, American Clean Power Association fact sheets: https://cleanpower.org/facts/state-fact-sheets/, last accessed February 2021.

- Biofuel, such as wood and maize grown specifically to be burnt, is more expensive than OSW and its environmental credentials are questioned, and
- Nuclear new build is more expensive than OSW, and novel less-expensive nuclear technologies remain at least a decade away.

After sense-checking, therefore, we consider 40 GW to be a reasonable target for the US East Coast by 2035 in comparison with the UK and we expect the market to continue well beyond that by consideration of the total electricity demand from the east coast states and their options for the energy mix. If the installed capacity reached an ultimate size of 60 GW the market would migrate to repowering at a rate of 2 GW per year, if it is assumed that turbines have an operational lifetime of 30 years.

2.2 Forecast of expenditure

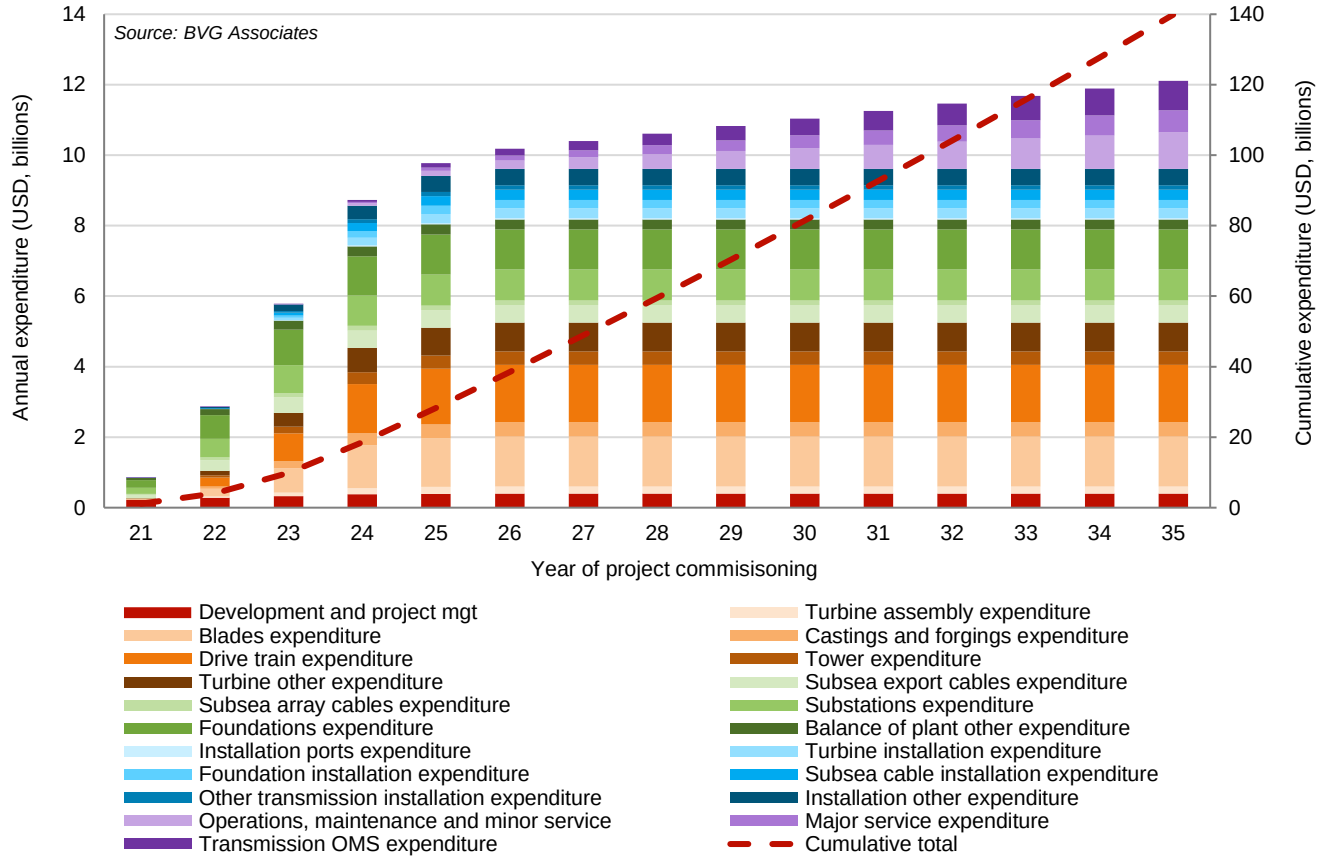


Figure 4 Forecast of annual OW expenditure.

This rate of new installed capacity drives demand for capital expenditure CAPEX), operational expenditure (OPEX) and decommissioning expenditure (DECEX). Some long-lead components may be manufactured three years before the windfarm installation date, whereas operations and maintenance expenditures occur in the years after installation. Figure 4 shows BVGA's forecast of expenditure, that shows a cumulative expenditure of $140 billion by 2035 and expenditure reaching a maximum of $12 billion per year in 2035.

The forecast of installed capacity is then used to determine total expenditure.

For this report the calculation of expenditure has used the following specification:

- We use project parameters typical for a typical US east coast project and apply this to all east coast projects. This does not, therefore, take account of project and site-specific factors that will affect individual project estimates, such as water depth, distance from installation port, project size or contracting strategy. These include:
- 1,000 MW windfarm using 15 MW turbines
- 35 m water depth with monopile foundations
- 40 km from shore with HVAC grid connection
- Final investment decision in 2021

- Expenditure is in constant 2020 USD, values are not increased for inflation in later years.
- Expenditure does not include the cost of equity or debt incurred by the project developer.
- We keep the expenditure estimate constant over the forecast period, to 2035. This does not, therefore, take account of higher costs in the early part of the forecast period as the industry mobilizes, or lower costs in the later part from increased industry learning, increased volume and technology improvements.
- Although these estimates will not precisely match any individual project, we judge that they will give an approximately right value of expenditure.

Source: BVG Associates

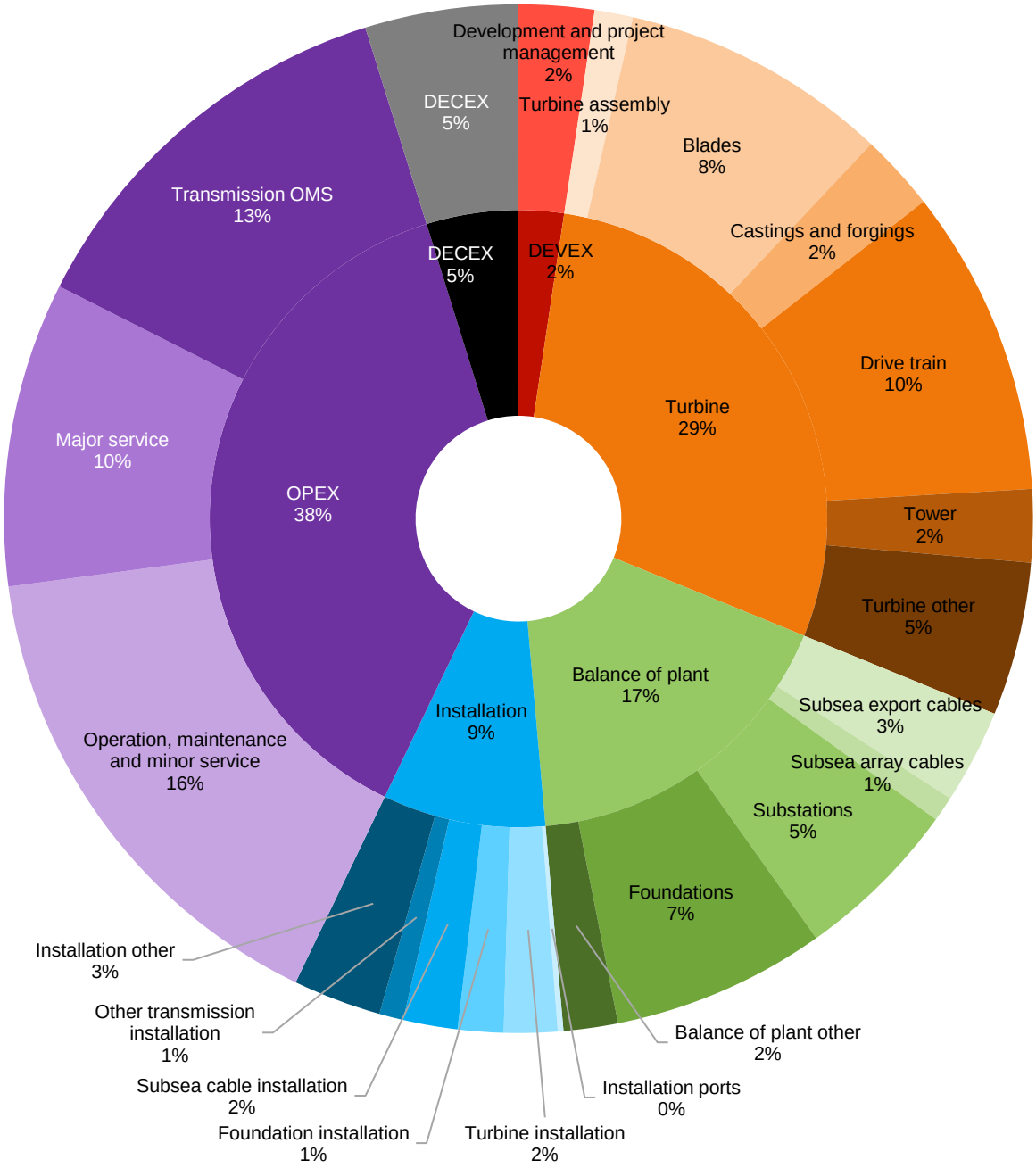


Figure 5 CAPEX and OPEX for an OSW farm of 1,000 MW installed capacity using 15 MW turbines.

2.3 North Carolina addressable markets

2.3.1 TAM SAM SOM

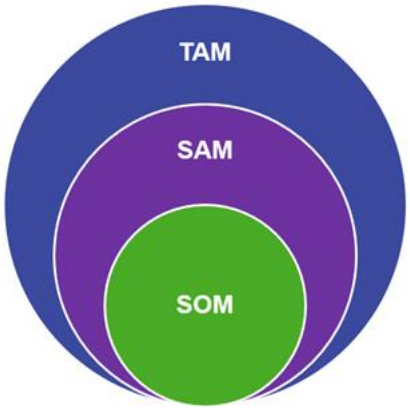


Figure 6 Diagram showing the relationship between TAM, SAM and SOM.

TAM SAM SOM are market sizes used to assess the potential revenues that can be gained for a specific entity (such as a company or state) within a market, see Figure 6 where:

- TAM (Total Addressable Market): is the total market demand for a product or service (even if the specific entity is not currently active in all locations). *Put simply, TAM is the whole of the market that could be targeted.*
- SAM (Serviceable Addressable Market): is the segment of the market that is addressed by the entity's current product or service and geographical reach. *Put simply, SAM is the part of the TAM that will be targeted, and*
- SOM (Serviceable Obtainable Market): is the part of the market that the entity can realistically win sales from when considering factors such as competition. *Put simply, SOM is the part of the SAM that will be realistically achieved.*

This section will calculate TAM and SAM.

2.3.2 Segmentation of the OSW market

North Carolina sits just south of the center of BOEM's current range of OSW lease and planning areas, as seen in Figure 7. What is the value of the TAM for OSW, as seen in Figure 4, that firms located in North Carolina expect to address? This expenditure is known as the Serviceable Addressable Market (SAM). The question is answered in two steps:

- First, we divide the forecast expenditure into two categories, being: A. the physical supply chain, and B. the project-specific activities (DEVEX, installation and operations, maintenance and service activities), and
- Second, we look at the distances over which it is viable to compete for these types of activity.

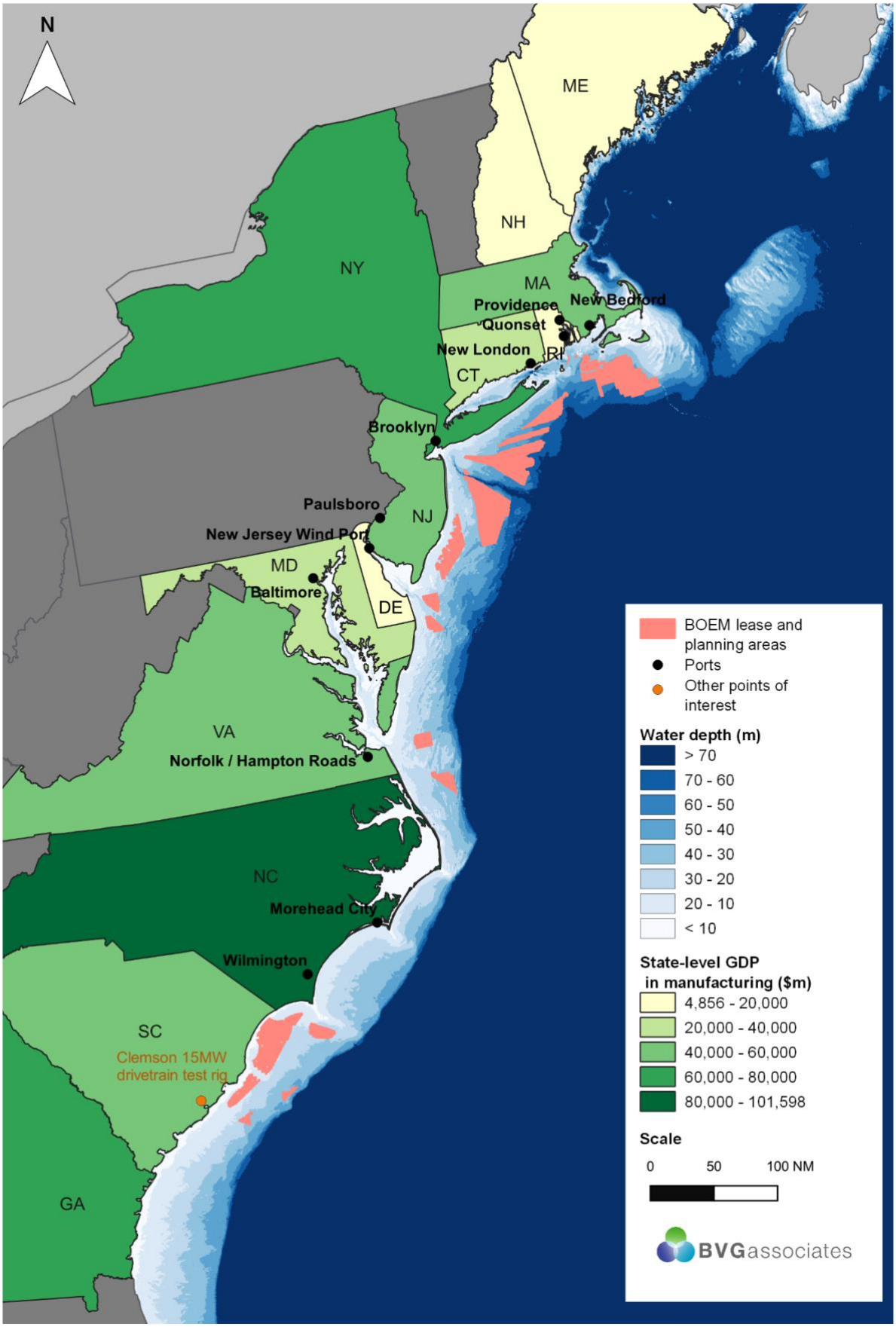


Figure 7 North Carolina's central position relative to the BOEM OSW lease areas on the East Coast showing 2019 manufacturing GDP.

A. Physical supply chain

OSW is a specialized business:

- A1. The major components are so large that they can only be made in purpose-built facilities that need to be located quayside for the purpose of outbound logistics, and
- A2. The supply chain for smaller components is so specialized that the wind turbine suppliers will normally qualify only one or possibly two component suppliers for each regional supply chain.

As such, a successful supplier of materials, components or equipment should reasonably anticipate having access to the whole US east coast market for the physical items that make up the windfarm, as shown in Figure 8.

The caveat to this is that in the short term many of these purpose-built facilities and specialized suppliers do not exist in the US, and the materials, components and equipment for the first wave of projects will come from established suppliers outside of the US until there is sufficient industry confidence in the US market to support their investment decisions in the local supply chain. For an OEM or tier 1 supplier to establish a new localized component supplier is not only a question of cost and logistics, it requires a robust risk assessment to ensure that components from a new source will fulfil all the operational requirements. OEMs, especially, are very restrictive in adapting their key component sourcing. Once an OEM or tier 1 supplier has established itself locally as an anchor company, the opportunities for local component suppliers increase significantly.

B. Project-specific (DEVEX, installation and operations, maintenance and service activities)

The location of windfarm sites has a far greater impact on the provision of installation and maintenance services than it does on the physical/manufacturing supply chain. This is because of the high logistics costs of the many journeys (vessel trips) that need to be made to transport people and materials to the site for the various installation and maintenance activities, whereas multiple components can be shipped from their base of manufacturing to a marshalling port. Ports used for marshalling components for installation are expected to be within 150 nautical miles of windfarm sites, and ports used for maintenance and service activities will nominally be within 50-75 nautical miles of the associated windfarms, although this could increase if the use of service operations vessels becomes more prevalent.

Three sites have been identified to date for OSW projects on the continental shelf in the directly offshore of North Carolina. These are: Kitty Hawk (being developed by Avangrid Renewables); Wilmington West, and Wilmington East – both of which are BOEM call out areas that have not yet been subject to lease area assignments.

The opportunity for NC should not be seen in the context of only providing marshalling ports for local windfarms; but rather, by taking advantage of NC's high-quality workforce associated with supporting the larger physical and manufacturing supply chain. This strategy would likely result in greater value to NC than only the installation and maintenance market sectors, as supporting the physical/manufacturing supply will be more constant across the OSW market as a whole than would the "lumpy" demand driven by installation and maintenance opportunities at nearby windfarms. That, and a partnership especially with Virginia, can result in a win-win situation for both states, with NC focused on the physical and manufacturing supply chain and Virginia on the marshalling facilities.

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 less than 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.

2.3.3 Calculation of TAM and SAM

Figure 8 shows the value of TAM and SAM as areas on a chart, with the X-axis representing the lifecycle spend per MW, and the Y axis representing the volume of offshore wind in MW.

Note, **this chart only contains the 34 GW of confirmed state and developer targets in each state along the East Coast. It does not include the 7 GW of anticipated targets** as BVGA cannot divulge expectations by state, **so the spend levels in this chart are less than the totals expected**. The purpose of the chart is to show relative areas.

It can be seen that:

- The TAM for the US east coast OSW market is $165 billion. This has been calculated as the spend to develop and build the 34 GW which will be installed by 2035, plus the spend to operate, maintain and decommission this capacity (even though some of this spend will be after 2035). This can be thought of as 100% of the spend.

- The TAM for physical supply chain expenditure is $76 billion or 46% of this total. The SAM is also $76 billion, as all of this market can be addressed from North Carolina. This value is all spent early in the project lifecycle, between final investment decision and commercial operations dates of the windfarm.
- The TAM for project-specific activities is larger, at $89 billion, however the SAM is only $23 billion. Although the exact location of windfarms in local states VA, MD and SC are not known, a simple assumption has been used that all windfarms in these nearby states are potentially addressable for project-specific installation, OMS and decommissioning activities. This expenditure, although large and relatively local, would be spread out over the 30-year lifecycle of the project.
- SOM values have not been calculated, as they depend on how the state of NC and firms within NC respond to the opportunities available. SOM is calculated as follows:

If BVGA's anticipated state targets of a further 7 GW were included in the area diagram the expenditures would increase, but the key messages would remain the same.

		Lifetime expenditure (in proportion to $/MW)																
Developer and state target (GW)	State (north to south)	Turbine assembly	Blades	Castings and forgings	Drive train	Tower	Turbine other	Subsea export cables	Subsea array cables	Substations	Foundations	Balance of plant other	Dev't and project mgt	Installation	Operation, maintenance and minor service	Major service	Transmission OMS	DECEX

Source: BVG Associates

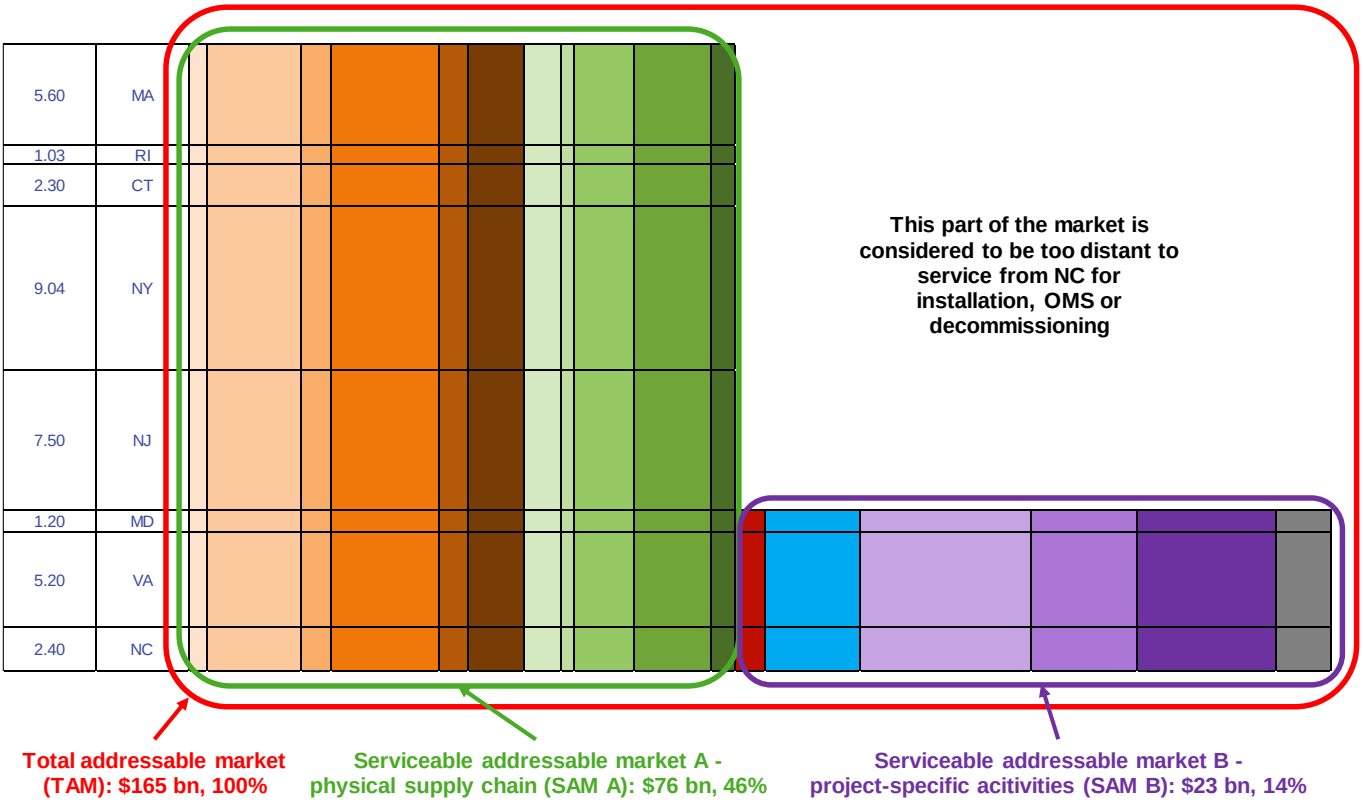


Figure 8 Area diagram showing the lifecycle value of TAM and SAM for North Carolina.

3 The physical supply chain

Summary:

The physical supply chain for offshore wind is very specialized, either by component size or by the demanding supplier qualification requirements, and so a single US plant should be able to address the whole US east coast market. It can be thought of as two types of manufacturing:

- Tier-1 components – these are so large they must be in manufactured in ports, and
- Lower-tier supply chain – small components, materials and equipment, likely to be located within manufacturing-oriented regions, ideal if located close to the major component manufacturers, but not essential.

Once established, tier-1 component facilities will “anchor” the manufacturers to those locations, with high-quality jobs, supplying a steady demand across many projects, lasting for many years. The race to win anchor tenants is already well underway, there are only a small number and they have already started to make decisions. Other states, including NY, NJ and VA, have an early-wave project advantage and have attracted commitments.

Prepare

- Continue to understand who the major, experienced supply chain companies are and their location decisions and their timescales. [R1]
- Engage with major suppliers and consider using the support from an offshore wind specialist to provide introductions and help secure their interest. Suppliers should include: wind turbine suppliers, experienced supply chain companies and potential new entrants from the US - both within NC and from out of state. Reflect the regional offering covered by SMART-POWER promoting the combined offering. [R2]

Facilitate

- Actively support connectivity and industry information sharing across the whole OSW supply chain, e.g., major component manufacturers, lower-tier manufacturers, developers (end customers), engineers, universities, equipment suppliers, training organizations, start-up incubators, venture capitalists, business consultants and legislators, as NC has successfully done for other industries such as pharmaceuticals. [R3]
- Actively support existing high-tier North Carolina based companies to pivot to the domestic OSW market, especially where they already have relevant skills and experience, or supply to the domestic onshore wind market, e.g. LS Cable and ABB Hitachi. [R4]

Accelerate

- Attract, with speed, determination and tenacity, the short list of high-tier anchor tenants to NC before they finalize their location plans elsewhere. Play to strengths with a focus on major (Tier 1) component manufacturers: especially for items with high labor content, e.g. blades and jacket foundations. [R5]

This objective of this section is to characterize the volume and value of major tier-1 components, including wind turbines, foundations and electrical balance of plant, needed, and the opportunities for NC industry. While this is study is not a jobs analysis, we do indicate the numbers of job associated with facilities.

The physical supply chain can be thought of as two types of manufacturing:

- **Tier-1 components** – These are the major constituent components that make up the turbine – such as nacelle, blades and tower – its foundation and the electrical balance of plant. They are so large that they must be manufactured in specialized facilities and located quayside for outbound logistics. The specialist nature of these facilities will anchor them in specific locations and means that they may not manufacture for any other industry, and
- **Lower-tier supply chain** – These are the multitude of firms supplying smaller components into the major component manufacturers. The very largest of these, such as hub castings, can still be very large and specialized. As you go further down the supply chain, however, many components and the facilities they are made in, become less wind-specific, although they will still have demanding supplier qualification requirements. This means that firms are likely to supply several different industries. In total the value added by the lower-tier supply chain is significant as it is similar to the value added by the tier-1 component suppliers.

3.1 Major components - turbine

3.1.1 Wind turbine tier-1 supply chain, the NC opportunity

Element	Likelihood of US supply within 5 years	Potential for NC supply	Short-term priority for NC	Notes
Nacelle, including hub	High	Medium	High	Needs a large pool of high-skilled labor and will pull in significant amounts of work from lower-tier component and manufacturing-process suppliers. It will anchor these jobs for the long term, leading to a steady and predictable workload for several decades. A facility would service the whole East Coast. Allocated a high priority as the benefits to NC would be so great.
Blades	High	High	High	Needs a large pool of high-skilled labor and will pull in significant amounts of work from lower-tier materials and manufacturing-process suppliers. It will anchor these jobs for the long term, leading to a steady and predictable workload for several decades. Facility would service the whole East Coast. Allocated a high priority because of NC's relevant competitive strengths.
Tower	High	Medium	Medium	Tower manufacturing is normally sub-contracted with short-term commitments (3 years is typical).
Power take-off (transformer, converter, switchgear)	High	High	High	Most likely to come from existing or expanded electrical-equipment plants, rather than a new plant. Allocated a high priority because of NC's relevant competitive strengths.

3.1.2 Scale of turbines

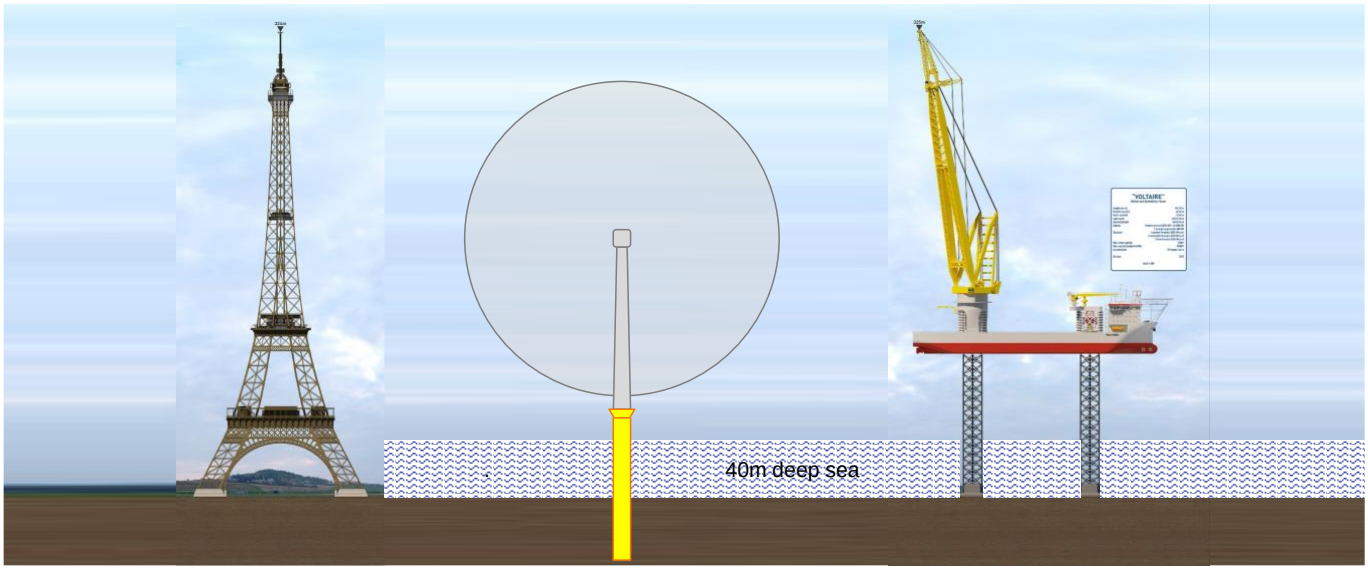


Figure 9 The relative size of modern offshore wind turbines – a 13MW Haliade-X being installed at a 40m deep site.

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 windfarms built from approximately 2023 onwards will be larger still. Figure 9 provides an idea of the size of these next-generation OSW turbines.

3.1.3 Nacelle, including hub and generator

Figure 10 GE Haliade-X nacelle: 13MW, 220m rotor, ≈600 tons.

Nacelle, hub and generator assembly may be co-located on one site. Key components are typically bid out by 'design-win' process and turbines will, most likely, be designed with a predominately European supply chain in mind. The east coast market is likely to use European designs that are currently manufactured in Europe. Significant assembly of related components in the US is only expected to be feasible if production of key components is also undertaken in the US, otherwise, the completed units would be shipped from their European facilities. The minimum viable size of a facility is likely to be one that produces 1 GW/year of nacelles and ideally one that can produce 2-3 GW/year. Initial investment is most likely by the market leader, that will then make it harder for the remaining wind turbine suppliers to invest.

As each plant requires at least $100m investment, the wind turbine suppliers will want to have confidence in the market and their pipelines before making final and significant investment decisions. A strategy for wind turbine suppliers could be to start with local US final assembly and provide more complex items, such as direct drive generators, from existing plants in Europe, progressively increasing local content to 100% over the course of years. The work, therefore, at the assembly plant and its supply chain is expected to start a few years behind the start of OSW project buildout.

- 2020-2023: Turbines are typically in the 9-11 MW range. The annual windfarm run rate rises to about 1 GW. The market is not sufficient for a US investment, and all nacelle, hub and generator assembly is undertaken outside the US.
- 2024-2027: Turbines are typically in the 12-15 MW range. The annual windfarm run rate is about 2.5 GW. Suppliers have localized some elements of their nacelle, hub and generator activity in the US.
- 2028-2035: Turbines are typically in the 16-18 MW range. The annual windfarm run rate is about 2.5 GW. It is likely that at a 1-2 GW/year production rate the market leading manufacturer and one other will invest in the development of a production facility.

We do not anticipate any Chinese wind turbine suppliers to supply to or manufacture in the US, as their products are not sufficiently competitive, and when they do become competitive, there will likely be concerns over trade policy and security of critical national infrastructure.

Due of the size and weight of components and the final assembled nacelle – too large to be transportable by road or rail – the assembly plant needs to be located at a port facility equipped with the infrastructure to trans-ship completed components to a marshalling facility. For inbound logistics considerations there is advantage to being located at the center of an industrial hinterland to minimize inbound transport costs, as well as providing lower property and labor costs. For outbound logistics there is advantage to being reasonably centrally located on the East Coast, near the majority of the OSW farms. The plant will need a labor force of several hundred people.

3.1.4 Blades

Figure 11 GE Haliade-X: 220m rotor, each blade 107m long, ≈55 tons – for comparison a 777ER has a wind span of 60m.

A typically blade factory produces approximately 500MW of output per production line, or "mold", per year. A modern and efficient plant could have up to four lines. We anticipate the US market to be able to support the two largest manufacturers to produce blades at facilities with two lines each, i.e., producing approximately 1GW per year, with any peaks in demand being met from a secondary non-US manufacturing site.

- 2020-2023: Blades are typically in the 75 to 85 m range. The annual windfarm run rate rises to about 1 GW. The wave of projects is not sufficient to attract US investment and all blade production is undertaken outside the US.
- 2024-2027: Blades are typically in the 90 to 110 m range. The annual windfarm run rate is about 2.5 GW. The market will support investment by the market-leader supplier with half of blades produced in the US.
- 2028-2035: Blades are typically in the 90 to 110 m range. The annual windfarm run rate is about 2.5 GW. The market will support investment by the top two US-based suppliers providing blades to three quarters of the market.

Plant location needs to be dockside for outbound logistics, ideally with space for storage of many months of blade production on site. The supply chain is largely in the form of raw materials that are easy to acquire, and these can be sourced globally with relatively low transport costs, consisting primarily of glass fiber, resin, balsa wood and carbon fiber. Proximity to boat building or aerospace composite manufacturing facilities and an experienced labor force would be an advantage. The plant would need a labor force of several hundred people, so labor costs will be an important factor.

3.1.5 Towers

Towers form part of the turbine scope but are almost always outsourced nowadays. The manufacturing supply chain is not very complex and tower production can be localized relatively easily. A potential barrier to investment is that turbine suppliers typically award contracts for approximately three years. If investors amortize their investment over this period, this is likely to make the towers too expensive.

- 2020-2023: The annual windfarm run rate rises to about 1 GW. The market is not sufficient for a US investment and all tower production is undertaken outside the US.
- 2024-2027: The annual windfarm run rate is about 2.5 GW. The market will support investment by two suppliers with two thirds of towers produced in the US.
- 2028-2035: The annual windfarm run rate is about 2.5 GW. No change from previously.

OSW turbine towers are larger in diameter than onshore towers, as the turbines are larger. However, OSW towers do not have the constraints of needing to be transported by land (in fact, they can only be transported by water). Despite the technology and processes being similar and suiting existing manufacturers of onshore towers, the scale of offshore towers is much larger and needs to be carried out dockside, ideally with storage of many months' worth of production.

Raw commodity materials consist primarily of steel plate and proximity to an experienced rolled-steel fabrication ecosystem is an advantage – North Carolina has such an experienced labor force. The plant would need a labor force of several hundred people.

3.1.6 Power take-off (transformer, converter, switchgear)

The items used in the wind turbine's power take-off include the following: a full-scale power converter, a step-up transformer to 66 kV and gas-insulated switchgear (compact switchgear is needed to fit in the constrained space available). These items have many applications across power transmission and heavy industry; therefore, OSW will not be their only or even primary market. The difference for the OSW industry is that these items may have unusual configurations because of the space limitations and may have very high reliability requirements despite the challenging offshore environment.

As these components can be readily transported by road or rail, there is no need to manufacture them in an expensive port facility, although proximity to the end customer is a small benefit. This is one set of components that could be

located well away from the ocean as long as there is sufficient road/rail infrastructure.

3.1.7 Turbine demand

Figure 12 shows that expenditure on turbines reaches an annual level of just under $5 billion/year (imported and locally manufactured). Note that this chart uses BVGA's "conservative" forecast, that rises to 3.5 GW/year and then stays constant. Although the annual installed capacity remains constant the number of turbines installed per year is seen to fall due to the increasing capacity of turbines. Note also that this chart shows expenditure and volumes versus the year of project commissioning, for simplicity, whereas the expenditure will actually be made during the period of several years of equipment manufacturing before project commissioning.

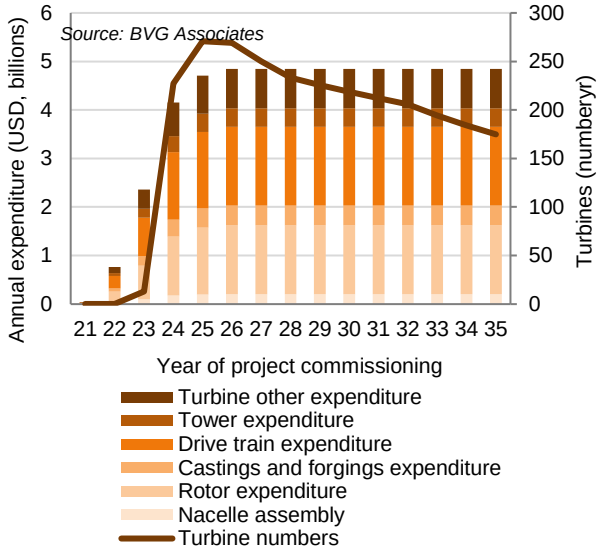


Figure 12 Demand and expenditure for turbines, shown versus year of project commissioning.

3.1.8 Potential anchor firms

Potential anchor firms, nacelles

GE Renewables, SGRE and Vestas (since they took full control of the MVOW joint venture). None of these manufacturers has made a commitment to an OSW manufacturing plant yet. SGRE are thought to be the most likely manufacturer to commit to a US nacelle factory as they have the largest sales pipeline in the US (provisional orders for 4,350 MW: Revolution Wind, South Fork, Sunrise and Dominion One-Three).

Profile of blade manufacturer SGRE in Hull, UK:

Wind turbine manufacturer SGRE has a blade manufacturing facility in Hull, which is ideally suited to supply wind farms in the North Sea. It employs more than 1,000 people, directly, at this facility.

It opened in 2016 with a reported investment of £160m by SGRE, plus investment of £310m by owner ABP on preparation for the manufacturing facility and the related infrastructure for other co-located OSW activity including a construction port.

The blade manufacturing facility has an internal area of 9 acres, seen to the left of center in the photograph above, plus many times that area for external blade storage.

Profile of tower manufacture, Marmen / Welcon's plans for the Port of Albany, New York State.

Marmen / Welcon[23] developed plans with Equinor and the Port of Albany for a plant to build towers and may build transition pieces. It was conditional on Equinor's OW project bid to NYSERDA.

The new plant will transform the port infrastructure. It will create up to 350 direct jobs in New York, as well as supporting further jobs in the supply chain.

The port development will begin in 2021 and the wind tower production is scheduled for the end of 2023. It is made up of four new buildings with a total of 14 acres on an 80-acre site. The realization will generate investments of hundreds of million US dollars.

[23] "Port of Albany Selected as the First Offshore Wind Tower Manufacturing Site in the Nation In Partnership between Marmen Inc, Welcon A/S and Equinor Wind", https://www.aapa-ports.org/files/Port%20of%20Albany%20Press%20Release%201-14-20_.pdf, last accessed February 2021.

Potential anchor firms, blades

LM Wind Power (GE Renewables' wholly owned blade-manufacturing subsidiary), SGRE and Vestas. None of these manufacturers has made a commitment to an OSW manufacturing plant yet. SGRE are thought to be the most likely manufacturer to commit to a US nacelle factory as they have the largest sales pipeline in the US (as nacelles), although they are understood to be considering a plant in VA, linked to the Dominion One-Three projects.

Potential anchor firms, towers

US manufacturers: Ventower, Broadwind, and non-US manufacturers including: CS Wind, Titan, Gestamp, Haizea and Ambau.

Marmen / Welcon JV has agreed to set up in the Port of Albany for towers and transition pieces on the basis of Equinor and BP's successful NYSERDA bid.

Potential anchor firms, power take-off

NC is already home to major electrical equipment suppliers Hitachi ABB and Schneider. It is considered unlikely that new factories will be built, rather it is anticipated that existing US facilities will make new sales from the new OSW market.

3.2 Foundations

3.2.1 Foundations tier-1 supply chain, the North Carolina opportunity

Element	Likelihood of US supply within 5 years	Potential for NC supply	Short-term priority for NC	Notes
Monopile	High	Medium	Low	Expected to account for the majority of turbine foundations on the east coast. Rated low as EEW has already made a commitment to Paulsboro.
Jackets	High	Medium	Medium	Expected to account for most of the remaining turbine foundations, are also needed for substation foundations. Jacket foundations for offshore oil and gas are currently manufactured along the US gulf coast.
Steel plate	High	Medium	High	Monopiles need very thick plate, which benefits from being very large and high quality for automated welding. Rated high as Nucor HQ in NC.

3.2.2 Foundation description, monopiles

Figure 13 Monopile departs Steelwind Nordenham for Yunlin windfarm: mass 1,732 tons, diameter 8 m, length 93 m.

The choice of foundation concept is dependent on water depth, turbine size, geologic/geotechnical conditions, environmental restrictions such as noise, sea state, vessel logistics, supply chain location, and infrastructure and workforce synergies with existing industrial bases. Monopiles are currently the foundation of choice in Europe and they continue to be selected for 10 MW+ turbine projects. Because large monopiles may have masses of 1,500 tons or more, they rely on the use of highly specialized vessels for installation. A high proportion of the monopile cost (approximately 50%) is the steel plate and currently there are no US production facilities with the capability of producing the plate to the appropriate scale (e.g., size and thickness). The viability of a US monopile factory would also likely be linked to highly variable and political steel tariffs and the pressure on power purchase price.

The upper part of a monopile has traditionally been manufactured as a separate "transition piece". Monopile fabricators currently supply the primary steel structure for

most of these, as they are made using the same equipment. Some future designs do not use a separate transition piece. In addition to the very large primary steel structures of the monopile and transition piece, this design of foundation also requires secondary steel elements, including boat landings and external ladders, main external work platform, internal work platforms, anode cages. This may be supplied by smaller, established local suppliers.

- 2020-2023: The annual windfarm run rate rises from 42 MW to about 1 GW. The market is not foundation for a US investment and all foundation production is undertaken outside the US. Even though EEW has made a commitment to Paulsboro, NJ, we expect this to be limited during this phase to final assembly of "can" sections supplied from EEW in Germany.
- 2024-2027: The annual windfarm run rate is about 2.5 GW. Monopiles will be the foundation of choice in water up to about 40 m in depth. One, possibly two, US-based suppliers will become established.
- 2028-2035: The annual windfarm run rate is about 2.5 GW. Any US investments will have been made by this stage of the market sector and the picture is unlikely to change significantly.

A monopile plant must be located dockside to allow access to marine transportation assets, ideally with space for storage of many months' of monopile production on site. A central location along the US East Coast, with moderately large air draft (e.g., bridges), would also allow the possibility of using the plant as a marshalling port, as practiced by Sif in Europe. Raw materials consist primarily of heavy steel plate and proximity to an experienced rolled steel fabrication ecosystem is an advantage. The plant would need a labor force of several hundred people.

3.2.3 Foundation description, jackets

Jackets are typically lighter foundation structures than monopiles (they use less steel) for a given windfarm site, however the costs of currently used designs are higher due to the higher labor requirements and the slower rate of production. Jackets are generally secured to the seabed using pin piles and these can be supplied by a monopile supplier. Suctions anchor jacket foundations add fabrication cost but eliminate installation noise as the hammering process is replaced by vacuum pump installation – this results in less potential acoustical impacts to marine mammals. Jacket manufacturers may also produce transition pieces and potentially on the same site, that reduces the investment costs and risks. Manufacturing jackets for OSW turbines requires a highly automated plant to be cost effective, because of the volumes involved and the lower-cost competition from the Far East.

Jackets are sometimes sent as a flat pack from the Middle East or Far East to European fabricators for final assembly, this is an option to localize part of the work in the US with less up-front investment.

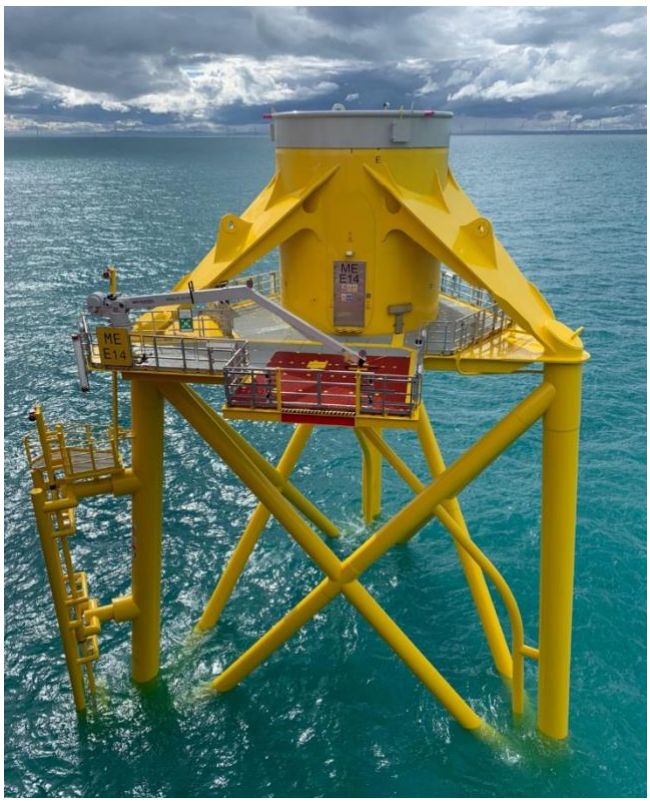


Figure 14 A typical jacket foundation for an OSW turbine at Moray East.

Substation jacket foundations will also be required, typically one per 500 MW of capacity.

- 2020-2023: The annual windfarm run rate rises from 42 MW to about 1 GW. The market is not sufficient for a US investment and all foundation production is undertaken outside the US.
- 2024-2027: The annual windfarm run rate is about 2.5 GW. It is unlikely that any competitive, high-volume suppliers will become established, although local firms may win work for: substation jackets, final assembly of turbine jackets or small orders of turbine jackets. There is a potential that some of these components could effectively be manufactured in the US Gulf Coast by existing suppliers to the oil and gas industry.
- 2028-2035: The annual windfarm run rate is about 2.5 GW. No change.

A jacket plant must be located dockside, ideally with space for storage of many months' of monopile production on site (if for turbine foundations). A central location along the US East Coast, with large air draft, would also allow the possibility of using the plant as a marshalling port.

3.2.4 Foundation description, steel plate

Monopiles need very thick plate, up to 120 mm (nearly 5 inches). This also benefits from being very large initial manufactured plates, that minimizes the number of edges that require welding. Individual plates of up to 42 t are currently being manufactured by some European suppliers.

Edge cutting and profiling is often carried out by the plate mill facilities, that results in the fabricators being more efficient. The ultimate tensile strength of the steel plate is not particularly high, with 355N/sqmm is typical. A very consistent fine-grained quality is needed to enable the high rate of automated welding required to efficiently manufacture the monopiles, that is achieved through thermo-mechanical rolling and use of very low carbon equivalent values.

Because of the size and mass of the plates, barge transport is ideal to transport plates between the between the mill facility and fabrication plant.

Similar steel plate, although of less-large dimensions, is used for other types of steel foundations and towers.

3.2.5 Foundations, demand

Figure 12 shows that expenditure on foundations of all types reaches an annual level of $1.2 billion/year (imported and locally manufactured). Note that this chart uses BVGA's "conservative" forecast, that rises to 3.5 GW/year and then stays constant. Although the annual installed capacity remains constant the number of foundations installed per year is seen to fall due to the increasing capacity of turbines. Note also that this chart shows expenditure and volumes versus the year of project commissioning, for simplicity, whereas the expenditure will actually be made during the up to a couple of years before project commissioning.

Foundation elements are critical components of any windfarm developments. They come in a variety of configurations based upon depth of water, geologic/geotechnical conditions and developer preferences.

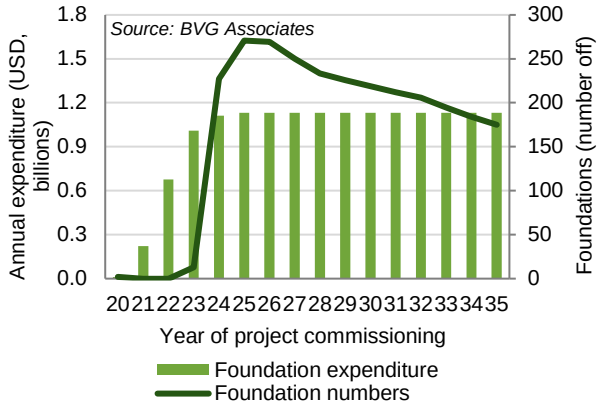


Figure 15 Demand and expenditure for foundations, shown versus year of project commissioning.

Monopile and jacket suppliers are discussed in more detail in the following sections, along with the supply of very large steel plate supply that is important for monopile fabrication.

Note, other foundation types, such as concrete gravity base, are possible, but are not addressed here as they are not competitive elsewhere and so if they win any market share, it is expected to be small. For example, Equinor has committed to using concrete gravity base foundations for Empire Wind as part of their PPA/OREC application, to increase local content.

Profile of monopile manufacturer Sif:

Monopile manufacturer Sif has facilities at Roermond and at Maasvlakte, seen above, in the Netherlands. It manufactures cylindrical "can" sections at Roermond and ships these by barge to Maasvlakte for fabrication into complete monopiles and primary steel structures for transition pieces. Sif has space to store complete wind farm volumes of MPs and TPs at its fabrication facility for collection by installation vessels, thereby avoiding the use of project-specific marshalling harbors and double handling It will directly supply the Dogger Bank project over 200 miles away.

Sif has the capability for detailed design and has been active in the development of TP-less designs. In 2020 announced its intention to purchase KCI the Engineers[24] to add to its design capabilities.

In total the two facilities have 19 acres of covered facility and 104 acres of external storage. In 2019 it employed 650 FTEs and shipped just under 200,000 t of components, of which more than 95% was to the OSW market.

[24] KCI Engineers, https://sif-group.com/en/news/sif-news/844-sif-intends-acquisition-of-kci-the-engineers, last accessed February 2021.

3.2.6 Potential anchor firms

Potential anchor firms, monopiles

EEW of Germany has announced a final investment decision for a monopile facility in Paulsboro:[25]

"Governor Phil Murphy, alongside EEW, Ørsted, legislators, and members of the building trades, today announced a $250 million investment in a state-of-the-art manufacturing facility to build steel components, known as monopiles, for offshore wind turbines that will serve the entire United States offshore wind industry. The facility, which will be located at the Paulsboro Marine Terminal in Gloucester County, is the largest industrial offshore wind investment in the United States to date and will create more than 500 high-paying jobs at full build out. Construction on the facility will break ground in January 2021, with production beginning in 2023."

A joint venture between Marmen and Welcon (Denmark) has plans to build a transition piece and tower facility at the Port of Albany, NY.[26]

Further established suppliers who might wish to set up in NC, either on their own or as part of a JV, include: Sif (Netherlands), Bladt (Denmark), Steelwind Nordenham (Germany) and SeAH Steel (South Korea).

Potential anchor firms, jackets

These include existing US fabricators of jackets for the oil and gas market, including Gulf Island Fabrication who supplied the jacket foundations for the Block Island project.

Established jacket suppliers to the OSW industry who may wish to enter the US, either on their own or as part of a JV, include: Bladt (Denmark), Navantia (Spain) and Lamprell (United Arab Emirates).

Potential anchor firms, steel plate

Potential U.S. anchor firms include Nucor, which is headquartered in NC and U.S. Steel.

3.3 Electrical balance of plant

3.3.1 Electrical balance of plant tier-1 supply chain, the North Carolina opportunity

Element	Likelihood of US supply within 5 years	Potential for NC supply	Short-term priority for NC	Notes
Export cable	High	Medium	Medium	As with foundations and monopiles, manufacturing facilities for this component may already be "promised" in other state PPA/OREC applications.
Array cable	High	High	High	As with foundations and monopiles, manufacturing facilities for this component may already be "promised" in other state PPA/OREC applications.
HV electrical equipment	High	High	High	We expect there to be several existing US plants which will manufacture HV electrical equipment for the onshore and offshore substations.
Topside fabrication and integration	Medium	Medium	Medium	Although the most likely suppliers will be existing oil and gas topside fabricators or ship builders, there is still the opportunity to establish a US specialist supplier.

[25] Announcement of new EEW plant in Paulsboro https://www.nj.gov/governor/news/news/562020/approved/20201222a.shtml, last accessed January 2021.

[26] Announcement of plans for new Marmen / Welcon plant in Albany https://www.welcon.dk/news/press-release/, last accessed January 2021.

3.3.2 Export cable

Manufacture of very high voltage and very high-capacity cables is a specialized business, requiring tall towers or deep subterranean pits for the vulcanization process. Activity, therefore, is likely to remain focused on existing plants. For OSW these cables can by up to 100 miles long, depending on the windfarm location and cable route, so need very high-capacity carousels to store and move them. A waterside location is essential as the carousels are too large and heavy to be transported by road or rail.

Export cable can be readily manufactured at non-US facilities and trans-shipped to a US staging port.

3.3.3 Array cable

Suppliers of array cables could be the same as the suppliers of export cable. Array cable operates at lower voltage and lower power and does not need to be supplied in such great lengths, so is generally less demanding to make, so there may be some additional suppliers.

As for export cable, array cable can be readily manufactured at non-US facilities and transshipped to a US staging port.

To start with, we will focus on the Export Cable suppliers, unless we find out there are additional suppliers who make Array cable only.

3.3.4 HV equipment

We expect there to be US facilities manufacturing HV electrical equipment for the onshore and offshore substations. Because this equipment is used across power networks, nationally, the additional work for OSW is not expected to result in new plant, although existing ones might expand. Because the wind farm sites are less than 100 miles from shore HVAC systems are expected to be used, rather than HVDC.

Two important differences from regular onshore HV equipment are:

- Offshore HV equipment needs to be suitably marinized, to provide a lifetime of reliable operation in the harsh offshore environment, and
- Offshore HV equipment, especially that used at the base of each wind turbine, needs to be compact. For example, gas-insulated switchgear is preferred.

It is possible that the investment tax credit regulations will lead to the pre-ordering of the main onshore and offshore transformers, as they are one of the easiest items to purchase to lock in the ITC, and should the project be delayed or cancelled they are a component which could be reused at a different project, thereby reducing the risk of early expenditure.

3.3.5 Substation, topside fabrication and integration

Substation topside fabrication and integration should require similar capabilities to oil rig topsides or ship fabrication and fit out.

We do not see that any new substation yards need to be built for this industry, but rather expect existing U.S. shipbuilding or oil and gas platform yards to be used.

3.3.6 Electrical balance of plant, demand

Export cable, demand

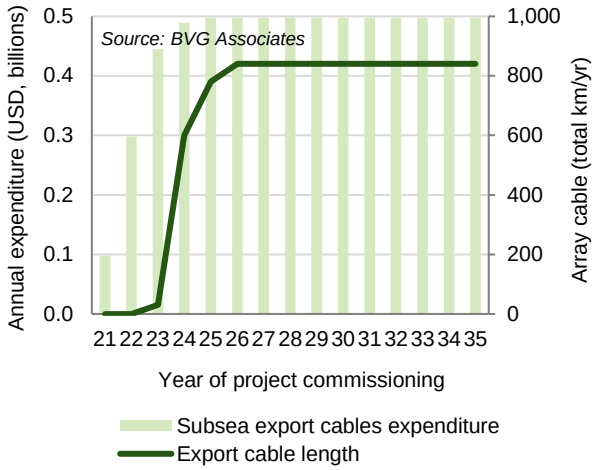


Figure 16 Demand and expenditure for export cable, shown versus year of project commissioning.

Figure 16 shows that expenditure on export and array cabling CAPEX reaches an annual level of exactly $0.5 billion/year (imported and local manufactured). Note that this chart uses BVGA's "conservative" forecast, that rises to 3.5 GW/year and then stays constant. Assumptions have been made regarding the length of export cable used per MW. Note also that this chart shows expenditure and volumes versus the year of project commissioning, for simplicity, whereas the expenditure will actually be made up to three years before project commissioning.

Array cable, demand

Figure 17 shows that expenditure on export and array cabling CAPEX reaches an annual level of exactly $130 million/year (imported and local manufactured). Note that this chart uses BVGA's "conservative" forecast, that rises to 3.5 GW/year and then stays constant. It can be seen that as turbines get larger in future years the total length of cable decreases. Note also that this chart shows expenditure and volumes versus the year of project commissioning, for simplicity, whereas the expenditure will actually be made up to three years before project commissioning.

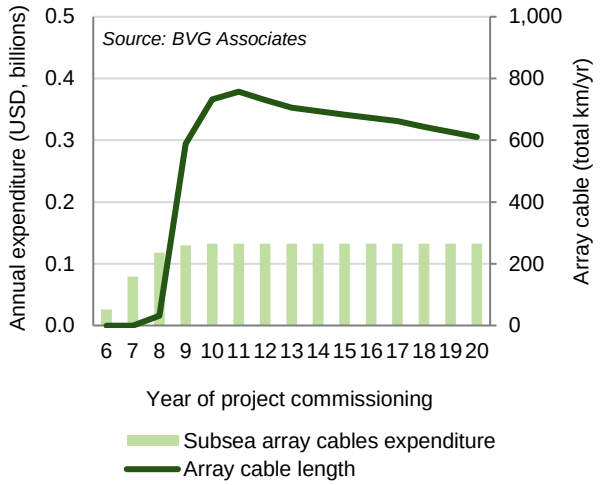


Figure 17 Demand and expenditure for array cable, shown versus year of project commissioning.

Offshore substations, demand

Figure 18 shows that expenditure on offshore substation CAPEX reaches an annual level of just under $0.9 billion/year (imported and local manufactured). This includes the expenditure for the topside fabrication, the electrical equipment within it, the integration of the equipment and the foundation structure. Note that this chart uses BVGA's "conservative" forecast that rises to 3.5 GW/year and then stays constant. An average future value of 500 MW/substation has been used, corresponding to seven substations/year. Note also that this chart shows expenditure and volumes versus the year of project commissioning, for simplicity, whereas the expenditure will actually be made up to three years before project is commissioned.

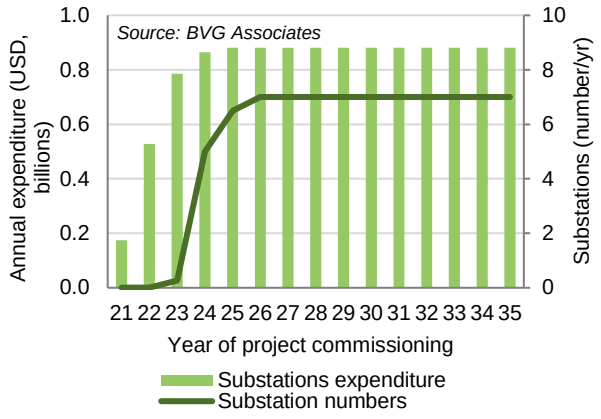


Figure 18 Demand and expenditure for transmission CAPEX, shown versus year of project commissioning.

3.3.7 Potential anchor firms, electrical balance of plant

Potential anchor firms, export cable

Potential anchor firms include existing firms who are active in the OSW industry:

- Prysmian (NKT), and
- LS Cable, which is already established in NC with a factory producing cable cores.

Nexans is another firm already active in the industry, but it already has a plant in SC, so it is not expected to be looking for new premises in NC.

Potential new entrants include:

- Southwire, and
- Kerite (Marmon Utility).

Potential anchor firms, array cable

Many of the firms listed in the previous section, who manufacture or could manufacture export cables, also manufacture array cables. They could be potential anchor firms for array cables but are not listed again here.

The following firms are further anchor firms:

- Hellenic Cables, JDR Cables and TKF.

Potential anchor firms, HV equipment

The established global HV equipment suppliers already serving the OSW market, who are large enough to provide the complete HV system, include:

- Siemens Energy
- GE Grid Solutions, and
- Hitachi ABB, note Hitachi ABB has its U.S. headquarters in NC, although it is understood that there is no HV equipment manufactured in the state.

There are other major suppliers to the OSW market who provide a more focused set of HV equipment, these include:

- Schneider, focus on switchgear, and
- CG Power Systems, focus on transformers.

Potential anchor firms, substation fabrication and integration

There are currently no firms in the U.S. specialized in the fabrication or integration of offshore substations.

The first contracts for Vineyard Wind 1 and the first Mayflower projects, have been won by European suppliers Bladt and Semco Maritime (both Danish) working together. Other experienced European suppliers include: Engie Fabricom (Belgium), HSM Offshore (Netherlands), Chantiers De l'Atlantique (France), Smulders (Belgium) and Babcock International (UK). Firms often cooperate in different groupings to fulfil the roles of EPCI contractor, topside fabricator and HV equipment integrator.

We are also aware of strong Far East competition, for example Sembcorp Marine.

We expect existing U.S. shipbuilding or oil and gas platform yards could be used for the domestic market. Another option would be to set up a new facility focused specifically on this market. Essentially, a large shed with good cranes next to a quay, with a reasonably skilled local workforce is needed. There is much less expensive equipment needed than, for example, a monopile or cable manufacturing facility. See profile, below, of a topside fabricator and systems integrator.

Profile of substation integrator HSM Offshore, NL.

HSM Offshore is a focused fabricator and systems integrator for offshore substations, supplying to the oil and gas and OSW markets. It is based at Schiedam, in the Netherlands and has direct quayside access to the Rhine.

It manufactures between two and three offshore substations per year, made up of one or more of: topside, foundations and systems integration.

HSM Offshore operates from the same yard as sister company HSM Steel Structures. The two companies, together, occupy 5 acres of factory on 17 acres of site.

3.4 Lower levels of the supply chain

The previous sections have focused on the Tier 1 manufacturers. **There is also considerable value supplied by the lower tiers of manufacturing into these Tier 1 suppliers. Given NC's strengths in manufacturing, this is an area where NC has a lot to offer to the Tier 1s**. For example:

- Nacelle assembly requires pitch bearings, yaw bearings, main bearings, hub castings, bedplate fabrication, pitch drive system, yaw drive system, generators, control cabinets, cooling systems, lighting, anemometers …
- Blade manufacture requires resins, glass and carbon raw materials and preformed items, lightning protection systems, blade bolts/inserts, sensors …

The challenge for NC manufacturers will be to qualify as new suppliers to the higher-tier suppliers, as those higher-tier suppliers look to increase the amount of local U.S. content.

An existing tier 1 supplier may already have a couple of existing suppliers that are qualified for their very high quality and delivery requirements. To qualify further suppliers could need a reasonably significant investment and so suppliers are not changed readily. Not only do capacity, capability and various processes need to be assessed, but components may need lifecycle testing on a special rig. An ideal time is either when a new supplier is setting up in a new country, or is introducing a new model, as new suppliers or components have to be qualified for both of these situations. For new models, selection is sometimes done via design and supply contracts.

Proximity to the anchor firm facilities will be an advantage, but is not essential, depending on the cost of transport as a proportion of the component cost.

4 East coast supply chain opportunity serviceable from North Carolina (project-specific marine activities)

Summary:

Marine activities need to be based relatively close to offshore wind projects to serve them economically, and so the projects anchor these activities.

- Installation is typically located within 175 nm of sites, good ports with plenty of space are required.
- OMS is typically located within 50 - 75 nm of sites, need much smaller ports.
- At first sight there is less urgency, as ports will only be needed in the last year or two before project commissioning.

However, a “competitive” volume of planned offshore wind capacity would help attract major manufacturers and port-based activities, as well as developers and development activity

Prepare

- Assess the competitiveness of an installation port along the southern North Carolina coast, as one input to the location of future lease areas off the coast. [R41]
- Assess further potential locations for OMS ports along the coast of North Carolina, as inputs the location of future lease areas. [R42]

Facilitate

- Include “local benefit” considerations in future windfarm procurement mechanism, as some other States have done, to ensure that work will be delivered from NC. [R21]

This objective of this section is to characterize the long-term service industry potential and the opportunities for NC-based maritime businesses. This is not a jobs analysis.

Project-specific marine activities include:

- Windfarm development and surveying
- Windfarm marshalling installation
- Operation, maintenance and service, and
- Windfarm decommissioning

These are described in the sections which follow.

4.1 Installation

4.1.1 Windfarm installation, the North Carolina opportunity

Element	Likelihood of US supply within 5 years	Potential for NC supply	Short-term priority for NC	Notes
Foundation and turbine installation	High	Medium	Low	In the short-term, VA ports will gain an early wave advantage from Kitty Hawk installation. There are no projects currently visible beyond that, so NC has time to assess whether there is benefit from a port towards the south of the state.
Cable installation, export and array	High	Medium	Medium	Cable installation requires a small number of large loads, and NC has the potential to supply cable, so there is the potential for cable installation activity to be based in the state.
Offshore substation installation	High	Medium	Medium	Substation installation involves a small number of large loads, often direct from the manufacturer, and so may be transported from a large distance.

4.1.2 Installation, description

Table 1 Different types of vessels used in transport and installation activities and some typical parameters.

Component transport	**Foundation installation vessel** (for 10 MW+ turbines)
	
Typically: 600x120 ft, 24-30 ft draft e.g. United Wind Logistics' Boldwind	Typically: 700x165 ft, 25-40 ft draft, max. lift >2,500 t e.g. OHT's Alphalift (currently under construction)
Wind turbine installation vessel (for 10 MW+ turbines)	**Cable installation vessel**
	
Typically: 500x180 ft, 25-40 ft draft, max. lift >2,000 t e.g. Dominion Energy's new Jones Act-compliant WTIV (currently under construction)	Typically: 450x100 ft, 18-28 ft draft e.g. Nexan's NKT Victoria

Foundation and wind turbine installation

Foundation and wind turbine installation is typically carried out using a construction base port. Transport vessels, see example in Table 1, ship the major components to the construction base port where some final assembly and test is carried out, and a stock of final assemblies is held ready for installation at site. An alternative for foundation manufacturing facilities with good storage space is that they can act as a construction base port for nearby sites.

In established OSW markets several turbine-sets of equipment are then loaded onto a large specialist foundation installation vessel or turbine installation vessel, see Table 1 again for examples of these vessels. They transport the components to the installation site and install the foundations or turbines using sophisticated lifting and handling equipment. Construction base ports are typically located within 175 nm of the installation site to minimize the time spent sailing back and forth. The cycle time to install a foundation or a modern wind turbine in good weather is less than a day.

The implication for the NC supply chain is that there will be work not just to manufacture new vessels, but also to own, operate and crew them, and to provide the construction ports and various services they will need for projects within a 175 nm radius.

Cable installation

Cable installation is the process of installing:

- Offshore array cables, which typically run from the offshore substation to wind turbines, and also between wind turbines, and
- Offshore export cables, which typically run between the offshore substation and a landfall location.

For each type of cable there will be at least one vessel with a large cable carousel which lays the cable. Other vessels may be involved to assist with other operations including clearing the route, preparing the trench, covering the cable after it has been laid, pulling cables into the turbine foundations and making terminations.

The implication for the NC supply chain is minor. As only a few cable collections will be needed per project a cable installation port can cost-effectively support wind farm sites further away than the typical 175 nm maximum for a foundation or wind turbine installation port, and cable factories themselves are the first choice, unless the cable is coming from a great distance.

Offshore substation installation

Offshore substation installation is typically a two-stage process whereby:

- First, the substation foundation is installed, and
- Second, the substation topside is installed onto the foundation.

Up to now the masses of substation foundations and topsides have been much heavier than those of the associated wind turbine foundations and wind turbines, so specialist very heavy lift vessels have been used, with the components delivered to site by transport barges.

For the next generation of 10+ MW turbines it may be that the new generation of foundation and wind turbine installation vessels will have sufficient capacity to transport and install them.

The implication for the NC supply chain is minor. As only a few substation installations will be needed per project a substation installation port can cost-effectively support wind farm sites further away than the typical 175 nm maximum for a foundation or wind turbine installation port, and substation integration factories themselves are the first choice, unless the substation is coming from a great distance.

4.1.3 Installation, technology

Change to installation technology include:

- A new generation of vessels is currently under construction for the new generation of 11-15 MW turbines and their foundations. While the turbine vessels remain jack-ups, the majority of new foundation installation vessels are dynamically positioned, so do not need to spend time lowering and raising their legs.
- The US Jones Act, which requires vessels which transport loads within the US to be made, owned and operated by US firms, is spurring creativity as to how installation will be done. It may be that feeder vessels compliant with the Jones Act will transport components to foreign installation vessels. On the other hand, the first US installation vessels have been ordered which appear to follow the pattern of the modern European ones.
- Some component manufacturers in Europe are marshalling components at their manufacturing sites for dispatch directly to sites, for example the monopile manufacturer Sif is marshalling and installing foundations for supply to the Dogger |bank site approximately 200 nm away. This saves double handling cost and lead time.

4.1.4 Installation, demand

Figure 12 shows that expenditure across all installation activities reaches an annual level of just under $1.5 billion/year (foreign and local contractors). Note that this chart uses BVGA's "conservative" forecast, that rises to 3.5 GW/year and then stays constant.

This value is the total addressable market (TAM). It is not all addressable from ports in NC as installation is normally cost effective at distances of up to 175 nautical miles only.

Although the annual installed capacity remains constant the number of foundations and turbines etc. installed per year is seen to fall due to the increasing capacity of turbines. Note also that this chart shows expenditure and volumes versus the year of project commissioning, for simplicity, whereas the expenditure will actually be made during the period of one or two years of installation activity before project commissioning.

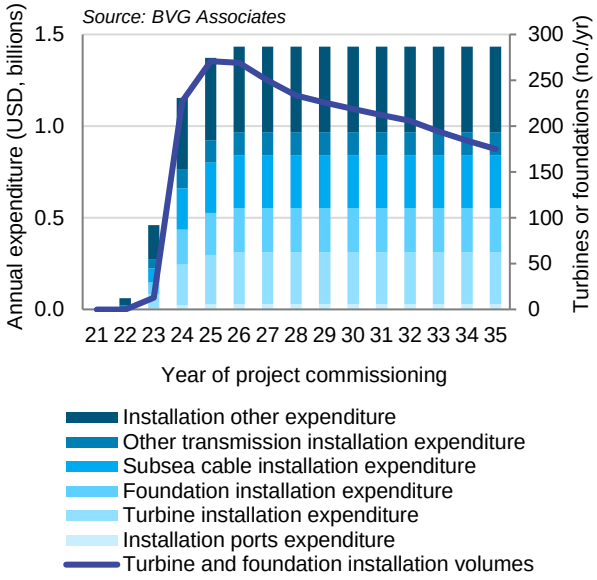


Figure 19 Demand and expenditure for installation and project insurance and contingency, shown versus year of project commissioning.

It is estimated that NC ports could cost-effectively address the market for foundation and wind turbine installation in NC, SC, VA and MD. If ports in other states gain a head start in this market it will become more difficult for NC ports to compete.

Cables and substations are expected to be marshalled at the facilities which manufactured them, unless they are being delivered from a great distance. The demand, therefore, depends greatly on the location of the suppliers which is not known yet.

4.1.5 Potential anchor firms

The ports of Wilmington and Morehead City are well-situated to become anchor firms for major component staging and / or wind farm installation activities, but this relies on there being a market close enough for them to access and there will be competition from nearby ports. The opportunities are described further in section 6, Infrastructure.

Vessel operators basing their fleet in one of these ports could also be considered anchor tenants, as they will draw in a multitude of support services. Established European installation vessel operators include:

- DEME, Van Oord, Jan de Nul, Cadeler, Fred Olsen Renewables, Heerema, Seaway 7, Boskalis, OHT, Saipem, with OHT and OSM Maritime having made commitments to enter the market.

Potential new entrants from the US for installation vessel operators include:

- All Coast, Mobro Marine, Crowley Maritime, and Dominion Energy and Eneti have already made commitments to purchase wind turbine installation vessels.

Profile of a typical installation port.

The modern construction base port planned for OSW projects at IJmuiden in the Netherlands is shown above. This picture shows the variety, and large numbers, of turbine components which could be marshalled for a commercial-scale project, some stacked high to minimize space needed.

The port has a total area of 15ha and a quay of 580m, 200m of which will be a heavy-duty quay with a water depth of 12.5m. The remaining 380m will be a standard quay with a water depth of 10m. The RORO ramp, small warehouse and small workshops can be seen in the foreground.

4.2 Operations, maintenance and service

4.2.1 Windfarm operations, maintenance and service, the North Carolina opportunity

Element	Likelihood of US supply within 5 years	Potential for NC supply	Short-term priority for NC	Notes
Windfarm operations, maintenance and minor service	High	High	Medium	The lifetime value associated with a windfarm OMS port is substantial and the continuous nature of the work and dedicated port facility anchors it to a specific location. Although it appears that Kitty Hawk will be supported from VA, NC should evaluate and prepare for how it might capture this value for further OSW projects.
Major service	High	High	Low	This activity also has a high value, but is not anchored to specific locations in the same way that maintenance and minor service is. The specialist vessels for a major service may need to be brought from out of state as and when.

Element	Likelihood of US supply within 5 years	Potential for NC supply	Short-term priority for NC	Notes
Transmission OMS	High	High	Low	As for windfarm operations, maintenance and service, but with total value per project.

4.2.2 OMS, description

Table 2 Typical OMS vessels and key parameters.

Crew transfer vessel (CTV)	Service operations vessel (SOV)
	
Typically: 80 ft long, 4-7 ft draft, service speed 25 kt e.g. Windserve Marine's Windserve Odyssey	Typically: 85x20m, 5-6m draft e.g. Edison Chouest Offshore's new Jones Act-compliant SOV (currently under construction)

Windfarm operations, maintenance and service

Windfarm operations relate to management of the asset such as control and operation of the asset including wind turbines and balance of plant, remote site monitoring, environmental monitoring, electricity sales, health and safety management, administration, marine operations supervision, operation of vessels and quayside infrastructure, and back office tasks.

Maintenance and service activities ensure the ongoing operational integrity of the wind turbines and associated balance of plant (foundations, array cables, offshore substation, export cables and onshore substation), including planned maintenance and unplanned service in response to faults, either proactive or reactive.

The most visible aspects of OMS activity are the port where operations and maintenance are based, the office / workshop / stores buildings and the CTVs or SOVs taking technicians to and from the wind farm. Unplanned service activity is more likely to involve larger vessels, travelling from a larger port on an infrequent basis. Sitting behind both will be a myriad of smaller businesses providing spare parts, equipment and various support services.

Maintenance and service activities can generally be divided into those which are above water and those which are "subsea". Subsea activities generally require more specialized equipment, but both can be supported using either CTV or SOVs, depending on the exact nature of the task.

A wind farm using CTVs needs an OMS port within a 50-75 nm radius, this is limited by the time needed to travel back and forth each day. A wind farm using SOVs can use an OMS port located further away, as it will typically only travel back and forth to the wind farm once every two weeks. See vessels in Table 2.

Development activity

Development and consenting covers the work needed to secure consent and manage the development process for an offshore wind farm through to financial close. Much of this work can be carried out from offices and using small vessels for surveys and site investigations.

It will not be described further because it involves small vessels which can be accommodated from a good selection of ports and there are no "anchor" facilities involved.

Decommissioning activity

Decommissioning involves the removal or making safe of offshore infrastructure at the end of its useful life, plus disposal of equipment. This will generally be the reverse of installation, although some elements of the foundations may be cut off below the seabed and left in-situ.

This activity will not begin until at least 35 years from now and so is not a short-term priority and will not be described further.

4.2.3 OMS, technology

A small number of themes lie behind the changes that will transform OMS in future years. These are all targeted at increasing the reliability of equipment and eliminating offshore work, as is expensive and holds risk.

- Digitization: digital technologies such as increased number of sensors, big data, AI and digital twins will shift operations and maintenance towards anticipating failures.
- Robotics: robots will be used increasingly for inspection, maintenance and repair of the turbines, blades and subsea.
- Efficiency and effectiveness: a shift from CTVs to SOVs is expected, with SOVs serving some wind farms closer than the current 50-75 nm breakpoint distance. They are proving to be more efficient in the use of technicians' time and more effective at minimizing the downtime of offshore equipment.

4.2.4 OMS, demand

Figure 12 shows that expenditure on OMS (for windfarm planned and unplanned OMS and for transmission OPEX) reaches an annual level of around $2.5 billion/year. Note that this chart uses BVGA's "conservative" forecast, that rises to 3.5 GW/year and then stays constant, resulting in a cumulative installed capacity of 41 GW of windfarms and their transmission connections requiring OMS services by 2035.

Although the total addressable market (TAM) for OMS expenditure is forecast to reach $2.5 billion/year by 203, only part of this is addressable from ports within NC.

Ports in NC could, at best, address that part of the OMS market for wind farms located in the waters off NC, VA, MD and SC.

The serviceable obtainable market (SOM) will depend on the level of competition from ports in other states.

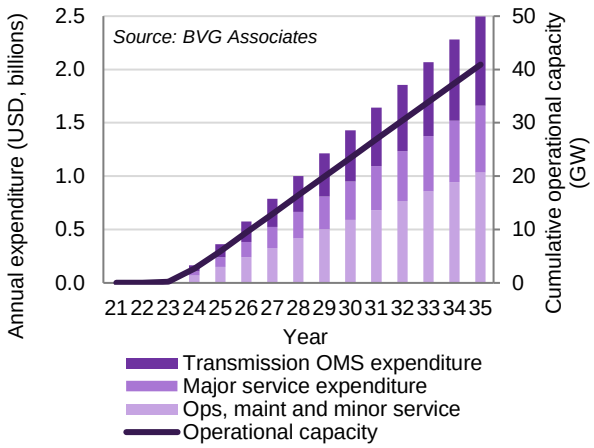


Figure 20 Demand and expenditure for OMS, shown versus year of project commissioning.

Profile of a typical OMS port.[27]

The picture, above, shows Ørsted's OMS base at the Royal Docks in Grimsby, UK. It represents a new generation of OMS ports set up for a cluster of OSW farms with installed capacities totaling many GW.

This dock is the OMS base for not just for Ørsted's currently operational Hornsea One project (1.2GW) several other smaller local projects, but also Ørsted's Hornsea Two (1.4GW) which is under construction and potentially Ørsted's Hornsea Three (2.4GW) and Four (1.0GW) projects which are under development. The dock has a water area of 20 acres.

Behind the car park can be seen the offices and a small number of units containing the operations center, workshops and warehousing. There are pontoons for CTVs in the dock closest to the operations center. Two red and yellow SOVs can be seen in the dock behind.

[27] Official Opening of the World's Largest Offshore Wind Operations and Maintenance Centre, https://orsted.co.uk/media/newsroom/news/2019/09/official-opening-of-the-worlds-largest-offshore-wind-operations-and-maintenance-centre, last accessed February 2021.

4.2.5 Potential anchor firms

Windfarm operations, maintenance and service

It is ports, rather than firms, which act as anchors for the activity around OMS. The ports, in turn, depend on the wind farms they are required to support. This study has identified ports which could be OMS ports, see section 6.2 and Appendix B for details.

5 Assessment of the North Carolina supply chain offering

Summary:

North Carolina has a strong supply chain focused on the onshore wind industry. North Carolina anchor companies form a strong basis for supply to the fast-growing offshore wind industry. Being a very business-friendly State, many strong companies are well represented, such as Nucor, Hitachi ABB, GE, and LS Cable.

The study included: (1) anchor company dialogues; (2) an economic development dialogue; (3) a workforce development dialogue and (4) a Tier 2 & 3 supply chain dialogue.

Prepare

- Actively support existing NC companies in the transition to OSW supply from North Carolina. [R15]
- Continue to promote and develop the NC Offshore Wind Supply Chain Registry. By the end of January, the new database had 42 sign ups. [R16]
- Consider the further integrating information about NC companies with wider US and global offshore wind databases, while keeping the platform accessible via North Carolina Department of Commerce website. [R22]

Facilitate

- Undertake further outreach and stakeholder activities especially with the companies in the NC Offshore Wind Supply Chain Registry. [R20]
- Evaluate establishing or being part of a more advanced database, possibly in collaboration with Virginia and Maryland. [R23]

Accelerate

- Assist existing and new anchor companies with access to market including securing appropriate sites, transport and port access. [R29]

5.1 Anchor companies

According to the Southeastern Wind Coalition, the wind energy industry already has a strong supply chain presence in North Carolina, with more than 70 active suppliers and nearly 30 of them producing components for the wind power sector. Although that production is focused on the onshore wind industry, it clearly indicates the flexibility and commitment of North Carolina companies to pursue new markets.

To secure scope and a sustainable role in the OSW supply chain is a significant challenge for mid-sized North Carolina suppliers and contractors, as these business relationships typically are established with Tier 1 and Tier 2 companies and not directly with the windfarm developer or the OEM selected for turbine scope. That is the point where the significant role of Tier 1 anchor companies become evident.

Enabling Tier 1 anchor companies to participate in the OSW supply chain does not only create economic benefit through the inhouse scope they secure, more importantly, these anchor companies act as “door openers” for the regional Tier 2 and 3 suppliers and further flow-on business. These considerations illustrate that:

- Strengthening existing anchor companies, and
- Attracting / enabling additional anchor companies

will generate an impactful multiplication effect to engage a broad range of North Carolina businesses with OSW.

Anchor companies typically pursue a share in the main contracting packages, which of course can vary depending on what contracting strategy a windfarm developer is applying. Examples of such packages are the following:

- Wind turbine supply, installation and service
- Foundation engineering, fabrication and installation
- Offshore substation engineering, fabrication and installation
- Electrical systems design and onshore substation
- Submarine cables (export and inter array) cable fabrication and installation
- Staging port operations and marine operations, and
- Operation, maintenance and service.

The study team held several meetings with established North Carolina anchor companies and also reached out to several potential anchor companies evaluating to position their OSW activities in North Carolina.

For confidentiality reasons, these prospective anchor companies cannot be named, as this is a public report. Anchor companies already established in North Carolina are summarized in the following paragraph, without

outlining strategies and ambitions as they have been discussed in private meetings:

5.1.1 Nucor

Nucor is the largest steel and steel products producer in the US, with an annual revenue exceeding 25 B$. Headquartered in Charlotte, NC and seven other locations in the State, it is the 3rd largest company based in NC. Nucor's ~1000 direct jobs further support an additional 4,000-5,000 jobs in North Carolina.

Nucor's wide range of products are well positioned to serve the OSW industry, primarily to provide raw material for foundations, including steel plates suitable for the towers and monopile foundations for the large turbine generation.

5.1.2 Duke Energy

With approximately 51,000 MW of generating capacity across the Carolinas, the Midwest and Florida, and serving 4 million electric customers in the Carolinas, Duke Energy is not only the leader in energy production, but also a key driver to North Carolina's supply chain and industrial base.

Duke Energy is committed to reducing carbon emissions, investing in resilient infrastructure while continuing to serve its customers with affordable energy. The company already has reduced carbon by 31% since 2005, and in 2019 announced accelerated carbon reduction goals of at least 50% by 2030 and net-zero carbon emissions by 2050.

Duke Energy Carolinas' and Duke Energy Progress' 2020 Integrated Resource Plans (IRPs) outline a broad range of portfolios, with pathways to achieve up to 70% CO2 emissions reduction by 2030 and including offshore wind.

These following steps will enable the appropriate balance between pace, cost, reliability, and innovation, and will create additional supply chain opportunities:

- Collaborate and align with states and stakeholders
- Accelerate transition to cleaner energy solutions
- Continue to operate existing carbon-free technologies
- Modernize electric grid, and
- Advocate for sound public policy that advances technology and innovation.

OSW and the related supply chain will complement other NC renewable energy sources well, especially solar, and will be well aligned with Duke's large project experience and key operational principles, such as a strong commitment to safety and environment.

Offering additional clean energy options will attract further anchor companies to establish a presence in North Carolina, as they will not only benefit from the state's "business friendly" environment, but also the ability to reach their ESG objectives.

Duke Energy will continue to support the energy transition, offering the industry a long-term investment strategy that will facilitate an OSW supply chain, related workforce training and infrastructure investments.

5.1.3 LS Cable

LS Cable is a leading US manufacturer and supplier of energy wire and cable products serving commercial, industrial, renewable energy and utility markets.

The company has supplied onshore wind and solar projects in the US, including North Carolina and has secured scope for the US OSW projects. One of the factories is based near Rocky Mount in North Carolina, that could, possibly with some modifications, play a key role to support the ocean cable needs of OSW.

5.1.4 Hitachi ABB

The power grid business has expanded its headquarters at Raleigh's Centennial Campus and has already added 150 jobs and has developed a 3,000 square foot customer experience center. The Raleigh location currently employs 450 people.

Hitachi ABB Power Grids' technology for OSW is essential for transmission and provides solutions onshore and offshore from energy-efficient turbine transformers to HVDC transmission that brings reliable power to the shore, all the way to AC grid integration and energy storage solutions.

With transmission and interconnection representing one of the key challenges to the OSW industry, that significant market potential, from a component but also engineering point of view, represents another key opportunity for North Carolina.

5.1.5 Avangrid Renewables

Avangrid's Kitty Hawk OSW project will be located 27 miles from the Outer Banks on a 200 square mile Wind Energy Area (WEA) selected to minimize impacts to other users of the ocean as well as to minimize impacts to the marine environment and coastal communities.

The project will provide considerable economic benefits to the region during construction and throughout the windfarm's lifetime. The WEA has the potential to generate 2,500 MW, enough to power approximately 700,000 homes.

Avangrid's Kitty Hawk project will accelerate NC's OSW supply chain transitions and is expected to generate nearly $2 billion in total economic impact over the next decade in VA and NC.

Avangrid will continue to reach out with supply chain opportunities for The Kitty Hawk project and has shown interest to collaborate with NCDOC on facilitating supply chain and infrastructure opportunities for NC.

5.2 Stakeholders and topics of engagement

The study team organized several supply chain engagement activities in November and December 2020 to inform local stakeholders about the opportunities in OSW, to address questions and to collect valuable feedback.

These outreach activities were structured as follows through four channels.

5.2.1 Channel 1: Anchor company dialogues

The dialogues took placed with several Tier 1 companies with a significant presence in North Carolina, such as outlined in Section 5.1. Topics included how to capture business from the various east coast OSW projects and enabling flow-on business opportunities for in-state Tier 2 and 3 companies.

Those confidential dialogues also included companies considering establishing operations in North Carolina. Important feedback regarding how the State could assist to attract additional anchor companies and how the supplier database should be structured to facilitate future business contacts has been collected and is reflected in this report's recommendations.

5.2.2 Channel 2: Economic development dialogue

On November 5, 2020, the study team held a virtual dialogue with various regional economic development organizations. The meeting involved about 20 participants, primarily representing regional economic development groups and focused on how to maximize the OSW supply chain ramp up by supporting existing suppliers in the state and attracting out of state operations already familiar with the industry.

The US east coast OSW long term opportunity was presented, followed by the supply chain database outline and Q&A / discussion.

Key findings included the importance of an ongoing regular dialogue and the recognition / communication of North Carolina's unique strengths as a large component manufacturing state, the high rating for business friendliness and the capabilities to serve the whole East Coast with OSW components, not just the region. This strategy would offset the availability of large-scale coastal facilities and provide a complementary fit to Virginia.

5.2.3 Channel 3: Workforce development dialogue

On November 6, 2020, the study team held a virtual dialogue with organizations and institutions involved in workforce development.

The US east coast OSW long term opportunity was presented, followed by the supply chain database outline and Q&A / discussion.

The meeting involved more than 25 participants from academia, businesses, consultancies and economic development groups. It addressed the challenge that currently only a minimum of US-aligned training programs have been developed and that collaboration between colleges, industry representatives and government entities will be required to define an appropriate curriculum and to agree on US OSW industry standards. Another important factor discussed was timing, to ensure that sufficient trained personnel will be available to serve the industry, but also to time the training programs in a way that new graduates have access to jobs upon completing their training. It was agreed that safety must be a key priority for any training efforts.

5.2.4 Channel 4: Tier 2 and 3 supply chain dialogue

On November 20, 2020, the study team held a virtual dialogue with local businesses, some of them already involved in OSW and others considering doing so. The meeting involved more than 20 participants, representing primarily North Carolina companies, but also universities, trade associations and economic development groups. The dialogue again involved three sections: The US east coast OSW long term opportunity, followed by the supply chain database topics and Q&A / discussion.

The biggest challenge discussed was securing access to OSW supply chain decisionmakers, transparency on the sourcing decision criteria and related project procurement plans. Especially for component suppliers, it has been historically difficult to gain access to the large domestic and global Tier 1 companies. Holding a series of these supply chain dialogues with related databases provides a further opportunities to establish contact between these groups.

Findings and suggestions from these sessions are reflected in the recommendations, and will require continued dialogue, in alignment with North Carolina's OSW implementation plan and in coordination with the leading organizations: North Carolina Department of Commerce, the Governor's Office, EPDNC and NCDEQ.

5.3 Multiple supply chain directories

Enabling organizations to the OSW industry, such as NCDOC, are implementing systems to raise the profile of this rapidly expanding industry and to provide support to all those companies engaged in or interested in OSW. Companies interested in pursuing OSW seek access to decision makers in the industry and wish to ensure that their ambitions are known.

With that goal in mind, many states and their respective organizations have set up supply chain databases, allowing companies to publicly indicate their interest and ability to supply products and services for US OSW projects. These database tools can assist organizations, developers and

Tier 1 suppliers to become aware of the local and regional supply chain, as well as visibility for potential business partners.

Overall, all supply chain registries and databases are very similar, providing basic company information, organization type, products and services categories and contact information. Some databases also provide specific OSW industry information. All supply chain registries are open to the public and are easy for companies to sign up for and share their information.

The following east coast supply chain databases are currently available:

- The National Offshore Wind Research & Development Consortium has created the Manufacturing, Services and Supply Chain (MSSC) "Capable Partner" Registry[28]
- The Business Network for Offshore Wind maintains the largest and most used OSW "Supply Chain Connect" database. It also provides the data warehousing platform for the National Offshore Wind R&D Consortium and the Virginia OSW supply chain registries[29]
- The Massachusetts Clean Energy Center offers and maintains the Massachusetts Offshore Wind Supply Chain database[30]
- The New York State Energy Research & Development Authority was the first state to establish OSW supply chain tools and maintains a Supply Chain, Workforce, Economic Development database[31]
- The Virginia Department of Mines, Minerals and Energy offers the Virginia Offshore Wind Supply Chain Resource Network Directory. This database is maintained through the Business Network for Offshore Wind supply chain platform, and Virginia has teamed up with VMA (Virginia Maritime Association) and the Hampton Roads Alliance for maximum impact.[32]
- The Southeastern Wind Coalition offers a Wind Industry Supply Chain database and map shown in Figure 21. This effort involves a comprehensive review and summary of existing wind industry supply chain assets in the region. The database includes current suppliers in the wind industry and companies in the region with the potential to begin supplying the wind industry. Both land-based and offshore focused companies are included. This effort aggregates work already completed at the individual state level and by groups like the Global Wind Network (GLWN) and the American Clean Power Association (ACP) formerly the American Wind Energy Association (AWEA).[33]

Table 3 provides a brief summary of the organizations with supply chain portals and databases. The design of the North Carolina Registry has been built based on feedback from those existing databases and in line with needs and opportunities in the region.

Table 3 Summary of supply chain directories or supply chain portals.

State enabling organizations	Federal enabling organizations	Developers and wind turbine suppliers
NCDOC	AWEA	Avangrid
SE Wind Coalition	BNOW	Dominion Energy
EDPNC	NREL	Duke Energy
NYSERDA	NOWRDC	Vestas
VA DMME		SGRE
MassCEC		GE Renewables

Table 4 shows the number of North Carolinian organizations in some of these databases.

[28] Capable Partner" Registry, https://nationaloffshorewind.org/toolbox/, last accessed February 2021.

[29] National Offshore Wind R&D Consortium and the Virginia OSW supply chain registries, https://www.offshorewindus.org/supplychain/, last accessed February 2021.

[30] Massachusetts Offshore Wind Supply Chain, http://directory.masscec.com/listing/, last accessed February 2021.

[31] Supply Chain, Workforce, Economic Development database, https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/Focus-Areas/Supply-Chain-Economic-Development/Supply-Chain-Database, last accessed February 2021.

[32] Hampton Roads Alliance, https://www.vaoffshorewind.org/, last accessed February 2021.

[33] Global Wind Network (GLWN) and the American Wind Energy Association (AWEA), https://www.sewind.org/map/find-companies, last accessed February 2021.

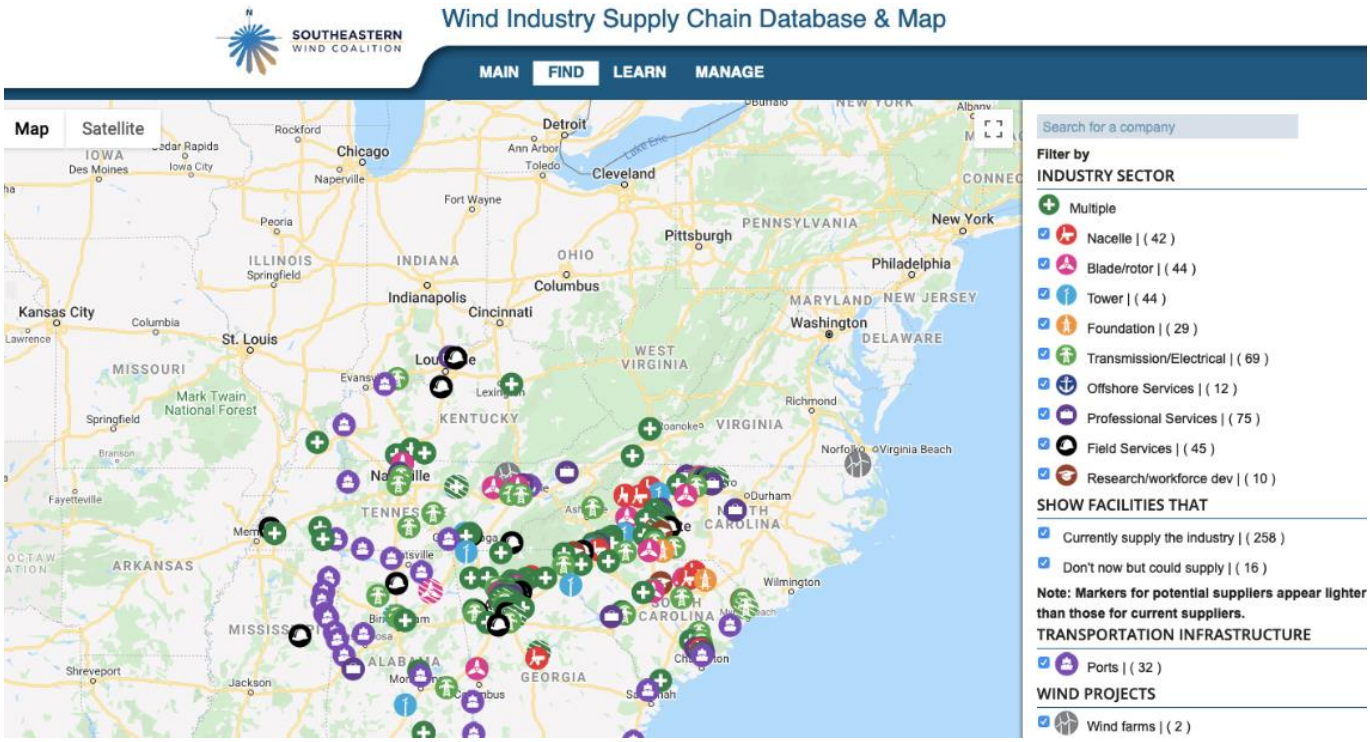


Figure 21 Southeastern Wind Coalition- Wind Industry Supply Chain database and map.

Table 4 Number of North Carolina companies registered in supply chain databases.

Database	Number of NC Companies Registered
NOWRDC	3
MassCEC	3
NYSERDA	2
SE Wind Coalition	118

5.4 North Carolina Offshore Wind Supply Chain Registry

NCDOC has launched an Offshore Wind Supply Chain Registry database to facilitate business opportunities in the rapidly expanding US east coast OSW industry. The study team developed this database to offer a platform to promote companies offering, or considering offering, OSW products and services, to encourage business partnerships, and to provide OSW developers and OEMs easy access to the North Carolina supply chain.

In a broad marketing effort, also involving the OSW dialogue partners for support and faster dissemination, a significant number of North Carolina suppliers have been contacted to log their company information in the registry and to provide feedback on the practicality of the tool. Most importantly, the database is featured the North Carolina Department of Commerce webpage, https://www.nccommerce.com/business/key-industries-north-carolina/energy/offshore-wind-industry, stating that companies (both inside and outside North Carolina) were strongly encouraged to join this publicly available supply chain registry by signing up through a brief survey. The front page is shown in Figure 22.

Figure 22 Front page of the registry

At this early stage, over 40 companies have signed up and shared their company information on the North Carolina OSW Supply Chain Registry. Some of the key statistics are displayed in the following pages.

The structure of the on-line Supply Chain Registry entry format is shown in Appendix A. It takes about 10 minutes to complete and primarily covers the following areas:

- Basic company information
- Products and services categories, and
- Onshore and offshore energy experience.

Several fields are optional to let the company or organization signing up decide, how much company information they wish to share. The information provided will be open to the public.

For a next phase, there are three options for consideration:

- Maintain a stand-alone North Carolina Registry
- Integrate with the Business Network for Offshore Wind (BNOW) and host the data on the BNOW server, while keeping the platform accessible via NCDOC website, and
- Evaluate establishing a more advanced database, possibly in collaboration with Virginia and Maryland.

Dialogue is in progress with several of the early sign ups to collect feedback to be implemented once the registry tool is converted into a database.

The early-stage sign-ups for the supply chain registry are given in Table 5 and North Carolina companies make up half of the entries as shown in Figure 23.

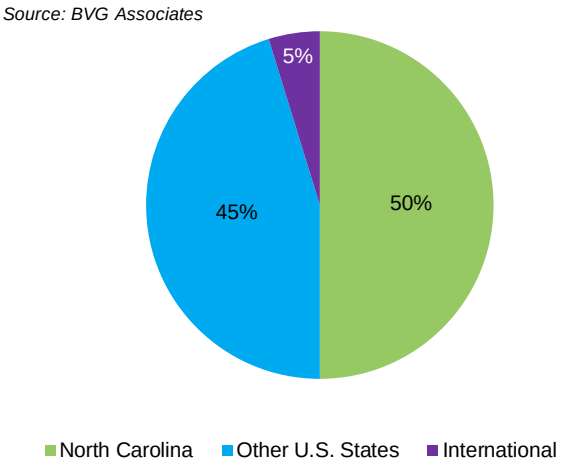


Figure 23 Early-stage database entry status by company location.

This may be an indication, following an initial outreach, that potential anchor companies are recognizing the business opportunity and the attractiveness of North Carolina as a manufacturing base. This early-stage trend may indicate progress to solicit and attract anchor company suppliers, what would serve the industry well and not only bring additional anchor companies to North Carolina, but also opportunities for sub suppliers and infrastructure projects.

About 90% of the registering companies have firsthand experience with wind energy, offshore energy or maritime operations as shown in Figure 24.

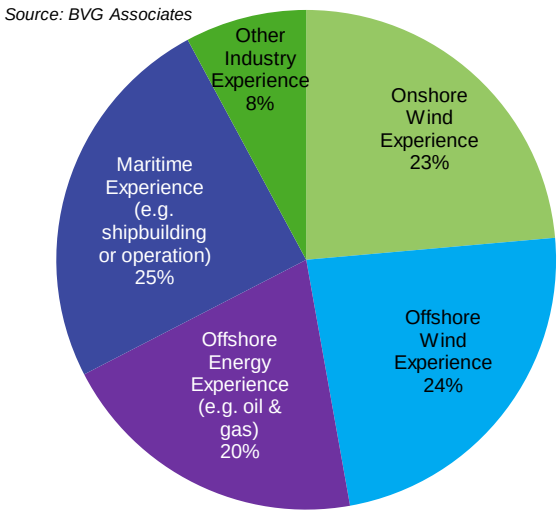


Figure 24 Early-stage database entry status by company experience.

About half the sign-ups are manufacturers and the spread across sectors is shown in Figure 25.

Once the OSW Supply Chain Registry reaches a significant number, possibly as a result of supply chain database sharing in state or out of state, then next step will be to determine the characteristics of those businesses and develop a plan how especially the new entrants can be supported to ensure a successful transition.

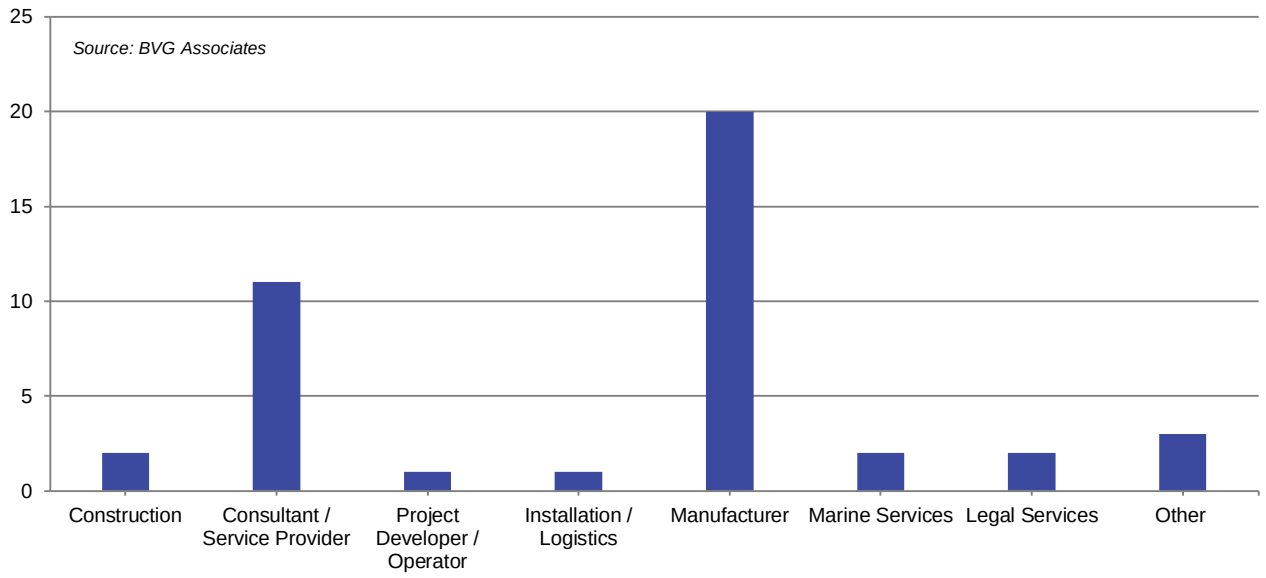


Figure 25 Early-stage database entries by company sector.

Table 5 Organizations signed up in the early stage of the database.

	Organization Name	State	Business Sector	Offshore Wind Experience	Offshore Energy (oil & gas) Experience
1	**Carver Machine Works, Inc.**	North Carolina	Manufacturer		
2	**Nucor Steel Hertford County**	North Carolina	Manufacturer	Yes	Yes
3	**East Coast Steel Fabrication, Inc.**	North Carolina	Construction		
4	**Perquimans County NC**	North Carolina	Other		
5	**Ashley Welding**	North Carolina	Manufacturer		
6	**Advanced Superabrasives Inc.**	North Carolina	Manufacturer		Yes
7	**AEGIS POWER SYSTEMS, INC.**	North Carolina	Manufacturer		
8	**American Roller Bearing Company**	Massachusetts	Manufacturer	Yes	
9	**Carver Machine Works, Inc.**	North Carolina	Manufacturer		
10	**FIRST MARINE SOLUTIONS**	International – UK	Marine Services	Yes	Yes
11	**Crowley Maritime Corporation**	Florida	Installation / Logistics	Yes	Yes
12	**Ventower Industries**	Michigan	Manufacturer	Yes	
13	**Tide Environmental LLC**	Georgia	Other		
14	**D&D Enterprises of Greensboro, Inc.**	North Carolina	Manufacturer		
15	**Additive America, Inc.**	North Carolina	Manufacturer		
16	**Normandeau Associates, Inc.**	Florida	Marine Services	Yes	Yes
17	**Amphenol**	North Carolina	Manufacturer		
18	**Fulcrum Boat Corp**	North Carolina	Manufacturer		
19	**Greenfield**	North Carolina	Consultant / Service Provider		Yes
20	**W International SC LLC**	South Carolina	Manufacturer		Yes
21	**Abbott Building Systems LLC**	Maryland	Consultant / Service Provider	-	-
22	**DataCrunch Lab, LLC**	North Carolina	Consultant / Service Provider		
23	**Hitachi ABB Power Grids**	Texas	Manufacturer	Yes	Yes
24	**Chet Morrison Contractors, LLC (MORRISON)**	Texas	Construction	Yes	Yes
25	**North Carolina State Ports**	North Carolina	Other		

26	**Beveridge & Diamond**	North Carolina	Legal Services	Yes	-
27	**Automated Control Concepts, Inc.**	New Jersey	Consultant / Service Provider		
28	**Mountain View Supply Co**	North Carolina	Manufacturer	-	-
29	**Womble Bond Dickinson**	North Carolina	Legal Services	Yes	Yes
30	**Booth and Associates, LLC**	North Carolina	Consultant / Service Provider		
31	**LS Cable Systems America, Inc.**	New Jersey	Manufacturer	Yes	Yes
32	**Sain Engineering Associates, Inc. (SEA)**	Alabama	Consultant / Service Provider		Yes
33	**SAERTEX USA**	North Carolina	Manufacturer	Yes	Yes
34	**Freudenberg Oil & Gas Technologies Ltd**	Texas	Manufacturer	Yes	Yes
35	**Black & Veatch**	Kansas	Consultant / Service Provider	Yes	Yes
36	**American Global Maritime Inc.**	North Carolina	Consultant / Service Provider	Yes	Yes
37	**Colite Technologies**	South Carolina	Project Developer / Operator	Yes	
38	**Blue Edge Consult**	International – Germany	Consultant / Service Provider	Yes	
39	**WRI Energy**	New York	Consultant / Service Provider	Yes	
40	**Robert E Derecktor Inc.**	New York	Manufacturer	Yes	
41	**SEARCH, Inc.**	Florida	Consultant / Service Provider	Yes	Yes
42	**INFRA-METALS CO.**	Virginia	Manufacturer	Yes	Yes

6 Ports and other transportation infrastructure assessment

Summary:

- North Carolina has a fully integrated, up-to-date high-capacity intermodal transport system consisting of rail, road, inland waterways and coastal waterways that connects well to North Carolina's coastline and adjoining states. The rail system, owned by CSX and Norfolk Southern, runs from north to south and east to west across the State. Similarly, the State's road infrastructure system is very robust and under constant upgrades and has further planned improvements to improve its connectiveness. The intermodal terminals in Charlotte and the new CSX Carolina Connector (CSX) at Rocky Mount with associated manufacturing space, are important locations where road and rail infrastructure come together offering users high-quality, reliable, and affordable access to intermodal systems.
- North Carolina has multiple port and water-front properties well-suited to support the OSW industry currently developing off the US East Coast.
- The early State project Kitty Hawk will likely be supported by Virginia ports. NCSPA-owned port assets, however, are well located to support later projects as staging ports and manufacturing sites for major (Tier 1) components and smaller components.
- Smaller-scale OSW components can be manufactured across the State.

Prepare

- Evaluate developing Southport/North Carolina International Terminal Property: This 600-acre, NCSPA-owned property is an exciting opportunity for North Carolina as it is one of the only potential "mega-port" facility locations on the US East Coast. This property represents a one-of-a-kind opportunity to be developed into an OSW mega-port facility where multiple Tier 1 manufacturers could set up shop, trans-ship completed components to other US and international destinations and marshal multiple OSW projects. It could also support O&M including for the Wilmington and South Carolina, and other future BOEM Call Areas., all from a single property. Form a long-term working group incorporating a wide-range of stakeholder to evaluate and explore the development options for this NCSPA-owned asset. [R43]
- Further explore using manufacturing sites next to CSX Carolina Connector for the manufacture of smaller components. [R44]
- Further explore using the Port of Wilmington and Port of Morehead City facilities with NCSPA allowing North Carolina earlier access into supply to OSW projects, and [R45]
- Educate and promote O&M Facility Opportunities. The infrastructure needed for O&M operations is smaller and less robust than other OSW port uses. Developers will look to use facilities nearest specific windfarms especially those close to shore so likely to use crew transfer vessels to access the windfarm. Work with owners and operators of such facilities to develop their offerings. [R46]

Facilitate

- Evaluate developing **Radio Island** next to the Port of Morehead City. This currently undeveloped location near a deep-water channel, intermodal connections with no air-draft restriction, could be very-well suited to support staging and manufacturing of Tier 1 and lower tier sub-components. [R47]
- Evaluate developing the **North Property and using the Wilmington Business Park/Vertex Property:** The Wilmington Business Park/Vertex Property is already developed to support heavy manufacturing activities. Together, these properties could be developed in a PPP fashion with the NCSPA and the owner of the Wilmington Business Park/Vertex Property. [R48]

The objective of this section of the report is to assess the various types of critical infrastructure (ports, waterfront and non-waterfront properties, and road, rail and waterway transport) versus the requirements of different OSW uses.

It is structured into the following sections:

- 6.1 Infrastructure requirements for OSW Ports
- 6.2 Assessment of the Morehead City and Wilmington Port Area facilities/properties (details of port assessments are contained in Appendix B)
- 6.3 Specific ports / properties evaluation
- 6.4 Utilization scenarios for Morehead City and Wilmington areas ports
- 6.5 Investment Opportunities in Ports/Facilities, and

- 6.6 Intermodal Transportation Assets.

6.1 Infrastructure requirements for OSW Ports

This section provides a summary of the infrastructure required meet the needs of the different OSW port types, as well as specific infrastructure requirements for each use. In all cases, the minimum required and industry-preferred requirements are described.

6.1.1 Manufacturing ports / facilities

Manufacturing facilities typically fall into one of the two following models:

1. Manufacturing of major (Primary/Tier 1) components such as blades, nacelles, foundation elements, towers, etc. These represent the large-scale components that require direct access to heavy-lift maritime vessels for delivery to staging and/or construction base/marshalling ports. The actual port infrastructure will vary according to what is being made. Table 6 provides a summary of the port-infrastructure requirements for major component-manufacturing facilities. As with construction base/marshalling ports, it is assumed that staging ports can relatively easily pivot to manufacturing ports as the infrastructure requirements are similar for all three end uses. Use of roll-on roll-off (RoRo) operations, rather than crawler cranes, can reduce quayside infrastructure, depending on the equipment to be loaded or unloaded.
2. Manufacturing of Tier 2, 3 and 4 sub-components such as specialized bearings, electrical components, transmission components, etc. This poses differing infrastructure requirements and are not tied to water-side port facilities. **Rather, this scale of OSW manufacturing could be accommodated across all of North Carolina**. Depending upon the scale of the items manufactured, the completed sub-components can be of a small-enough scale for transshipment by intermodal means such as rail, road and/or smaller vessels. The facilities associated with the manufacturing of these smaller-scale components are believed to be a strength of North Carolina with its highly trained work force, affordable living conditions and in-place intermodal transport systems, many of which are already directly connected to the port systems located both in Virginia and North Carolina.

For many OSW-component manufacturing facilities of any scale, distance from the facility to a staging or construction base/marshalling port is not a primary physical characteristic restriction, as it is generally assumed that these facilities will be able to maintain a product flow sufficient to support the WTIVs. Smaller-scale components can be fabricated at various-scale inland facilities and intermodally transported to an assembly or construction base/marshalling port while larger-scale components can be shipped via heavy-lift cargo vessels to a construction base/marshalling port.

Table 6 Manufacturing Port Requirements

Attribute	MDR	PDR	MDR	PDR	MDR	PDR	MDR	PDR	MDR	PDR	MDR	PDR	MDR	PDR	MDR	PDR
	Blades		Generator		Nacelle Assembly		Tower		Monopile Foundation		Jacket Foundation		Gravity base Foundation		Submarine Cable	
Minimum site acreage	35	75	10	20	15	30	30	50	30	50	50	100	25	50	20	30
Minimum quayside length (ft)	550	800	330	660	330	1,000	330	660	330	660	600	1,200	200	600	300	400
Minimum channel depth (ft)	20	34	20	34	24	36	20	34	20	34	28	34	20	50	20	34
Air draft restriction (ft)	70	100	50	75	75	120	100	250	100	250	130	300	130	300	100	250
Distance to WEA's (nm)**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bearing capacity at quayside (psf)	1,000	4,000	1,500	2,000	2,000	4,000	2,000	3,500	2,000	4,000	3,000	5,000	2,000	4,000	2,000	3,000
Bearing capacity across site (psf)	500	3,000	1,500	2,000	2,000	4,000	1,500	3,000	2,000	4,000	3,000	5,000	2,000	4,000	1,500	2,000

MDR= Minimum Defining Restriction, **PDR**=Preferred Defining Restriction

6.1.2 Construction base / marshalling ports

A construction base/marshalling port is a centralized facility that supports the actual construction of an OSW farm. They are typically relatively close to the OSW site. Completed major components (e.g., bladed, nacelles, towers and foundation) are received, pre-assembled as required and shipped out to the OSW site for installation. Construction base/marshalling ports are highly specialized facilities and require very robust infrastructure (see Table 3 for details), including the following:

- Sufficient quayside berthing spaces for multiple vessels simultaneously, some of which would offload components while simultaneously supporting/vessels uploading components for delivery to the installation site.
- Highly robust quayside/relieving platforms with sufficient load-bearing capacity to support large crawler-crane/self-propelled modular transport (SPMT) operations capable of picking and handling component with weights exceeding 2,000 tons. The use of crawler cranes for the first wave projects will be required due to Jones Act constraints and the lack of US-flagged wind-turbine installation vessels (WTIVs). The components could be delivered to the WTIVs by US-flagged feeder barges that will not be equipped with cranes of adequate capacities for load-out purposes.
- A large-associated laydown/staging area(s) for completed components prior to their pre-assembly and transport to the OSW site will be required. Depending upon the size of the offshore project being supported, 50 to 100 individual component sets may need to be available on the site as a time to support the WTIVs.

In Europe, construction base/marshalling ports are located in areas where there are no air-gap restrictions from bridges, power lines or other infrastructure. This allows for unimpeded access to the ports for WTIVs (their vertical clearance requirements are due to the height of undeployed spuds) and allows for many of the component elements to be shipped to the windfarms in a vertical fashion – this is a methodology preferred by OSW developers as it lowers risks associated with transferring components a sea as part of their installation. The use of US-flagged feeder barges, at least for the US first wave projects, will likely necessitate the transshipment of components in a horizontal and/or partially vertical geometry, which will obviate to some degree the challenge the air-gap restrictions associated with many US east coast ports and properties.

For port facilities managing major OSW components, there are differing facility load-bearing requirements for the quayside and upland areas of the sites. Facilities also need to be designed with respect to live-load bearing capacity (also known as point loads). Typically, OSW Construction Base/Marshalling facilities use heavy-lift cranes, such as the Liebherr TCC 78000, along the quayside to transfer components. These cranes exhibit kneeling loads that are distributed onto a point at the footing when lifting heavy components. For example, the New Bedford Marine Commerce Terminal (MCT) was designed for a 20,000 pounds per square foot live-load bearing capacity to account for crane kneeling and lifting of large-scale OSW components. Live-load bearing capacity is more site-specific requirements than the general load-bearing capacities presented in Table 7 as crane pads and other accommodations can be utilized where cranes will operate to adjust for this live load capacity.

Table 7 Construction base / marshalling port and staging port requirements.

Attribute	Minimum Defining Restriction	Preferred Defining Restriction
Minimum Site Acreage (acres)	25	50
Minimum Quayside Length (ft)	660	1,200
Minimum Channel Depth (ft)	38	50
Air Draft Restriction (ft)	400 (vertical components) 130 (feeder barge)	Unlimited
Distance to WEA's (nm)	<125	<75
Load Bearing Capacity at Quayside (psf)	4,000	5,000-6,000
Load Bearing Capacity at Site (psf)	2,000	4,000

6.1.3 Staging ports

Due to the present lack of US manufacturing capacity for many of the large-scale OSW components, and the relatively small sizes and/or lack of the initial construction base/marshalling ports, the first-wave projects will likely be constructed with components manufactured overseas, primarily in Europe. In order to the support a constant/uninterrupted flow of components to the WTIVs, as required by their "just in time" logistics model, it is anticipated that the European OEMs/major components suppliers and developers will use the services of staging ports wherein completed components are stored until they

are needed at the construction base/marshalling port. To minimize the potential for breakdowns in the logistics of supplying the components to a construction base/marshalling port, staging ports should ideally be located within a few tens of miles from their associated construction base/marshalling port. However, depending upon the region and logistical models, the staging ports could be located a greater distance away. The large-scale nature of the individual major components will require that they be transshipped by maritime vessels (e.g., barges) from the staging port to the associated construction base/marshalling port. Other than air-gap restrictions, staging ports require infrastructure similar too by not quite so robust as do construction base/marshalling ports in the form of quay-side length, soil-bearing capacities, laydown areas. As such, as the US OSW industry matures off of the US East Coast, it is envisioned that the uses of a staging port could pivot to support construction base/marshalling port-type operations and/or manufacturing operations with selected upgrades to their infrastructure.

6.1.4 Operations, Maintenance and Service/Operations and Maintenance

OMS/O&M facilities, hereinafter referred to as O&M facilities, begin operations as the construction of a windfarm is nearing completion. The main purpose of the O&M facility is to house the technology, technicians and support/managerial personnel to operate an in-service windfarm, and the technicians, equipment and vessels necessary to conduct regular inspections and to complete repairs, as necessary. An O&M facility supports the OSW farm by providing crew, equipment staging, berthing space for vessels transportation to and from the windfarm.

As a whole, O&M facilities have much- less robust and smaller port infrastructure requirements as the vessels (similar to larger commercial fishing vessels) and associated components are much smaller and require smaller, less-robust port infrastructure than for other OSW uses. Further, in the event that a larger port facility is developed for larger-scale OSW uses, including an O&M-support component would be a relatively minor upgrade(s). As such, the evaluation of facilities in this report focuses on other OSW uses such as staging, manufacturing and construction base/marshaling uses – O&M operations infrastructure could be added at later dates to ports that have been developed to support other OSW uses.

There are two types of O&M vessels, including the following (see also Table 2 Typical OMS vessels and key parameters.):

- Crew Transfer Vessels (CTVs) that support daily crew operations with maximum 1.5-to-2.0 hours of one-way transit time, and,
- Service Operation Vessels (SOVs) that services long-term, multi-day/week operations and only periodically return to their base port.

During installation and commissioning project periods, or during peak-service periods, CTVs may work in conjunction with SOVs, where both the SOV personnel and the CTV crews reside on the SOV, and the CTV remains offshore as long as weather can allow, sometimes up to seven-to-ten days. This is normally not the assumption during the normal O&M phase of an OSW project. There is a second type of SOV operating mode wherein vessels providing routine/prescheduled operations can move up and down a coastline following the good weather. In this operational model, the SOVs come into ports along their way throughout the season for crew-changes, victualling, bunkering, etc. During seasonal poor-weather periods, these SOVs return to a base port to await the next operational window.

Due to the different types of operations, discussed above, the type of O&M operations being conducted and the distance a port facility is from the windfarm they are supporting, as well as drives the type of O&M vessels utilized. O&M port infrastructure requirements for CTVs and SOVs differ due to their overall size difference and the types of operations they support.

CTV operations

A CTV port facility typically provides a primary headquarters for day-to-day O&M activities, remote-monitoring/operation-center services, major maintenances, daily transportation of technicians and supplies to the offshore windfarm, and unplanned deployment of personnel or equipment for emergencies or failures. Typical average vessel speeds of CTV's are 15-25 knots, leading to a recommended transit distance of less than 50 nautical miles (NM) one way from an associated wind far, which results in nominal-conditions travel time under two hours for the vessels and crew. Table 8 provides the typical port requirements to support CTV operations.

Table 8 CTV Port Requirements

Attribute	Minimum Defining Restriction	Preferred Defining Restriction
Minimum site acreage (acres)	2	15
Minimum quayside length (ft)	165	330
Minimum channel depth (ft)	12	18
Air draft restriction (ft)	≥20	Unlimited
Distance to wind farm (nm)	<50	<40

SOV Operations

SOVs are larger vessels that are utilized to support a greater variety of offshore wind operations including geotechnical and seismic surveys, tug and supply operations, construction support and providing maintenance support. SOVs typically provide routine maintenance for windfarms that are located to far offshore to be effectively supported by CTVs. O&M operations, that can effectively be conducted by crews working multi-week shifts and are more effectively conducted by hotel-style SOV vessels.

The typical operational model for SOVs is that they will return to port every two-to-three weeks for a change of crew personnel and resupply. Ideally this can be completed with a transit overnight (10-20 knots in 12-14 hours), crew change during the day, and transit back to the field the next night, so that only one working day is lost. As summarized in Table 9, relative to CTVs, SOVs are larger vessels and require greater water depths, larger air drafts, and longer quayside.

Table 9 SOV Port Requirements

Attribute	Minimum Defining Restriction	Preferred Defining Restriction
Minimum site acreage (acres)	2	15
Minimum quayside length (ft)	200	248
Minimum channel depth (ft)	18	23
Air draft restriction (ft)	>=130	Unlimited
Distance to WEA's (nm)	<240	<=140

6.1.5 CTV/SOV Steaming Distances from OSW Lease Areas

As discussed above, CTVs operating on a daily basis have a maximum steaming distance from their base port of 50 nm) and SOVs supporting operations associated with a single windfarm have a maximum steaming distance for the base of 240 nm. These maximum steaming distances result in the following general ramifications for North Carolina ports, that are discussed in detail below.

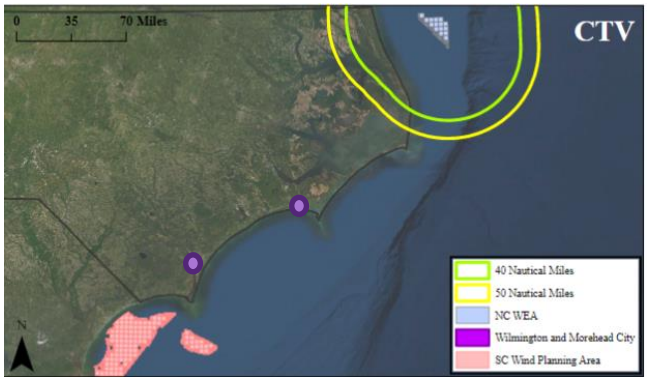


Figure 26 Map of North Carolina Lease Areas and BOEM Call Out Areas and Suitable CTV Steaming Distances.

- CTVs: There are no apparent strong candidate ports to provide O&M services for the lease areas associated with the northern part of the State (to service Kitty Hawk and Dominion windfarms). There are potential properties located near the mouth of the Cape Fear River that could potentially be well suited to provide O&M services for the BOEM Wilmington and South Carolina Call Out Areas. However, none of these Call Out Areas are currently "active" and, at best, would represent third-wave projects.

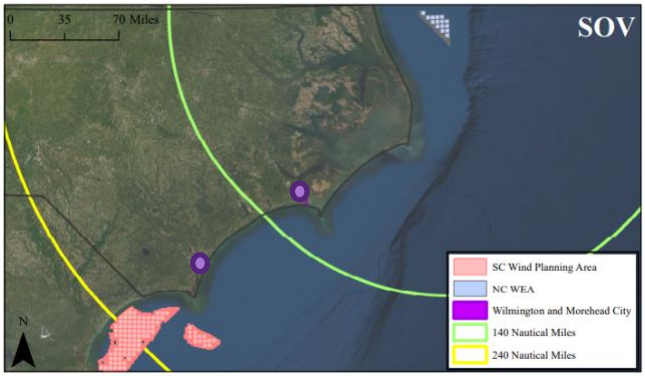


Figure 27 Map of North Carolina WEA and Suitable SOV Distances.

- SOVs: The Morehead City port area is well-suited to provide O&M operations, from a steaming distance perspective for the northern lease areas and southern BOEM Call Out Areas. Similarly, the ports/properties located in the Wilmington areas would be well-suited to support operations O&M operations for the southern BOEM Call Out Areas. This area is located just in range of the Kitty Hawk and Dominion lease areas.

CTV operations are not likely a prime target for North Carolina due to the locations of the first-wave projects and the locations of port facilities in Virginia. SOV ports could be a good target for North Carolina. It should be noted that due to the relatively small footprint of these types of ports, both CTV/SOV operations could be folded into a larger redevelopment project such as Radio Island in Morehead City.

6.2 Assessment of the Morehead City and Wilmington Port area facilities/properties

To evaluate viable uses for the ports in the vicinity of PMC and POW to support OSW operations, Table 15 through to Table 27, in Appendix B, have been prepared based on the criteria discussed in detail in Section 6.1. This evaluation was conducted to determine potential facility OSW uses based on a port's (or potential port's) physical characteristics and site availability. PMC and POW are both analyzed in detail. Additionally, the identified viable properties located in the vicinity of two main port facilities and examples of potential CTV and SOV properties were also analyzed for potential OSW uses, in accordance with the following evaluation criteria.

- **Red** highlighted table cells identify a facility characteristic that does not meet the minimum or preferred defining restrictions for that type of facility, thus making it considered not viable for offshore wind use in that category.
- **Amber** highlighted table cells identify a facility that meets the minimum defining restriction but does not meet the preferred defining restriction or meets the restrictions but has an external influence that prevent the site from being fully viable based on that characteristic, rendering it only potentially viable.
- **Green** highlighted table cells indicate that the site characteristics meet the preferred defining restriction and there is little to no needed upgrades or influence to make that characteristic ready for the specific offshore wind use(s), and therefore results in a viable classification for offshore wind use.

It is important to note that in the event a facility is determined as not viable or potentially viable for a specific category, it does not immediately exclude the facility from being considered for use in the offshore wind industry. Required facility upgrades are possible and are discussed on a port-by port-basis.

This assessment has been made anticipating that the facilities under consideration would provide manufacturing services to the OSW industry, however, operations such as CTV, SOV and marshalling operations were assumed to be associated with the first-wave Kitty Hawk and Dominion Energy OSW projects. Facilities in both the PMC and POW areas would be well suited to provide such services to the BOEM Call Out areas located off Wilmington and Morehead City; however, these OSW projects are at best third-wave projects and will not likely be active for several years. As such, this initial evaluation was conducted without considering the later projects.

It is not feasible nor particularly helpful to evaluate multiple properties for potential CTV and SOV operations due to the following:

- These are typically smaller properties and would likely not require State incentives to support their development
- Properties available along North Carolina coastline are not well located to provide CTV services for the Kitty Hawk and Dominion lease areas; and
- The water-side properties evaluated as part of this study are of sufficient size that it would be relatively feasible to cut out a small portion of them to support O&M operations as part of overall development plans.

That being said, the Southport/North Carolina International Terminal facility, Mann's Harbor and Engelhard Business Park were selected to illustrate the results of typical CTV and SOV O&M ports. If requested, additional facilities could be assessed as part of future work-flow components. It should be noted that many of these types of properties are currently improved with infrastructure associated with existing operations (e.g., ferry operations, recreational marinas, etc.).

6.3 Specific ports / properties evaluation

This section provides a summary of the attributes of several port assets along the coast of North Carolina that were evaluated (see Figure 28).

A summary table of the analyses for each port is included in Appendix B. Note, recreation, wildlife, and residential properties were excluded from this analysis.

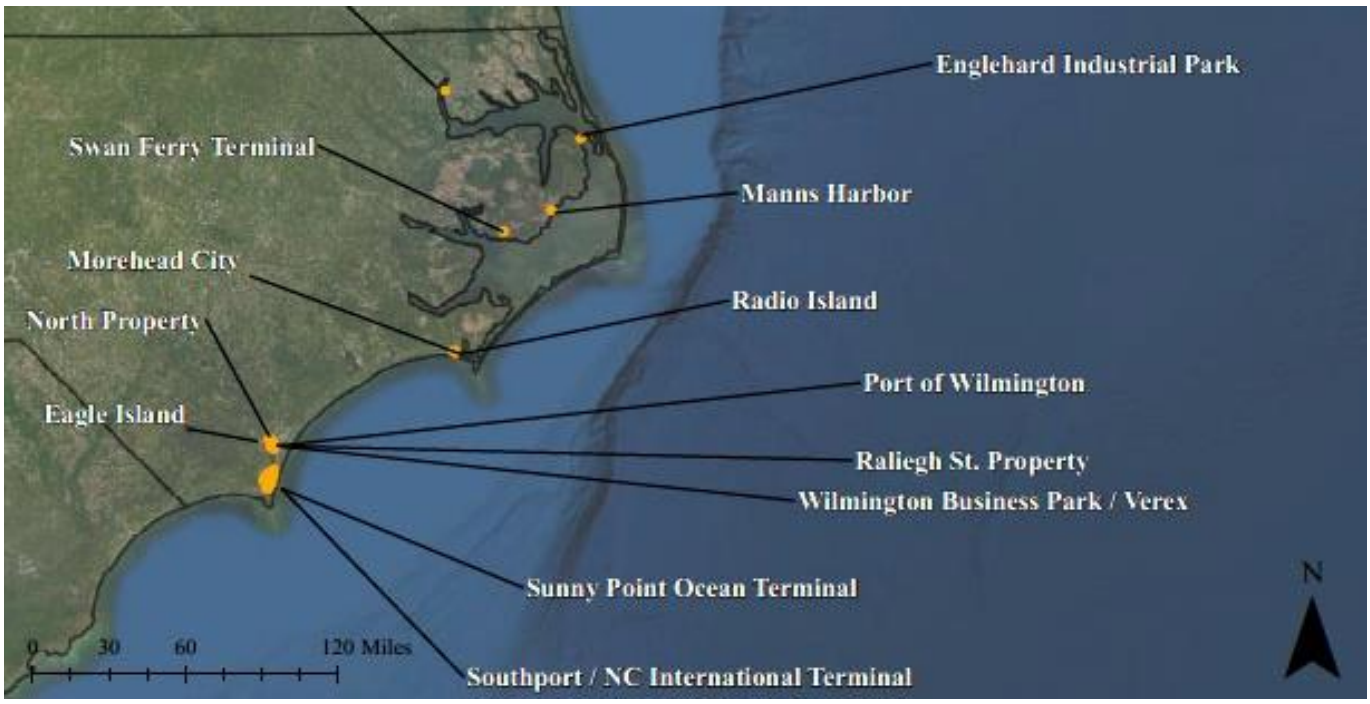


Figure 28 North Carolina port facilities assessed.

6.3.1 North Carolina State Ports Authority

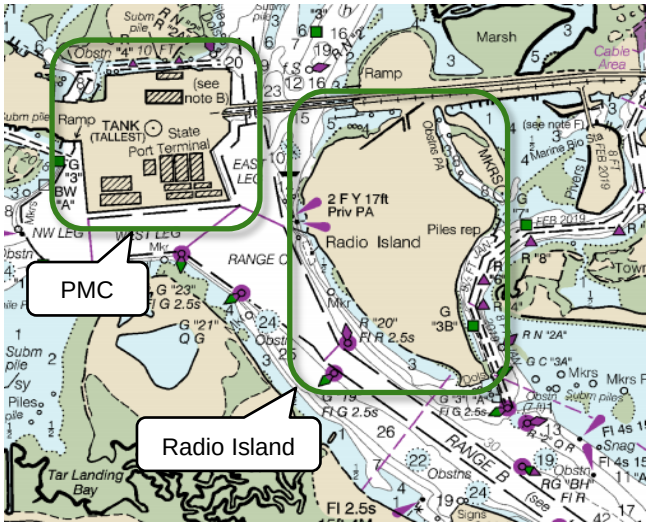


Figure 29 NOAA Chart 11547 of PMC, Radio Island, and Adjacent Shipping Channels.

The following facilities are owned and operated by the North Carolina State Ports Authority (NCSPA).

Port of Morehead City

The Port of Morehead City (PMC) is a currently operating a 128-acre breakbulk and dry-bulk facility located in Morehead City, North Carolina. The port is one of two deep-water port facilities in the State of North Carolina. The facility has nine berths, open storage dry-bulk facilities, one million square feet of covered storage, and is a designated Foreign Trade Zone.

Port of Morehead City and surrounding sites: transportation infrastructure assessment

PMC maintains access to transportation infrastructure connecting the facility to local, regional, and international transportation networks.

- Rail service in the vicinity of the port is provided by Norfolk Southern Railway. Additionally, terminal switching infrastructure is operated by Carolina Coastal Railway. The NCSPA owns the rail line that operates within the PMC itself, while the railroad bascule bridge located to the northeast of the property (which connects Morehead City to the adjacent Radio Island facility) is owned by the North Carolina Department of Transportation (NCDOT). A detailed figure of PMC, Radio Island, and the associated rail infrastructure in included in Appendix B.
- Secured port gate entry is designated to expediate road/motor carrier's arrival and departure at the facility. There is vehicular access via US 70 that segments the north and south portions of the facility. This roadway runs over a fixed bridge that transverses the maritime shipping channel adjacent to the facility, resulting in the northern portion of the facility to have a 65-foot air-draft restriction.
- The PMC is equipped with a heliport that is owned and operated by the US Navy. There are no registered air-clearance restrictions (e.g., infrastructure height restrictions) due to air facilities around the site (see Appendix B for an air infrastructure and clearance map for Morehead City and Radio Island).

- PMC is located directly adjacent to a 45-foot Mean Lower Low Water (MLLW) channel that is operated by the US Army Corps of Engineers (USACE) and is located approximately four miles from the Atlantic Ocean. Additional berthing space at the facility is serviced by a 35-foot MLLW channel and 10-foor MLLW channel located on the south and north property boundaries, respectively. PMC, Radio Island and the adjacent federally maintained channels can be visualized in Appendix B.

Radio Island

Radio Island, which is situated directly southeast of the PMC, is an approximately 100-acre parcel of land also owned by the NCSPA and available for development. Radio Island has a T-head pier with liquid-petroleum bulk transfer and storage infrastructure located in the western portion of the property. Neighboring the Radio Island NCSPA parcel is road and quayside owned by the US Department of Defense (DOD) and private residential buildings on the eastern edge of the island.

Due to its proximity to PMC, Radio Island is well suited with connections to intermodal transportation assets. Coastal Carolina operates the rail line north of Radio Island along US 70. NCSPA-rights away connect the site to the larger Coastal Carolina and Norfolk Southern rail network, although rail does not appear to be currently functional to access the interior of the site. There is vehicular access via US 70 directly to the site. Furthermore, Radio Island's western waterfront is situated next to a 45-foot MLLW channel (Figure 2) that allows deep-water access. In conversations held with NCSPA personnel, redevelopment of Radio Island is the preferred alternative to support the OSW industry versus utilizing the PMC itself.

Port of Wilmington

As the other deep-water port facility in North Carolina, the Port of Wilmington (POW) is a 284-acre facility, located approximately 26 miles from the open sea and is situated along the northern bank of the Cape Fear River. The POW primarily includes container, bulk, breakbulk and Ro-Ro operations. With nine berth, modern warehouse facilities, and as a designated Foreign Trade Zone, the POW supports international trading activities as well as US industrial-based services. Detailed site maps for the POW and area properties discussed below are provided in Appendix B.

Figure 30 Map of Wilmington Area Facilities

Port of Wilmington and surrounding sites: transport infrastructure assessment

As an intermodal facility, the POW supports the transport of containers and other bulk commodities. The overall facility is well-connected to the North Carolina intermodal assets including maritime vessels, railroads and roadway infrastructure:

- Intermodal rail services are provided by CSX Transportation to the site with rail switching provided by Wilmington Terminal Railroad (WTR). The NCSPA operates rail assets within the property and to surrounding storage facilities. Detailed rail infrastructure and connections at Wilmington, North Property, Wilmington Business Park, Raleigh Street, as discussed in detail below, and Eagle Island are included in Appendix (B). CSX rail services includes on-docking rail and the "Queen City Express" service between the POW and CSX's Charlotte Intermodal Terminal located in Charlotte, North Carolina.
- The POW is equipped with two secured port-gate entries with vehicular access via US Highways 17,117, 74/I-74, 421, I-40, and I-140.
- The POW is situated a few miles away from the Wilmington International Airport. This results in a 400-foot clearance restrictions for any infrastructure located on the facility. Detailed airport and air clearance restrictions in the vicinity of the POW and the surrounding facilities are Included in Appendix B.
- The POW is located on the northern bank of the Cape Fear River adjacent to at 42-foot MLLW. Federal channel that leads directly out to open ocean (NOAA Chart 11537). According to information from the

NCSPA, there is an air-draft restriction along the channel of 212 feet due to the presence of Duke Energy lines, that are located approximately 2.7 nautical miles south of the POW property line. Wilmington, adjacent facilities, and maintained federal channels are included in in Appendix B.

Based upon discussions with NCSPA, due to US Department of Defense (DOD) requirements and their current plans for the POW, the NCSPA preferred alternative to support the OSW industry includes development on one or more of the below-referenced properties.

North Property

The North Property is a 100-acre vacant parcel located to the north of the POW and is currently owned by NCSPA. This property is currently undeveloped and available for redevelopment to support OSW. As a part of the POW network, the transportation infrastructure in the vicinity of the Port of Wilmington is accessible to the same channel, rail network and road infrastructure. The property would require a full build out of required on-site infrastructure including a robust quay side, upland laydown area, etc. The property exhibits a 212-foot air-gap.

Southport/North Carolina International Terminal

This is a large, 600-acre property is located near the mouth of the Cape Fear River. The NCSPA purchased the property from Pfizer and proposed redeveloping the property into the North Carolina International Terminal that would serve as a high-density, automated container terminal capable of serving 12,000-20-foot equivalent unit (TEU) vessels with 50-foot drafts. The project was cancelled due to public opposition and the property has lain fallow since. The property is undeveloped, and its waterfront is located some distance away from the main federal channel. The property exhibits overall elevations greater than 20-feet above mean sea level and does not have any air-gap restrictions.

6.3.2 Facilities not owned by the North Carolina State Ports Authority

Eagle Island property

Eagle Island is a 1,400-acre USACE-owned and operated confined disposal facility (CDF) that is utilized for the disposal of material dredged from the Cape Fear River. It is currently undeveloped and has no existing quayside, engineered uplands or other robust port characteristics required for OSW uses. Its only apparent transport connections are to the Cape Fear River and US Highway 17 and 74/I-74. The property is situated next to a deep-water channel that exhibits a 212-foot air-gap. Due to the placement of dredged materials to fill the CDF, this property likely exhibits poor geotechnical characterizes and would require significant upgrades and improvements to make it viable for OSW uses.

Wilmington Business Park/Vertex property

This is a 68-acre, ex out-of-service railcar manufacturing facility that closed in 2018 and is located off the water to the southeast of the POW. Owned by the Industrial Realty Group it was previously operated by the Vertex Rail Co., and is currently available for lease. There are five buildings onsite, including the following:

- 52,668 square foot Warehouse Building
- 70,400 square foot Assembly Building
- 2,975 square foot Office Building
- 8,240 square foot Paint shop/Storage Building

Due to its heavy-manufacturing facilities, 22 cranes, railroad connection, and proximity to the POW, this facility is a strong candidate for the manufacturing of Tier 2, 3 and 4 sub-components. Currently, the facility is accessible to POW via Raleigh Street and State Road 1100. To support Tier 1 component manufacturing, the facility would need to be provided access to the river via a heavy-haul roadway and a quayside would need to be constructed.

Raleigh Street property

This 76-acre property consists of two connected, undeveloped parcels, NCSPA owned properties are located adjacent and to the north of the Wilmington Business Park/Vertex Property. Similar to this property, the Raleigh Street property does not have direct access to a quayside along the river, but the facility has road access to I-40 and US-74 within five miles and indirect water access via the Cape Fear River Federal Channel (air draft restriction 212feet). Wilmington Terminal Railroad provides rail access to the site. The facility has water, sewer, electric and gas onsite but no building infrastructure.

Sunny Point Military Ocean Terminal property

This 8,500-acre facility is an active US DOD military logistics facility utilized for the storage and distribution of ammunition and is located approximately 12 miles south of the POW on the east bank of the Cape Fear River. It is currently improved with the maritime infrastructure to support its US DOD logistical operations. It is not known if this facility would be available to support OSW operations of any kind. If it is similar to the Earle Naval Weapons Station located in New Jersey, even in the event that a portion of the property were set aside for OSW uses, the current munitions loading and unloading operations and associated “blackout” periods would make marshalling challenging. The property does not exhibit any air-gap restrictions, as it is located downstream of the Duke Energy power lines, that cross the river.

Manns Harbor Marina property

The 12-acre Manns Harbor Marina Property, that is located adjacent to US Hwy 64 (5227 Highway 64-264), in the northern portion of the State (see Appendix B), was selected as a typical potential CTV O&M facility. The facility

recently increased boating access for docking in the Dare County community. This is one of a few waterfront facilities in North Carolina with a steaming distance of under 50 nautical miles to the Kitty Hawk windfarm. A seven-foot-deep channel services the site, that is located to the south of the Manns Harbor Bridge. Although as previously discussed, CTV facilities are not a prime candidate for North Carolina, this facility serves as an example of what potential sites would be available in the state for this OSW service. It is unknown if this facility would be able to serve OSW operations at this time, but moderate upgrades would likely be required at the quayside to increase berthing for CTV vessels, and dredging would likely be needed to increase channel depth for commercial uses.

Swan Ferry Terminal

Located in Swanquater, North Carolina (see Appendix B) the Swan Ferry Terminal services ferries from the communities of Swanquater to Ocracoke on the Outer banks. The facility consists of two piers for docking ferry vessels, timber dolphins for berthing, two buildings and small parking-lot space. The entire parcel, that is owned by NCDOT, is 83 acres in size, with over 35 acres of undeveloped land. This facility is located 140 nautical miles from the Kitty Hawk lease area, making it potentially suitable for SOV O&M operations with modification to the quayside infrastructure and channel. Interest or availability of this site for OSW operation has not been verified.

Englehard Business Park

Nestled in Engelhard, North Carolina (see Appendix B), this eight-acre property is located along a 14-foot-deep federally maintained channel. The North Carolina Marine Industrial Park Authority owns and operates this facility, that is located 75 nautical miles from the Kitty Hawk windfarm. In addition to the Swan Ferry Terminal, this facility serves as an example of an SOV facility within the State, with moderate redevelopment and facility upgrades required to pivot to support SOV O&M operations. While it has not been verified that this facility would be available to serve OSW in the future, it currently has 7 acres available for commercial development.

Riverbulk Terminal

Located in Edenton, North Carolina, this is a privately-owned, 50-acre industrial site with heavy-lift-capable, water-front infrastructure located on the Chowan River. With its existing quay side, 100,000-square foot building, crane pad and associated marine/industrial infrastructure, this facility is an excellent example of a privately-owned property that could be pivoted to OSW manufacturing of components. The facility's location on the Intercoastal Waterway and nearby highway system connects the facility to the other manufacturing and port facilities located in the region. Its maximum available water depth of 12-feet would limit the property use to the manufacturing on sub-components.

6.4 Utilization scenarios for Morehead City and Wilmington areas ports

As part of this portion on the project, and in order to evaluate potential-use scenarios for several east coast ports and facilities, a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was conducted. It analyzed the North Carolina facilities discussed above, as well several other OSW ports and facilities that have been identified as partners and/or competitors to North Carolina in other east coast states.

The SWOT analysis was prepared for targeted final OSW uses of manufacturing purposes. This end-use was selected as it represents the most likely potential-use scenario for North Carolina facilities to support the first and second wave OSW wind projects in the Southeast, Mid-Atlantic and New England regions. Further, pivoting between staging and manufacturing uses require similar initial facility upgrades. Upgrading to construction base/marshalling would require significant additional upgrades and would likely only be feasible to support the construction of third wave projects including those BOEM Call Areas off of Wilmington and South Carolina.

The following SWOT analyses was performed assuming facility end uses of manufacturing OSW components, as such, a few of the ports/properties described above, which were more relevant for other end-uses, were not carried through the analyses.

6.4.1 SWOT Analysis

The primary North Carolina ports and properties evaluated as part of this study are presented above. The following provides a summary of facilities located in other east coast states that are included in the SWOT analyses, and all can be seen in Figure 31.

- The proposed New Jersey Wind Port, that will be located the eastern shore of the Delaware River in Lower Alloways Creek adjacent to PSEG's Hope Creek Nuclear Generating Station
- The proposed Arthur Kill Terminal (also known Atlantic Offshore Terminals) located on the northwestern tip of Staten Island, New York, adjacent and downstream of the Outer Bay Crossing
- The South Brooklyn Marine Terminal located in the western part of Brooklyn, New York, upstream of the Verrazano Bridge
- Port of Bridgeport located in Bridgeport, Connecticut on the Long Island Sound
- New Bedford Marine Commerce Terminal, Massachusetts located along the west banks of the Acushnet River upstream of a New Bedford hurricane barrier

- Rhode Island properties including the Port of Providence, the proposed South Quay Marine Terminal and Port of Davisville (Quonset), all of which are located along the Providence River upstream of the Newport Bridge, and
- Virginia properties including the Norfolk Southern Lamberts Point property and Portsmouth Marine Terminal (PMT), both of which are located in the Hampton Rhodes area and downstream of any bridges.

There are many additional properties located up and down the East Coast including the Werner Power Station located in New York, the New London State Pier located in Connecticut and the Salam Powerplant located in Massachusetts that are currently being considered by other states to attract the OSW Supply Chain. The facilities above were selected to represent prototypical facilities to be carried through the SWOT analyses.

To parametrize the results of the SWOT analysis, and as summarized in Table 10, the above-referenced facilities were assigned numerical values based upon the following color-coding scheme:

- **Amber** highlighted table cells identify a facility that would require significant reconfiguration/monies to make it viable to support future OSW manufacturing operations.
- **Blue** highlighted table cells identify a facility that could be reasonably configured/reconfigured to support future OSW manufacturing operations.
- **Green** highlighted table cells a facility that is fully or nearly ready to support OSW manufacturing operations in its current configuration.

The SWOT analysis incorporated both quantitative and qualitative analyses components. In order to provide a numerical presentation of the analyzed parameters, each category was assigned the following numeric value ranges: Green: 8 to 10; Blue: 4 to 7; and, Amber: 1 to 3. The quay-side parameters including actual length, potential length, known load-bearing capacities and potential load-bearing capacities were evaluated on a separate basis (Appendix B) and an average scoring per facility for these four parameters was input into the SWOT analysis.

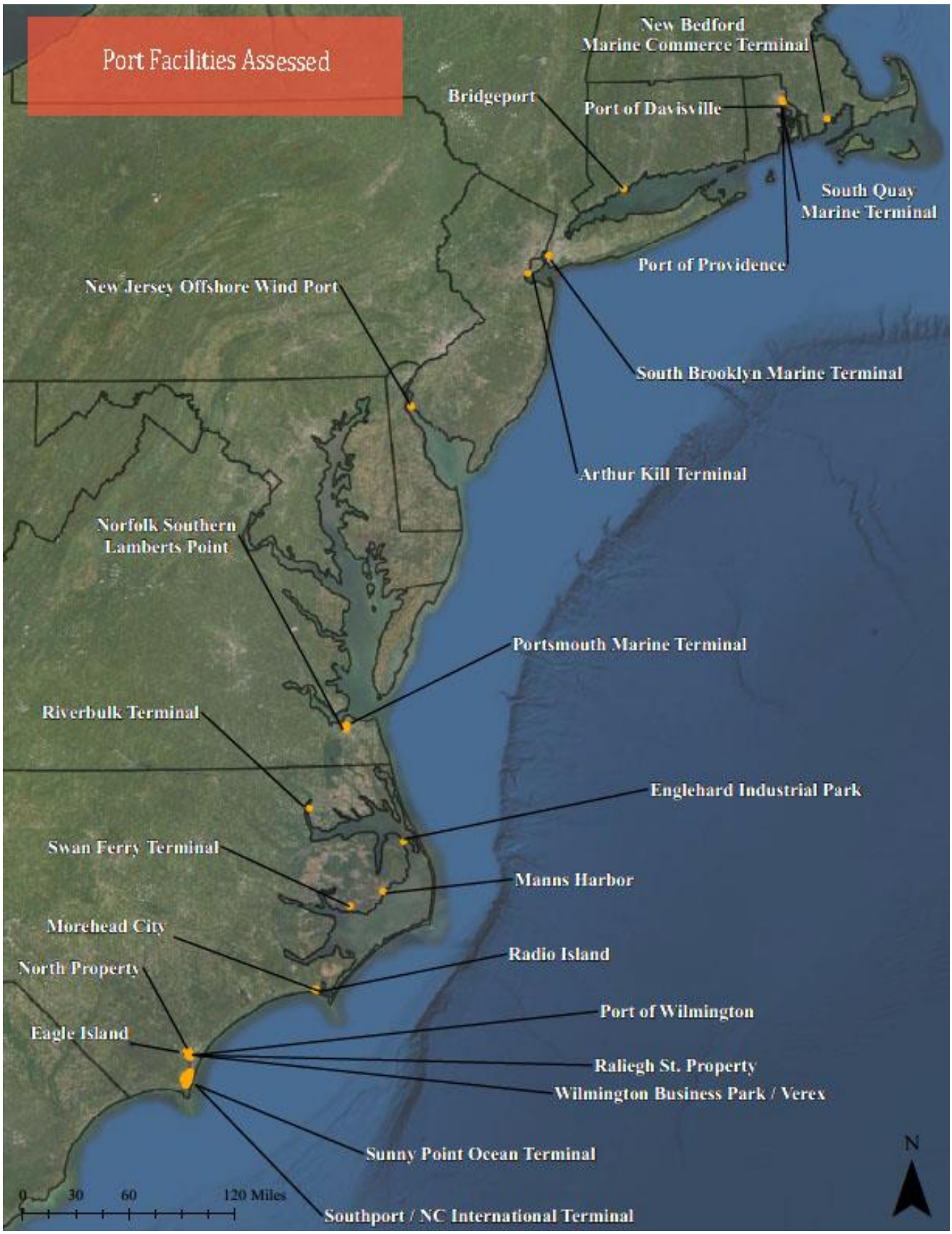


Figure 31 East Coast port facilities assessed.

Table 10 SWOT analysis for OSW manufacturing uses (includes staging), for ports listed from north to south.

Facility	Ownership	State	Facility Readiness	Facility Availability	Site Acreage	Cost to Redevelop	Quayside Infrastructure	Air Draft Restriction	Channel Depth	Score
New Bedford Marine Commerce Terminal	MassCEC	MA	10	5	2	9	10	10	7	**53**
South Quay Marine Terminal	Private	RI	1	8	3	1	6	7	7	**33**
Port of Providence	Public	RI	8	5	10	8	9	7	10	**57**
Port of Davisville (Quonset)	Public	RI	8	7	10	3	9	7	8	**52**
Bridgeport	Private	CT	5	10	1	5	8	10	10	**49**
New Jersey Wind Port	NJ	NJ	1	10	10	1	6	10	7	**45**
South Brooklyn Marine Terminal	NYNJPA	NY	8	9	9	7	10	7	10	**60**
Arthur Kill Marine Terminal (NY)	Private	NY	1	7	1	1	6	10	7	**33**
Norfolk Southern Lamberts Point	VPA	VA	7	7	10	7	9	10	10	**60**
Portsmouth Marine Terminal	VPA	VA	9	5	10	7	9	10	10	**60**
Radio Island	NCSPA / Public	NC	1	10	10	2	6	10	10	**49**
Morehead City	NCSPA / Public	NC	7	2	10	5	8	10	10	**52**
Eagle Island	ACOE	NC	1	3	10	1	6	7	10	**38**
North Property	NCSPA	NC	1	10	10	2	6	7	10	**46**
Port of Wilmington	NCSPA	NC	8	2	10	7	9	7	10	**53**
Wilmington Business Park/Vertex	NGO	NC	8	10	10	8	3	7	1	**47**
Raleigh Street Property (NC)	NCSPA	NC	2	10	9	5	3	7	1	**37**
Sunny Point Marine Terminal	DOD	NC	6	3	10	3	10	10	10	**52**
Southport / NC International Terminal	NCSPA	NC	1	7	10	3	6	10	5	**42**

The following provides a summary of each SWOT-analyses parameter included in Table 11 and a narrative of the results:

Facility readiness

This parameter represents a facility's readiness to support OSW operations associated with the manufacturing of Tier 1 components such as blades, towers, nacelles, etc., from an existing infrastructure perspective including the presence of heavy-lift cranes, robust quay side, high-bearing capacity uplands soils, etc. The New Bedford Marine MCT scored the highest in this category as it is currently the only OSW industry-built port in the US. The existing port facilities of POW, South Brooklyn Marine Terminal, Port of Providence, Port of Davisville (Quonset) and VA Portsmouth Marine Terminal also scored highly in this category as they all currently support robust port-use programs. A few of the facilities score as a blue in this category as they are current port facilities that would require more-significant infrastructure upgrades. The properties that are currently undeveloped score lowest in this category as they would require the greatest amounts of infrastructure upgrades. It should also be noted that the Wilmington Business Park/Vertex property scored highly in this category due to its historic heavy-manufacturing uses.

Facility availability

This parameter basically represents whether a facility and its owners/operators are willing to make their facilities open to OSW manufacturing uses of Tier 1 components. The majority of the facilities evaluated scored high for this category. The following provides a summary of this evaluation:

- The PMC and POW scored lower in this parameter as the NCSPA indicated a strong preference for a development project of NCSPA -owned assets such as Radio Island and the North Property.
- The Wilmington Business Park/Vertex scored high even though its lack of waterfront access makes its use for manufacturing Tier 1 components challenging; however, this property is vey-well suited for manufacturing of smaller OSW sub-components able to be transported by rail or road.
- The Eagle Island and Sunny Point Marine Terminal scored low as it is unknown whether the current owners would consider offering portions of their properties up for OSW manufacturing Uses.
- The Southport/North Carolina International Terminal scored lower due to significant public opposition of past proposal to develop the property into a container port.
- The Norfolk Southern Lamberts Point facility scored lower as it is anticipated that this facility will be utilized as a receipt and staging facility for OSW sub-components manufactured in North Carolina and then will transport by barge/rail to the nearby Virginia Portsmouth Marine Terminal construction base/marshaling ports for the first and second wave projects.

Available acreage

The majority of the evaluated properties scored high in this category, with the exception of the following:

- The Arthur Kill Marine Terminal and New Bedford MCT are both currently slated for construction base/marshalling and O&M uses, not manufacturing of Tier 1 components.
- Reportedly the Port of Bridgeport will be utilized to support the fabrication/installation of secondary steel on transition pieces and support future O&M operations.

Cost for redevelopment

The manufacturing of Tier 1 components requires that a port facility have much-more-then-typical robust infrastructure to support the lifting and handling of towers, foundation elements, transmission pieces, nacelle, etc. For this analysis,

- **Green** represents development costs up to $5 million,
- **Blue** represents development costs ranging from $5 to $50 million, and
- **Amber** represents development costs ranging from $50 million to $100 million, or greater.

These ranges reflect that infrastructure upgrades are a very expensive undertaking and the high costs represent a major issue in the development of the OSW marketplace in the US, primarily, what entity will pay for them and, once identified, at what point in the industry life cycle will these funds actually be expended? As summarized in Table 10:

- The ports of New Bedford MCT and ProvPort exhibit the lowest overall estimated fees to "become ready." The Wilmington Business Park/Vertex property score well in this category due to its former heavy manufacturing uses. It should be noted that this facility would be utilized for the manufacturing of sub-components transportable by rail and/or road.
- The remainder of the facilities would moderate- to high-cost upgrades to support manufacturing operations of Tier 1 components.
- Several of the facilities will never likely be utilized for these purposes either due to their restricted area (i.e., Arthur Kill Marine Terminal) or their limited access to adjacent waterfronts (i.e., Wilmington Business Park/Vertex property).

Quayside conditions

As discussed above, this parameter includes a sub-evaluation of existing and potential quayside conditions and existing and future load-bearing capacities. In general, the existing port facilities scored the highest in this category with unimproved water-front properties scoring in the mid-ranges.

Air-draft restrictions

During the initial years of planning for the development of OSW ports on the East Coast, especially those associated with construction base/marshalling operations, this was considered to be a key-facility parameter as the European construction practices required trans-shipment of major components from the quay side to the offshore installation site in a vertical geometry to avoid high-risk crane movements at sea. Further, the non-deployed spuds of WTIVs coming into a construction base/marshalling port also result in air-gap challenges. However, with the promise of over 35 GW of east coast OSW projects in the pipeline (which is incentivizing European developers to revise their practices to meet the needs of the American market), the lack of US-flagged WTIVs, that will necessitate the use of feeder barges, and that manufactured Tier 1 components can be transshipped horizontally to associated staging and construction base/marshalling ports make this a less-than-critical parameter for the facilities under consideration.

The majority of the facilities included in the SWOT analysis do not exhibit air-gap restrictions. The POW-area ports do have an air-gap restriction of 212-feet due to the presence of Duke Energy transmission lines crossing the river to their south. The Rhode Island and South Brooklyn Marine Terminal exhibit air-gap restrictions due to the presence of bridges.

A new vessel challenge has arisen of late in the form or beam restrictions. The New Bedford MCT has a beam restriction due to the size of the channel opening in the adjacent hurricane barrier and the Rhode Island facilities due to width-restrictions associated with the Newport Bridge.

Channel depth

This is a critical infrastructure component as facility approach channels and quay sides must have sufficient depth to support large-scale vessel operations. High costs are typically associated with dredging operations required to support OSW manufacturing port operations. Most of existing port facilities and shore-front properties scored well in this category. The two non-waterfront properties (i.e., Wilmington Business Park/Vertex property and the Raleigh Street property) exhibited a low scope. The Southport/North Carolina International Terminal scored a mid-range due to the distance between its waterfront and the Federal navigation channel.

6.4.2 SWOT analysis discussion

Based upon the results of the previously-mentioned SWOT analysis, Table 11 provides an overall, numerical ranking of the facilities evaluated to support manufacturing of Tier 1 OSW components.

Table 11 Facility ranking based upon SWOT analysis for manufacturing use.

Facility	State	Score
Portsmouth Marine Terminal	**VA**	**60**
Norfolk Southern Lamberts Point	**VA**	**60**
South Brooklyn Marine Terminal	**NY**	**60**
Port of Providence	**RI**	**57**
Port of Wilmington	**NC**	**53**
New Bedford Marine Commerce Terminal	**MA**	**53**
Morehead City	**NC**	**52**
Port of Davisville (Quonset)	**RI**	**52**
Sunny Point Marine Terminal	**NC**	**52**
Bridgeport	**CT**	**49**
Radio Island	**NC**	**49**
Wilmington Business Park/Vertex Property	**NC**	**47**
North Property	**NC**	**46**
New Jersey OSW Port	**NJ**	**45**
Southport/NC International Terminal	**NC**	**42**
Eagle Island	**NC**	**39**
Raleigh Street Property	**NC**	**37**
Arthur Kill Marine Terminal	**NY**	**33**
South Quay Marine Terminal	**RI**	**33**

This SWOT ranking and analyses indicated the following with respect to North Carolina existing port facilities and available undeveloped facilities:

- **Sub-component manufacturing facilities**: From the perspective of manufacturing Tiers 2, 3 and 4 subcomponents, the North Carolina port facilities and

other properties assessed in this evaluation score quite well due to the State's robust intermodal assets, that as discussed below, support the manufacturing of the smaller-scale components that can then be transported by rail, road and/or barge.

- **Tier 1 Manufacturing / staging facilities**: As with construction base/marshalling uses, due to facility readiness and availability constraints, none of the North Carolina ports or properties are considered to be "shovel ready" to support the first and second wave OSW projects off of the US East Coast with respect to the manufacturing of Tier 1 OSW components and for staging of such components. With upgrades, the Radio Island, North Property and Southport/NC International Terminal properties could potentially be well suited to this use.
- **O&M operations**: Based upon distances to the existing BOEM lease areas, North Carolina ports are not optimally located to support CTV O&M operations. Some SOV operations could effectively be run out of the State's ports. Both CTV and SOV O&M operations could be effectively run out of State ports to support future third wave projects associated with the BOEM Wilmington and South Carolina Call Areas.
- **Construction base / marshalling ports**: Based upon the facility readiness, availability, distance to the existing BOEM lease areas associated with the first and second wave OSW projects and newly-implemented MOU with Virginia and Maryland, the North Carolina ports are not currently well suited for this OSW use. However, the Radio Island, North Property and Southport/NC International Terminal properties could potentially be suited for this use to support future third wave projects associated with the BOEM Wilmington and South Carolina Call Areas.

The following provides a summary of the North Carolina facilities strengths, weakness, opportunities and threats. Please note that this analysis is solely from an infrastructure perspective and other State assets such as the presence of a cost-effective labor force, right-to-work status, etc., are addressed elsewhere in this report.

Strengths

North Carolina exhibits several significant strengths to support its entrée into the OSW market space, including the following:

- The State's existing intermodal transportation system, that will allow for the effective transport of raw materials and completed sub-components by rail, road and/or maritime means. This allows for the State's two primary port assets, in the form of the POW and PMC, to be fully utilized for container and break-bulk-type operations. This also allows for the flexibility in siting new manufacturing facilities and/or allow for the pivoting of existing manufacturing facility to OSW sub-component manufacturing. It should be noted that the opportunities associated with the OSW market are not just limited to coastal areas of the State, rather the manufacturing of OSW sub-components could be conducted at properties anywhere in the State and the completed products shipped to their final point(s) of use via intermodal resources.
- The presence of serval NCSPA-owned, undeveloped waterfront properties including Radio Island, the North Property and the Southport/North Carolina International Terminal Property, that are available to be developed into specialized OSW manufacturing and/or staging uses.
- The State's MOU with Virginia and Maryland to support the development of the OSW industry developing off the East Coast of the US This will allow for ease of access to the Norfolk Southern Lamberts Point facility to receive completed sub-components manufactured in North Carolina to support the construction of the first and second wave projects.
- The presence of several undeveloped facilities that could provide construction base/marshalling port operations associated with future third wave projects associated with the BOEM South Wilmington and South Carolina Call Areas.

Weaknesses

North Carolina exhibits the following weaknesses to entering into the OSW marketplace:

- Current lack of existing port facilities, or designated ports, dedicated to construction base/marshalling port operations and future Tier 1 component manufacturing. Other states such as New Jersey and New York are ahead of North Carolina in this perspective.
- The POW and PMC are not currently available for any reconfiguration to support the short-term needs of the OSW industry. This does not allow the State to support the shorter-term needs of the marketplace out of the State's two deep-water port facilities.
- The North Carolina ports are not well located to support CTV O&M operation for the existing BOEM Lease Areas.
- Many of the land-side facilities of the State are accessed only by shallow water channels and waterway systems, and extensive dredging would be required to support development of these properties to support manufacturing of Tier 1 components – this is much less of an issue if the properties were to manufacture smaller-scale sub-components that could be shipped via shallower-draft barges. Further, there are only limited inlets/access points through the barrier beach system, that result in potentially longer vessel-transient times.

Opportunities

- The presence of several properties that could be effectively redeveloped to support the OSW uses including Radio Island, Southport/North Carolina International Terminal, Wilmington Business Park/Vertex Property and the North Property.
- The presence of a fully-integrated intermodal transportation system that "opens up" the manufacturing of smaller-scale, sub-component to manufacturers located across the State and not just limited to coastal areas. Many of these properties could quickly pivot to manufacturing of OSW sub-components.
- Availability of privately-owned land-side properties, such as the Raleigh Street and Wilmington Business Park/Vertex properties, that could be quickly redeveloped to support the manufacturing of OSW sub-components. If access to the adjacent undeveloped waterfront or POW quay sides were granted, both of these properties could be developed to support the manufacturing of Tier 1 OSW components.
- The presence of two existing deep-water ports, that could be slightly re-configured to support short-term OSW uses.
- The presence of the BOEM Wilmington and South Carolina Call Areas, that could represent a strong future marshalling- and construction base marshaling port operations.

Threats

- Other State's procurement policies, that require a level of net economic benefits/local content requirements that force use of in-state assets.
- Other State's investment programs and opportunities to encourage the development of private port facilities.
- The presence of existing facilities in other states, that are being "offered up" to support the OSW industry.
- Moving too slowly to support the buildout of the OSW infrastructure. Massachusetts, New York and New Jersey are all taking active steps to be first-wave projects in the OSW industry. By taking this tact, these states are working hard to "attract more than their fair share" of the OSW Supply Chain market.

6.5 Investment Opportunities in Ports/Facilities

The following provides the study team's preliminary recommendations for North Carolina to invest in various properties evaluated as part of this study. It should be noted that there are literally hundreds of potential manufacturers and associated properties located in the State that could feasibly pivot their existing operations or be developed to meet the needs of manufacturing of OSW sub-components and provide them to their end-point users by rail, road and/or maritime vessel transport modes. Although not part of this study, the team strongly recommends that the State, cities and counties continue to provide strong incentives for manufactures to set up in North Carolina in the form of tax-incentive programs, free-trade zones associated with sites including ports and intermodal terminals.

The following provides a summary of the evaluation of several of the facilities evaluated above, including Radio Island, the North Property, the Wilmington Business Park/Vertex Property and the Southport/NC International Terminal. This evaluation provides a high-level discussion of the market time frames and evaluation of the schedules for development of OSW opportunities. Please note that these facilities were selected to provide a discussion of their potential investment feasibility, as well as to illustrate development strategies of typical water-front properties, in-land former manufacturing property and a large, undeveloped water-front property. Such evaluations could be prepared for any North Carolina property under a future work-flow component.

Table 12 presents an overview of upgrade cost, the time it would take to deliver and the potential employment opportunity for these facilities.

6.5.1 Radio Island

Radio Island is an NCSPA-owned asset located nearly adjacent to the POW facility. It has a sufficiently large available land area to support future OSW staging, manufacturing, construction base/marshaling and O&M operations. This facility is particularly well-suited to support Virginia port construction base/marshaling operations for the existing southern BOEM Lease Areas as a staging and manufacturing port facility. The primary strengths of this property include the following:

- NCSPA-owned asset that has been designated as available for development
- Located adjacent to a deep-water access channel
- No air-gap restrictions, and
- Served by both road and rail infrastructure, although both of these services would likely require upgrading.

Figure 32 Re-use staging facility scenario for Radio Island.

Figure 33 Re-use manufacturing facility scenario for Radio Island.

As illustrated in Figure 32 and Figure 33 it is envisioned that the facility could first be developed as a staging facility to support the first and second wave projects associated with OSW projects that would be marshaled out of Virginia. In this scenario, the facility would be a receiving/staging port for Tier 1 OSW components manufactured in Europe. While Radio Island is located a bit far from the from the Kitty Hawk and Dominion Lease Areas, a robust logistical system could be developed to support the receipt, staging and delivery of Tier 1 OSW components to Virginia. This facility also has the advantage of being at a lower latitude than Massachusetts, New Jersey and New York ports and winter-ice conditions would not occur to negatively impact component-delivery schedules. As the property would be utilized to the handling of Tier 1 components, a highly-robust quayside would need to be constructed and large areas of the upland areas strengthened to support crawler crane and SPMT operations.

As the US OSW industry develops, it is further anticipated that more and more US manufacturing of OSW components will occur. Radio Island is very-well suited to be a manufacturing location for the larger-scale Tier 1 components due to the following properties:

- Location adjacent to a deep-water channel to allow access to maritime-trade vessels for receiving raw materials and transshipping of completed components
- Existing railroad transportation assets, although the rail system would likely require up-grading; and
- Current open-space areas that are of sufficient size to support the manufacturing of all scales of OSW components.

Figure 34 Re-use construction base / marshaling facility scenario for Radio Island.

In this scenario, the property would be initially developed to support staging operations that would result in an initial income stream to make the site economically viable. It is envisioned that, later, Radio Island would be further-developed with buildings, infrastructure and additional

staging/laydown areas to support the use into a manufacturing facility that would presumably result in higher amounts of income for the facility and would result in additional, high-paying manufacturing jobs.

As the US OSW marketplace continues to evolve, there will likely be additional needs for more southern construction base/marshaling ports. As illustrated in Figure 34, the Radio Island facility could be further developed to support southern construction base/marshaling and would require the installation of a quay-side crane lane and the upgrade and development of additional upland areas to support the handling of heavier, more massive components.

6.5.2 North property and Wilmington Business Park/Vertex property.

The two properties consisting of the North Property and the Wilmington Business Park/Vertex Property represent an interesting opportunity to form a public-private partnership (PPP) between the NCSPA and the Industrial Realty Group that currently owns the Wilmington Business Park/Vertex Property. As indicated in Figure 35 and Figure 36, much like the Radio Island Property, the NCSPA-owned North Property could be developed for use as a staging facility to support operations for the first and second wave projects that will be marshaled out of Virginia.

Figure 35 Re-use staging facility scenario for North property.

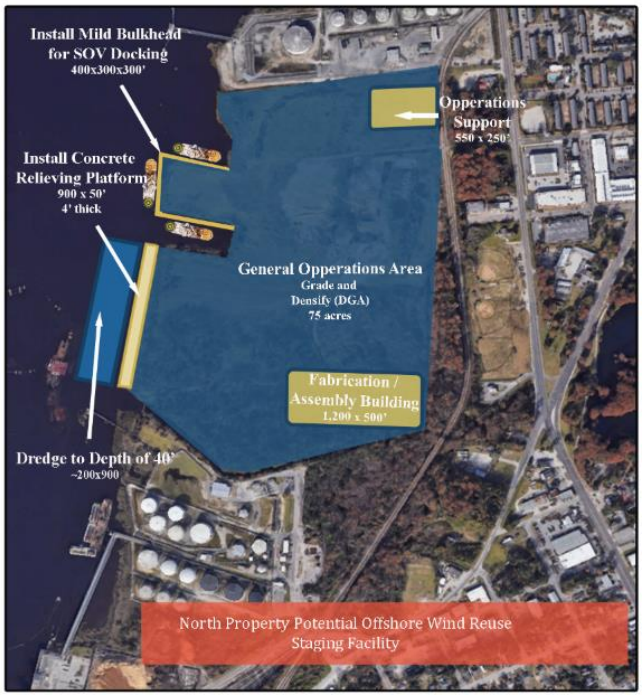


Figure 36 Re-use manufacturing facility scenario for North property.

Similarly, this facility could also be utilized to support the manufacturing of OSW components for later projects as the US-based Supply Chain develops. The North Property would also be a candidate to support SOV-type O&M operations, both for the more southern BOEM Lease Areas and future projects associated with the BOEM Wilmington and South Carolina Call Areas.

As discussed in detail above, due to its recent history of heavy manufacturing activities, the Wilmington Business Park/Vertex Property is a very strong candidate to support the manufacturing of Tiers 2 through 4 OSW sub-components. The property's access to intermodal rail and road assets would allow for the receipt of raw materials and the delivery of completed sub-components to Tier 1 component assembly, staging and marshaling ports. Finally, as indicated in Figure 37 and Figure 38, there are both existing road and rail access assets between the North Property and the Wilmington Business Park/Vertex Property that could allow for a two-property integrated scenario where sub-component manufacturing would be conducted at the Wilmington Business Park/Vertex Property and sub-components could be assembled and trans-shipped out to a marshaling port from the North Property. This PPP scenario would be extremely valuable in showing other potential manifesting entities that North Carolina is indeed "open for business" and more-than-willing to work with firms to bring them to the State.

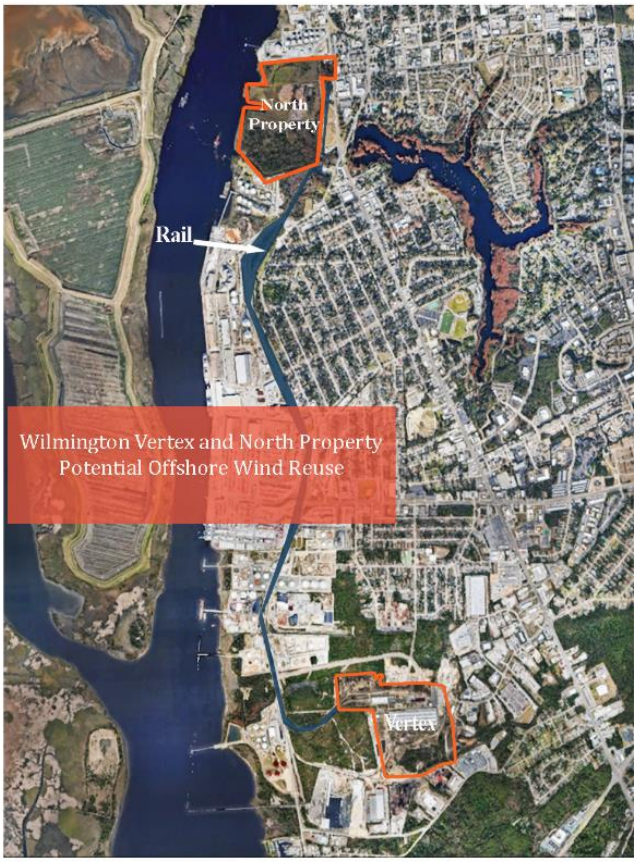


Figure 37 Integrated scenario for two properties, high-level view, with sub-component manufacturing at the Wilmington Business Park/Vertex property and sub-component assembly and shipping at the North property.

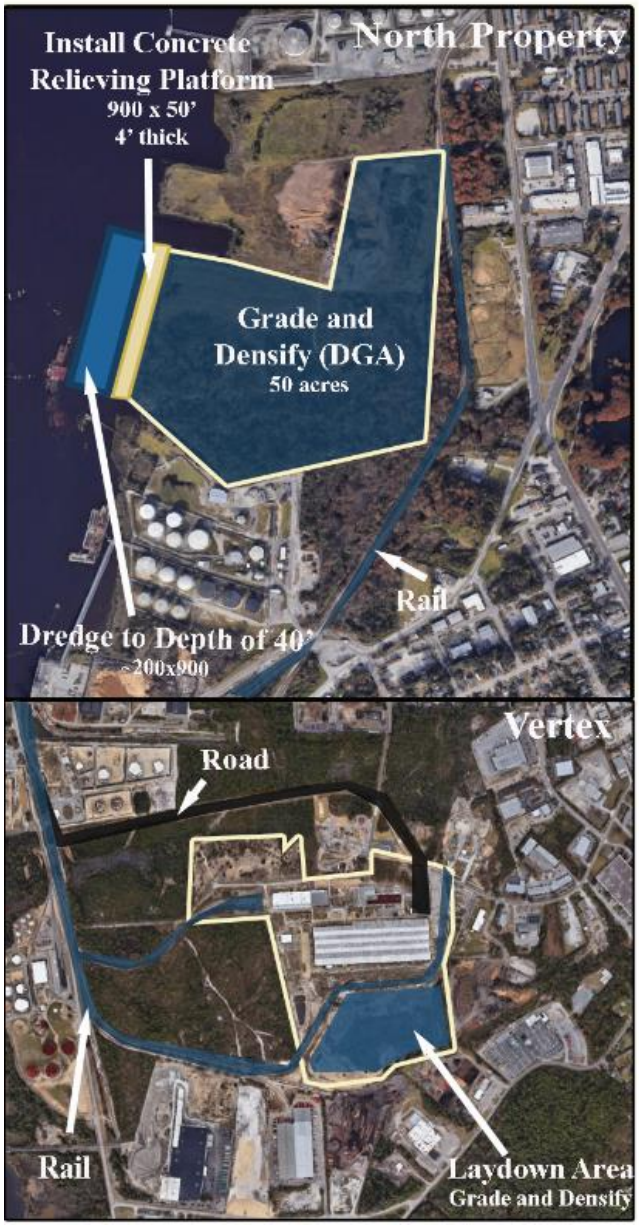


Figure 38 Integrated scenario for two properties, detailed view.

6.5.3 Southport/NC International Terminal property

As discussed above, this currently vacant, 600-acre property is located approximately five miles north of the mouth of the Cape Fear River and is downstream of any air-gap restrictions. The Southport/NC International Terminal Property represent an NCSPA-owned asset that could be developed in the longer term into a “mega port” along the lines of typical European OSW port facilities that integrate manufacturing, staging and construction/base port operations out of one large and integrated facility. This property is one of the only such port authority-owned assets along the US East Coast that exhibits OSW attributes of large areas, location near to the Atlantic Ocean and no air-gap restrictions.

The development of such a mega port could represent a significant game-changer in the US and International OSW Supply Chain marketplace. With all of North Carolina's other resources and assets (e.g., affordable housing, right-to-work status) discussed elsewhere in this report, the costs of Tier 1 components at this facility could be highly-competitive with other states and countries resulting in lower LCOEs for their projects – as such, manufactured goods from this property could be used as an entrée into the International OSW market.

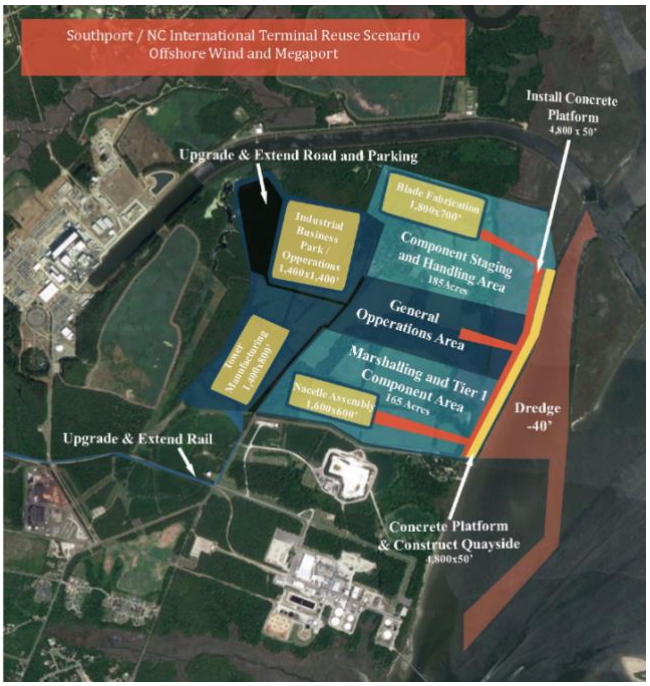


Figure 39 Re-use integrated OSW facility scenario for Southport/NC International Terminal property.

As illustrated in Figure 39, the facility has sufficient area to support the manufacturing infrastructure associated with several Tier 1 components including blades, towers, foundations, nacelles, etc.; staging of all OSW components and a robust quay side to support pre-assembly and construction base/marshaling operations. Besides its location and overall acreage, the property exhibits the following attributes:

- Potential to be developed into the Nation's only fully integrated OSW mega port capable of supporting all aspects of the OSW industry including staging, manufacturing of all levels of components, construction base/marshaling operations and O&M operations out of one facility
- Existing road and rail interconnections, although both would require upgrading
- Relatively high, uplands topographic elevations that would make the property hurricane resilient
- A long potential quay side; and
- Once developed, portions of the overall property could potentially be utilized for future container and/or DOD uses.

Development of this property into a functioning OSW port facility is considered as a long-term goal and opportunity for the following reasons:

- The permitting and design timeframes would be quite long and would not likely be ready to support the first and second wave OSW projects.
- The cost of development would be high due to the need to develop the property, including a long, robust quay side and dredging that would be required to create a sufficiently deep quay side and to allow vessel access to the deep Federal navigation channel.
- The property is located over 300 miles south of the Kitty Hawk and Dominion BOEM Lease Areas that makes it unattractive for construction base/marshalling operations.
- The costs to develop are likely too high to support the first- and second wave projects in the form of the Kitty Hawk and Dominion projects. However, this property is very-well situated to support third wave projects, particularly those associated with the BOEM South Wilmington and South Carolina Call Areas.
- The original NCSPA plans to develop the project into a container port were reportedly thwarted by public opposition. It is hoped that as OSW represents the production of "green energy," public opposition would represent a lesser challenge. The time potentially required to run a public-relations program would need to be built into any project timelines/schedules.

6.5.4 Recommendations

Based upon the review of existing port facilities and available properties located in the Wilmington and Morehead City areas, the following preliminary recommendations are provided:

- **Existing POW and PMC Facilities – Prepare and Facilitate:** Currently, the NCSPA has expressed the desire that any OSW project-related infrastructure upgrade projects include a development component of NCSPA-owned assets such as Radio Island, the North Property, Southport/NC International Terminal, etc. It is recommended that NCSPA be re-contacted by the appropriate State entity to evaluate whether there is potential that some portions of the properties could be utilized to support OSW operations. As indicated in Table 12, this could result in a cost-effective means of allowing North Carolina into the first and second wave projects and thereby make the State a larger initial player in the marketplace.
- **Radio Island – Facilitate and Accelerate:** Due to its more northern location in the State, currently

undeveloped condition, location near a deep-water channel, intermodal connections and lack of air-draft restriction, this property is very-well suited to support the OSW industry associated with the Kitty Hawk and Dominion first and second wave projects in the form of a staging port. The facility could then be pivoted manufacturing of Tier 1 and lower tier sub-components. The use of the property could eventually pivot to support construction base/marshaling port uses; however, the likely target projects would be the third wave BOEM Call areas located off Wilmington and South Carolina that would more effectively served by North Carolina assets in the Wilmington Area. It is recommended that North Carolina evaluate the efficacy, timing, costs and potential user interests in these options. As indicted in Table 12, progressive increase in OSW usage (i.e., staging to manufacturing uses) would increase the project costs and implementation schedule as well as increase the number of jobs that would be generated. The potential, staged development costs would likely be balanced out by fees accrued during the earlier uses of the property.

- **North Property and Wilmington Business Park/Vertex property – Prepare, Facilitate and Accelerate:** Together, these properties represent an opportunity to develop a two-property, integrated, PPP scenario to support the manufacturing of all tiers of OSW components at both properties. The initiation of sub-components manufacturing at the Wilmington Business Park/Vertex Property could represent an early, available work-flow component as the property is already developed to support heavy manufacturing activities. This two-property integrated scenario represents a potentially interesting and unique opportunity as it could be developed in a PPP fashion with the NCSPA and the current owner of the Wilmington Business Park/Vertex Property – this could be seen as a prototypical and catalytic project illustrating how the State can successfully work with a private property owner to advance North Carolina's position in the OSW industry. The preliminary high-level estimated of project implementation schedules, associated costs and number of jobs generated are included in Table 12.

- **Southport/North Carolina International Terminal property - Facilitate and Accelerate:** This 600-acre, NCSPA-owned property represents a very-exciting opportunity for North Carolina as it is one of the only potential "mega-port" facility locations on the US East Coast. As summarized in Table 12, it would not be appropriate to develop this property to support the early Kitty Hawk and Dominion OSW projects as they will be more effectively marshaled out of Virginia. The strength of this property lies in its potential ability to support marshaling of third wave BOEM projects off Wilmington and South Carolina, and other future BOEM Call Areas that may potentially be designated off of the Southeast States. Additionally, as the US OSW industry matures, it is anticipated that the OSW Supply Chain will have much more confidence in the market and will be willing to invest in additional manufacturing facilities to keep up with the market demand. This property represents a one-of-a-kind opportunity to be developed into an OSW mega-port facility wherein multiple Tier 1 manufacturers could set up shop, trans-ship completed components to other US and international destinations and marshal multiple OSW projects, all from a single property. It is recommended that North Carolina set up a long-term working group incorporating a wide-range of stakeholder to evaluate and explore the development options for this valuable and currently underutilized NCSPA-owned asset.

- **Future O&M facility opportunities – Prepare and Facilitate:** The infrastructure associated with both CTV- and SOV-type O&M operations required smaller and less robust facility infrastructure than do other OSW port uses. It is believed that some O&M facilities will develop in response to the locations of specific windfarms. However, it will be appropriate to "offer up" potential spaces for these type of operations at larger North Carolina ports as they are developed.

Table 12 High level overview of upgrade cost, the time it would take to deliver and employment opportunity for facilities assessed for different activities.

Activity	Port of Morehead City	Radio Island	Port of Wilmington	North Property	Vertex Property	Raleigh Street Property	Eagle Island	Sunny Point Military Ocean Terminal	Southport / NC International Terminal
Staging	$$	$$$	$	$$$			$$$$	$$	$$$
Manufacturing of Subcomponents	$$	$$$	$$	$$$	$	$$$	$$$$	$$	$$$$
Manufacturing of Top Tier Components	$$$	$$$$	$$	$$$$			$$$$	$$$	$$$$
Marshalling	$$$	$$$$	$$$	$$$$			$$$$	$$$$	$$$$
CTV Operations	$	$	$	$			$	$	$
SOV Operations	$	$	$	$			$$	$	$

Key: = unsuitable site for activity

$ = 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 3 years
= greater than 3 years, up to 7 years
= greater than 7 years to complete

= 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

6.6 Intermodal Transportation Assets

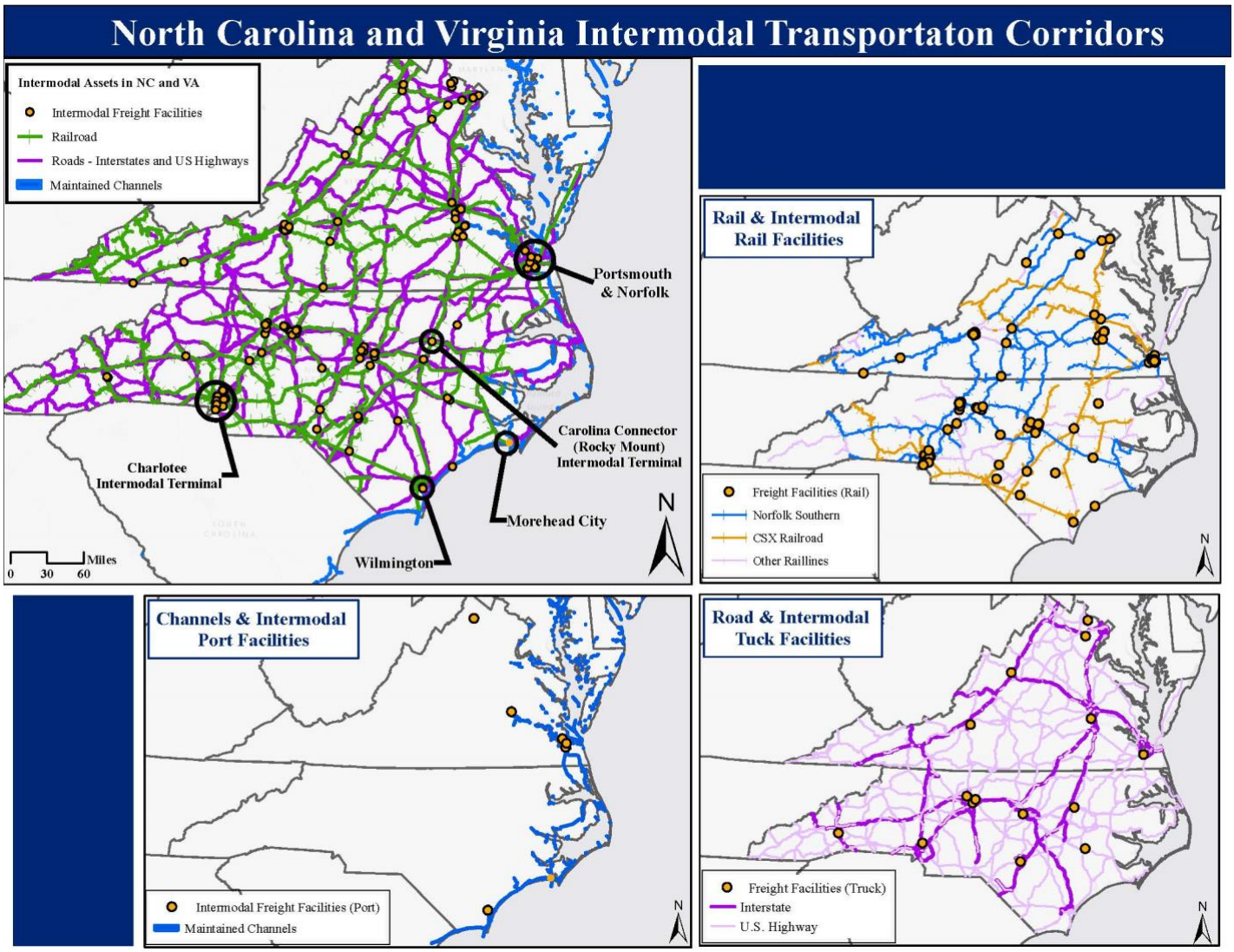


Figure 40 North Carolina and Virginia Intermodal Transportation Resources

As illustrated in Figure 40, one of North Carolina's strongest assets to attract and support the developing OSW manufacturing industry from an infrastructure perspective is the State's intermodal transportation system consisting of high-quality, high-capacity, and integrated roads, rail systems, airports, canal systems and ports, as well as its existing and future manufacturing assets. Its land-side intermodal assets, including the Charlotte and CSX Carolina Connector Terminals, allow for the development and operation of effective logistical models, and will also attract new manufacturing businesses to their regions. As discussed above, there are literally hundreds of manufacturing facilities and potential properties located across North Carolina that could enter into the manufacturing of OSW subcomponents. It is believed that the majority of these facilities already have existing access to one or more intermodal assets that makes their pivoting to OSW manufacturing quite feasible. As such, the opportunities to enter into the OSW manufacturing industry is fully open to inland properties and not just limited to coastal properties or regions.

The majority of Tiers 2, 3 and 4 sub-components are of small enough scale that they can be transported by rail, road and/or shallower-draft maritime vessels to their point of final disposition/use, be it a Tier 1 manufacturing facility located at Radio Island or a major marshaling port located in Virginia or other state. This fully-integrated transportation system also allows State manufacturers to "keep up" with this industry – early OSW projects may require delivery of products to facilities in Virginia, while later third wave projects may be marshalled out to a facility in the Wilmington area. With the existing State transportation system, a manufacturing firm can ship their competed products to the east, west, north and south to service a wide range of project locations. Additionally, manufacturing entities can depend upon this system to allow them to

"play" the raw materials market and not necessarily be limited to a single supplier due to infrastructure constraints.

North Carolina is improved with an intermodal transportation system that fully integrates its road, rail and inland/coastal waterway resources. This system fully connects State's inland manufacturing assets to both North Carolina ports, as well as Virginia marshaling ports via rail, road and maritime vessel. Further, North Carolina is constantly updating its transportation infrastructure as confirmed through the following projects:

- The I-87 corridor project that will be both relevant and synergistic with the CSX Carolina Connector in Rocky Mount and its application to OSW Supply Chain surface transportation critical infrastructure.
- The I-42 project that includes a 137 mile planned interstate route from I-40 south of Raleigh to Morehead City. This highway will support the use of PMC and Radio Island in future OSW projects.
- The I-73 and I-74 that will use a combination of mostly existing highways with some sections of new roadways to make their way through North Carolina. Again, any upgrades to State infrastructure
- The proposed $834 million Wilmington Harbor Navigation Improvement Project which was included in the Water Resources Development Act of 2020. The project would deepen the navigational channel leading to the POW from 42-feet to 47-feet further enhancing the Cape Fear River to support large, deep-draft OSW vessels.

North Carolina's continued upgrading of its transportation resources sends a strong single to manufacturing entities who are considering entering into the OSW market – that of the State is working hard to attract manufacturing businesses and new manufacturing facilities can be located anywhere in the State and utilize the intermodal transportation system to support North Carolina businesses.

The following provides additional discussions points specificity regarding how various entities would be supported by the State's intermodal transportation system issues.:

- **Sub-component Manufacturing Facilities**: This is an industry component that North Carolina "shines in," as all of the State's intermodal transportation resources could be brought into play from an infrastructure perspective. The existing road system consisting of well-maintained and high-capacity assets will allow the transport of raw materials to various manufacturing facilities, as well as supporting the delivery of smaller sub-components to Tier 1 manufacturing/assembly ports and marshalling ports. For the first wave Kitty Hawk and Dominion OSW projects, these associated "destination ports" will likely be Virginia facilities such as the Norfolk Southern Lamberts Point facility and the Portsmouth Marine Terminal. Both of these facilities are also improved with high-quality rail access. This transportation mode would be very effective in allowing the trans-shipment of completed sub-components from North Carolina manufacturing facilities to Tier 1 manufacturing/assembly facilities.

  A good example of this type of existing facility is the privately-owned Riverbulk Terminal facility discussed above. It is currently zoned and improved to support manufacturing operations. It's location along the Intercoastal Waterway and access to the State's road system would allow an OSW manufacturing entity excellent access for the receiving of raw materials and the distribution of completed component to locations anywhere in the US, especially associated with the projects in the Southeast, Mid-Atlantic and New England regions.

  As second interesting target area for attracting new manufacturing assets to the State is the region around the Charlotte and CSX Carolina Connector Intermodal Terminals. A manufacturing entity setting up shop in either region would have access to the fully integrated and affordable intermodal system located away from the coastline.

- **Tier 1 Component Manufacturing Facilities**: As part of this study, the CSX Transportation Load Engineering and Design Services (LEDS) Group was queried and it was confirmed that due to the scale of industry-anticipated Tier 1 completed components such as blades, nacelles, towers and foundation elements, they will be too large to transport by rail, and by extension, road. As such, completed components must be manufactured, staged, trans-shipped and/or marshalled out of highly specialized coastal port facilities. The existing State port facilities and several of the NCSPA-owned, currently undeveloped water-side assets have access to the appropriate waterways to support this component of the OSW industry. Further, these facilities typically have current road/rail access to, or their access points could be upgraded, to support the delivery of raw material and sub-components from land-side manufacturing facilities located elsewhere within the State. As such, the State's road, rail and maritime assets will allow land-side facilities to manufacture sub-components and allow delivery of them to Tier 1 component manufacturing facilities for eventual delivery to marshaling ports.
- **Staging Facilities**: In this scenario, State port facilities are utilized to take delivery of Tier 1 components from overseas that are then staged and eventual loaded onto maritime vessels to a marshaling port. This port use would require road-way access to allow port workers to access the property, and potentially typical marine vessel stevedoring providers such revictuals, fueling vehicles, sanitary waste vehicles, etc., to

service vessels visiting the property. This port use offers North Carolina with an early entrée into the OSW industry.

- **Construction Base/Marshaling Facilities**: These types of OSW facilities have to most challenging and complex logistical operating models as there needs to be “just enough” Tier 1 component available at the port to allow for the preassembly of major components prior to their trans-shipment out to the WTIVs servicing the offshore windfarms. The facilities must have sufficiently long and robust quaysides to support the delivery of components and to allow for the simultaneous transport of pre-assembled components out to the windfarms.
- **CTV/SOV O&M Facilities:** O&M ports will be operation for well over 20 years to support the long-term operations of the windfarms located off the US East Coast. Due to their steaming-distance limitations, CTV facilities are typically located relatively closely to the associated windfarms that restricts their locations. For instance, CTVs would not likely stage out of Radio Island for service the Kitty Hawk project. As they stay out as sea for several weeks at a time, SOVs have much larger service areas. In general OSW O&M facilities are much smaller in scale and typically not constrained by access to high-speed or large-capacity intermodal resources.

7 North Carolina's business climate – strengths, gaps and implications for offshore wind

Summary: Much of North Carolina's competitive edge in the offshore wind space revolves around the state's strengths in manufacturing, augmented by the state's long history as a leader in clean energy market development. Traditional industrial recruitment and retention strategies are potentially the most important tools for attracting and expanding opportunities for OSW component suppliers, while actions to expand the clean energy market in North Carolina have the dual benefit of expanding the total east coast market opportunity, as well as shifting the nexus of market development down the East Coast and closer to the North Carolina labor market. The following menu of policy options includes a mix of best practices demonstrated by other states and new ideas that best take advantage of North Carolina's inherent strengths.

For North Carolina Industrial/Manufacturing Policies:

Prepare

- Designate a North Carolina OSW Director for Economic Development. [R17]
- Create an OSW economic development team. [R18]
- Organize and facilitate a North Carolina OSW Industry Task Force. [R19]
- Establish year-round schedule of regular outreach events – virtual or in person. [R20]

Facilitate

- Organize "fact finding" visits to wind installations for local and state policymakers and business leaders. [R24]
- Support research including public/private partnership development for OSW deployment. [R25]
- Support public/private research collaboration for OSW advanced manufacturing and supply chain logistics. [R26]
- Provide tailored coaching and mentoring to individual companies regarding OSW. [R27]
- Work with utilities to Enable Large Energy Users to Directly Access OSW Resources. [R28]

Accelerate

- Create and fund a North Carolina Green Bank that can provide investment to support OSW firms. [R30]
- Provide targeted incentive support to OSW-related firms. [R31]
- Provide targeted incentive support for OSW innovation. [R32]
- Reinstate and expand the Renewable Energy Equipment Manufacturer Tax Credit. [R33]

For expanding North Carolina's Clean Energy Market:

Prepare

- Designate a formal offshore wind point person in NCDEQ. [R6]
- Study wholesale market reform options and ensure that implications for OSW are considered. [R7]

Facilitate

- Accelerate Leasing of Existing WEAs in the Carolinas and Pursue Additional Area Designations. [R8]
- Remove barriers to investment in grid infrastructure. [R9]
- Identify permitting steps for onshoring transmission and land-based infrastructure. [R10]

Accelerate

- Set an OSW deployment target for the State. [R11]
- Create a specific OSW procurement mechanism. [R12]
- Create more opportunity for OSW capacity expansion through decarbonization efforts. [R13]

For Workforce:

Prepare

- Conduct a job skills analysis. [R34]
- Develop an inventory of industry-relevant training already available. [R35]
- Promote the training opportunity to North Carolina. [R36]
- Promote the training opportunity to the OSW Industry. [R37]

Facilitate

- Establish a Wind Energy Technician Training Program. [R38]
- Establish training partnership with the Mid-Atlantic Wind Training Alliance. [R39]

Accelerate

- Provide funding for new infrastructure, equipment and curriculum. [R40]

In this section we note North Carolina's strong business climate for manufacturing and examine the existing and new economic development incentives that can be used to attract industry or businesses, that facilitate the deployment of OSW.

7.1 North Carolina's General Business Climate

North Carolina's manufacturing environment has many companies with expertise across many sectors. It is the type of environment that wind turbine and wind turbine component manufacturers in particular will find familiar. It already has manufacturing for onshore wind turbines and the hope is that it would be seriously considered for the manufacture of components currently only manufactured in Europe. North Carolina's strengths include:

- Ranking 1st among east coast states and 5th in the nation in the value of its manufacturing sector's Gross Domestic Product (GDP)[35]. The nearest east coast state is New York, ranked 9th, with a level that is 30% lower than North Carolina's; the remaining east coast states have levels that are at least 40% lower.
- Out of all industrial sectors, manufacturing leads the state in GDP contribution at 17.2%. The nearest east coast state is South Carolina, with 16.3%.
- The largest manufacturing industries, by employees, are food, chemicals, fabricated metal products, transportation equipment and machinery
- Manufacturing employs over 470,000 workers in the state in 10,250 manufacturing companies.[36]
- The weekly wages in manufacturing place it 7th among the state's 19 industrial sectors. Manufacturing wages are higher on average than healthcare and social assistance, transportation and construction.
- The governors of Maryland, North Carolina, and Virginia forming in 2020 the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER).[37] This recognizes that working together these three states can make the region the natural choice for the offshore wind supply chain.
- Having highly rated quality of life factors including[38]
  - Low cost with high personal satisfaction
  - Moderate climate - mild winters, long pleasant periods of spring and fall, and warm summers, and
  - Top medical facilities.
- Generally having a low tax burden offering one of the lowest-cost tax environments for business in the country. A national non-profit think tank, The Tax Foundation, ranked North Carolina the fourth best

[35] Based on 2019 data from the US Bureau of Economic Analysis.

[36] North Carolina Manufacturing Extension Partnership (NCMEP), 2019 data.

[37] Memorandum of Understanding Among Maryland, North Carolina, and Virginia To Create the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER), https://files.nc.gov/governor/documents/files/SMART-POWER-MOU_FINAL.pdf, last accessed February 2021.

[38] You'll Love It Here In North Carolina, https://edpnc.com/why-north-carolina/quality-of-life, last accessed February 2021.

climate for corporate taxes and the tenth best overall in its *2021 State Business Tax Climate Index*[39], that measures the impact of each state's taxes on business activities.

7.1.1 North Carolina's infrastructure and policies support offshore wind

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

- Pro-business climate
- Strategic geographic location
- Relatively large electricity consumption (9% of east coast states' electricity) and growing demand for renewable energy
- Relatively low CO_2 electricity footprint
- The North Carolina Clean Energy Plan set goals of 70% reduction in power sector greenhouse gas emissions by 2030 and a carbon-neutral power sector by 2050[40]
- The major electricity provider to most of North Carolina, Duke Energy is on a trajectory to meet its near-term carbon reduction goal of at least 50% by 2030 and long-term goal of net-zero by 2050[41]
- Good transport links for components including for smaller components by inland waterways, rail and road
- Congestion-free navigation
- Unrestricted air draft waterways
- High-quality maritime workforce, and
- Existing waterfront and infrastructure with further potential to expand, and
- Relatively low-cost land.

7.1.2 Local offshore windfarms would provide a boost to the industry

- Together, Maryland, North Carolina, and Virginia have over a third of the electrical consumption of the coastal states from Maine to Georgia. This reflects the sizeable role of manufacturing in these states, not just population.
- North Carolina's large electricity consumption relative to other Atlantic Coast states and its appetite for clean energy indicate a large potential for offshore wind to meet the state's clean energy needs in coming decades. For example, 8 GW of offshore wind would generate a quarter of the state's 2019 electricity consumption, and electricity demand is expected to increase as the state's economy decarbonizes through 2050.

7.1.3 Lessons from Europe

The offshore wind industry was established in Europe and the contracting largely follows its established pattern. The UK has the largest market to date and has seen considerable reductions in the price of offshore wind. It now has a target of 40GW by end 2030. The market is rapidly becoming a global market both in location of windfarms and the supply chain with many oil and gas companies pivoting to supply offshore wind.

Initially offshore wind projects required significant price support, so it was necessary for European governments to offer that. As the price dropped and supply increased European governments then made it a requirement to bid for that support and auctions have reduced the price further to levels at or below any other future electricity generation. All established European markets require developers to take part in an auction for price support. In the UK model there is a two-stage process where a developer competes to develop a specific site and once won and developed, it competes again for price support in the form of a contract for difference (CfD) offer by the Government. In the Danish model that is used by many other countries, the state develops the windfarm and has a single auction process for the developer to compete to finalize the development and get some price support again in the form of a CfD. The CfD guarantees a price for the power. If the developer does not achieve that, then the Government funds the difference in revenue, while if the developer exceeds the price it pays the extra revenue to the Government. In the UK, the CfD is for 15 years and the last Allocation Round 3 resulted in the price of 39.65 £$_{2012}$/MWh for windfarms going live in 2023/24. This price is below the expected reference price of electricity, so the Government expects to achieve an income from them. It is the 15 years of price certainty in the CfD that is what developers need. In other European

[39] State Business Tax Climate Index, https://statetaxindex.org/state/north-carolina, last accessed February 2021.

[40] North Carolina Clean Energy Plan, https://deq.nc.gov/energy-climate/climate-change/nc-climate-change-interagency-council/climate-change-clean-energy-16, last accessed February 2021.

[41] Duke Energy presents options to further accelerate carbon reduction in Carolinas, Duke Energy, https://news.duke-energy.com/releases/duke-energy-presents-options-to-further-accelerate-carbon-reduction-in-carolinas, last accessed February 2021.

countries where transmission is provided by government, bids of zero have been received where bidders are expecting to rely solely on the market for their income and certainty of income. In those economies offshore wind is the cheapest form of new generation. While there will be challenges of adapting the energy system both technically and commercially, it will now be done around wind generation as the core future generation technology.

LCOE for offshore wind has fallen dramatically in Europe and is projected to fall further with 30% cost reduction for windfarms installed in 2030 as the next generation of larger turbines (14MW+) are installed. This reduction will happen despite an overall small trend towards deeper and further from shore sites. Since the wind turbine market is global, the US will benefit from almost all that LCOE reduction, but will have some higher cost due to some installation inefficiencies arising from the lack of Jones compliant vessels and higher transport costs as key components continue to be supplied from Europe.

The largest supply contract is for turbine supply that covers the turbine, tower, and installation of the tower and turbine. This contract is invariably tied with a parallel operations and maintenance contract that covers the supply of operations and maintenance that includes elements of the port base. Wind turbine suppliers have a pecking order of what major components they are willing to contract to others. They routinely do this with towers and installation.

Type certification of a turbine involves assessing the suppliers of safety critical components and so that will limit the suppliers a wind turbine supplier is able to use. Also, since the major components are now so large, supply will be limited to those with suitable facilities to manufacture them. Usually, such suppliers invest in parallel with the wind turbine manufacturers to enable production of the next generation of turbines.

The three main turbine suppliers build their own blades and will decide where and when to have new facilities as current facilities reach capacity. The location will depend on the location of the market so US and Asia are likely candidates. We explore the likelihood of new US facilities in Section 4.

The UK has the largest offshore wind market but has struggled to attract major component suppliers. Industry and the UK Government agreed in 2019 to a sector deal to raise UK content from its current 45% to 60% for windfarms installed in 2030.[42] The UK's current focus is on attracting suppliers of monopiles, towers, blades, cables and reestablishing substation manufacturing where it believes it is competitive. There are some other activities such as jacket foundation manufacture where the UK knows it is inherently uncompetitive due to the relatively high labor content and size of the investment needed to overcome that, that it will not seek to maintain or establish such facilities. There are significant differences between the ongoing struggle to establish supply chain in the UK and establishing supply chain on the US East Coast. The US market is further from Europe so there are far greater transport risks and costs. The world market is growing, requiring further production facilities and the US east coast market is growing to such a scale that it makes sense to locate new production in the US than elsewhere in Europe. Auctions in the US are triggering investments in facilities to make the heavy components such as towers and gravity foundations which are the first components expected to be manufactured in a new market. That is happening at an early stage in the US market and gives confidence that further manufacturing with be established in the US.

Another factor that is relevant to manufacturing for offshore wind is the importance of regional clusters. This is a young industry being driven rapidly by technology and process innovation. It is useful for higher-tier manufacturers to be close to a relevant manufacturing ecosystem to help drive them forwards.

Innovative manufacturers need such things as: lower-tier suppliers, equipment suppliers, specialized software vendors, relevant consultants, specialized industry testing facilities, a labor pool of sufficient size with good local training at a variety of levels, university-level research, funding for small innovators and the ability to see their products in use and get feedback from customers. Germany and Denmark have experienced this and will look for similar cultures before releasing more complex components currently made and assembled in Europe to local manufacture. NC's manufacturing strengths are that it has many of these elements in place already and as the industry develops it will need to ensure that its clusters or ecosystems become more than the sum of their parts.

An aim of NC working with Maryland, and Virginia in the Southeast and Mid-Atlantic region should be to make itself the easiest location in the US to do offshore wind business in, and so the "natural choice" for the supply chain.

7.2 Drivers for OSW Supply Chain - Policy Options for Manufacturing and Energy Markets

As discussed throughout this report, much of North Carolina's competitive edge in the offshore wind space revolves around the state's strengths in manufacturing and

[42] Industrial Strategy Offshore Wind Sector Deal, HM Government, https://www.gov.uk/government/publications/offshore-wind-sector-deal , last accessed February 2021.

the opportunity to be a home to significant parts of the newly emerging east coast supply chain for a projected 30+GW, $100+ billion industry over the next decade. This overarching strength in manufacturing is augmented by the state's long history as the Southeast's leader in clean energy market development. ***When evaluating policies and programs that can support the state's efforts to capitalize on this opportunity, the potential tools fall into two categories - industrial/manufacturing and expanding the clean energy market.*** Traditional industrial recruitment and retention strategies are potentially the most important tools for attracting and expanding opportunities for tier 1 and 2 component suppliers. Actions to expand the clean energy market in North Carolina have the dual benefit of expanding the total east coast market opportunity, as well as shifting the nexus of market opportunity down the East Coast and closer to the North Carolina labor market. Both of these are considered as a part of this analysis in the following two sections (7.3 and 7.4). The report will summarize both:

- The existing state polices, programs and ongoing actions relating to both *industrial/manufacturing* and *expanding the clean energy market* that affect the environment for OSW development in the state; and
- Examples of the policy "best practices" used by other states, as adapted to fit the North Carolina context, as well as new ideas specific to North Carolina's OSW market status.

Section 7.5 concludes the discussion on North Carolina's business climate for offshore wind by summarizing existing relevant workforce support for firms and identifying additional options the state can pursue based on stated industry needs and the best practices identified by a review of other states.

7.3 North Carolina Industrial/Manufacturing Policies

North Carolina has a host of existing industrial recruitment and retention policies and programs already available to support both new firms coming to the state and existing North Carolina firms to expand and reorient to the needs of the OSW industry. Other east coast states have identified additional wind-specific industrial policy offerings to supplement their existing economic development toolbox and truly raise their state's attractiveness in the eyes of manufacturers. This section identifies our existing polices and notes some of the best practices used elsewhere that North Carolina policymakers should consider.

7.3.1 Current Industrial Recruitment and Retention Policies

With a goal of lessening tax burdens and lowering overall operating costs for companies that invest and create jobs in North Carolina, the state offers numerous discretionary grants, tax exemptions, and other support for companies that are interested in locating and doing business in the state. These incentives are coordinated by EDPNC and sponsored by multiple state and local economic and community development sources.

For recruitment and retention, EDPNC will take a lead role with large manufacturers, service companies and other major investors/employers. Additional support will be provided by NCDOC, which awards and administers all economic development incentives. For the largest potential employment and investment recruitments, EDPNC, NCDOC, the Governor's Office and the North Carolina General Assembly can all be involved in developing custom incentives; however, the state has a wide range of standardized programs and incentives that have relevance to the OSW sector, including:

- Job Development Investment Grant (JDIG) and the Transformative Project JDIG
- One North Carolina Fund (OneNC)
- Specific grant funds targeting Building Demolition and Reuse, Public and Transportation Infrastructure Needs, and
- Tax Exemptions (from sales and use taxes) for Manufacturing and R&D.

***North Carolina Development Tier Designations*.** The N.C. Department of Commerce annually ranks the state's 100 counties based on economic well-being and assigns each a tier designation. For 2021, the 41 most distressed counties are designated as Tier 1, the next 39 as Tier 2 and the 20 least distressed as Tier 3.[43] This tier system is incorporated into both the JDIG and OneNC Fund programs to encourage economic activity in the less prosperous areas of the state. Figure 25, below, is a map of 2021 economic development tiers for North Carolina counties.

[43] Most years, the distribution of Tier Designations is 40/40/20 but for 2021, per the accompanying memo released with the 2021 designations, there is a tie for the 40th position in Tier One, leading to the 41/39/20 distribution. For more information see https://files.nc.gov/nccommerce/documents/Research-Publications/2021-Tiers-memo_asPublished_113020.pdf, last accessed February 2021.

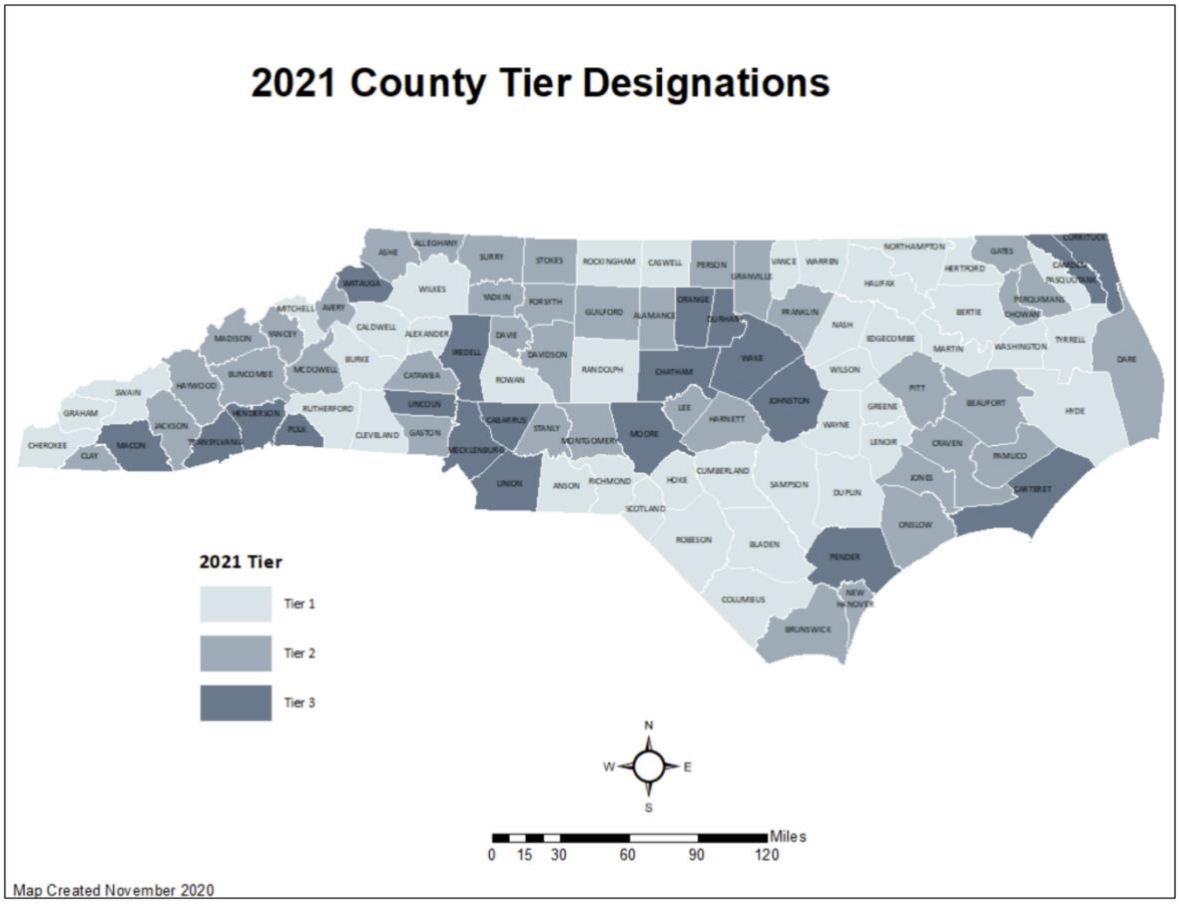


Figure 41 Map of 2021 priority for economic development tiers for North Carolina counties.

Job Development Investment Grant (JDIG)[44] and Transformative Project JDIGs. [45] The JDIG is a performance-based, discretionary incentive program that provides cash grants directly to new and expanding companies to help offset the cost of locating or expanding a facility in the state. The amount of the grant is based on a percentage of the personal income tax withholdings associated with the new jobs.

The amount of a JDIG award is calculated by weighing a number of factors to determine its potential value, including the location of the project, the county tier designation, the number of net new jobs, the wages of the jobs compared to the county average wage, the level of investment and whether the industry is one the state's targeted industry sectors. Grant funds are disbursed annually, for up to 12 years, to approved companies following the satisfaction of performance criteria set out in grant agreements.

For projects located in a Tier 1 county, 100% of the annual grant is paid to the company. For projects located in a Tier 2 county, 90% of the annual grant is paid to the company, and 10% is transferred to the Utility Account, a state program to fund infrastructure projects in Tier 1 and Tier 2 counties. For projects located in a Tier 3 county, 75% of the annual grant is paid to the company, and 25% is transferred into the Utility Account.

There are no restrictions on the use of JDIG funds. The company can use JDIG funds for any purpose.

For a project to be considered for JDIG, the following criteria must be met:

- The project must be competitive with locations outside North Carolina and remain competitive until the grant is formally awarded.
- The project results in a net increase in the company's employment in North Carolina. JDIG cannot be used to incent job retention.
- The project increases opportunities for employment and strengthens the state's economy.

[44] "Job Development Investment Grant," https://edpnc.com/incentives/job-development-investment-grant/, last accessed February 2021.

[45] "Transformative Project – Job Development Investment Grant," https://edpnc.com/incentives/job-development-investment-grant-transformative-project/, last accessed February 2021.

- The project is consistent with the economic development goals of the state and of the area in which it is located.
- The project must meet the county average wage requirement.
- The grant must be necessary for the completion of the project in North Carolina.
- The benefits to the state outweigh the costs, rendering the grant appropriate for the project.
- The company must provide health insurance and pay at least 50% of the premiums for participating employees.
- The company must meet statutory occupational safety and environmental compliance requirements.
- For a project in a Tier 3 county, the local government(s) must provide incentives.

A five-member Economic Investment Committee (EIC) evaluates projects and makes decisions regarding JDIG awards. NCDOC administers the program on behalf of the EIC. Grant applicants are required to pay a $10,000 nonrefundable fee with the submission of a completed application if the project is either a high-yield project, transformative or located in a Tier 3 area, $5,000 if the project locates to a Tier 2 area, and $1,000 if the project locates in a Tier 1 area. Grant recipients are also required to pay an annual fee with the submission of each annual report, when filed with the NCDOC. The annual fee amount is the greater of $2,500 or .03% of the grant amount awarded to the company. North Carolina statute requires that the company maintain operations at the project location, or at another approved site in North Carolina, for at least 150% of the term of the grant.

JDIG has a High-Yield Project (HYP) provision for any company that creates 1,750 jobs and invests $500 million, which can provide a grant worth up to 90% of personal income withholdings for up to 20 years. JDIG also has a *Transformative Project* provision for any company that creates 3,000 jobs and invests $1 billion, which can provide a grant worth up to 90% of personal income tax withholdings of eligible employees for up to 30 years. In addition, as long as the company maintains the minimum requirements, all jobs created over the term of the grant – again, up to 30 years, can be included in the annual grant payment calculations.

One North Carolina Fund (OneNC). OneNC is a discretionary cash-grant program that allows the Governor to respond quickly to competitive job-creation projects. The North Carolina Department of Commerce (NCDOC) reviews applications and makes recommendations for funding to the Governor. Awards are based on the number of jobs created, level of investment, location of the project, economic impact of the project and the importance of the project to the state and region.

Awards are allocated to local governments as part of a negotiated challenge grant. By statute, OneNC requires that a local government provide an incentive to match the OneNC funding. The required local match depends on the tier designation of the county.

In a Tier 1 county, the local government must provide no less than one dollar for every three dollars provided by OneNC. In a Tier 2 county, the local government must provide no less than one dollar for every two dollars provided by OneNC. In a Tier 3 county, the local government must provide no less than one dollar for every one dollar provided by OneNC.

Funds awarded to a company must be used for 1) installation or purchase of equipment; 2) structural repairs, improvements or renovations of existing buildings; 3) construction of or improvements to water, sewer, gas or electric utility distribution lines or associated equipment for existing buildings; and/or 4) construction of or improvements to water, sewer, gas or electric utility distribution lines or associated equipment for new or proposed buildings to be used for manufacturing and industrial operations.

For a project to be considered for OneNC, the following criteria must be met:

- The project must be competitive with locations outside North Carolina and remain competitive until the grant is formally awarded.
- The project must meet the county average wage requirement.
- The local government must match the grant via cash, fee waivers, in-kind services, infrastructure improvement or donations of land, buildings or other assets.
- The company must provide health insurance and pay at least 50% of the premiums for participating employees.
- The company must meet statutory occupational safety and environmental compliance requirements.

Applications are accepted on an ongoing basis and subject to availability of funds. OneNC funding is dispersed in 25% increments as the company creates new jobs. For instance, if a company commits to creating 100 jobs over three years, as soon as the company has created the first 25 jobs, it is eligible to receive 25% of the award. North Carolina statute requires that the company maintain at least 90% of the new jobs in operation at the project location, or at another approved site in North Carolina, for a period of up to two years after the grant end date.

Other Economic Development Grant Programs – Building Demolition and Reuse. The Community Development Block Grant, Demolition Program (CDBG Demolition) and the Building Reuse Program (CDBG Building Reuse) are designed to fund the demolition of

vacant and dilapidated industrial buildings and properties, or to renovate and upfit vacant industrial and commercial buildings for economic development purposes. A pair of similar programs, the Rural Building Demolition Program and the Rural Division - Building Reuse Program, target rural communities using North Carolina Development Tier Designations as part of the decision criteria.

Other Economic Development Grant Programs – Public Infrastructure and Transportation. Three Public Infrastructure incentive programs exist. The Community Development Block Grant, Economic Development Program provides grants to units of local government for public infrastructure development. The Utility Account program provides infrastructure grants to units of local government in Tier 1 and Tier 2 counties in the state. The Rural Division, Economic Infrastructure Program provides grants to local governments to assist with public infrastructure projects that will lead to the creation of new, full-time jobs.

The Golden LEAF Foundation, a North Carolina grant-making organization that manages the state's tobacco settlement funds, also makes infrastructure grants through its Economic Catalyst Program. Golden LEAF considers applications to assist eligible state, regional and local economic development entities with grants to support projects in which a company will commit to create a specific number of full-time jobs in a tobacco-dependent or economically distressed area.

Additionally, three grant programs provide assistance for transportation infrastructure needs that benefit economic development. The North Carolina Departments of Commerce and Transportation sponsor a Joint Economic Development Program that can provide transportation improvements and infrastructure that expedites industrial/commercial growth and provides new jobs or job retention. The North Carolina Department of Transportation (NCDOT) also provides a Rail Industrial Access Program that uses state funds to assist in constructing or refurbishing railroad spur tracks required by a new or expanding industry to encourage economic development. Finally, the North Carolina Railroad Company (NCRR) offers the NCRR Invests program, which provides assistance to companies that take advantage of the state's freight rail opportunities and create jobs by locating or expanding their company in North Carolina.

Manufacturing and R&D Tax Exemptions. North Carolina offers one of the lowest-cost tax environments for business in the country, including generally low tax rates as well as several targeted tax exemptions for manufacturing and R&D investment.

Some of the state's relevant corporate exemptions include:

- *Machinery and Equipment, Sales and Use Tax Exemption* - Mill (generally manufacturing) machinery, including parts or accessories as well as specialized equipment for loading or processing, is exempt from sales and use tax. For a list of items that are classified as mill machinery, please see Section 58 of the North Carolina Department of Revenue's Sales and Use Tax Technical Bulletin.[46] Note, North Carolina does not levy a sales and use tax on repairs to industrial machinery or service contracts for mill machinery.
- *Electricity, Fuel and Natural Gas, Sales and Use Tax Exemption* - Retail sales, as well as the use, storage or consumption of electricity, fuel and piped natural gas sold to a manufacturer are exempt from sales and use tax for use in a manufacturing operation. This exemption does not apply to electricity used at a facility at which the primary activity is not manufacturing. For purposes of the exemption, a "facility" is (1) a single building or (2) a group of buildings that are located on a single parcel of land or on contiguous parcels of land under common ownership. "Facility" also refers to any other related real property contained on the parcel(s) where manufacturing activity occurs.
- *Raw Materials, Sales and Use Tax Exemption* - Purchases of ingredients or component parts of a manufactured product that become an ingredient or component part of tangible personal property are exempt from sales and use tax. In addition, packaging items that constitute a part of the sale (retail or wholesale) and are delivered with the product to the customer are exempt from sales and use tax.
- *Inventory, Property Tax Exclusion* - North Carolina and its local governments do not levy a property tax on inventories. Inventories owned by contractors, manufacturers and merchants (retail and wholesale) are excluded from property tax. Inventories are defined as goods held for sale in the regular course of business by manufacturers, retail and wholesale merchants and construction contractors. For manufacturers, the term inventory includes raw materials, goods in process and finished goods, as well as other materials or supplies that are consumed in manufacturing or processing. Inventory also refers to any commodity or part thereof that accompanies and becomes part of the property being sold.
- *Research and Development Activities for Physical, Engineering and Life Science Companies* - Sales of equipment, or an attachment or repair part for

[46] "NC Tech Bulletin Sect 58," https://www.sales-tax.info/PDF_Files/NCTech%20Bulletin%20Section%2058%20-%20NC%20Mfg.pdf, last accessed February 2021.

equipment for companies primarily engaging in research and development activities in the physical, engineering, and life sciences, including in the industry group, 54171 NAICS code is exempt from sales and use tax.

For a full list of items that are exempt from the sales and use tax, please see North Carolina General Statute 105-164.13.

Other Economic Programs. The NCDOC administers the *One North Carolina Small Business Program*, which helps small, innovation-based companies bridge the gap between innovation and the marketplace – by matching highly competitive federal Phase I Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) grants. These grants help the small businesses develop and commercialize innovative new technologies.

Duke Energy, Dominion Power and the state's municipal and cooperative utilities also all have economic development programs and tariffs designed to improve energy-related infrastructure and to reduce energy costs for manufacturing companies. These utilities work closely with EDPNC and their programs are described on the websites of the power companies.

Current Wind Leadership Infrastructure. The Governor's Office has already designated several key roles and structures within state government to facilitate OSW development in the state. The state has a *designated liaison to BOEM* for federal policy and regulatory issues within the NCDEQ as well as an *Interagency OSW Task Force* led by the Governor's Office, which includes representatives from EDPNC, NCDOC, NCDEQ, NCDOT, NC Ports, and NCDMVA. The Task Force meets quarterly to discuss coordinated state strategy and action in support of the industry.

7.3.2 Industrial/Manufacturing Best Practices for OSW

For North Carolina to capture a strong position in this rapidly growing industry, active steps are critical to increase OSW awareness with businesses, economic development professionals, workforce development, the legislature and infrastructure decision makers. Growing such awareness is time critical to address the significant lead times and capital cost required to advance new windfarm developments for North Carolina, as well as establishing an industrial base to serve the offshore wind industry all the way up the East Coast.

Several other states have recognized that especially for anchor companies, only one or two locations will be needed to serve the entire market. For example, a monopile foundation plant has committed to the Paulsboro area in New Jersey, and a wind turbine tower plant has been announced for upstate New York on the Hudson River. Once these first wave projects have taken position, the business case for a second location is likely to be weaker, illustrating the advantage of moving early.

The following menu of policy options includes a mix of best practices demonstrated by other states and new ideas that best take advantage of North Carolina's inherent strengths. These options focus on several critical themes that emerged in discussions with industry and North Carolina stakeholders as well as reviews of other states' actions:

- *Expand OSW Personnel* – the OSW industry, neighboring state partners, other state agencies and existing North Carolina economic development and workforce stakeholders need both a concierge for state services and a coordinator to make sure existing and new programs prioritize and work for the OSW industry.
- *Raise awareness* – there should be multiple efforts to raise awareness of the OSW opportunity for the state, focused on businesses, policymakers, economic development professionals, and educational institutions.
- *Promote public/private research partnerships* – the State's research universities are well positioned to work with the wind industry on issues they face today in advanced manufacturing and environmental/siting interests as well as in helping to develop next generation energy grid systems and turbine components.
- *Provide financial support* – along with states' generic recruitment incentive programs, many have found ways to create custom incentives for offshore wind and other clean energy firms to set themselves apart from their neighbors when recruiting firms.

We believe that each of these options warrant further discussion and deliberation. Stakeholders and decision-makers are advised to carefully evaluate the implications of the below options—and the subsequent design and implementation of those options—in the regulatory and market context of North Carolina. Specific recommendations are described blow.

Prepare

- *Designate a North Carolina OSW Director for Economic Development [R17].* Identify a specific lead for the state's economic development strategy as it relates to the OSW opportunity, based in NCDOC. Multiple east coast states including Massachusetts, New York, New Jersey, Rhode Island, and Virginia have all identified, at a minimum, a key point-of-contact for OSW discussions in their respective states. The Offshore Wind Director would be responsible for administering a North Carolina Office for Offshore Wind (described below), and lead efforts to develop and enhance services to optimize the State's effectiveness in attracting, supporting, growing and retaining a strong OSW supply chain. The Director

would also serve as a representative on the state's Interagency OSW Task Force, and support NC's role in the tri-state gubernatorial MOU on regional OSW collaboration, the *SMART-POWER* Agreement, described in Section 7.3, below.

- *Create an OSW Economic Development Team [R18].* Designate an OSW lead for key agencies and state entities that should have a proactive role in growing the OSW economic opportunity for the state. The OSW Economic Development Team should be led by the OSW Director for Economic Development and include representation from state entities including (but not limited to) NC Works, EDPNC, NCDEQ, and NCSU's NCCETC and Industry Expansion Solutions (IES). This will allow the State to better understand the OSW industry needs and to integrate OSW as a priority into the day-to-day workforce and economic development work of NCDOC and EDPNC. The North Carolina OSW Economic Development Team should:
    - Serve as the custodian of the roadmap to achieve any future North Carolina offshore wind commercial development goal,
    - Provide clear and timely guidance on eligibility and access to existing resources applicable to offshore wind, and
    - Provide regular updates covering market and technology development, university collaborations, project schedules, supply chain opportunities and other resources as appropriate.
- *Organize and Facilitate a North Carolina OSW Industry Task Force [R19].* An industry cluster, similar to the efforts in Virginia by the Hampton Roads Alliance in partnership with Old Dominion University and the state, could be led by a regional or statewide economic development group or by a university entity with a history of convening diverse stakeholders, like the UNC System's Coastal Studies Institute (CSI) or NCCETC. This activity may need support and leadership from NCDOC or another source. For example, GO Virginia awarded a $529,788 grant to the Hampton Roads Alliance to attract a supply chain for the offshore wind industry to the region. The Taskforce should include industry members and groups like the local chambers of commerce, as well as other stakeholders like the OSW Economic Development Team, the NC State Ports Authority, and representative of the military community.
- *Establish year-round schedule of regular outreach events – virtual or in person [R20].* While senior state leadership and an OSW Industry Taskforce, as noted above, are key drivers to keep stakeholders engaged, there are several options to work with out-of-state OSW promoters to keep the momentum. This has been done in several states and other entities including BOEM, Business Network for Offshore Wind, Sierra Club, National R&D Consortium, developers such as Avangrid, NREL, and global industry organizations such as Norwegian Energy Partners of Carbon Trust.
- *Promote the NC OSW Supply Chain Registry to identify potential supply chain participants [R16]*. As discussed in Section 5.4 above, NCDOC has launched an Offshore Wind Supply Chain Registry database to facilitate business opportunities for existing North Carolina firms with relevant skills and products, as well as for potential corporate recruits that could be enticed to invest in the State. The Registry will be a useful tool for NCDOC and EDPNC to help guide their recruitment efforts and to aid participating firms in tapping into the wide array of assistance available to support their effort to join the rapidly expanding US east coast offshore wind industry. NCDOC should focus on identifying the correct points of contact in potential firms of interest identified through broad efforts like NAICS code searches or industry group memberships.
- *Promote regional collaboration in policy development and supply chain development, working with counterparts in Virginia and Maryland to align offshore wind needs with regional business capacity, to help secure business opportunities for regional state partners [R14].* In support of the SMART-POWER MOU, the state should work with its counterparts in Virginia and Maryland on industry-focused research and other relevant opportunities.
- This work would seek to:
    - Address federal issues as a single voice or with a common agenda
    - Engage collectively with the offshore wind industry to understand supply needs/preferences to help facilitate a 'best fit' scenario with each state's core strengths
    - Coordinate relevant investments in supply chain recruitment efforts, infrastructure at ports, electricity transmission grids, policy development, industry-focused research and other relevant opportunities.
    - Encourage communication and cooperation among companies, workforce training providers and university researchers.
    - Promote the North Carolina manufacturing edge as component supply for major components, and associated manufacturing and coastal facilities in North Carolina.

Facilitate

- *Organize "fact finding" visits to wind installations for local and state policymakers and business leaders [R24].* The NCDOC should organize in person and virtual visits to the Virginia and/or Rhode Island

offshore wind installations in operation. Such visits give policymakers and business leaders a better understanding of the scale of the technologies and the potential economic opportunity. Participants can learn from developers, local economic development officials and area residents during such visits and have an opportunity to ask questions from knowledgeable sources directly involved in the projects.

- *Support research including public/private partnership development for OSW deployment [R25]*. The collective research capabilities of the UNC System institutions and other private universities, including three of the leading research universities in the country (UNC-Chapel Hill, NC State University and Duke University) creates significant opportunity for coordinated industry/academic research on wind sector needs. Such collaborations can entice high-paying research jobs from the private sector's R&D arms, attract federal R&D grant funds to the state's economy and to accelerate the transformation of academic research findings (and inventions) into commercially viable technological innovations and industry practices. Many research needs in the near-term center around the needs of incremental improvement in technology and related infrastructure and deploying today's technology efficiently. Numerous centers and individual researchers work on these kinds of topics and could be promoted to wind companies as research partners. Along with NCSU, Duke and UNC-CH, collaboration with other institutions like East Carolina University, Old Dominion University (VA), and the National Offshore Wind Research and Development Consortium (NOWRDC) may be desirable. For example, under the coordination of the UNC System's Coastal Studies Institute (CSI), the North Carolina Renewable Ocean Energy Program (NCROEP), identifies and provides funding for research that could beneficially be linked to OSW wind industry research priorities around deployment. This work could be conducted under two of the NCROEP's existing Strategic Research Initiatives:
    - Improve the Efficiency, Maintenance and Power Outputs of Renewable Energy Devices - Research and product development is currently underway developing new technologies to improve the overall efficiency and power output of current and future renewable ocean energy devices.
    - Environmental and Regulatory Assessment - Environmental and ecological assessments are researching how marine hydrokinetic energy generation may influence the habitats, ecosystems and uses off the North Carolina coast.
- *Support public/private research collaboration for OSW advanced manufacturing and supply chain logistics [R26].* Identify and coordinate entities in the UNC System with relevant advanced manufacturing research and technical assistance and work with EDPNC and NCDOC to connect these industry-relevant programs to OSW manufacturers to facilitate research, student internships, and opportunities to collaborate on federally funded research grants. Centers like the Nonwovens Institute (NWI)[47] for blade technology, the Supply Chain Resource Cooperative (SCRC)[48] and the Clean Energy Smart Manufacturing Innovation Institute (CESMII)[49] are examples of the types of institutions that could participate. This kind of effort could be coordinated through the UNC Collaboratory, which has experience in managing inter-university partnerships and grants in support of industry-identified needs.
- *Provide tailored coaching and mentoring to individual companies regarding OSW [R27].* NCDOC should work with the Golden LEAF Foundation, the North Carolina Manufacturing Extension Partnership (NCMEP) and Industry Expansion Solutions (IES) at NCSU to offer training for North Carolina companies in expanding into the offshore wind industry. This could be done by partnering with the Business Network for Offshore Wind, as the state of Rhode Island recently announced,[50] to provide a virtual learning course at no cost to state-based businesses interested in entering the OSW market. The Network's *Foundation 2 Blade*[51] training program works to ensure local businesses have the tools and information they need to capitalize on the expanding OSW market. Similarly, in Virginia, the Hampton Roads Alliance and Dominion Energy co-hosted a series of events designed to prepare regional businesses to become part of Dominion Energy's Coastal Virginia Offshore Wind Project. Topics discussed included supply chain opportunities,

[47] Nonwovens Institute (NWI), https://thenonwovensinstitute.com/, last accessed February 2021.

[48] Supply Chain Resource Cooperative (SCRC), https://scm.ncsu.edu/, last accessed February 2021.

[49] Clean Energy Smart Manufacturing Innovation Institute (CESMII), https://www.cesmii.org/, last accessed February 2021.

[50] Business Network for Offshore Wind, https://www.offshorewindus.org/2020/11/19/rhode-island-partners-with-network-for-business-based-osw-training/, last accessed February 2021.

[51] Foundation 2 Blade, https://www.offshorewindus.org/foundation-2-blade/, last accessed February 2021.

supplier diversity, and preparing to work on a Dominion Project.[52]

- *Work with utilities to enable large energy users to directly access OSW resources [R28].* The State should work with utilities and policymakers to create a mechanism where OSW can be made available to larger energy customers in the state to enhance the ability of the economic development community to satisfy the needs of businesses with green energy corporate goals. While the scale of even the largest individual energy users is tiny in the scheme of significant OSW development, such customers tend to be high profile and influential in energy market discussions. Furthermore, certain types of companies (e.g., tech companies, data centers, biotechnology firms) sometimes make siting decisions for their operations at least partially on the basis of the availability of dedicated clean energy supply for their operations. This mechanism could be similar to the Green Source Advantage (GSA) Program established in HB 589 that allowed large businesses, universities, and the military to directly procure renewable energy. The GSA program, which is nearly fully subscribed for large businesses in its current form, could be modeled to allow direct purchase of offshore wind energy by interested customers when it becomes available.

Accelerate

- *Create and fund a North Carolina Green Bank that can provide investment to support OSW firms [R30].* Green banks use funds to reduce the risk for private investment to support energy efficiency and clean energy. Green banks support consumers and businesses in the area of clean energy and could be used, for example, to support investments in public infrastructure needed by firms engaged in OSW supply chain manufacturing or project development. Green banks also facilitate market development by centralizing administration for originators and lenders, and connecting capital supply to market demand. Because green bank investments leverage a diverse mix of funds, they reduce risk to private lenders and induce participation in emerging green markets like OSW. Green banks in other states are capitalized through various sources, such as general appropriations from the state, proceeds from state carbon or renewable energy credit trading programs, and public benefit charges on electric utility bills. There may also be federal support available in the coming months to support a green bank mechanism, or at least federal loan programs that could also be tapped for similar purposes.

- *Provide targeted incentive support to OSW-related firms [R31].* For example, the Maryland Offshore Wind Capital Expenditure Program provides grants to businesses entering the offshore wind supply chain by offsetting their capital costs.[53] Initially, targeted support initiatives 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. The rollout of additional elements could be staged to match the growing needs of the industry, most likely first addressing wind turbine suppliers and second tier suppliers to support manufacturing. The second phase could be targeted toward port infrastructure and attracting businesses involved in construction and deployment as the Wilmington WEAs move forward. The third phase could be the transition to OMS.

- *Provide targeted incentive support to support OSW innovation [R32].* An additional, parallel effort could target innovation for prolonged growth of the supply chain. For example, in New Jersey the state is providing $1.25 million to fund programs supporting innovative, early-stage clean energy technology companies. The New Jersey Economic Development Authority (NJEDA) plans to use this funding in partnership with the New Jersey Commission on Science Innovation and Technology (NJCSIT) to develop a seed grant program that will aid local clean energy technology businesses during critical proof-of-concept and prototyping stages. The NJEDA also intends to execute a research and development asset mapping and voucher initiative to increase equitable access to and utilization of the State's existing clean technology innovation programs and initiatives.

- *Reinstate and expand the Renewable Energy Equipment Manufacturer Tax Credit [R33].* In 2010, North Carolina House Bill 1829 reinstated a tax credit for costs incurred in the construction or retooling of a facility to manufacture renewable energy property or "a major component subassembly for a solar array or wind turbine." Eligible costs include construction and equipment costs specifically associated with the manufacture of eligible equipment. The credit was worth 25% of the eligible costs and claimed in five equal annual installments beginning with the year the facility is placed in service. The credit expired again in

[52] Dominion Project, https://hamptonroadsalliance.com/wp-content/uploads/2020/12/CVOW-Hampton-Roads-Education-Series-Presentation-12-03-2020_FINAL.pdf, last accessed February 2021.

[53] Provide targeted incentive support to OSW-related firms, https://energy.maryland.gov/Pages/Info/renewable/offshorewindbusinessdevelopment.aspx, last accessed February 2021.

2014.[54] Other states on the East Coast use tax credits to encourage investment already: New Jersey has a 100% tax credit for investments of at least $50 million in offshore wind.[55] Rhode Island is using state tax to support redevelopment of a Providence port facility for use in offshore wind development.[56]

7.4 Expanding North Carolina's Clean Energy Market

Since the global oil crises of the 1970s and 1980s, North Carolina has always been regarded as a regional leader investigating and supporting the development of alternative energy sources. Early support for clean energy incentives and the creation of state-chartered institutions like the Alternative Energy Corporation (now known as Advanced Energy) and university programs like the North Carolina Solar Center (now NCCETC) brought the state to prominence as a regional leader in clean energy interest. In 2007, the passage of the Southeast's first (and still only) Renewable Portfolio Standard elevated the state from regional prominence to national leader. The result of the RPS and numerous other policy interventions was to establish North Carolina as the second largest state market for solar deployment in the U.S. and home of one of the largest land-based wind farms on the East Coast. North Carolina has a host of existing clean energy policies and programs in place to support the growth of clean energy in the state, including the OSW industry. This section identifies North Carolina's existing clean energy polices and identifies some of best practices implemented elsewhere that state policymakers could consider to increase the market "pull" for offshore wind.

7.4.1 Existing OSW-Related Clean Energy Policies in North Carolina

The General Assembly, Governor's Office, NC Utilities Commission Public Staff, NCDEQ State Energy Office, the NC Climate Change Interagency Council, and the NC Energy Policy Council all have roles and responsibilities associated with the state's energy policies and programs. Over the years, all of these entities have, at various times, provided significant leadership and policy support for clean energy that has elevated the State to a position of clean energy leadership in the region and the country. Some of the key policies that have helped to create a nascent OSW market in North Carolina include:

- Leadership – initiatives like the recently signed multistate SMART-POWER agreement and the State's 2019 Clean Energy Plan, drive market reforms that open opportunities for clean energy to grow.
- Market structures – structures like the state's renewable portfolio standard set a framework to grow clean energy but allows market forces to optimize implementation of the goal, while still creating opportunities for emerging technologies with "set asides" for North Carolina-relevant technologies (e.g. biomass from swine waste) so they have a chance to grow.
- Focus on removing barriers to growth – studying transmission grid investments that would allow the movement of electricity to load centers, or mitigating concerns about decommissioning windfarms years at end-of-life that could have slowed progress today without proper study and consideration.

Specific existing energy market initiatives and programs with relevance to OSW are described below.

Regional Collaboration – SMART-POWER Agreement.[57] The governors of Maryland, North Carolina, and Virginia formed a three-state collaboration to advance offshore wind projects in the region and promote the Southeast and Mid-Atlantic United States as a hub for offshore wind energy and industry. The creation of the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER) provides a framework for the three states to cooperatively promote, develop, and expand offshore wind energy and the accompanying industry supply chain and workforce. Specifically, the three states have formed a SMART-POWER Leadership Team with representatives from each signatory jurisdiction that work to streamline the development of regional offshore wind resources.

Leadership – Executive Order 80. In October 2018, Governor Cooper issued Executive Order 80,[58] "North Carolina's Commitment to Address Climate Change and

[54] N.C. Gen. Stat. § 105-129.16I, through the DSIRE Database, https://programs.dsireusa.org/system/program/detail/4280/renewable-energy-equipment-manufacturer-tax-credit, last accessed February 2021.

[55] The total expenditure approved for the program is $100 million. See https://www.njeda.com/financing_incentives/large_business/Offshore-Wind-Tax-Credit-Program, last accessed February 2021.

[56] The redevelopment will be funded using tax credits from the Rebuild Rhode Island program. See https://pbn.com/development-of-east-providence-marine-terminal-gains-15m-in-rebuild-rhode-island-incentives/, last accessed last accessed February 2021.

[57] Regional Collaboration – SMART-POWER Agreement, https://governor.nc.gov/news/maryland-north-carolina-and-virginia-announce-agreement-spur-offshore-wind-energy-and-economic, last accessed February 2021.

[58] Governor Cooper issued Executive Order 80, https://files.nc.gov/ncdeq/climate-change/EO80--NC-s-Commitment-to-Address-Climate-Change---Transition-to-a-Clean-Energy-Economy.pdf, last accessed February 2021.

Transition to a Clean Energy Economy." Relevant provisions include:

- Reducing statewide greenhouse gas emissions to 40% below 2005 levels by 2025.
- Creating a North Carolina Climate Change Interagency Council, which is led by NCDEQ and made up of the Secretary or designee of each cabinet agency and a representative from the Governor's Office. The Council's duties include recommending new and updated goals and actions to meaningfully address climate change and developing, implementing, and evaluating programs and activities that support statewide climate mitigation and adaptation practices.
- Directing the NCDOC and other cabinet agencies to take actions supporting the expansion of clean energy businesses and service providers, clean technology investment, and companies with a commitment to procuring renewable energy.
- Directing NCDOC to conduct a clean energy workforce assessment that evaluated the current and projected workforce demands in North Carolina's clean energy sectors, assessed the skills and education required for employment in those sectors, and recommended focus and action to help North Carolinians develop such skills and education for specific clean energy segments seen as promising job creators for the State, including OSW.
- Directing NCDEQ to develop a North Carolina Clean Energy Plan "that fosters and encourages the utilization of clean energy resources, including energy efficiency, solar, wind, energy storage, and other innovative technologies in the public and private sectors, and the integration of those resources to facilitate the development of a modern and resilient electric grid."

Leadership – NC Clean Energy Plan. As directed by EO 80, NCDEQ led the preparation of the 2019 NC Clean Energy Plan (CEP).[59] The CEP increased the states decarbonization goals to reduce electric power sector greenhouse gas emissions by 70% below 2005 levels by 2030 and to attain statewide carbon neutrality by 2050. It also included goals to accelerate clean energy innovation, development, and deployment to create economic opportunities for both rural and urban areas of the state and to foster long-term energy affordability and price stability for North Carolina's residents and businesses by modernizing regulatory and planning processes.

Along with the three goals, the CEP contains more than three dozen recommendations spread across six "strategies" as described in the figure below. Many of the broader recommendations are impactful for OSW, but several specifically target OSW (including the impetus for this report). In Section H of the CEP, "Clean energy economic development opportunities," the report specifically includes three recommendations for OSW:

- H-1. Identify and advance legislative and/or regulatory actions to foster development of North Carolina's offshore wind energy resources.
- H-2. Create and foster statewide and regional offshore wind collaborative partnerships with industry, the public, stakeholders, and neighboring states to bring economic growth to North Carolina.
- H-3. Conduct an assessment of offshore wind supply chain and ports and other transportation infrastructure to identify state assets and resource gaps for the offshore wind industry.

[59] NC Clean Energy Plan, https://files.nc.gov/governor/documents/files/NC_Clean_Energy_Plan_OCT_2019_.pdf, last accessed February 2021.

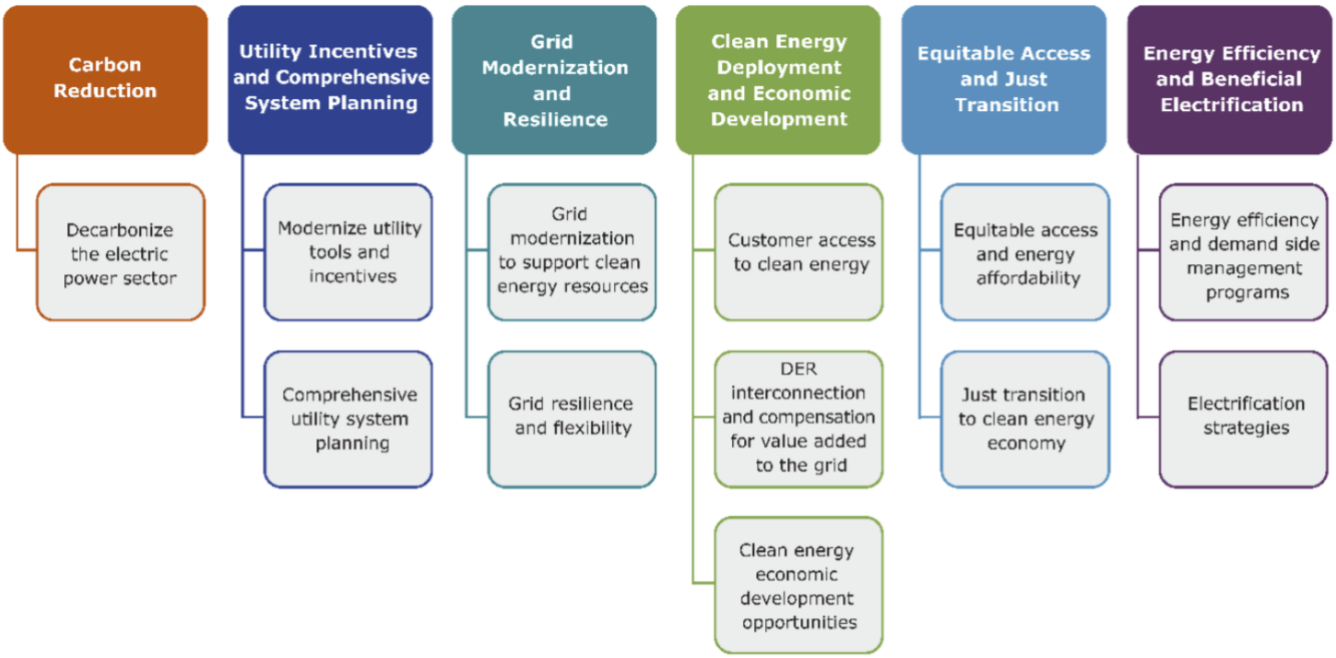


Figure 42 NCDEQ Clean Energy Plan Strategy Areas[60]

Market Studies – The A-1 Carbon Policy Analysis and B-1 "NERP" Study. A key portion of the CEP recommendations are the stakeholder-informed studies for Carbon Reduction (Recommendation A-1) and Utility Incentives and Comprehensive System Planning (Recommendation B-1). These two studies led to the significant stakeholder-driven reports issued in early 2021 with analysis and recommendations to state policymakers on major electricity market reforms. The A-1 carbon policy study group and the B-1 group, also called the North Carolina Energy Regulatory Process (NERP) group, touched on a number of policy issues that would benefit the deployment of OSW, including pathways to decarbonization of the state's electrical system, wholesale power market reform, and increased use of clean energy for new resources. Several of these studies' outputs are mentioned in recommendations below.

From February to December 2020, a group of North Carolina energy stakeholders collaborated through the NERP process to consider updates to utility regulations and electricity market structures. NERP served as a platform for exploration and advancement of CEP recommendations, specifically fulfilling the "B-1" recommendation to "launch a North Carolina energy process with representatives from key stakeholder groups to design policies that align regulatory incentives and processes with 21st century public policy goals, customer expectations, utility needs, and technology innovation."

Through NERP, additional recommendations of the CEP were considered, including in-depth attention to:

- Adoption of a performance-based regulatory framework (PBR) (B-2)
- Enabling securitization for retirement of fossil assets (B-3)
- Studying options to increase competition in the electricity system (B-4)
- Implement competitive procurement of resources by investor-owned utilities (C-3)

NERP participants recommended regulatory changes in four key reform areas, summarized here:

- The General Assembly and the North Carolina Utilities Commission (NCUC) pursue a comprehensive package of PBR reforms to include a multi-year rate plan (MYRP), revenue decoupling, and performance incentive mechanisms (PIMs).
- The General Assembly direct the NCUC to conduct a study on the benefits and costs of wholesale market reform and implications for the North Carolina electricity system.
- The General Assembly expand securitization to be an available tool for electric utilities to retire undepreciated assets, in addition to the current authorization related to storm recovery costs.

[60] CEP, page 53.

- The General Assembly expand existing procurement practices to utilize competitive procurement as a tool for electric utilities to meet energy and capacity needs defined in utility Integrated Resource Plans (IRPs) and where otherwise deemed appropriate by the NCUC.

The full NERP report is available online and several of its recommendations have possible implications for OSW, discussed below. [61]

Transmission – The North Carolina Transmission Planning Collaborative. Transmission owners in North Carolina participate in the voluntary planning organization called the North Carolina Transmission Planning Collaborative (NCTPC), which was established in 2005. Members include Duke Energy Carolinas, Duke Energy Progress, the North Carolina Electric Membership Cooperatives (NCEMC), and municipal power systems (ElectriCities). The NCTPC coordinates a joint transmission planning process with its members. One of the largest barriers to OSW market development identified by utility stakeholders is the need for transmission system upgrades which would allow for easier movement of electricity on an east-west path across the state. As of the date of this report, the NCTPC's Transmission Advisory Group (TAG) is continuing its study of transmission needs associated with the potential development of OSW. An update provided during the December 15, 2020 TAG meeting stated that the study included a "Preliminary Screening" of 29 possible injection sites in eastern North Carolina and 2 in Virginia and that the screening had been reviewed with sponsors. From that list, three sites were selected for more detailed study that is currently underway. A report on the detailed screening is expected by end of Q1-2021.[62]

Clean Energy Targets – North Carolina Renewable Energy and Efficiency Portfolio Standard. Session Law 2007-397, also referred to as Senate Bill 3 (SB-3), requires Investor-Owned Utilities (IOUs) in the state to meet up to 12.5% of their energy needs by 2021 through renewable resources (RE) or energy efficiency (EE) measures. (Electric cooperatives and municipal electric suppliers were only required to meet 10% of retail sales in electricity by 2018 with RE or EE). The electric power suppliers may comply with the REPS requirement in a number of ways, including:

- use of renewable fuels in existing electric generating facilities
- generation of power at new RE facilities
- purchase of power from RE facilities
- purchase of RE certificates,[63] or
- implementation of EE measures.

Under the law, renewable energy includes solar photovoltaic (PV), solar thermal hot water, wind, geothermal, tidal energy and biomass resources. Specific portions of the RE, called "carve-outs" or "set asides," must be derived from solar photovoltaic, swine waste and poultry waste. All electric suppliers must meet these set asides, the requirements for which have ramped up since 2008 to a final required source-specific supply of approximately 1% of the electricity demand by 2020.

Clean Energy Targets – Duke Energy's IRP and the "High Wind" Scenario. Duke Energy's 2020 IRP lays out six scenarios for reaching its goals of halving its carbon emissions by 2030 and achieving net-zero carbon by 2050. Some of the scenarios that would yield the most dramatic carbon reductions are based on more aggressive targets set out in North Carolina's Clean Energy Plan, which suggests cutting emissions 70 percent by 2030 (versus 2005 levels). To reach such a level, Duke fleshed out for the first time in an IRP filing several possible options, one of which is a "high wind" path that would capture the offshore wind potential of the Carolinas coastal waters. Duke noted, however, that such a scenario would require policy changes in both North and South Carolina and increased investment in supply chain and transmission capacity. The "high wind" case sees 2,650 megawatts of offshore wind by 2035.[64] Note that the A-1 carbon policy report described above includes energy and economic modeling that will provide additional information about the costs and benefits of various clean energy futures and policy impacts.

Permitting – HB 589 and Executive Order No. 11. In July 2017, Governor Roy Cooper signed Executive Order No.

[61] North Carolina Energy Regulatory Process, https://files.nc.gov/ncdeq/climate-change/clean-energy-plan/NERP-Final-Summary-Report.pdf, last accessed February 2021.

[62] North Carolina Transmission Planning, http://www.nctpc.org/nctpc/document/TAG/2020-12-15/M_Mat/TAG_Meeting_Presentation_for_12152020_FINAL.pdf, last accessed February 2021

[63] A renewable energy certificate (REC) is a tradable financial certificate, which represents 1 megawatt-hour (MWh) of RE electricity that was generated from an eligible RE source.

[64] https://www.greentechmedia.com/articles/read/duke-energy-lays-out-its-long-term-clean-energy-pathways-and-their-price-tags, last accessed January 2021. Also, https://renews.biz/62394/duke-eyes-offshore-opportunities-off-carolinas/, last accessed February 2021.

11 (EO 11),[65] "Promoting Wind Energy Development," which aims to promote wind energy in the state and to mitigate the effects of the temporary wind energy permit moratorium outlined in HB 589 of 2017 that expired on December 31, 2018. Key provisions of EO11 include:

- Except as provided by law, NCDEQ, the Coastal Resources Commission (CRC), and all other agencies, departments, boards, and commissions under the jurisdiction of the Office of the Governor shall make best efforts to promote wind energy in the State of North Carolina.
- NCDEQ and the CRC shall make best efforts to expedite pre-application review and processing of all wind energy facility and wind energy facility expansion permit applications that are not completed and submitted by January 1, 2017.
- NC DEQ shall to the extent feasible, support the Department of Commerce to make best efforts to recruit innovative energy projects, including wind energy facility and wind energy facility expansion projects, to North Carolina, and process new wind permit applications without prejudice.

Decommissioning – HB 329 Process. HB 329 was signed into law on July 19, 2019. Among its provisions, the law directed the Environmental Management Commission (EMC) to adopt rules developed by a DEQ stakeholder process to manage decommissioning of utility-scale solar and wind energy facilities.[66] Following approval from the EMC, the NCDEQ "Final Report on the Consideration of Establishing a Regulatory Program for the Management and Decommissioning of Renewable Energy Equipment" was submitted to the General Assembly on January 15, 2021. The Final Report recommends no new rules for wind turbines, stating that "existing rules are sufficient to manage the end-of-life (EOL) equipment used in wind energy generation facilities."

Direct Financial Incentives. On December 27, 2020, the federal government implemented the first offshore wind specific Investment Tax Credit (ITC) as a part of a $1.4 trillion federal spending package alongside a $900 billion COVID-19 virus relief spending bill. The existing wind production tax credit (PTC) was extended by one additional year, and a new 30% investment tax credit was created for offshore wind ITC will benefit projects with construction start after 2016 through the end of 2025. Additionally, the December 31, 2020 IRS ruling has firmed up a 10-year Safe Harbor provision, enabling projects with construction start as late as 2025 (qualified by a "Physical Works Test" or the "Five Percent Safe Harbor") to apply the 30% ITC as long as the project reaches commercial operation before December 2035. This new program is expected to strengthen the offshore wind industry and also provide advantages to rate payers. North Carolina's energy policy landscape currently has no direct, energy-focused financial incentives applicable to the OSW industry. The North Carolina Renewable Energy Tax Credit program provided North Carolina businesses with a tax credit equal to 35% of the cost of eligible RE property constructed, purchased or leased by a taxpayer and placed into service in North Carolina during the taxable year. However, the state tax credit expired on December 31, 2016.

7.4.2 North Carolina Clean Energy Policy Options for OSW

A common characteristic among U.S. states seeking investment in development of offshore wind projects (and the associated supply chain) is the presence of state action incentivizing OSW deployment. Capital flows toward business and regulatory certainty and OSW developers and manufacturers are attracted to states that have both a high potential wind resource as well as a predictable and hospitable business environment.

The following menu of policy options includes a mix of best practices demonstrated by other states and new ideas that best take advantage of North Carolina's inherent strengths. These options focus on two critical themes that emerged in discussions with industry and North Carolina stakeholders as well as reviews of other states' actions:

- Expand the size of the opportunity for OSW – almost every state on the East Coast that has expressed interest in OSW has moved to stake out a market capacity target of some sort and then worked to make it as concrete as possible with portfolio requirements, guaranteed procurements or other mechanisms. Industry decisionmakers consider these market markers in the form of policy actions, business incentives, and economic development opportunities when making job creation and capital investment commitments. As already noted, additions to expand the OSW energy market in North Carolina have the dual benefit of expanding the total east coast market opportunity (making the U.S. market more attractive to foreign wind companies), as well as shifting the mid-point of market opportunity down the East Coast and closer to the North Carolina labor market and industrial suppliers. North Carolina's large electricity consumption relative to other Atlantic Coast states, continuing trends toward electrification of transportation and other possible increases in energy demand, and the state's growing appetite for clean energy to replace existing fossil-based energy supplies all indicate a large potential for offshore wind to meet

[65] Executive Order No. 11, https://www.EO11 - Promoting Wind Energy Development.pdf (nc.gov), last accessed February 2021.

[66] Section 2.(d) of S.L. 2019-132 (H329).

the state's energy needs in coming decades. But the state needs to take steps to formalize its own "marker" for market potential to the OSW industry. While the target needs to be realistic, in some ways a larger goal is better, as the State can also work on the supply side by trying to accelerate existing WEA leases and even to add new WEAs to federal waters off North Carolina's coast.

- Remove barriers – the State needs to focus on barriers to wind energy deployment while supporting and enhancing its existing coastal economy (e.g., tourism) – particularly the transmission grid investments needed, and help finding a path to mitigate regulatory and community concerns regarding needed right-of-ways and permitting of infrastructure (and potentially to new WEAs).

Again, we believe that each of these options warrant further discussion and deliberation. Stakeholders and decision-makers are advised to carefully evaluate the implications of the below options—and the subsequent design and implementation of those options—in the regulatory and market context of North Carolina. Specific options are described below.

Prepare.

- *Designate a Formal Offshore Wind Point Person in NCDEQ [R6].* North Carolina already has taken the important step of designating an offshore wind point of contact in NCDEQ as the liaison to BOEM and the Interagency OSW Task Force and to represent North Carolina on the SMART-POWER initiative. To better facilitate the coordination of a unified state strategy that maximizes economic development potential, the State should formally recognize the OSW Point Person in NCDEQ in this role. This point person's role would include continuing their existing functions as well as working with the NCDOC OSW Director to ensure OSW issues are actively integrated into the programmatic work of NCDEQ's energy programs. NC DEQ's OSW point person would be responsible for participating in the OSW Economic Development Task Force, leading efforts to integrate OSW as a priority into the day-to-day work of the NCDEQ, and working with the state's business and university communities to pursue federal grant opportunities that facilitate OSW development. The NCDEQ OSW Point Person would focus on work with BOEM to accelerate the auctions for existing WEAs and to expand the number of NC-adjacent WEAs. They would also lead state efforts resulting from the SMART-POWER Agreement relating to energy policy and market collaboration.
- *Study Wholesale Market Reform Options and Ensure that Implications for OSW Are Considered [R7].* The state should support the NERP recommendation[67] to the General Assembly to direct the NC Utilities Commission (NCUC) to conduct a study on the benefits and costs of wholesale market reform and implications for the North Carolina electricity system. The study should be specific in including the potential implications of improved wholesale market access for OSW developers including whether improved access to regional wholesale markets creates stronger demand for electricity generation from coastal NC OSW projects, and in turn increases the speed of development and creates downward pressure on cost for projects developed in current or future NC WEAs.

Facilitate.

- *Accelerate Leasing of Existing WEAs in the Carolinas and Pursue Additional Area Designations [R8].* North Carolina should work with the SMART-POWER coalition, members of the three states' Congressional delegations, and BOEM to find ways to accelerate the lease auctions for the two Wilmington WEAs that have been identified to allow for development by 2030. North Carolina should seek to have BOEM conduct a lease auction and execute lease agreements for 2.5GW of OSW development of North Carolina's coast by 2022.
- The State should work with BOEM, the Department of Defense, the NC State Ports Authority, commercial shipping, fishing, and tourism interests, and other stakeholders to identify additional WEAs for leasing off the North Carolina coast. By adding additional defined opportunities for development (i.e. created by adding WEAs in the region), SMART-POWER can help to shift the critical mass of the overall OSW investment opportunity to the south and therefore create further rationale for locating industry investment in North Carolina. It is also essential to ensure the State has WEAs of sufficient scale to meet:
  - The needs of a large electricity consumption (9% of east coast states' electricity), that is likely to grow with decarbonization especially of transport
  - The goals in the North Carolina Clean Energy Plan of 70% reduction in power sector greenhouse gas emissions by 2030 and a carbon-neutral power sector by 2050, and
  - The growing demand for renewable energy from business and industry not least those manufacturing for offshore wind.

[67] North Carolina Energy Regulatory Process, Summary Report and Compilation of Outputs, December 22, 2020 as accessed online at https://deq.nc.gov/CEP-NERP , last accessed February 2021.

- *Remove Barriers to Investment in Grid Infrastructure [R9].* The state should work with the NCUC and the state's utilities to evaluate the results of the North Carolina Transmission Planning Collaborative study on transmission needs for OSW development and determine next steps based on the study results. The state should then work with the General Assembly and regulated utilities to develop draft legislation that addresses transmission infrastructure needs, addressing expedited siting, permitting for rights-of-way, and other measures to advance the grid investments in order to deploy this valuable energy resource. Additionally, the NCUC should agree with recent settlement agreements between Duke and other stakeholders that transmission congestion would be a "primary criterion" in future Grid Improvement Plan iterations.[68] This could be complemented with a stakeholder process to engender community support around transmission corridors for the infrastructure investments needed. Such a process could involve affected stakeholders early on to identify concerns and develop mitigation measures as well as providing information to stakeholders about the economic development and job creation impacts of OSW development.
- *Identify Permitting Steps for Onshoring Transmission and Land-based Infrastructure [R10]*. A number of states including New York and California are working to reduce permitting delays for OSW infrastructure. To accomplish a similar goal in North Carolina, NCDEQ could work with the Coastal Resources Commission (CRC), the NCDOA State Environmental Review Clearinghouse or other appropriate agencies to identify relevant onshore permitting requirements for offshore wind transmission and infrastructure projects under the Coastal Area Management Act (CAMA) and other regulatory authorities. NCDEQ could then evaluate whether barriers exist and whether modifications are warranted to facilitate or expedite permitting and rights-of-way for transmission and other grid infrastructure needed (e.g., substations), while protecting the environment. This study could be complemented with a stakeholder process to engender coastal community support for the infrastructure investments. Such a process could involve affected stakeholders early on to identify concerns and develop mitigation measures as well as providing information to stakeholders about the economic development and job creation resulting from OSW development. In addition, the Utilities Commission could fast-track the process for determining the Certificate of Public Convenience and Necessity for OSW-generated wind resource development and necessary transmission.[69]

Accelerate.

- *Adopt a Specific OSW Procurement Requirement {R11] and Mechanism [R12].* The North Carolina General Assembly should adopt an offshore wind procurement requirement, through either a clean energy standard, renewable portfolio standard or other appropriate legislative device and develop an appropriate procurement mechanism necessary to achieve the statutory OSW requirement. In developing the procurement mechanism, the General Assembly may consider elements to increase North Carolina jobs and economic development as well as reduce costs. Every state on the East Coast with a significant effort to attract OSW investment and development has a target for OSW deployment, either by set by executive action or as a part of legislated energy policy like an RPS set aside. As noted by Duke Energy in its 2020 IRP filing, wind (particularly offshore) is a potentially valuable resource in the Carolinas because it complements solar generation and improves resource diversity for achieving various carbon reduction goals.[70] Setting a significant state requirement would strengthen OSW industry interest in North Carolina and enable development of a strategy to ensure that North Carolina continues to diversify its energy resource mix. The legislation could also direct a study regarding the potential use of North Carolina content requirements as a part of the utility procurement. Such a study could also look at a SMART-POWER regional content requirement.
- *Create More Opportunity for OSW Capacity Expansion through Decarbonization Efforts [R13].* Under the auspices of the Clean Energy Plan, two stakeholder-informed study groups (the A-1 Decarbonization group and the B-1 NERP group) examined various options to decarbonize the state's electricity mix. Options under consideration include an explicit asset retirement mechanism for coal plants, mechanisms to increase the relative cost of coal (and natural gas generation) like carbon pricing or joining the Regional Greenhouse Gas Initiative (RGGI),[71] or creating an expanded renewable portfolio standard or a new, broader clean

[68] See the last sentence of Section III of each of these settlements: https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=8beee01d-5e38-4032-9c6e-482fcfdccba0 and https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=2d59661b-3d53-43d0-965f-82eb2db1c0d0, last accessed February 2021.

[69] CEP, p.108

[70] Duke Energy's 2020 Integrated Wind Resource Plan September 18 Technical Briefing, https://www.duke-energy.com/_/media/pdfs/our-company/irp/duke-energy-2020-irp-technical-briefing.pdf?la=en, last accessed February 2021.

[71] The Regional Greenhouse Gas Initiative is a regional carbon credit trading program. More information is available at https://www.rggi.org/, last accessed February 2021.

energy standard. All of these options would have the effect of removing generation capacity currently supplied by coal-based energy plants, creating room within the state's portfolio for new capacity from lower carbon options. Other factors, like the potential for greater job and economic development benefits resulting from the OSW supply chain, and the usefulness of OSW to help balance out the state's significant solar portfolio should also be considered when evaluating the results of these studies. The latter two options, the RPS and CES, could also include specific carve-outs for OSW which could be an implementation mechanism for the above recommended state OSW requirement, thereby increasing the defined opportunity for OSW, as it is an emerging technology that needs to achieve economies of scale to help drive down cost.

7.5 Workforce Skills and Needs for OSW

Workforce is one of the biggest challenges that confronts any major industry or employer looking to open or locate in a new area. Much like the policy discussion, OSW workforce needs are split into two main categories – (1) traditional manufacturing jobs for the supply chain and (2) construction, operation and maintenance jobs for the windfarms themselves. The workforce skills needed are different for these categories, but North Carolina has both a reputation as a leading manufacturing state and a vast coastal economy that already supports a significant and varied workforce.

On the supply chain side, North Carolina's existing workforce infrastructure is both appropriate to the need and unmatched in its effectiveness. Most recently, Site Selection Magazine recently ranked North Carolina's workforce development culture as the best in the region.[72] As the presence of the supply chain in the state grows, more customized training and education of the workforce needs to grow accordingly. North Carolina's workforce system is well situated to accommodate this growth as it comes. The robust program offerings available are detailed below.

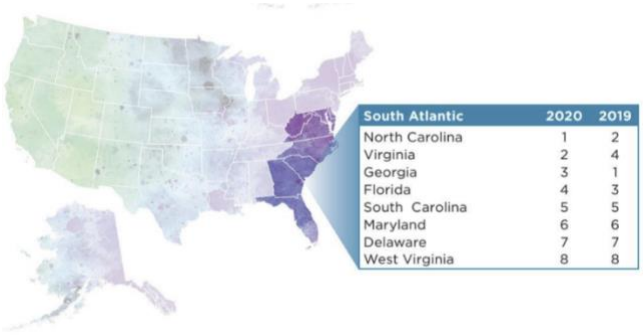


Figure 43 Regional Workforce Development System Rankings (*Site Selection Magazine*, January 2021)

Employment in the construction, operation and maintenance side of the OSW industry covers a wide array of technical, scientific and trade-related skill sets. As North Carolina WEAs are leased and developed, the preparedness of North Carolina's workforce is critical for those seeking to deliver lower labor costs and higher quality skill sets to wind developers and operators. It is critical to be ready for this need as it emerges over several years by determining the credentials and industry standards necessary, or to adapt established practices to the extent required, in order to create the workforce as the opportunity emerges with the development of North Carolina WEAs. Because the OSW industry is new to North Carolina (and all of the East Coast), the state should look more established markets in Europe and work closely with industry to identify their talent needs. Most of this report's workforce recommendations look toward North Carolina being ready for this job creation opportunity in a few years when the opportunity becomes tangible. The State should immediately work to understand the job skills that will be needed and then, in conjunction with its partners in the SMART-POWER agreement, work to develop wind-specific training options that draw upon existing strengths in the regions' maritime and construction industries to begin developing the first generation of American wind technicians for offshore development.

[72] Mark Arend, "The 2021 Regional Workforce Development Rankings," *Site Selection Magazine (Digital Edition), January 2021, https://siteselection.com/digitalEdition/2021/jan/, last accessed February 2021.*

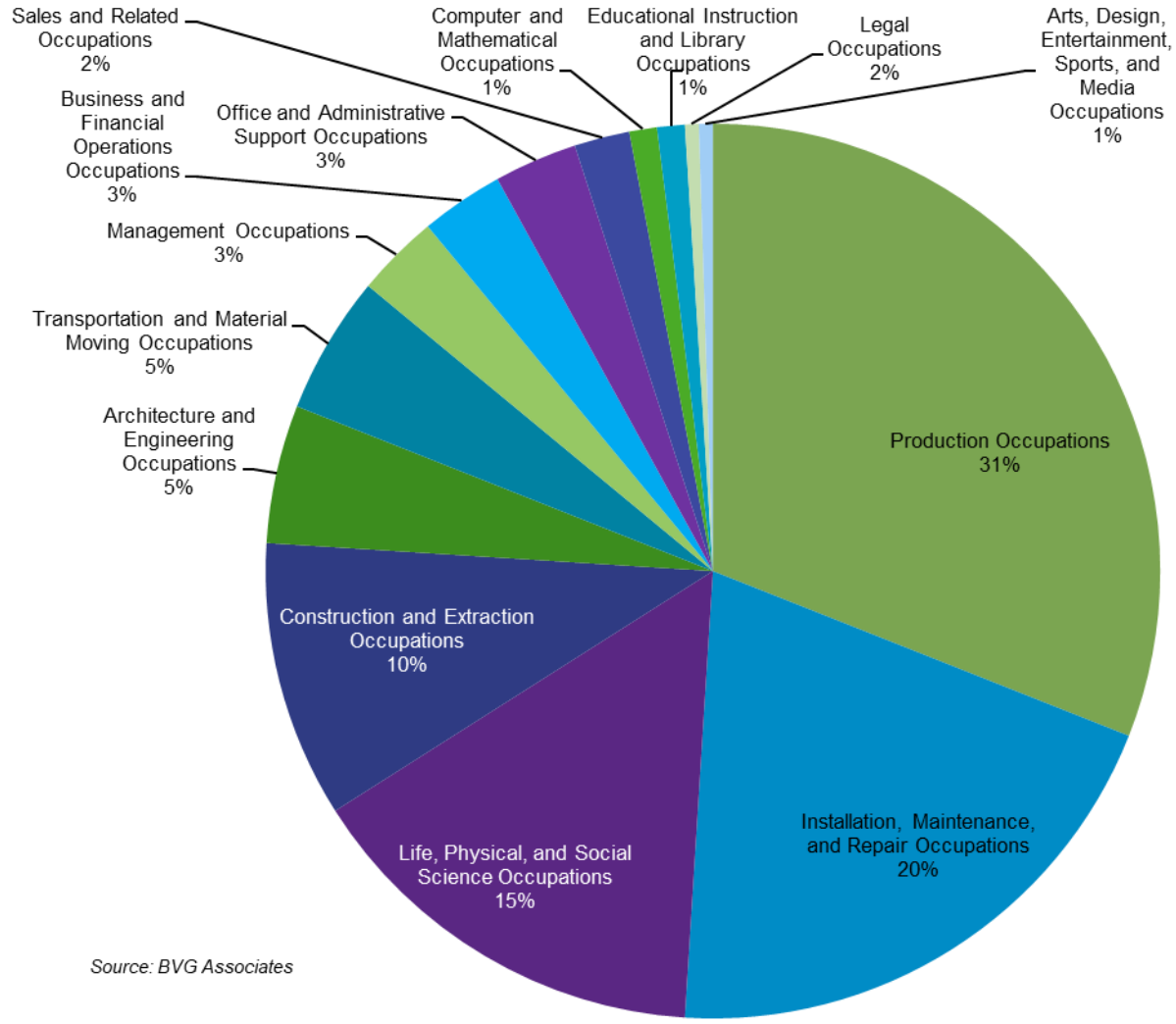


Figure 44 Breakdown of occupations in the total offshore wind supply chain

7.5.1 OSW Workforce Skills Requirements

Manufacturing for Supply Chain. North Carolina is well positioned and resourced to work with individual companies to identify skill needs and to help recruit and train the needed employees though existing programs in the state's community colleges and other traditional training providers .According to 2019 Bureau of Economic Analysis data for gross domestic product (GDP) by state, North Carolina has the fifth-largest manufacturing GDP in the US, behind only California, Texas, Ohio, and Illinois, all of which have larger populations than North Carolina. Additionally, North Carolina's manufacturing GDP is well ahead of all the US east coast states. North Carolina's total GDP is the seventh-most manufacturing intensive, well ahead of the US average, and well ahead of all the US east coast states. Skills for manufacturing OSW components will vary significantly depending on the item in question, but North Carolina's existing manufacturing base for the automotive industry is a reasonable analog – the state is one of the largest suppliers of components to the automotive industry.

Construction, Operation and Maintenance for Windfarms. North Carolina has an established history in workforce development for the maritime industry, with the coast shaping a unique and important segment of the state's economy. Historically the maritime workforce has been dominated by seafood and commercial fishing opportunities, access to global markets through shipping and transport, and tourism and recreation. The northern coastal region also supplies significant workforce to the defense industries in Hampton Roads, Virginia.

Many specific OSW requirements for safety protocols, welding, maritime, composites, general manufacturing,

CNC machining[73] and six sigma/lean manufacturing are already available through multiple North Carolina workforce development agencies and community colleges, but these requirements need to be better understood and the providers need to be surveyed to match their offerings and to identify any gaps. These organizations can adapt their existing programs to improve utilization of many existing education and training programs by integrating OSW training modules into existing 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 first step would be to work with these providers to match their program offerings to the detailed OSW requirements.

Direct Jobs Created by an OSW project. 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 45.

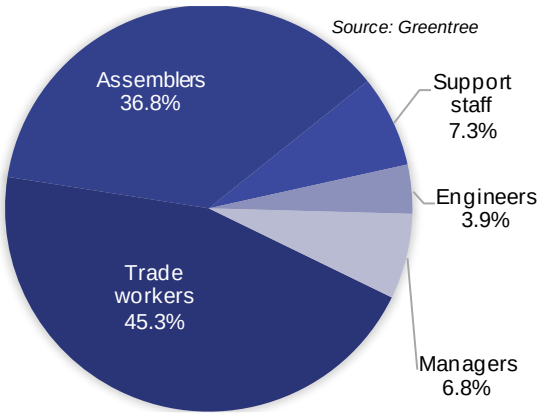


Figure 45 Breakdown of directly employed workers by job type in OSW.

Although many of the trade and assembler positions will require technical or industry certifications, *North Carolina's coastal workforce is likely well equipped to accommodate the OSW industry needs. In many cases, the skills of North Carolina'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 North Carolina 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 13direct workforce FTE requirements are estimated for a range of project activities.

Table 13 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**

[73] CNC machining is a manufacturing process in which pre-programmed computer software dictates the movement of factory tools and machinery. The process can be used to control a range of complex machinery, from grinders and lathes to mills and routers. With CNC machining, three-dimensional cutting tasks can be accomplished in a single set of prompts. Short for "computer numerical control," the CNC process runs in contrast to — and thereby supersedes — the limitations of manual control, where live operators are needed to prompt and guide the commands of machining tools via levers, buttons and wheels. To the onlooker, a CNC system might resemble a regular set of computer components, but the software programs and consoles employed in CNC machining distinguish it from all other forms of computation. From, https://astromachineworks.com/what-is-cnc-machining/#:~:text=CNC%20machining%20is%20a%20manufacturing,lathes%20to%20mills%20and%20routers, last accessed February 2021.

* 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 windfarm, 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 the 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.

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

Safety Training. North Carolina workers will need to be trained to work offshore, which requires additional levels of safety training beyond land-based positions. Most employees 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. North Carolina has a well-established network of OSHA safety training providers.
- STCW safety training is required for all seagoing personnel. 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.
- 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.

Technical training. Other critical skill sets include certified welders, cutters, solderers and brazers for marine and non-marine settings to produce, construct and repair equipment and structures built with steel. CNC machinists will also 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.

For blade manufacturing, 75% of the 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.

In general, quality control (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 specifically in weld inspection. OSW activity should provide an opportunity for 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.

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.

7.5.2 NC Workforce Demographics

Highly educated and skilled workers cost less in the Tar Heel State. A Right-to-Work state, North Carolina boasts an impressive array of vocationally trained workers and those with advanced degrees. Our pool of 460,000+ manufacturing employees is the largest in the region, and our talent pipeline consists of roughly 140,000+ postsecondary degree and certificate recipients each year.

7.5.3 NC Workforce and Training Landscape

Workforce development in North Carolina is delivered through numerous programs administered by various state and local agencies under the authorization of several key pieces of legislation (see Figure 29). These workforce development programs are designed to support the regional and state economy by creating, training and when necessary retraining a robust workforce to match the needs of the state's businesses and institutions.

Table 14 Landscape of Workforce Development in North Carolina.

Laws	Carl D. Perkins Career & Technical Education Act	Workforce Innovation and Opportunities Act (WIOA)	Wagner-Peyser Act
Programs	Secondary and Post-Secondary CTE Programs	WIOA Adult, Youth & Dislocated Worker Programs	Employment Service Program
State Agencies	NC Department of Public Instruction NC Community College System	NC Works Commission NCDOC Division of Workforce Solutions NC Community College System	NC Works Commission NCDOC Division of Workforce Solutions NCDOC Division of Employment Security
Local Agencies	School Districts Community Colleges	Career Centers Local Area Workforce Development Boards	Career Centers Local Area Workforce Development Boards

Workforce Strategy Coordination. State-level post-secondary workforce strategy for industry is primarily coordinated by NCDOC through the NCWorks Commission and at the local level by twenty-three (23) local area workforce development boards (WDBs) serving the state's eight (8) EDPNC Prosperity Zones throughout North Carolina.

- *NCWorks Commission.* The NCWorks Commission recommends policies and strategies that enable the state's workforce and businesses to compete in the global economy. The Commission is designated as the state's Workforce Development Board under the federal Workforce Innovation and Opportunity Act. Led by a private sector chair, the 33-member Commission includes representatives from the business community, heads of state workforce agencies, educators, and community leaders. All members are appointed by the Governor. The Commissions' mission is to ensure North Carolina has an innovative, relevant, effective, and efficient workforce development system that develops adaptable, work-ready, skilled talent to meet the current and future needs of workers and businesses to achieve and sustain economic prosperity; and to ensure North Carolinians are ready for the jobs of today and tomorrow by increasing access to education and skills training, fostering employer leadership to prepare workers, and supporting and scaling local innovation.
- *Local Workforce Development Boards.* WDBs work collectively to plan, coordinate, oversee, and deliver workforce solutions through the NCWorks system. Local Workforce Development Boards are the conveners of the workforce system on a local level in the state of North Carolina. They are business-led and supported by local elected officials. The Boards are charged with bringing together industry, education, labor, community, government, and other stakeholders in workforce to develop demand-driven strategies connected to regional economies and labor markets.
- *NC Prosperity Zones*. The State of North Carolina operates eight administrative regions known as Prosperity Zones. Each Zone features a one-stop, physical location, providing citizens and businesses the ability to interact with representatives from multiple state agencies, as well as to encourage better collaboration between the agencies themselves. The state deploys subject matter experts in each Zone, from transportation and environmental topics to workforce development, community planning and liaisons to existing businesses in the Zones.

The WDBs have developed demand-driven, market-oriented sector strategies to ensure that North Carolina's workforce development programs align cohesively with the various targeted industry clusters germane to their local and regional economic development organizations. Most of the local area WDBs include the catch-all advanced manufacturing as a highly desirable strategy, given North Carolina's proud history and national acclaim for its prowess in legacy commodity manufacturing. Offshore Wind Supply Chain and Infrastructure operations/employers offer a wide array of potential employment and training opportunities for these WDBs. As the needs of the OSW community, whether related to manufacturing or the construction, development and operations side of the industry, are better understood by the WDBs and NCDOC, they can work with the state's local career centers, local Community Colleges, the UNC System, and other related service providers to meet their needs, as evidenced in this excerpt below from the 2019-2021 NC Works Commission Strategic Plan.

"After extensive stakeholder work and programmatic reviews, the following system wide goals and objectives were created for the workforce development system:

- Prepare workers to succeed in the North Carolina economy by increasing skills and education attainment.
- Create a workforce system that is responsive to the needs of the economy by fostering employer leadership.
- Promote replication of creative solutions to challenging workforce problems by supporting local innovation.
- Promote system access, alignment, integration, and modernization."

Additionally, influential non-profit organizations like *myFutureNC*[74], a statewide nonprofit organization focused on educational attainment, also provide guidance to state workforce strategy. myFutureNC, the result of cross-sector collaboration between North Carolina leaders in education, business, and government, is working across sectors and in communities throughout the state to close gaps in postsecondary attainment, promote alignment between educational programming and business/industry needs and ultimately improve the quality of educational opportunities for all North Carolinians. The organization seeks to confer two million post-secondary credentials by the year 2030 via an aggressive, comprehensive statewide strategic plan that has been enthusiastically endorsed and adopted by dozens of local, regional and state partners in academia, business and government. This effort can be a natural ally to any existing or new industry clusters that generate job opportunities across a wide spectrum of skill sets and disciplines. OSW supply chain and infrastructure training needs and job creation can be facilitated and capitalized upon by these dynamic, local/regional/ statewide public private partnerships.

[74] myFutureNC, https://www.myfuturenc.org/, last accessed February 2021.

Workforce Training Providers. Many entities make up the landscape of training providers in the state. Assistance is delivered by NC Works and the Division of Workforce Solutions in conjunction with the local WDBs, Career Centers and the Community College System along with many others. The NC Works Commission and the NCDOC Division of Workforce Solutions coordinate statewide interaction to ensure cooperation and coordination, and concomitant avoidance of duplication, across jurisdictional boundaries. The Community College System Office does the same for the state's 58 local community colleges.

- *NCWorks*. NCWorks is North Carolina's workforce system. Job seekers can search for jobs, create resumes, and find education and training. Employers can find candidates, post jobs, and search labor market information.
- *Division of Workforce Solutions (DWS)*. DWS helps North Carolina's job seekers find employment and businesses find workers. DWS offers services for adults, veterans, youth, and more and helps employers find the qualified talent they need to make their businesses thrive. To maintain the quality of all those services, DWS trains the state's workforce professionals. They operate NCWorks Online, the state's official job-search portal that is helping connect talented individuals with employers. Their funding comes from the Workforce Innovation and Opportunity Act, the Wagner-Peyser Act, and the Trade Adjustment Act, as well as special grants.
- *Local Workforce Development Boards.* WDBs deliver workforce solutions through the NCWorks system. Boards help people and businesses across the state gain access to programs and services that make North Carolina one of the most skilled, productive, and motivated workforce systems in the nation. They oversee local *NCWorks Career Centers* in partnership with the NCWorks Commission and Division of Workforce Solutions to deliver workforce solutions, assist job seekers with improving their skills and finding jobs, and help businesses develop a qualified workforce.
- *NC Community College System.* North Carolina's system of community colleges – the Nation's third largest – serves 700,000 students a year with associate degree programs, university transfer programs, short-term workforce training, high-school dual enrollment, career and technical education and adult basic education. The NC Community College System and its 58 constituent members all maintain a current, up to date catalogue of both curriculum programs leading to associate degrees as well as the various certificate and occupational skills credential offerings both of which will be highly relevant to the needs of OSW Supply Chain and infrastructure employers.
- *N.C. Universities*. North Carolina boasts 53 colleges and universities, including 17 public universities. The state is home to top-tier research universities like Duke University, the University of North Carolina at Chapel Hill, North Carolina State University, and North Carolina A&T. Numerous esteemed private colleges, including Wake Forest University and Davidson College, are also located in the state. Across the system, multiple technical degrees are offered in renewable energy specific areas, as well as critical OSW-related technology research fields.
- *Targeted Centers and Programs*. Many specialized centers and programs exist in the UNC System, the NC Community College System and as stand-alone non-profit organizations in the state that can help with advanced skills and industry specific needs. Some key resources include:
- *Golden LEAF Foundation.* The Golden LEAF Foundation, a North Carolina grant-making organization, can provide support to help a company train and develop a skilled workforce. Golden LEAF supports projects that help close the skills gap and increase the pool of highly qualified people in a North Carolina community, both now and in the future. The foundation funds projects that demonstrate a market demand for skilled workers and aim at developing skill sets required by businesses looking to locate or expand in a North Carolina rural community.
- *Industry Expansion Solutions (IES).* IES is an engineering-based, solutions-driven, client-focused unit of NC State University. IES works with industries across North Carolina to provide solutions to assist in strategic direction, improve performance and processes and address top line growth. Programs include assistance for Continuous Improvement, Evaluation and Assessment, Growth and Innovation, and Health and Safety. A full list of solutions and training programs is available in the IES website.[75] IES is also the lead agency for the NC Manufacturing Extension Partnership (NCMEP).[76]
- *North Carolina Military Business Center (NCMBC).* NCMBC is a statewide business development and technology transition entity of the North Carolina Community College System, headquartered at Fayetteville Technical Community College (FTCC). The mission of the NCMBC is to leverage military and other federal business opportunities to expand the economy, grow jobs and improve quality of life in North Carolina. NCMBC can help link companies to transitioning military veterans seeking employment

[75] IES website, https://www.ies.ncsu.edu/solutions/, last accessed February 2021.

[76] NC Manufacturing Extension Partnership, https://www.ncmep.org/, last accessed February 2021.

and provide training for companies looking to work with the state's vast military community.

- *University Energy Centers (UECs).* Over the last 30 years, the State has created three University Energy Centers – the NC Clean Energy Technology Center (NCCETC) at NCSU, the Center for Energy Research and Technology (CERT) at NC A&T, and the Appalachian Energy Center (AEC) at Appalachian State University. These three UECs have a long history of being funded by the State through the State Energy Program (now in NC DEQ) to function as a *de facto* University Extension Service for energy issues – the "hands and feet" of the State Energy Office for implementation of policies and programs. The UECs provide unbiased technical support to public and private sector interests regarding the use of clean energy, including renewable energy, energy efficiency, and alternative transportation, as well as enabling technologies like "smart" grid and energy storage. The Centers leverage their state support to secure federal grants and other resources that allow them to maximize their impact in support of NC economic development and job creation goals.

7.5.4 Industry Incentives and Program Assistance for Workforce Training and Recruitment

Employee Recruiting & Screening. Every local area Workforce Development Board has on its staff a director of business services whose responsibility includes constantly monitoring the demands of the existing employer base in their respective labor shed as well as to participate in new and expanding industry recruitment with local and state economic developers. This team of specialists can access all available client populations to include dislocated workers, under-employed current workers, separating military personnel, and both adult and youth cohorts who qualify for participation under the federal Workforce Innovation and Opportunities Act (WIOA). Client referrals from a host of statewide partner organizations include the NC Military Business Center run under the auspices of the NC Community College System office that work to establish resource and referral service both for separating Veterans as well as spouse employment for members of the military still on active duty. The NCDOC Division of Employment Security (DES) maintains active databases for those individuals exhausting their Unemployment Insurance benefits and need job search assistance in re-establishing employment in demand-driven, growth-oriented industries.

NCWorks Career Centers can provide job applicant screening and qualified candidate referrals, up-to-date labor market facts and projections (such as wages), information on tax credits for hiring particular groups of workers, space to conduct job interviews and help arranging job fairs. These services are offered at no cost to businesses.

In addition to the WIOA funded employee outreach and engagement efforts, the 17-member UNC System and 36-member NC Independent Colleges and Universities all maintain active and effective Career Development Centers whose primary goal is to seek and secure gainful employment for the graduates of their respective institutions. These units are staffed by employment and career specialists who are adept at connecting their alumni as well as their existing undergraduate and graduate students with employment opportunities that can and do include internships, co-op programs, externships and capstone projects that employers can access with ease.

Customized Training Program. The Customized Training Program provides education, training and support services for new, expanding and existing business and industry in North Carolina through community colleges, serving all 100 counties of the state. Training experts work closely in partnership with employers to tailor programs to meet specific needs. The goal of Customized Training is to foster and support three key aspects of a company's well-being: Job Growth, Technology Investment, and Productivity Enhancement.[77]

On-the-Job Training Program. On-the-Job Training provides North Carolina a means to expand and enhance workforce service delivery to the State's citizens. Through OJT, a wage reimbursement incentive may be provided to a business to help offset the cost of training a new employee with limited skills. Wage reimbursement ranges from 50 to 75 percent, depending upon the size of the business, with the higher percentage for businesses with up to 250 employees. OJT contracts are limited to the time required for the employee to become proficient in his/her job, not to exceed six months. Prior to hire, an individualized training plan is developed with the employer that will allow the new employee to gain the required competencies.

Incumbent Worker Training Program. The Incumbent Worker Training Program is designed to support training needs, whether a firm is creating jobs, investing in new machinery and equipment, or streamlining processes for efficiency. Incumbent Worker Training Program resources may support training needs assessment, instructional design, development and delivery. Incumbent Worker Training helps offset the cost of training employees who have worked for a business consistently for six months or more. Training should lead to an increased skill level, so that employees can be promoted, and the employer can backfill opportunities for less skilled or experienced employees. The business must participate in the cost of the

[77] Job Growth, Technology Investment, and Productivity Enhancement, https://www.nccommunitycolleges.edu/customized-training, last accessed February 2021.

training, through cash payments or in-kind contributions, based upon the size of the company.

Golden LEAF Economic Catalyst Grant Program. The Foundation's Economic Catalyst grant program includes a category that supports workforce development, with funding to help with the delivery of training programs offered by eligible entities, typically the local community college. Golden LEAF funds are usually used for acquisition of training equipment or construction/renovation of space needed to provide the training. Training must be available to the public and be for transferable skills. Golden LEAF funds may be used in conjunction with, but not to displace training funds available through other sources such as the NC Community College System. When Golden LEAF funds are used for costs associated with job training, Golden LEAF will typically require evidence of an inducement agreement demonstrating that the company is obligated to meet the job creation projections and wage goals, and providing appropriate consequences should the company fail to satisfy its obligations; however, Golden LEAF usually does not require a claw back specifically for the Golden LEAF grant funds.

NCWorks Local Innovation Fund. The NCWorks Local Innovation Fund supports efforts by communities across North Carolina to meet workforce challenges through a competitive grant process. As part of the state's NC Job Ready initiative, the $2 million fund finances grants to communities to pilot innovative programs or adapt and replicate successful program models that address local or regional workforce issues. The fund supports projects that do one or more of the following:

- Address an underserved community or population currently disconnected from the education and workforce system
- Bring together diverse community organizations
- Increase educational attainment, and
- Develop talent pipelines for in-demand, high-wage occupations.

To be eligible for grants, community teams must include the local workforce development board and should also include education, community, labor and business leaders. Two types of grants have been made available:

- One-year "capacity grants" of up to $100,000 to assist communities that need additional capacity building to strengthen partnerships, identify community needs and resources, and build local support; and
- Two-year "implementation grants" of up to $400,000 to assist communities that already have a collaborative team and an innovative idea ready for implementation, and have built the local support needed to be successful.

The Local Innovation Fund is an initiative of the NCWorks Commission, while the Division of Workforce Solutions within the N.C. Department of Commerce helps administer the fund.

Work Opportunity Tax Credit (WOTC). The Work Opportunity Tax Credit (WOTC) is a federal tax credit available to employers who hire individuals from eligible target groups who are qualified for positions but face significant barriers to employment. In North Carolina, the Commerce Department's Division of Workforce Solutions administers WOTC and determines eligibility for the target groups. The size of tax credit which employers can claim depends upon the target group of the individual hired, the wages paid to that individual in the first year of employment, and the number of hours that individual worked. A business can receive from $1,200 to $9,600 for each eligible employee.

Veterans Programs. Home to nearly 800,000 veterans and several major military installations, North Carolina has a distinguished history in serving the U.S. military, veterans, and their families. The Division of Workforce Solutions provides job seeker services for veterans, transitioning service members, and eligible spouses at the NCWorks Career Centers throughout the state. The majority of these centers have specialized staff—all of whom are veterans—who provide the following services to veterans, in addition to the services provided to all job seekers:

- Assessment Interview
- Career Guidance Services
- Individual Employment Plan
- Staff-Assisted Job Search Activities
- Basic Staff-assisted Career Services

DWS also continues to work closely with veteran centric organizations in North Carolina such as the USO, Veterans Affairs, Triangle Veterans Association, and others. The DWS North Carolina for Military Employment (NC4ME) also hosts multiple hiring events throughout the year focused on veterans and transitioning service members. The NC4ME model excels at screening applicant resumes to match with industry requirements, then hosts initial interviews to facilitate the hiring process.

7.5.5 NC Workforce Recommendations for OSW

As discussed above, OSW workforce needs fall into two main categories – traditional manufacturing and construction, operation and maintenance for the windfarms themselves. The workforce suggestions are different for these categories, with manufacturing-side ideas focused on promotion and specific targeting of existing programs, while construction, operation and maintenance ideas focus on developing a clear understanding of needs, identification of existing training and gaps, and interstate collaboration to ensure coverage of industry needs while avoiding unsustainable duplication of offerings.

Prepare.

- *Conduct a job skills analysis [R34].* In consultation with the OSW industry (as identified by the NC OSW

Registry and other relevant industry groups), have the Board of Science, Technology & Innovation lead a job skills analysis for construction, operation and maintenance needs faced by the OSW industry. This analysis should include a literature review of any previous studies conducted in the U.S. or overseas. Coordinate with industry, trade organizations, and accrediting bodies like the Interstate Renewable Energy Council (IREC)[78] to support development of job task analyses (JTA)[79] for specific OSW-focused jobs.

- *Develop an inventory of industry-relevant training already available [R35].* Based on the job skills analysis, have the Board work with relevant stakeholders to identify existing public and private training options already available from N.C. community colleges and other training providers. Have special focus on existing training resources applicable to maritime safety and capability.
- *Promote the training opportunity to North Carolina. [R36].* Have the University Energy Centers partner with NCWorks to conduct seminars about offshore wind job creation for trade and business groups, high schools, vocational technical schools, colleges, and universities so that students, energy workers, and job seekers can train to work in the industry.
- *Promote the OSW training opportunity to the OSW Industry [R37].* EDPNC should develop additional collateral materials for workforce assistance and training available to the OSW industry. The materials should be shared with supply chain firms identified through the NC OSW Registry.

Facilitate.

- *Establish a Wind Energy Technician Training Program [R38].* In collaboration with industry and academia, design and establish a Wind Energy Technician Training Program at a coastal community college near the larger ports in conjunction with training programs at the state's existing University Energy Centers. The Program should coordinate existing and new workforce and innovation efforts to position North Carolina as a leader in offshore wind and to ensure equitable access to opportunities in this new and expanding industry for minorities and women. Programs should include relevant safety training programs; best-in-class wind turbine technician training programs; and a plan to establish pathways for North Carolina students and workers to enter the offshore wind industry.
- *Establish training partnership with the Mid-Atlantic Wind Training Alliance [R39].* As a part of SMART-POWER agreement, have the NC Community College System and the participants in the newly proposed *Wind Energy Technician Training Program* work with the State of Virginia and the Mid-Atlantic Wind Training Alliance partners (New College Institute, Centura College and the Mid-Atlantic Maritime Academy) to coordinate and offer industry-required certifications for wind project operations and long-term maintenance for the mid-Atlantic region.

Accelerate.

- *Provide funding for new infrastructure, equipment and curriculum [R40].* Support the expansion of programs by providing new infrastructure, equipment and curriculum development grants and funding for community colleges, University Energy Center workforce development programs and technical institutes that are specific to addressing the workforce needs for OSW. Funding could come from established workforce grant programs administered by the state or new appropriations to the UNC system and the NC Community College System.

[78] See the IREC website, "Credentials & Quality Assurance," https://irecusa.org/workforce-development/credentials-qa/, last accessed January 2021.

[79] A job task analysis (JTA) is a systematic process of determining a detailed job description, broken down into performance domains and tasks that define the job being performed. The detailed job description contains the duties and tasks required to perform the job, and the associated knowledge, skills and attitudes (KSAs). The results of a JTA study, among several purposes, include usage as a basis for developing or revising curricula for education/training programs designed to prepare individuals to do a job. In industries in which jobs change due to advancements in technology or other environmental factors, JTA studies are particularly useful in providing current descriptions of what people do in their jobs, and for enabling education/training institutions to prepare individuals to do those jobs. JTAs are traditionally used by secondary and post-secondary educators, business or industry trainers, government or military trainers, and test developers.

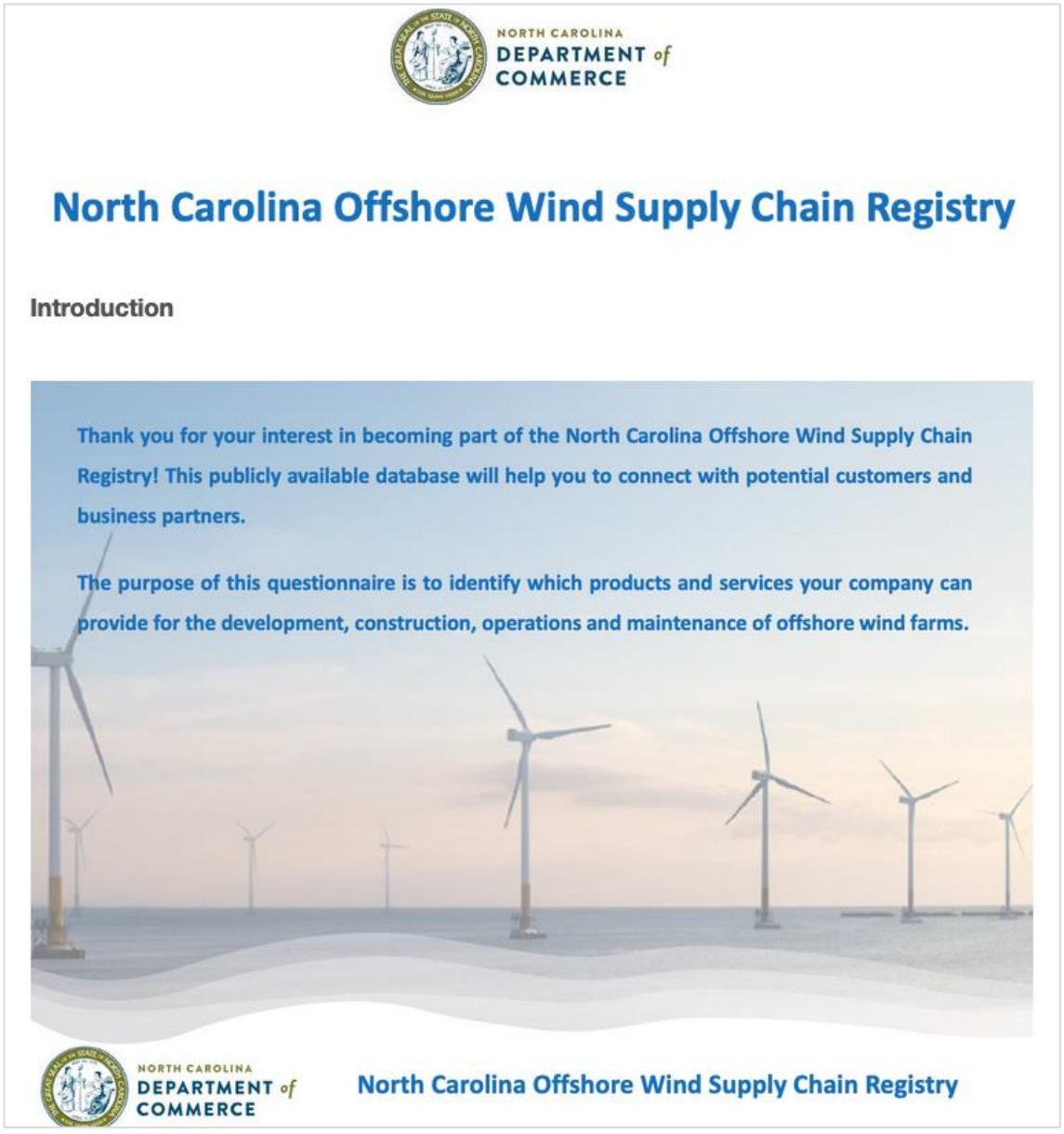
Appendix A- NC Supply Chain Registry Survey Layout and registry extract

Questionnaire background

The current database is structured as a user friendly 30 question online entry format. It provides a strong head start for North Carolina based companies looking for customers and partners, or global companies looking for local partners.

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

Questionnaire




NORTH CAROLINA
DEPARTMENT of
COMMERCE
North Carolina Offshore Wind Supply Chain Registry
The survey will take approximately 10 minutes to complete and covers the following areas:
- Basic company information
- Products and services categories
- Onshore and offshore energy experience
By clicking continue, you agree that the company information provided in this registry will be open to the public.
←
→
Survey Completion
0%
100%

The survey will take approximately **10 minutes** to complete and covers the following areas:
- Basic company information
- Products and services categories
- Onshore and offshore energy experience

By clicking continue, you agree that the company information provided in this registry will be open to the public.

1. Organization Name

2.
Website (optional)

3.
Company Bio (optional)

4. Contact

- [ ] Name
- [ ] Title
- [ ] Email
- [ ] Phone Number (please use international format, e.g. +1 for US)

5. Street Address

6. Postal Code

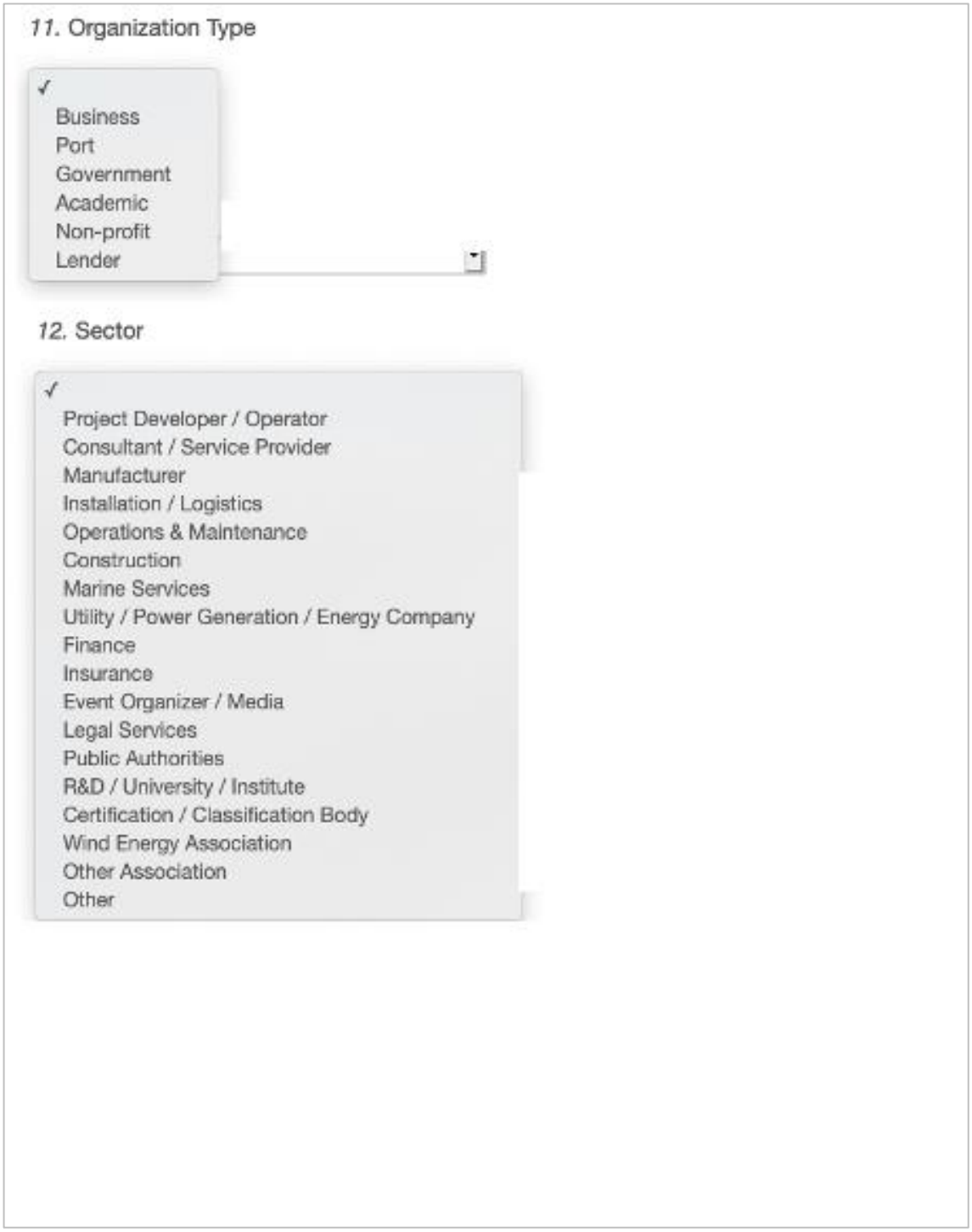
7. City

8. Country

9. State (if in US)

10.
Company Status (optional; multiple answers are possible)

- [ ] Minority Business Enterprise (MBE)
- [ ] Women Business Enterprise (WBE)
- [ ] Small Disadvantaged Business Enterprise (SDBE)
- [ ] Service-Disabled Veteran-Owned Business Enterprise (SDVOBE)
- [ ] Veteran-Owned Small Business (VOSB)


11. Organization Type
✓
Business
Port
Government
Academic
Non-profit
Lender
12. Sector
✓
Project Developer / Operator
Consultant / Service Provider
Manufacturer
Installation / Logistics
Operations & Maintenance
Construction
Marine Services
Utility / Power Generation / Energy Company
Finance
Insurance
Event Organizer / Media
Legal Services
Public Authorities
R&D / University / Institute
Certification / Classification Body
Wind Energy Association
Other Association
Other

13.

Please review the following supply chain categories and select the products/materials and services relevant to your company profile.
Multiple answers are possible.

- ☐ P01 Wind Power Production Equipment (PRODUCTS/MATERIALS)
- ☐ P02 Heat & Cooling Production Equipment (PRODUCTS/MATERIALS)
- ☐ P03 Hatches / Grids / Gates (PRODUCTS/MATERIALS)
- ☐ P04 Pumps and Compressors (PRODUCTS/MATERIALS)
- ☐ P05 Valves & Accessories (PRODUCTS/MATERIALS)
- ☐ P06 Pipes / Hoses / Filters / Gaskets etc (PRODUCTS/MATERIALS)
- ☐ P07 Generators (PRODUCTS/MATERIALS)
- ☐ P08 Transformers (PRODUCTS/MATERIALS)
- ☐ P09 Tower Structures / Poles / Accessories (incl Overhead Line Conductors) (PRODUCTS/MATERIALS)
- ☐ P10 Cables / Conductors / Cabinets / Accessories (PRODUCTS/MATERIALS)
- ☐ P11 SF-6 System and Accessories (PRODUCTS/MATERIALS)
- ☐ P12 High Voltage Equipment / Materials / Switches (>=1000V AC / 1500V DC) (PRODUCTS/MATERIALS)
- ☐ P13 Low Voltage Equipment / Materials / Switches (<1000V AC / 1500V DC) (PRODUCTS/MATERIALS)
- ☐ P14 Relay Protection Units (PRODUCTS/MATERIALS)
- ☐ P15 Control Stations / Systems / Network Information Systems (PRODUCTS/MATERIALS)
- ☐ P16 Metering / Instrumentation Equipment (PRODUCTS/MATERIALS)
- ☐ P17 Batteries / Emergency Power Generators / UPS (PRODUCTS/MATERIALS)
- ☐ P18 Building / Civil Construction Materials (PRODUCTS/MATERIALS)
- ☐ P19 Heating / Ventilation / Air Conditioning (HVAC) (PRODUCTS/MATERIALS)
- ☐ P20 Safety / Protection / Security / Fire Fighting Equipment (PRODUCTS/MATERIALS)

- [ ] P21 Transport / Material Handling Equipment (PRODUCTS/MATERIALS)
- [ ] P22 Workshop Equipment and Materials (PRODUCTS/MATERIALS)
- [ ] P23 Tools / Hand Tools (PRODUCTS/MATERIALS)
- [ ] P24 Transmissions and Hydraulic / Pneumatic Packages (PRODUCTS/MATERIALS)
- [ ] P25 Tanks / Vessels / Columns etc (PRODUCTS/MATERIALS)
- [ ] P26 Chemicals / Oils / Gases / Paints (PRODUCTS/MATERIALS)
- [ ] P27 Environmental Equipment / Products (PRODUCTS/MATERIALS)
- [ ] P28 Office Materials / Equipment (PRODUCTS/MATERIALS)
- [ ] P29 Computer / Telecommunication Equipment / Software (PRODUCTS/MATERIALS)
- [ ] P30 Lighting (PRODUCTS/MATERIALS)
- [ ] P31 Ports (PRODUCTS/MATERIALS)
- [ ] P32 Nacelle (PRODUCTS/MATERIALS)
- [ ] S01 Turnkey Project (Design / Procurement / Construction / Installation) (SERVICES)
- [ ] S02 Building & Construction Works (SERVICES)
- [ ] S03 Water / Sewage Construction Works (SERVICES)
- [ ] S04 Construction / Maintenance Services – Building (SERVICES)
- [ ] S05 Installation / Maintenance of Power Production Equipment (SERVICES)
- [ ] S06 Installation / Maintenance of Transmission / Distribution Equipment (SERVICES)
- [ ] S07 Installation / Maintenance of Utility Systems (SERVICES)
- [ ] S08 Consultants – Business & Technical (SERVICES)
- [ ] S09 Administrative Services (SERVICES)
- [ ] S10 Computer & Telecom Services (SERVICES)
- [ ] S11 Legal / Financial / Insurance Services (SERVICES)
- [ ] S12 Marine Services (SERVICES)
- [ ] S14 Other Installation / Mechanical / Maintenance Services (SERVICES)
- [ ] S18 Transport / Supply / Disposal Services (SERVICES)
- [ ] Enter the six-digit NAICS - North American Industry Classification System Code (2017) that best describes your company's main business operations:
  *NAICS (Primary)
  [ ]
- [ ] [ ] Other

14. Please list any available specialty manufacturing or installation equipment (e.g. steel rolling press and capacity). (optional)

15. Please list available facility laydown area in acres. (optional)

16. Please list available fabrication floorspace in sq. ft. (optional)

17. Does your company have any Onshore Wind experience?

- ○ Yes
- ○ No

17a. Please elaborate on Onshore Wind activity and/or project(s).

18. Does your company have any Offshore Wind experience?

- ○ Yes
- ○ No

18a. How many years of Offshore Wind experience does your company have?

18b. Please elaborate on Offshore Wind activity and/or project(s).

19. Does your company have any Offshore Energy (e.g. oil & gas) experience?

- ○ Yes
- ○ No

19a. Please elaborate on Offshore Energy (e.g. oil & gas) activity and/or project(s).

20. Does your company have any Maritime (e.g. shipbuilding or operation) experience?

- ○ Yes
- ○ No

20a. Please elaborate on Maritime (e.g. shipbuilding or operation) experience.

21. Does your company have a partnership with another company relevant to Offshore Wind that you would like to promote?

- ○ Yes
- ○ No

21a. Please elaborate on business partnership(s).

22. Please provide any additional information about your organization that would be relevant to the development, construction, operations and maintenance of Offshore Wind farms. (optional)

Registry extract:

Appendix B - Assessment of the Morehead City and Wilmington port area facilities/properties

This Appendix contains the detailed assessment of port area facilities/properties mentioned in section 6, including NCSPA-owned assets, privately held properties and selected ports/facilities located in other states. Assessments are provided for:

- Port of Morehead City (PMC)
- Radio Island
- Port of Wilmington (PoW)
- North Property
- Wilmington Business Park/Vertex property
- Raleigh Street property
- Eagle Island
- Sunny Point Military Ocean Terminal
- Southport/North Carolina International Terminal
- Manns Harbor
- Engelhard Business Park
- Swann Ferry Terminal, and
- Riverbulk Terminal

Table 15 Viable offshore wind uses for the Port of Morehead City.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

PMC was determined to not be within a viable distance for CTV or construction base/marshalling operations associated with the Kitty Hawk and Dominion windfarm projects. Additionally, interviews with PCSPA representatives have led to the determination of not viable for site availability for every offshore wind use.[80] This category largely discourages the viability of PMC in any capacity for offshore wind use. Site availability aside, the facility is determined to be most viable for SOV and manufacturing activities with a few potential quayside upgrades required to support manufacturing uses. The quay-side channel depth would need to be deepened to support the manufacturing of certain components and to support marshalling operations. The bearing capacity of the quayside would require upgrades to support manufacturing and marshalling operations.

Table 16 Viable offshore wind uses for Radio Island.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

Due to lack of existing quayside and upland infrastructure, Radio Island ranks as not viable in these two attributes, although there is potential for redevelopment to change this determination. Radio Island is currently available from the NCSPA for lease purposes, making the site rank viable for this category. The property is poorly situated to support CTV O&M operations but is potentially viable for SOV operations. Additionally, with upgrades to the upland and quayside facilities, the site is viable for the majority of OSW manufacturing use. Such upgrades would also make Radio Island viable to support construction base/marshalling operations associated with future BOEM Call Areas located off the Wilmington and South Carolina coast lines.

[80] The PCSPA representatives indicated that their preferred alternative for supporting the OSW was to utilize PCSPA-owned but not developed properties.

Table 17 Viable offshore wind uses for POW.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

POW was determined to not be within a viable distance for CTV, SOV or construction base/marshalling operations associated with the Kitty Hawk and Dominion projects. As with PMC, PCSPA representatives have indicated that their preferred alternative would be to utilize undeveloped PCSPA-owned assets versus utilizing the POW. This is partially due to existing US DOD contractual issues that require the PCSPA to reserve space for use during periods of emergency operations. Site availability aside, the facility is determined to be most viable for most manufacturing activities with a few potential quayside upgrades to support OSW uses. The facility's 212-foot air-gap restriction would make the property less viable for marshalling and certain manufacturing operations.

Table 18 Viable offshore wind uses for North Property.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This property is well located and has sufficient water-front space and uplands area to support many offshore wind uses, although it is located too far away from the Kitty Hawk and Dominion projects to support CTV, SOV and construction base/marshalling services. The property would require significant improvements including the construction of a robust relieving platform/quay side and upland staging areas. The facility's 212-foot air-gap restriction would make the property less viable for marshalling and certain manufacturing operations.

Table 19 Viable offshore wind uses for the Vertex property.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This property is well located to support sub-component (i.e., Tier 2 through Tier 4) manufacturing operations. As the facility has been utilized for these purposes in the past, it is anticipated that the bearing capacities of its soils would be sufficient to support the manufacturing of OSW components. In the event that Tier 1 components were manufactured at the property, a heavy-lift haul road would be required to allow access to a vacant river-side property to the west of the facility. The water-side facility has sufficient space to allow for an approximately 800-foot-long quayside. The facility's 212-foot air-gap restriction would make the property less viable for marshalling and certain manufacturing operations.

Table 20 Viable offshore wind uses for the Raleigh Street property.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This property is well located to support sub-component manufacturing operations. In the event that Tier 1 components were manufactured at the property, a heavy-lift haul road would be required to allow access to a vacant river-side property to the west of the facility. The water-side facility has sufficient space to allow for an approximately 800-foot-long quayside. The uplands soil bearing capacities would likely require upgrading to support OSW-related operations. The adjacent channel's 212-foot air-gap restriction would make the property less viable for marshalling and certain manufacturing operations.

Table 21 Viable offshore wind uses for Eagle Island.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This facility is well situated to support any of the OSW operations that could be implemented at the POW, Raleigh Street, North and Wilmington Business Park/Vertex properties. Ownership of the property would need to be acquired from the USACE. Due to the placement of on-site materials as part of CDF operations, significant work would be required upgrade the property's soil-bearing capacities. The facility's 212-foot air-gap restriction would make the property less viable for marshalling and certain manufacturing operations.

Table 22 Viable offshore wind uses for Sunny Point Military Ocean Terminal.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This facility is well-located, large enough and improved with infrastructure to support most OSW operations. However, there has been no indication provided that the US DOD would allow parts of the facility to be utilized for private operators to support OSW operations. The property would likely only be useful for manufacturing activities if the US DOD requires periodic shutdown of tenant operations during periods of munitions handling – this restriction would limit its use for CTV, SOV and marshalling operations, which require a much-more rigorous logistical model with no operational interruptions. The final rating of this property would be contingent upon the areas that the US DOD would consider to be allowed for redevelopment to support future OSW operations. This facility does not exhibit any air-gap restrictions.

Table 23 Viable offshore wind uses for Southport/North Carolina International Terminal.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

The location and area of this property are very-well suited to support any and all OSW-related operations with the exception of O&M and marshalling services for the Kitty Hawk and Dominion project. It had a long waterfront, and atypically for the properties evaluated as part of this project, a large and naturally elevated uplands area. The main challenges with this property are related to the complete lack of infrastructure and its distance from the Federal channel. Further, previous NCSPA development plans were thwarted by public opposition.

Table 24 Example potential CTV facility - viable offshore wind uses for Manns Harbor.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This property could be redeveloped to support SOV operations associated with the Kitty Hawk and Dominion projects. However, the property exhibits an air-gap restriction and would require dredging.

Table 25 Example potential SOV facility - viable offshore wind uses for Engelhard Business Park.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This property could also be redeveloped to support SOV operations associated with the Kitty Hawk and Dominion projects. However, the property exhibits an air-gap restriction and would require significant dredging and development of a quay side.

Table 26 Example potential SOV facility - viable offshore wind uses for Swan Ferry Terminal.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											
Site Availability											
Quay Load Bearing Capacity (psf)											

This property could also be redeveloped to support SOV operations associated with the Kitty Hawk and Dominion projects. However, the property exhibits an air-gap restriction and would require significant dredging and development of a quay side.

Table 27 Riverbulk Terminal.

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Acreage											
Quayside Length (Actual)											
Quayside Length (Potential)											
Channel Depth											
Air Draft Restriction											
Distance to Kitty Hawk/ Dominion LAs (nm))											

Attribute	CTV	SOV	Construction Base	Blade Manufacturing	Generator Manufacturing	Nacelle Assembly	Tower Manufacturing	Monopile Foundation Manufacturing	Jacket Foundation Manufacturing	Gravity Base Foundation Manufacturing	Submarine Cable Manufacturing
Site Availability											
Quay Load Bearing Capacity (psf)											

Located in Edenton, North Carolina, this is a privately-owned, 50-acre industrial site with heavy-lift-capable, water-front infrastructure located on the Chowan River. With its existing quay side, 100,000-square foot building, crane pad and associated marine/industrial infrastructure, this facility is an excellent example of a privately-owned property that could be pivoted to OSW manufacturing of components. The facility's location on the Intercoastal Waterway and nearby highway system connects the facility to the other manufacturing and port facilities located in the region. Its maximum available water depth of 12-feet would limit the use of the property to the manufacturing on sub-components.

Appendix C - Summary of recommendations

This appendix brings together the recommendations from the whole report and is organized by the six recommendations of the Executive Summary.

#	Recommendation in Chapter	Report section	Section	Prepare, Facilitate, Accelerate
Solicit and attract "anchor company" suppliers to North Carolina, with a focus on major components				
1	Continue to understand who the major, experienced supply chain companies are and their location decisions and their timescales.	3	Summary	Prepare
2	Engage with major suppliers and consider using the support from an offshore wind specialist to provide introductions and help secure their interest.	3	Summary	Prepare
3	Actively support connectivity and industry information sharing across the whole OSW supply chain.	3	Summary	Facilitate
4	Actively support existing high-tier North Carolina based companies to pivot to the domestic OSW market, especially where they already have relevant skills and experience, or supply to the domestic onshore wind market.	3	Summary	Facilitate
5	Attract, with speed, determination and tenacity, the short list of high-tier anchor tenants to NC before they finalize their location plans elsewhere, where these play to NC strengths.	3	Summary	Accelerate
Define and accelerate North Carolina OSW project development strategy				
6	Designate a formal offshore wind point person in NCDEQ.	7	7.4	Prepare
7	Study wholesale market reform options and ensure that implications for OSW are considered.	7	7.4	Prepare
8	Accelerate Leasing of Existing WEAs in the Carolinas and Pursue Additional Area Designations.	7	7.4	Facilitate
9	Remove barriers to investment in grid infrastructure.	7	7.4	Facilitate
10	Identify permitting steps for onshoring transmission and land-based infrastructure.	7	7.4	Facilitate
11	Set an OSW deployment target for the State.	7	7.4	Accelerate
12	Create a specific OSW procurement mechanism.	7	7.4	Accelerate
13	Create more opportunity for OSW capacity expansion through decarbonization efforts.	7	7.4	Accelerate
Support the multi-state regional supply chain cluster, SMART-POWER, making it the easiest place for developers and suppliers to do OSW business in the southeast and mid-Atlantic regions				
14	Promote regional collaboration in policy development and supply chain development, working with counterparts in Virginia and Maryland to align offshore wind needs with regional business capacity, to help secure business opportunities for regional state partners.	7	7.3	Prepare
Enable and grow North Carolina's business opportunity				
15	Actively support existing companies in the transition to OSW supply from North Carolina	5	Summary	Prepare
16	Continue to promote and develop the NC Offshore Wind Supply Chain Registry	5	Summary	Prepare
17	Designate a North Carolina OSW Director for Economic Development.	7	7.3	Prepare
18	Create an OSW economic development team.	7	7.3	Prepare
19	Organize and facilitate a North Carolina OSW Industry Task Force.	7	7.3	Prepare
20	Establish year-round schedule of regular outreach events – virtual or in person.	7	7.3	Prepare

#	Recommendation in Chapter	Report section	Section	Prepare, Facilitate, Accelerate
21	Include “local benefit” considerations in future windfarm procurement mechanism, as some other States have done, to ensure that work will be delivered from NC.	4	Summary	Facilitate
22	Consider further integrating information about NC companies with wider US and global offshore wind databases, while keeping the platform accessible via North Carolina Department of Commerce website	5	Summary	Facilitate
23	Evaluate establishing or being part of a more advanced database, possibly in collaboration with Virginia and Maryland.	5	Summary	Facilitate
24	Organize “fact finding” visits to wind installations for local and state policymakers and business leaders.	7	7.3	Facilitate
25	Support research including public/private partnership development for OSW deployment.	7	7.3	Facilitate
26	Support public/private research collaboration for OSW advanced manufacturing and supply chain logistics.	7	7.3	Facilitate
27	Provide tailored coaching and mentoring to individual companies regarding OSW	7	7.3	Facilitate
28	Work with utilities to Enable Large Energy Users to Directly Access OSW Resources.	7	7.3	Facilitate
29	Assist existing and new anchor companies with access to market including securing appropriate sites, transport and port access	5	Summary	Accelerate
30	Create and fund a North Carolina Green Bank that can provide investment to support OSW firms.	7	7.3	Accelerate
31	Provide targeted incentive support to OSW-related firms.	7	7.3	Accelerate
32	Provide targeted incentive support for OSW innovation.	7	7.3	Accelerate
33	Reinstate and expand the Renewable Energy Equipment Manufacturer Tax Credit.	7	7.3	Accelerate
Enable and sustain North Carolina’s business opportunity through workforce development				
34	Conduct a job skills analysis.	7	7.5	Prepare
35	Develop an inventory of industry-relevant training already available.	7	7.5	Prepare
36	Promote the training opportunity to North Carolina.	7	7.5	Prepare
37	Promote the training opportunity to the OSW Industry.	7	7.5	Prepare
38	Establish a Wind Energy Technician Training Program.	7	7.5	Facilitate
39	Establish training partnership with the Mid-Atlantic Wind Training Alliance.	7	7.5	Facilitate
40	Provide funding for new infrastructure, equipment and curriculum.	7	7.5	Accelerate
Strengthen and promote existing infrastructure assets and key strategic properties				
41	Assess the competitiveness of an installation port along the southern North Carolina coast, as one input to the location of future lease areas off the coast.	4	Summary	Prepare
42	Assess further potential locations for OMS ports along the coast of North Carolina, as inputs the location of future lease areas.	4	Summary	Prepare
43	Evaluate developing Southport/North Carolina International Terminal Property: a 600-acre, North Carolina State Ports Authority (NCSPA) owned property that is one of the only potential “mega-port” facility locations on the US East Coast.	6	Summary	Prepare
44	Further explore using manufacturing sites next to CSX Carolina Connector at Rocky Mount for the manufacture of smaller components.	6	Summary	Prepare

#	Recommendation in Chapter	Report section	Section	Prepare, Facilitate, Accelerate
45	Further explore using the Port of Wilmington and Port of Morehead City facilities with NCSPA, allowing North Carolina earlier access to supply OSW projects.	6	Summary	Prepare
46	Educate and promote O&M Facility Opportunities. Work with owners and operators of such facilities to develop their offerings.	6	Summary	Prepare
47	Further explore developing Radio Island, adjacent to the Port of Morehead City, for manufacturing and staging of Tier-1 and lower tier sub-components.	6	Summary	Facilitate
48	Further explore developing the North Property and the Wilmington Business Park/Vertex Property for manufacturing and staging of Tier-1 components and for use as a construction base port.	6	Summary	Facilitate